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THE JOINT BROADCAST SERVICE SUPPORTING BOSNIA:

VALUE TO THE WARRIOR AND LESSONS LEARNED

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Preface

This research gave me the rare opportunity to build on past duties with the MILSATCOM Joint Program Office and the Air Force Communications Agency, and bridge the gap to my follow-on assignment at USEUCOM/J6. I am sure the knowledge and contacts developed will help me at EUCOM in many intangible ways in the years to come.

I wish to thank everyone who helped me out in this undertaking throughout its varied path. At the MILSATCOM JPO, I especially want to thank LCDR Pete Ayotte, USN (ret), for sponsoring this effort and critically reviewing the manuscript during his last week on active duty.

At USEUCOM, I cannot thank Maj Boronow, USAF, enough for providing much of the information and support for this research, including going into the office on Thanksgiving Day to help me collect a wide variety of documents. Also, thanks go out to CPT Susan Tungate, USA, who always backed up Maj Boronow when I needed more information.

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Finally, I will never be able to thank my wife, Lynne, and children, Michelle and Michael, enough for putting up with Daddy ignoring them for so long while writing this paper. They deserve to have more.

Abstract

The DOD is developing the Global Broadcast Service (GBS) to answer the warfighter's critical communications needs. It features high bandwidth, one-way broadcast of multimedia products to forward-deployed forces. As part of the proof-of-concept the DOD deployed the Joint Broadcast Service (JBS) to the EUCOM theater of operations to provide limited operational support to the UN peacekeeping effort in Bosnia-Herzegovina. The author developed criteria for evaluating the value of this operational support and used these criteria to determine the value of the video, data file, and streaming data products as of November 1996.

The initial effort was to provide Predator Unmanned Aerial Vehicle video to forward deployed commanders. The high impact nature of this capability was confirmed on at least two occasions demonstrating the potential for a very high value. However, the success of the peacekeeping mission provided few opportunities for this high value to be realized.

In contrast, due to the rapid deployment of JBS to support efforts in Bosnia, the concepts, software and tools necessary to effect the "Smart Push" and "Warrior Pull" themes of JBS/GBS for data files lagged far behind the video. As a consequence, the software and tools necessary to implement the information management concept of operations were not available in November 1996. This resulted in generally low usage,

impact and value to the user. The one exception was the distribution of large format imagery files to Tuzla, Bosnia-Herzegovina.

From the factors contributing to the assessed value, the most critical lessons learned become apparent. These lessons are the need for software and tools to implement the theater CINC's information management concept and the need to integrate JBS sites with Local Area Networks, Defense Information Systems Network and allied systems. Additional lessons learned include the need for improved implementation, operations and maintenance strategies, and recommendations for future products to broadcast via JBS/GBS.

Chapter 1

Introduction

In 1996, the DOD rapidly integrated key commercial technologies to deploy a high bandwidth communications network for the peacekeeping operation in Bosnia. This system is called the Bosnia Command and Control Augmentation (BC2A) system. A subset of the BC2A system is a high-bandwidth, one-way broadcast network called the Joint Broadcast Service (JBS). JBS is capable of sending large amounts of data and video to multiple locations at the same time. This video capability provides a myriad of new opportunities such as sending reconnaissance video in near real time to forward deployed and rear echelon commanders. The data capability provides the potential to obtain large files such as imagery, weather and database files much quicker than before while reducing the traffic off of existing command and control systems.

Concurrently with the deployment of the BC2A system, the DOD is developing the Global Broadcast Service (GBS) which will draw heavily on lessons learned from this limited operational use of the JBS in Bosnia. However, it is not enough to just provide a list of lessons learned. In this day of declining budgets and limited personnel, it is necessary to point out the most critical lessons so appropriate resources are applied first where they can have the most effect. Since the reason any new system is added to the military's arsenal is to add value to the warfighter, the most valuable lessons will be those, that when heeded, add value for the warrior. Therefore, this paper will assess the value of the JBS system in Bosnia so far, and, from factors contributing to the assessed value, will determine the most critical lessons learned.

The study begins with a description of the planned GBS system with an emphasis on the stated mission need, operational requirements and concept of operations. This will give an overview of what GBS is supposed to do. From there the study describes the JBS system and its operation as of November 1996, one month before the originally planned end date of the US involvement in Bosnia.[1] Once this information base is laid, criteria to determine the value of the JBS and then assess the value for various possible information distribution processes is developed. Given the technical nature of this topic, familiarity with communications systems would be helpful to the reader. Finally the most important lessons learned from JBS will be derived from the various value assessments and incorporated into an overall lessons learned chapter with recommendations for the GBS development.

Notes

[1] William J. Perry, US Secretary of Defense, "DOD News Briefing," 4 December 1995; on-line, Internet, 14 March 1997, available from http://www.dtic.mil/defenselink/ news /Dec95/ t120495_tper1204.html.

Chapter 2

Global Broadcast Service (GBS)

Mission Area Description

To evaluate the usefulness of the JBS and attendant lessons learned for GBS, an understanding of the mission area that the operational users require GBS to support is essential. According to the GBS Joint Operational Requirements Document (JORD), GBS will provide high speed, one-way broadcast of large information products to deployed, on the move, and garrisoned troops. This includes joint, US Allied and Coalition Forces. This increased information flow will support the full range of operations from routine operations and exercises, through crisis actions and up to operations against opposing forces short of nuclear war.[1]

Although GBS will improve the transmission of very large products to forces in garrison, the vision stated in the GBS Concept of Operations emphasizes the mobile and deployed forces where GBS can augment existing limited communications.[2] This emphasis was echoed by the first BC2A Program Manager during the official announcement of the BC2A program when he stated it will benefit the warfighter by providing communications where it is limited, commonly referred to as “the last mile.”[3]

Program Overview

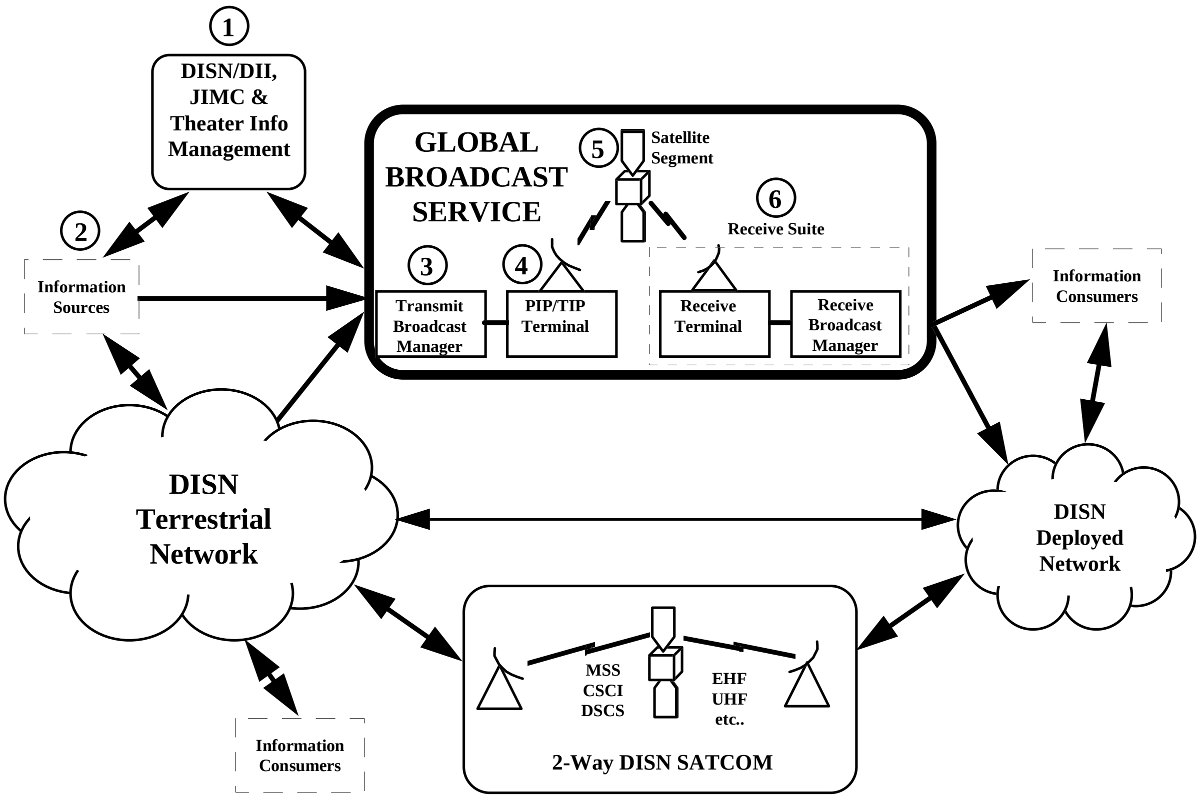
The GBS Program is currently in the first of three phases identified in the GBS JORD. This first phase consists of demonstrations and a limited operational capability using leased Ku band satellites. This includes a continental United States (CONUS) GBS testbed and the JBS supporting "Joint Endeavor," an operation in the USEUCOM theater of operations. The operational use of JBS will be the focus of the latter portion of this paper to determine how useful it was to the operator and lessons learned to heed in the following program phases. The second phase will provide the initial operational capability using dedicated GBS transponders on military satellites. The system acquisition for this phase is currently in progress and the likely chief benefactor of this research. Phase III will upgrade system capabilities to meet the objective JORD requirements.[4] For the remainder of this paper, referral to GBS focuses on the descriptions and capabilities of Phase II.

System Overview

The Global Broadcast Service (GBS) will provide secure, high speed, one-way broadcast of data, imagery and video to joint and multinational forces in the field. The program is exploiting commercial off-the-shelf Direct Broadcast System (DBS) technology to rapidly provide data capacity almost 200 times larger then what was available during Desert Storm.[5] To avoid information overload at the user receive sites, the system design and operational concept must embrace "Smart Push" and "User Pull" concepts to ensure the user gets what he needs, and only what he needs. Furthermore, the system must be integrated into the Defense Information Infrastructure (DII) Common Operating Environment (COE).[6]

System Description

The GBS will consist of a transmit and receive broadcast management function coupled to injection terminals, satellites, and receive suites. The system will be DII COE compliant to allow interface with information sources and end users all within the Defense Information Systems Network (DISN).[7] The basic components are depicted in Figure 1 and described below in more detail. Although not a formal part of the GBS program, the information managers are essential to the success of the program and are described below as well.



Source: Adapted from CAPT Joseph Delpino, "GBS Program Review," briefing, September 1996, 8.

Figure 1. GBS Block Diagram Integrated into DISN Network

Information Managers

Referring to figure 1 (item 1), the information managers are the Theater Information Manager's (TIMs) for each theater and the Joint Information Management Center (JIMC) located at the Pentagon, Washington, DC.[8] The TIMs develop dissemination policy and priorities for their area of responsibility.[9] The JIMC's functions include searching national and theater information sources (item 2), and retrieving information products from those sources.[10] Once the JIMC has obtained a product, it stores it and adds information describing the product to a product catalog which is routinely broadcast to all receive sites.[11] These products are now available upon request to support "User Pull."

Transmit Broadcast Manager

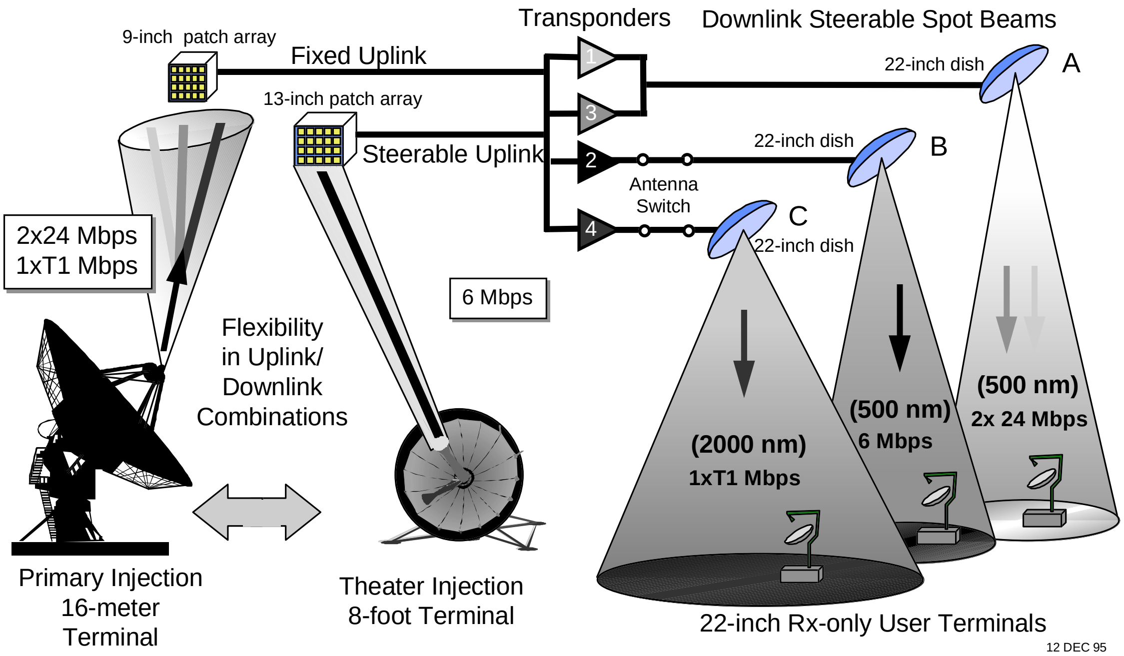
The Transmit Broadcast Manager (TBM, figure 1, item 3) schedules all GBS transmissions in accordance with the TIM guidance.[12] It then builds the transponder streams and transmits them through the appropriate Primary Injection Point or Theater/Tactical Injection Points.[13]

Primary and Theater/Tactical Injection Points

There is one fixed location Primary Injection Point (PIP) within the footprint of each satellite (figure 1, item 4). There may also be one or more transportable Theater/Tactical Injection Points (TIPs), but only one can transmit at a time to the same satellite. (Phase III will add the capability for multiple PIP's and TIP's per satellite). Each PIP can uplink up to 94 Mbps. Each TIP can uplink a minimum of 6 Mbps.[14]

Satellite Segment

UHF Follow-On (UFO) satellites eight, nine and 10 will each host one GBS payload (figure 1, item 5). As depicted in figure 2, each payload contains one fixed and one steerable uplink receive antenna. These antennas will feed four transponders, each capable of 24 Mbps throughput. Then, depending on the chosen configuration, the transponders feed a combination of the two steerable 500 nm spot beam antennas and the one steerable 2000 nm spot beam with a maximum throughput of 96 Mbps. One possible configuration uses two transponders to send two 24 Mbps data streams through one 500 nm spot beam, one transponder to send a 6 Mbps data stream through the second 500 nm spot beam, and one transponder to send a 1.554 Mbps data stream through the 2000 nm spot beam.[15] The UFO satellites may be augmented in Phase II by commercial satellites to provide worldwide coverage.[16]



Source: US Space Command, *Global Broadcast Service (GBS) Concept of Operations*, 24 January 1996, 10.

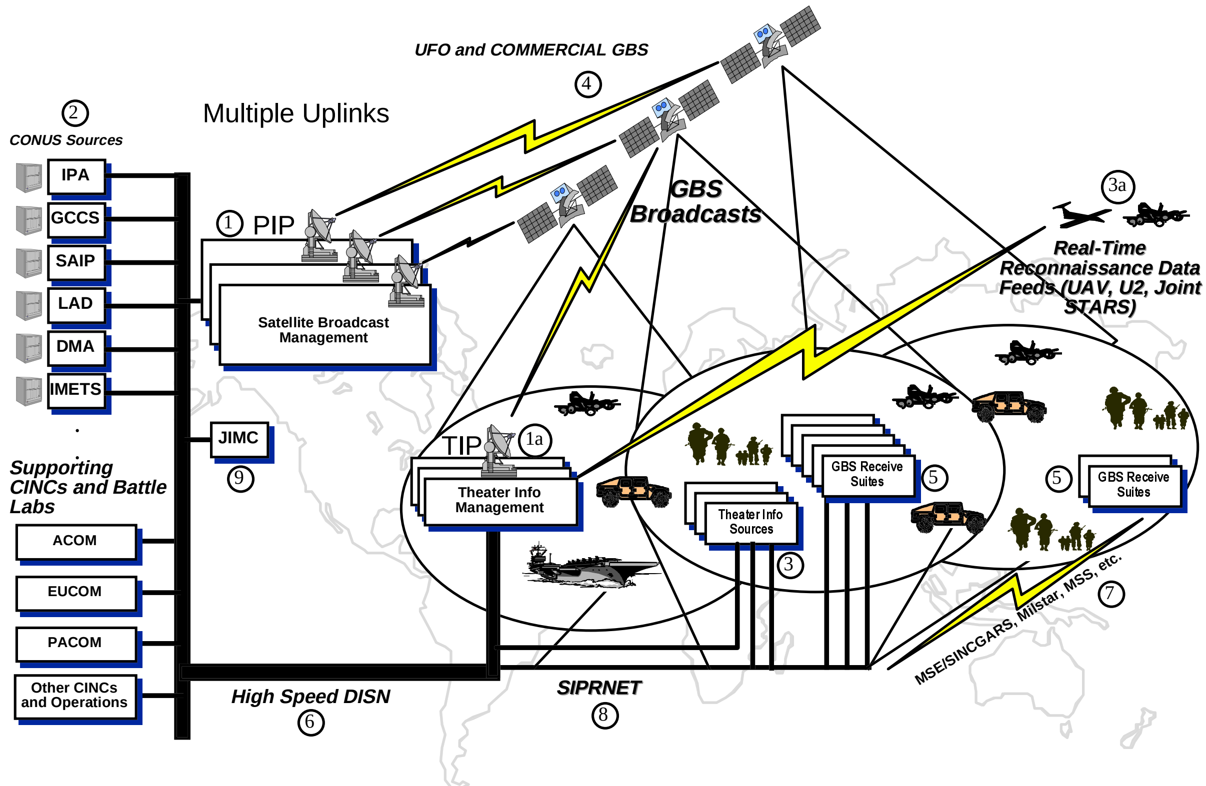
Figure 2. CINC Endorsed GBS Configuration Using UFO Satellites

Receive Suites

As shown in figure 1 (item 6), "the receive suite includes the receive terminal, cryptographic equipment, (when required) [sic] and the receive broadcast management equipment. The receive terminal will consist of a small satellite antenna and receiver equipment that will receive and convert downlink GBS radio frequency (RF) signal into a bit stream."[17] Several types of receive terminals will be fielded including fixed ground, transportable, shipboard and submarine terminals in Phase II. Phase III will add ground mobile, manpack and airborne terminals.[18] "The receive broadcast management equipment will provide the functions necessary to convert the broadcast into a video and DII and COE compatible format."[19]

Concept of Operations

A top-level GBS concept of operations is pictured in figure 3. Three primary information flows are broadcasting continuous data such as audio or video, “Smart Push” of information and “User Pull.” For continuous data broadcasts, the PIP or the TIP (items 1 and 1a) obtain the desired information from CONUS sources (item 2) or theater information sources (items 3 and 3a). The injection point then uplinks the signal to its designated GBS satellite (item 4) which in turn broadcasts the signal to all sites in theater (item 5) within the satellite antenna footprint. As an example, real-time reconnaissance feeds such as Unmanned Aerial Vehicle (UAV) video (item 3a) might be downlinked to the TIP which will then uplink the signal to the satellite as previously described. Any theater-originated signals could also be broadcast back to the CONUS through a high speed DISN ground line (item 6). Similarly, for the “Smart Push” information flow, the PIP or the TIP (items 1 and 1a) will obtain products specified by the TIM (item 1a) from CONUS and theater sources (items 2 and 3) and broadcast them through the satellite (item 4) to designated sites (item 5).



Source: Adapted from CAPT Joseph Delpino, "GBS Program Review," briefing, September 1996, 6.

Figure 3. GBS Concept of Operations Overview

For the "User Pull" information flow, the receive sites (figure 3, item 5) send in a request via available assets. The request path may be via lower bandwidth communications (item 7), such as the Army's Mobile Subscriber Equipment (MSE) or SATCOM such as Milstar, and on through the Secret Internet Protocol Router NETwork (SIPRNET, item 8). Alternately, if available, the path may be directly through the SIPRNET. Depending on the request, the JIMC (item 9) or the TIM (item 1a) would receive the request, obtain the product from CONUS or theater sources (items 2 or 3), then route the desired product through the PIP or the TIP (items 1 or 1a) as appropriate, and on to the requesting site (item 5). If deemed appropriate, the JIMC may also route products via delivery systems other than GBS.[20]

As detailed in this chapter it should be clear the goal for GBS is to augment the existing strained command and control systems with high bandwidth, multimedia broadcasts to all echelons of forces. Although the system will be based on existing DBS technology, there are still many areas requiring development. Details such as encryption, integration with allied systems and implementing the "Smart Push/User Pull" vision need to be well thought out, put into place and tested. Fortunately, the JBS operational use supporting Bosnia provides an extremely valuable environment in which to learn.

Notes

[1] US Army Signal Center, *Global Broadcast Service Joint Operational Requirements Document*, draft, 13 February 1997, 1,4.

[2] US Space Command, *Global Broadcast Service (GBS) Concept of Operations*, 24 January 1996, 1.

[3] Col Edward Mahen, "DOD News Briefing," 2 February 1996; on-line, Internet, 9 October 1996, available from http://www.dtic.mil/defenselink/news/Feb96/+020796_t020kam.html.

[4] US Army Signal Center, *2*.

[5] Brig Gen James R. Beale, "Global Broadcast Service (GBS)," briefing, location and date unknown, electronic file dated 18 October 1996.

[6] US Army Signal Center, 4,7.

[7] CAPT Joseph Delpino, "GBS Program Review," briefing, location unknown, September 1996, 8.

[8] Ibid., 9.

[9] US Army Signal Center, 3.

[10] Delpino, 9.

[11] HQ USEUCOM/J6, *Concept of Operations Bosnia Command and Control Augmentation*, *Annex D*, *Information Management*, 20 September 1996, A-5, A-8.

[12] US Army Signal Center, 3.

[13] Delpino, 12.

[14] US Army Signal Center, 9.

[15] US Space Command, 9-10.

[16] US Army Signal Center, 2.

[17] Ibid., 3.

[18] Ibid., 11-13.

[19] Ibid., 3.

[20] Delpino, 9.

Chapter 3

Joint Broadcast Service (JBS)

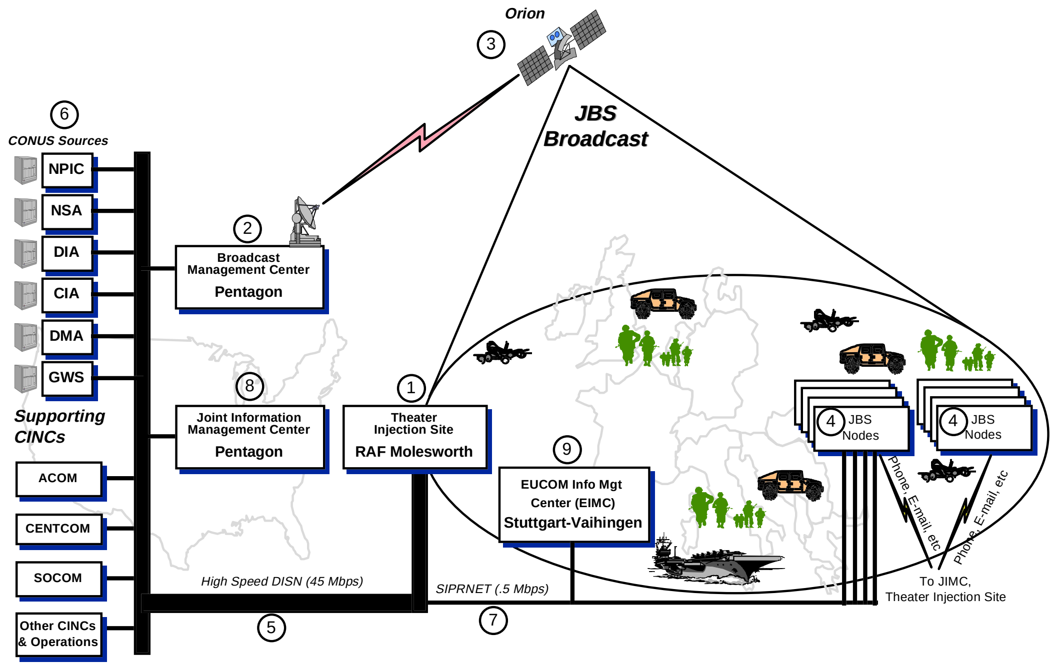
System Overview

A subset of the BC2A system, the JBS broadcasts one-way, high bandwidth, multimedia information to 27 receive sites throughout the European theater (see figure 4). The JBS is an integral part of the overall BC2A system which is also comprised of the Very Small Aperture Terminal (VSAT) satellite and terminals shown in figure 5. In this figure the VSAT satellite (item 1) and nodes (item 2) are shown in gray and are connected by dotted communication paths. The JBS is based on the same DBS technology as GBS, and both are envisioned to have a similar "Smart Push/User Pull" design to avoid end user information overload.

Initial operational capability began in April 1996 with a 2 Mbps US SECRET Internet Protocol (IP) data channel and at least one, 4 Mbps video channel. By 1 August 1996 the Combined Air Operations Center (CAOC) in Vicenza, Italy was receiving a REL NATO (Releasable North Atlantic Treaty Organization) broadcast with more sites gradually being added. By 15 September 1996 the REL NATO channel was converted to NATO SECRET to increase the integration with the NATO allies.[1] Plans call for the IP data channel to eventually be replaced by an Asynchronous Transfer Mode (ATM) channel with a bandwidth of 5 Mbps or larger.[2] In November 1996 a small subset of the JBS nodes added an ATM channel for test purposes prior to upgrading the remainder of the sites in 1997.[3]

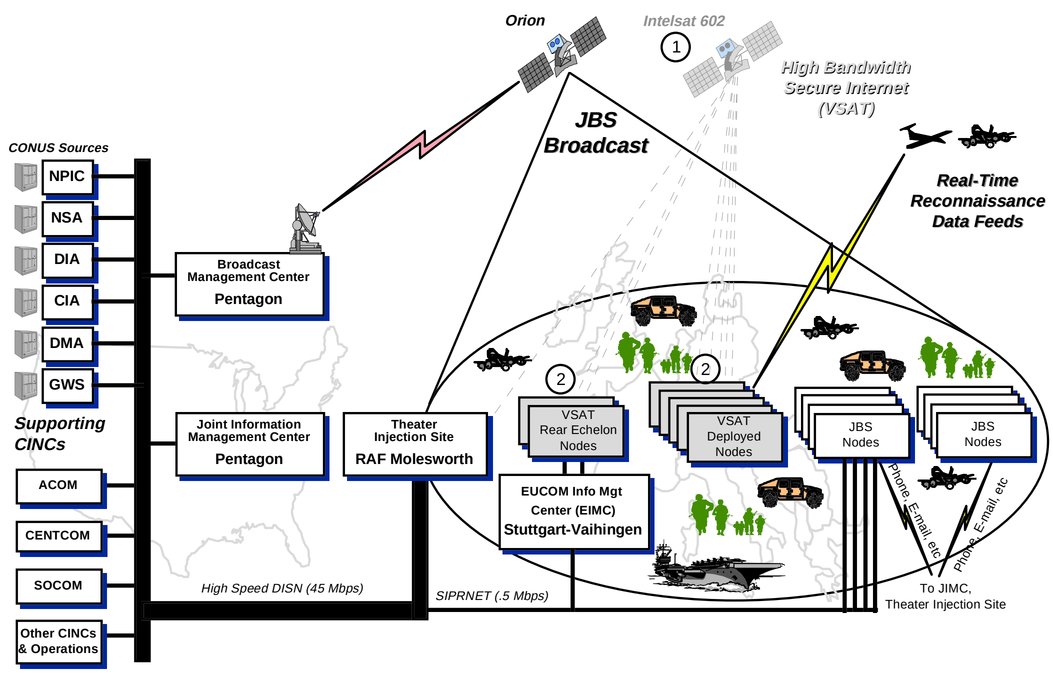
System Description

Referring to figure 4, the JBS consists principally of a Theater Injection Site (item 1), a broadcast site (item 2), a satellite transponder (item 3) and receive suites (item 4). Integral to these pieces is the high speed DISN connection (item 5) from the Theater Injection Site to the broadcast site and CONUS information sources (item 6). Many receive sites are also connected to the SIPRNET (item 7) and, in turn, to the DISN. Also integral to the principal JBS components are the information managers (items 8 and 9). Any discussion of JBS must begin with them as they obtain and organize the information needed for broadcast.



Source: Adapted from Maj William Boronow, HQ USEUCOM, "Bosnia C2 Augmentation," briefing, not dated.

Figure 4. JBS Subset of BC2A



Source: Adapted from Maj William Boronow, HQ USEUCOM, "Bosnia C2 Augmentation," briefing, not dated.

Figure 5. BC2A System

Joint Information Management Center

Shown in figure 4 (item 8), the JIMC performs the same basic functions for JBS as it is envisioned to be used for GBS described in Chapter 2. The major difference is that in November 1996 the product catalog for ordering products was still in development and not available for product requests.[4]

EUCOM Information Management Center

Shown in figure 4 (item 9), the EUCOM Information Management Center (EIMC) located at HQ USEUCOM, Stuttgart-Vaihingen, Germany, is the equivalent of the GBS Theater Information Manager. It developed both the Information Management Concept of Operations (CONOPS) for JBS and an interim procedure to be used until the software and tools necessary to fully implement the CONOPS are in place. JBS baseline software version 2.0 scheduled for installation in March 1997 will provide basic functionality to implement the CONOPS.[5] Until this functionality is in place, approving the JBS video broadcast schedule and channel allocations is the primary dissemination guidance that the EIMC provides.[6]

Theater Injection Site

The Theater Injection Site (TIS) is located at RAF Molesworth, UK (figure 4, item 1). It injects data and audio/video from European theater sources through the high speed DISN line to the JIMC and the Broadcast Management Center (BMC, figure 4, item 2). The BMC then performs the actual broadcast to the JBS receive sites. This method is termed “virtual” injection.[7]

Broadcast Management Center

The Broadcast Management Center (figure 4, item 2) is co-located with the JIMC at the Pentagon, Washington, DC.[8] The BMC receives information to be broadcast from the JIMC, sets the broadcast schedule, and uplinks that information to the satellite.[9]

Satellites and Connectivity

For JBS, the Defense Information Systems Agency (DISA) leases a dedicated Ku band transponder on the Orion-1-Atlantic commercial satellite (figure 4, item 3). The satellite receives the uplink from the BMC in Washington, DC, and the downlink provides spot beam coverage over the European theater. It is capable of delivering 30.3 Mbps to terminals using a one meter receive antenna.[10] In November 1996 the bandwidth was allocated as shown in Table 1. These allocations are determined by the EIMC and may vary due to current circumstances.

Table 1. JBS Bandwidth Allocation

Product	Bandwidth
Broadcast Program Guide	1 Mbps
Predator Nomad Endeavor Video	3 Mbps
Cable News Network (CNN)	3 Mbps
Armed Forces Radio and Television Services	3 Mbps
IP Data + Classified Audio	3 Mbps
Overhead	750 kbps
IP Data + Audio NATO	2 Mbps
ATM Data (in test and evaluation)	5 Mbps
Available	**9.55 Mbps**

Sources: HQ USEUCOM/J6, *Concept of Operations Bosnia Command and Control Augmentation, Annex B, Joint Broadcast System (JBS) Implementation*, 20 September 1996, B-6; and Lt Gwen Eckman, JIMC, "Re: JBS research questions," E-mail, 14 March 1997.

Although not part of the JBS system, the INTELSAT 602 satellite (figure 5, item 1) is necessary to get the Predator UAV video to the JBS BMC for broadcast over JBS (see description in Current Operations).[11]

Receive Suites

The receive suites (figure 4, item 4) consist of a receive antenna and multiple modular units depending on each site's desired capability. See Appendix A for more details. See also Appendix B for a list of the 27 JBS receive sites and a map showing their locations.

A key part of the receive suite is the Receive Data Manager (RDM) software. According to the JBS CONOPS, "the RDM software unwraps the JBS delivered files and places them into directories for access by client workstations running existing applications which exploit the JBS-delivered data files."[12] Unfortunately, key applications such as the Image Product Archive (IPA) for retrieving imagery products were not yet functional in November 1996.[13]

The receive sites are also scheduled to be integrated into local US Local Area Networks (LANs) and NATO LOCE classified networks where applicable. In November 1996 the integration was still limited and for many sites the JBS suite was stand-alone.[14]

Current Operations

HQ EUCOM developed the BC2A Concept of Operations, dated 20 September 1996. This concept is a detailed, CINC adapted plan based on the planned JBS configuration and the GBS CONOPS dated 26 January 1996. Unfortunately, much of concept is not yet possible, particularly for data products, largely because the necessary system software for this function is still under development. The description below of how information is currently requested and flowed through the system is based on viewing system operations and interviews with personnel at several JBS sites during 25-29 November 1996, and other documents as noted. Changes made since then have also been included where known.

Video

The JBS is currently broadcasting 24 hour dedicated video channels for the Predator UAV, the Armed Forces Radio and Television Service (AFRTS) and the Cable News Network (CNN).[15] Referring to figure 5, the Predator UAV video (item 3) is downlinked to the Taszar, Hungary ground station co-located with a deployed VSAT node (item 2). There it is annotated with a classified voice overlay in near real time to describe the video. The unclassified video and encrypted classified audio (CONFIDENTIAL REL-IFOR) are uplinked through the VSAT satellite (INTELSAT 602) to the TIS at RAF Molesworth, UK. From there data are sent back to the Broadcast Management Center in the Pentagon through the 45 Mbps DISN ground line. Finally, the video and audio are uplinked to the JBS (Orion) satellite using a dedicated 3 Mbps channel and relayed to the 27 JBS receive nodes.[16] If the Predator UAV is not flying, then the broadcast is essentially a blank screen. Once the ATM upgrade is in place, JBS will have the capability to broadcast classified video up to US SECRET as well.[17]

To get the AFRTS and CNN programming to deployed forces, these program feeds are received by appropriate analog and digital video receive equipment at the Broadcast Management Center.[18] Then the BMC retransmits these signals in dedicated 3 Mbps channels via the JBS satellite to the receive suites.

If other audio/video sources are desired, a request is made to the JIMC, and the JIMC investigates the possibility of acquiring the requested signal for rebroadcast. If the JIMC can obtain the requested signal, the EIMC validates the need and directs necessary adjustments to the broadcast schedule and channel allocations.[19]

Data Files

As mentioned previously, the BC2A CONOPS lays out the desired process for requesting and distributing data products. This CONOPS is based on the same “Warrior Pull” and “Smart Push” concepts detailed in the GBS CONOPS. However, at this time the system does not yet support these concepts; hence the more appropriate nomenclature—“Manual Push and Peck” and “Manual Warrior Pull.”

The “Manual Push” concept process flows in the following manner. User sites and the EIMC use the telephone, E-mail or other available communications means to advise the JIMC and the Joint Analysis Center (JAC) at RAF Molesworth, UK of products needed on a regular basis. The JIMC manually creates a listing of such products whereas the JAC sends all new imagery created for the Balkan area each day to all sites.[20] Daily, both sites develop a batch file to send all regularly scheduled products at a certain time each day. To send these files, the JIMC transmits the data to the BMC via the local network. Then the BMC schedules and uplinks the data to the JBS satellite which in turn downlinks the data. The requesting site’s RDM recognizes the file is addressed to it and saves the file(s). For JAC products, there is no LAN connection to the TIS in another building.[21] As a consequence, a tape is created first and walked over to the TIS.[22] From there it is “virtually injected” into the JBS through the 45 Mbps DISN pipe to the BMC at the Pentagon. Then the BMC schedules and uplinks the data to the JBS satellite which in turn downlinks the data. The RDM at each site recognizes the files addressed to it and saves the file(s).[23]

Once the "Manual Push" process is completed, the "Peck" part comes into play. In November 1996 it was common for 100-200 files to be pushed a day, including many undesired weather files from CONUS.[24] Unfortunately, the "Build-A-View" software initially provided by the contractor to find desired files does not work.[25] For an operator to find the desired files, he has to scroll through all of the received files (ordered by date time group). Then he must open the information data (called "meta-data") associated with each file to get a short description to determine if that was the correct file or if he needs to continue looking. This can be such an inefficient task that at least one site came up with a workaround that shifted the inefficiency back to the TIS. For instance, the US National Intelligence Cell in the CAOC at Vicenza sometimes requested the rebroadcast of certain files later in the day so that they could find them.[26] This was desired because these files would now be the last ones in the queue instead of intermixed among 100 or more files originally sent together.

As previously mentioned, instead of a "Warrior Pull" concept, current operations are more like "Manual Warrior Pull." The warrior sends the JIMC a request for a particular product via the telephone, e-mail, fax, SATCOM or other convenient means. The JIMC then searches national information sources for a product matching the requested data's description. When a suitable product is found, the JIMC sends the data as described in the "Manual Push and Peck" process.

If the JIMC cannot find a suitable product, then the request must be passed on to the functional Request For Information (RFI) process. Note that users may go directly to the

RFI process, especially if they are looking for functional specific data such as imagery or weather. Since the majority of requested data products during this study's observation period were for imagery, discussion will center on the intelligence RFI process for EUCOM as used in conjunction with JBS. In this process, warriors send a request, typically via telephone, to the Imagery Watch Officer at the theater intelligence center, the JAC. The Watch Officer will oversee a search of all available information sources to see if the requested product is available. If not, the appropriate personnel at the JAC will be tasked to develop the requested product.[27] Once it is ready to be sent, it has to be saved to tape and hand carried to the TIS. From there it is virtually injected, uplinked and received as in the "manual push and peck" process.

Streaming Data

Another type of information the JBS is capable of broadcasting is called "streaming data," and, as the name implies, streaming data is a continuous bit stream of data. The three types that JBS can currently broadcast are BINOCULAR, Tactical Related APplications (TRAP) and Tactical Information Broadcast Service (TIBS). To receive one of these signals, the user must coordinate with the JIMC on a case-by-case basis. Once it has been arranged, the BMC receives the stream through satellites from their sources. The BMC converts the continuous stream into packets to send through the JBS satellite. At the receiving end, specialized RDM software for each type of data reconstructs the continuous stream from the packets for the end user.[28]

This description of JBS shows many parallel concepts between GBS and JBS. However, the current JBS limitations in information management and integration with other systems hamper the JBS' ability to fulfill its "Smart Push/Warrior Pull" vision. By examining the value of the existing system to the user, the factors that limit the system's value will become apparent.

Notes

[1] HQ USEUCOM/J6, *Concept of Operations Bosnia Command and Control Augmentation, Annex B, Joint Broadcast System (JBS) Implementation*, 20 September 1996, B-4, B-5.

[2] Ibid., B-4, B-26.

[3] Capt Mitch Maddox, HQ USAFE/SCMJ, Ramstein AB, Germany, inteviewed by author, 26 November 1996.

[4] Maj William Boronow, HQ US European Command, draft memorandum, subject: Command BC2A 0-6 Oversight Visit to Bosnia, 21 November 1996, 1.

[5] Douglas Karo, Draper Labs, Inc, E-mail message, "BC2A IMS changes,".17 March 1997.

[6] HQ USEUCOM/J6, *Concept of Operations BC2A, Annex D*, A-6, A-7.

[7] Ibid., A-9.

[8] Lt Gwen Eckman, Joint Information Management Center, Pentagon, Washington, D.C., interviewed by author via telephone, 12 Novmenber 1996.

[9] HQ USEUCOM/J6, *Concept of Operations Bosnia Command and Control Augmentation*, 20 September 1996, 15.

[10] HQ USEUCOM/J6, *Concept of Operations BC2A, Annex B*, B-6.

[11] HQ USEUCOM/J6, *Concept of Operations BC2A*, 17-18.

[12] HQ USEUCOM/J6, *Concept of Operations BC2A, Annex B*, B-13.

[13] Maj William Boronow, HQ US European Command, draft memorandum for record, subject: Trip Report, EUCOM O-6 BC2A oversight trip to Bosnia 12-14 November 1996, undated.

[14] Ibid.

[15] Lt Gwen Eckman, JIMC, Pentagon, Washington, D.C., "Re: JBS research questions," E-mail, 14 March 1997.

[16] HQ USEUCOM/J6, *Concept of Operations BC2A, Annex B*, B-19 to B-21.

[17] Ibid., B-8.

[18] Ibid., B-16.

[19] HQ USEUCOM/J6, *Concept of Operations BC2A, Annex D*, A-7, A-8.

[20] LT Jack Shriver, JAC, RAF Molesworth, UK, "fwd: JBS Research Questions," E-mail, 23 February 1997.

[21] LT Jack Shriver, JAC, RAF Molesworth, UK, "fwd: JBS Research follow up questions," E-mail, 21 February 1997. US Secret and NATO LAN connections between the TIS and the JAC were installed between December 1996 and February 1997. As of 21 February 1997, these connections were undergoing system testing and were not used operationally.

[22] LT Jack Shriver, JAC, RAF Molesworth, UK, interviewed by author, 25 November 1996.

[23] HQ USEUCOM/J6, *Concept of Operations BC2A, Annex B*, B-16 to B-18.

Notes

[24] Boronow, draft memorandum, subject: Command BC2A 0-6 Oversight Visit, 1.

[25] Ibid.

[26] TSgt McAllister, Imagery Division Unit Support Branch, JAC, RAF Molesworth, UK, interviewed by author, 25 November 1996.

[27] MSgt Olsen, Imagery Watch Officer, JAC, RAF Molesworth, UK, interviewed by author, 25 November 1996.

[28] HQ USEUCOM/J6, *Concept of Operations BC2A, Annex B*, B-18, B-21.

Chapter 4

Joint Broadcast Service: Value to the Warrior

Determining the value of any capability to the armed forces is very subjective and open to debate. However, it is important to try to estimate the value of the JBS to the forces in Bosnia to validate the GBS concept. By understanding what aspects of JBS proved the most useful, the least useful, and why, the users and the GBS Program office can shape GBS development to optimize its benefits.

To determine value criteria for JBS, an understanding of value is prerequisite. According to Webster's dictionary, "value" means "relative worth, utility, or importance."[1] So in the case of adding a communications system to an existing infrastructure, establishing what gives the new system more relative worth, utility or importance is the first step.

Adding a new communication system is similar to buying any system or product. There are two basic characteristics to evaluate: performance and cost. Every person, business or government agency purchases a new product to either obtain some new or increased performance for their money or to have the same performance but at less cost. Cost is self-explanatory, but it remains important to determine what performance factors to evaluate in a communications system.

To determine the performance factors, the purpose of any communication system must be understood first. According to Webster's dictionary, "communications" is "a system (as of telephones or telegraphs) for communicating information. . . ."[2] It follows that the purpose of any communications system is simply to communicate or transmit information.

In the process of transmitting information there are two primary performance factors: the type of information a system carries and the speed at which it transmits. Based on these factors as well as cost, it follows that the only reasons for any end user to desire to add to or replace any communications system at his location falls under one these three categories: (1) the new system provides desired information that cannot be obtained by existing systems, (2) it provides the same information but in a substantially quicker time, (3) it provides the same information in a similar time frame but is substantially more efficient (less manpower/less cost).

For a military system, this study proposes these three categories are also in priority order, with the first one having the potential to have the biggest mission impact. Given the rapid advances in information technology, new information can be a force multiplier, while getting information quicker is needed to stay inside the opposing forces Observe-Orient-Decide-Act (OODA) loop as proposed by Lt Col John Boyd.[3] Lastly, if no additional capability is needed, then more efficient systems are desired in this era of declining defense budgets.

Based on these assertions, the following criteria are used to make a qualitative statement about the value of three generic JBS capabilities (video, data files, streaming data). First, to have any value at all, the information provided by that capability must meet one of the three categories described above for adding to or replacing a communications system (new, quicker or cheaper data). Once this criterion has been met, the capability in question is assumed to have some value and the next step is to determine how much.

In the military, all new systems need to support the overall mission. Referring back to the definition of value, the amount of relative worth, utility or importance to the mission must now be determined. Since JBS is not a critical command and control system and is only intended to augment existing systems, it is unlikely that a few uses are going to substantially alter the course of the conflict. History reveals very few systems which have such a high impact with few uses. One example is the use of the atomic bomb to end World War II. However, repeated use of a new capability might give that winning edge, the ultimate goal of all military systems. For instance, the highly sought after C-17 aircraft carries more cargo than its predecessors, but it must still be used repeatedly during a conflict to have a high relative worth compared to the C-130 or C-141. Hence, the value of a capability is postulated to be a qualitative measure of the average of its mission impact and its usage. The result is rating of low, low-moderate, moderate, moderate-high or high value. Figure 6 provides a flow chart summarizing the value determination process and Appendix C contains a matrix of all possible impact, usage and resulting value assessments. For each capability assessed, a table summarizes the analysis.

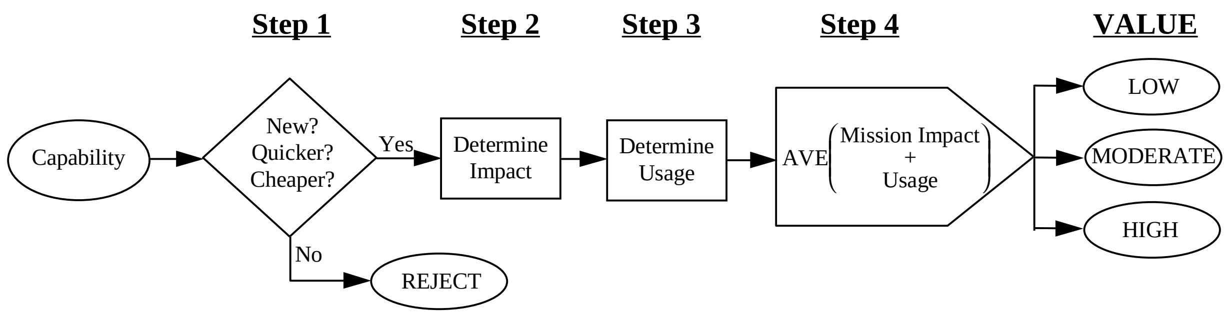


Figure 6. Value Determination Flowchart

Given the lack of quantitative usage data and the subjective nature of "mission impact," the various value assessments resulting from this analysis are necessarily only rough indicators. However, the author believes these value assessments coupled with their rationale are sufficient to identify areas to focus on during the GBS development process.

Video

To assess the value of the video capability, the first step is to determine if the video feed meets any of the criteria in figure 6, step 1. Indeed, the video feed does provide new information which could not be provided by existing communication systems, specifically, the broadcast of Predator UAV, CNN and other desired video sources to the forward deployed units. Thus the video capability does add some value, but how much?

Following the flowchart the next steps are to determine the usage and impact of the video. On the average, the Predator flies a 1-3 hour daily mission.[4] However, given the great success of the peacekeeping force so far, most Predator missions are uneventful, resulting in little impact to the overall mission. On the other hand, interviews and E-mail correspondence with HQ EUCOM personnel identified two situations where the Predator video broadcast over JBS had major impact to the mission.

The first happened in Han Pijesak, B-H on 5 July 1996 and the second at Mostar, B-H on 11 February 1997. In both instances, several geographically separated senior officers used the desktop Video-Teleconference (VTC) capability provided through the VSAT to discuss the situation amongst themselves and direct the Predator pilot team to points of interest.[5] In real-time the senior officers saw the resulting Predator video on the JBS monitor. In the Mostar situation, the VTC involved the French Multi-National Division (MND) at Mostar, the Sustainment Force (SFOR) Joint Operations Center (JOC) in Sarajevo, B-H, the CAOC in Vicenza, Italy, and the Predator ground station in Taszar, Hungary. Through the VTC, the Predator mission was first diverted to Mostar due to a developing situation, then it was extended while directing the Predator, and finally when the Predator ran low on fuel, an AC-130 was requested to take the Predator's place.[6]

For future consideration, note that in both these examples the desktop VTC capability provided through the VSAT was used to coordinate with the Predator pilot team. Although the warriors used the VSAT very little on a day to day basis,[7] the senior officers used it for high impact situations. It is difficult to say though, that the VSAT desktop videoconference capability was required for the collaboration in conjunction with the Predator video broadcast through JBS. A voice conference over existing communication networks should be able to accomplish the same coordination since the real video of interest was the Predator video itself.

These examples clearly illustrate the high impact potential of the JBS video capability. Yet, coupled with the low number of high impact missions, the overall value of JBS to Joint Endeavor with respect to the existing communication infrastructure is only moderate. Looking at it from the opposite viewpoint yields the same results. Since the Predator flies almost daily, the JBS video broadcast has a high usage rate, but its average mission impact is low. Based on the formula, the overall JBS value is still moderate as shown in table 2.

Table 2. JBS Value to the Warrior, November 1996: Video

JBS PRODUCT	USAGE	IMPACT	VALUE
Video	Low	High	Moderate

Note that the moderate value is only for the JBS video capability as used in the current peacekeeping mission in Bosnia-Herzegovina where there have been few situations resulting in high impact Predator video broadcast via JBS. Not only has the peacekeeping mission gone very well, but JBS was not developed and deployed to broadcast Predator video until several months after troops first arrived when confrontations were most likely and surveillance may have been the most useful. The potential impact for Predator video broadcast via JBS is recognized by the forward-deployed commanders[8] and will undoubtedly be a high value commodity in any future conflict.

Data Files

Starting with the value criteria again, the first step is to determine if the data file transfer capability of JBS meets one of the three categories necessary for a new system to have at least some value. Given the large 2 to 3 Mbps bandwidth of a data channel (increasing to 5 or more Mbps when ATM is fully incorporated into the system),[9] versus the 512 kbps available in Bosnia in 1995,[10] the JBS appears to meet the criteria for being able to send the same information substantially quicker than before JBS. Therefore, according to the stated criteria the JBS data file transfer capability appears to have some value. However, upon examination of the whole information cycle detailed in Chapter 3 for the JBS configuration as of 27 November 1996, this may not always be true. In some cases the lack of information management capabilities and integration with existing networks add sufficient time delays such that the user may not get the desired data faster over JBS than with existing systems. In these cases, using JBS would have no value according to the stated criteria. To determine when the JBS does add value, the information cycle timeline needs to be examined for both the "Manual Warrior Push and Peck" and the Manual Warrior Pull" processes described in Chapter 3. In conjunction with determining when the JBS adds value, the amount of usage and impact needs to be assessed to determine how much value it adds.

"Manual Warrior Push and Peck"

Examining the "Manual Warrior Push and Peck" timeline reveals that more files are sent than the end user desires. To make matters worse, users must "peck" through the list of pushed files to find the desired ones. Thus to determine actual transmit time it is necessary to estimate how long it takes to send the pushed files plus how long it takes the user to identify the desired files. Then, comparing that time with retrieving just the desired files via the SIPRNET using an existing system such as Intelink-S (a web browser based search and retrieval system for intelligence data up to the US SECRET classification level), a value comparison is possible.

As detailed in Appendix D, an average day's scheduled broadcast consisting of primarily 90 imagery files and 100 weather files would take approximately 35 minutes.

However, based on user feedback, the weather data pushed from the CONUS was mostly unused and only certain imagery files were desired by given sites.[11] To determine, then, the real time it takes to push the files to the end user, it is necessary to determine how many pushed files are not needed and how long it takes the end user to search all pushed files to find the desired ones. Based on the results of the JBS User Questionnaire summarized in Appendix G, a more reasonable number of desired imagery files per day is 30 or less. This results in as many as 160 undesired files. As shown in Appendix D it could take an additional 47 minutes to identify the desired files after all files had been received. This adds up to a total time of over 80 minutes to send and receive desired files. To put this into perspective, the "effective" data rate for JBS in this example as defined by equation F.1 in Appendix F is only 202 kbps (0.202 Mbps).

Not taken into account here but worth mentioning, the forward deployed sites did not yet have the BC2A equipment connected to US classified systems or the NATO LOCE classified system.[12] Thus operators either printed a product and carried it over to appropriate analysts or manually copied files to hand carry to the analyst's systems for further study. This creates an additional delay before the desired files are in the hands of the people who need them.

Similarly, if the site downloaded only the 30 desired files using an available 512 kbps SIPRNET node instead of JBS, the site could have received all the desired files in approximately 33 minutes. Although it is unlikely the entire 512 kbps bandwidth would be available to one user, it may be possible to achieve the 202 kbps "effective" data rate of JBS. This example can be summarized as follows: the determination of when a user can receive desired data faster via JBS than an existing system is based on the number of undesired files pushed, the relative data rates of the two systems, the average size of the files, and the time for an operator to open meta-data for each pushed file as he searches for desired files. Equation F.2 in Appendix F quantifies this relationship. Using this equation for the above example with 30 desired files, no more than 45 undesired files can be pushed through a 3 Mbps JBS channel before it takes longer to receive the desired data in a usable form than using the 512 kbps existing system. This does not even take into account the time needed to manually transfer to an analyst's workstation. Given the number of assumptions and lack of quantitative data for all files sent in November 1996, it is difficult to say the number of days in which more than 45 undesired files were pushed to the receive sites, but given the large number of pushed weather files it is likely that this was true most days.[13] If all these assumptions were always true, then according to our criteria the "manual push and peck" process for large numbers of 4 MB files has no value. Fortunately, they are not always true, but given that under some circumstances operators using existing systems can obtain desired data faster than the JBS system, the second criteria, substantially faster, is not met. As a result, the impact is low.

To finally determine the value of the "manual push and peck" process, the usage level must be determined to couple with the impact rating. Since getting the extra communications bandwidth to forward deployed sites is a primary purpose of JBS and GBS, assessing the usage level of these sites is appropriate. The usage level varied from site to site with the British and French MND's at Banja Luka and Mostar not really using it for day to day products. Other sites such as the ACE Rapid Reaction Corps at Sarajevo, B-H and the 1st Armored Division at Tuzla, B-H used it more, but with the lack of information management capabilities and integration into existing US and NATO LANs, the usage level was low.[14] This low usage level combined with lack of impact determined above results in a low overall value for the JBS "Manual Push and Peck" process (table 3). This evaluation is echoed by the BC2A O-6 Oversight Visit to Bosnia memorandum which states, "By not having the system perform according to the EIMC plan, we are turning off users and actually making use of the system more difficult than existing systems such as Intelink-S and LOCE."[15]

Table 3. JBS Value, November 1996: "Manual Warrior Push and Peck"

JBS PRODUCT	USAGE	IMPACT	VALUE
Data: "Manual Warrior Push and Peck"	Low	Low	Low

"Manual Warrior Pull"

The next process to investigate regarding data is the "Manual Warrior Pull" process. Following the same criteria the first step is to examine the information cycle described in Chapter 3 to determine how long it would take to receive and identify requested files via JBS and compare those results with retrieving the same files via an existing system such as Intelink-S. This process will be further broken down to considering requests of smaller files (2-4 MB) and very large files (>300 MB).

The portion of the information cycle of interest begins when the JIMC or the JAC has obtained the requested products and ends when the requesting site receives all requested files. Since imagery was the primary type of data file broadcasted by JBS in November 1996, and the JAC is the EUCOM POC for imagery RFIs, examining the timeline for the JAC is appropriate. At first glance, it appears that a 3 Mbps JBS data channel would certainly transmit needed files to the user faster than an existing 512 kbps system. Upon closer examination, the JAC is in a different building than the TIS at RAF Molesworth, UK and there was no LAN connection between them. As a result, the interim transfer time required to write the products to tape and walk it over to the TIS adds a significant percentage of time to the total transfer time. When the JAC finishes installing and testing the fast ATM LAN currently in progress, the interim transfer time will be minimized to the point where it would not be worth considering.

The first case to study is requests for smaller files, approximately 2-4 MB. This is the predominant case since all the requested files transmitted by the JAC in November 1996 are in this category (Appendix E, tables 9 and 11). Appendix F, equation F.3 can be used to show that JBS takes over 27 minutes to get an RFI response back to the requester. This calculation uses the median number of RFI files sent per transmission, 12.5 (Appendix E, table 13), and a conservative interim transfer time of only 25 minutes.[16] This translates into an "effective" data rate of only 256 kbps (Appendix F, equation F.4). Comparing this time to using a 512 kbps existing system, it would take less than 14 minutes to send the same files. Once again, the whole 512 kbps bandwidth would not be available to one user, but achieving 256 kbps may be possible.

To determine the point at which the JBS becomes faster than the 512 kbps system for this RFI process, use equation F.6 in Appendix F. The result is that a request would have to be for more than 27, 4 MB files. Given that only two of 10 RFI transmissions in November contained more than this, the stated criteria suggests then that there was no value in the eight RFI broadcasts which potentially took longer via JBS than an existing system. However, this would be too harsh an assessment since, realistically, the entire 512 kbps SIPRNET bandwidth would not have been available to one site so the breakpoint is somewhat lower than 27 files. Yet Equation F.7 in Appendix F shows the existing system would only need to provide 168 kbps to equal the JBS manual pull process when eight, 4 MB files are broadcast. Since five of 10 RFI transmissions were eight files or less (Appendix E, tables 9 and 11), this is a reasonable breakpoint. Based on this, the time saved (if any) using JBS for the majority of these RFIs was not substantial as required by the stated criteria, and thus when JBS had value, its impact was low.

Having determined the impact, the next step is to look at the amount of usage to determine the value for the smaller file size category of the manual warrior pull process. Looking at the theater injection logs (Appendix E, tables 9 and 11) at the number and location of RFIs in November 1996, only four sites had requests fulfilled through a total of 10 JBS broadcasts on a total of four days. Since some RFIs were fulfilled through multiple broadcasts as products became available, the number of separate RFIs satisfied through JBS was between six and eight. This represents a low JBS usage when compared to the total of 40 imagery RFIs supporting the Bosnian theater disseminated via all methods[17]. This was supported in an interview with the chief of the analysis division at the JAC who had recently been transferred from an assignment as commander of the US National Intelligence Cell (US NIC) in Sarajevo, B-H supporting the Commander at IFOR headquarters. He said he did not use JBS for time sensitive products due to the inherent lag in transferring the products from the JAC to the TIS first.[18] Thus the low impact coupled with low usage results in a low value for the manual warrior pull process for the most prevalent size and number of files. This assessment is summarized in table 4.

Table 4. JBS Value, November, 1996: "Manual Warrior Pull" (Small Files)

JBS PRODUCT	USAGE	IMPACT	VALUE
Data: "Manual Warrior Pull" (Small Files)	Low	Low	Low

The second case to consider is for very large files. One of the success stories for JBS has been the ability to send extremely large files, 300 to 600 MB, to Tuzla, B-H. These files are created using a legacy system called the FACPAC which allows the analyst to piece together parts of different imagery files to create one large picture. Due to the huge file size, these files were never transmitted electronically before. Instead, printouts of the files were sent via courier, a method which could take four days to get the imagery to the desired location.[19] Now, however, the Tuzla JBS terminal receives these large electronic files, and due to the industriousness of Chief Warrant Officer Rodriguez, a FACPAC was installed there where he prints out these large files in support of the MND.[20]

Looking again at the stated criteria for value it must be determined when and if the FACPAC files add value and the associated impact. In this case, it passes the first test since the JBS provides data that was not accessible with existing systems and certainly passes the second test in providing the imagery substantially quicker. As previously postulated, providing a new capability has the potential for providing the biggest mission impact. Investigating the usage will provide some information regarding the FACPAC's impact.

Two instances of transmitting FACPAC files via JBS have been identified. The first was in July 1996 when six FACPAC files were sent to Tuzla to support the planned elections in Bosnia-Herzegovina.[21] The second instance was deduced from the JAC logs which show at least one 311 MB file was transmitted to Tuzla on 31 October 1996.

According to the JAC logs, this was the only large file broadcast between 27 August and 31 November 1996.[22] However, the FACPAC operator at the JAC interviewed on 25 November 1996 did not mention this later instance. It is possible that he was on travel or just not aware of those transmissions on 31 October 1996.[23] Regardless, given this usage, a qualitative assessment of the impact is needed so the overall value can be determined.

The impact of large format imagery is inherently greater than smaller imagery due to the ability to see more items in relation to each other. Couple this with the intended use to support elections which are critical to establishing long range political stability and enabling nation building processes to begin, the potential impact of this capability is moderate to high. However, due to the limited use, one or two occurrences, the overall value was at best moderate. This assessment is summarized in table 5.

Table 5. JBS Value, November 1996: "Manual Warrior Pull" (FACPAC Files)

JBS PRODUCT	USAGE	IMPACT	VALUE
Data: "Manual Warrior Pull" (FACPAC files)	Low	Moderate-High	Moderate

Streaming Data

The stated criteria cannot be used for streaming data. Since the streaming data currently sent by JBS is Signals Intelligence (SIGINT), any discussion of how it was used and what impact it had would be classified. However, the JBS User Questionnaire (Appendix G) and users conference confirm that the users desire this capability, and the users have not given any negative feedback.[24]

Summary: Value to the Warrior

Table 6 summarizes the JBS value to the warrior as of November 1996 in the various areas discussed. The author feels compelled to emphasize that this is an independent assessment of the JBS value to the operational user in Bosnia-Herzegovina as of November 1996, the month before the originally scheduled departure of US troops from the region. It in no way reflects the potential value once the system matures and transitions to GBS.

Table 6. Summary: JBS Value by Product, November 1996

JBS PRODUCT	USAGE	IMPACT	VALUE
Video	Low	High	**Moderate**
Data Files			
Manual Warrior Push and Peck	Low	Low	**Low**
Manual Warrior Pull (Small Files)	Low	Low	**Low**
Manual Warrior Pull (FACPAC files)	Low	Moderate-High	**Moderate**
Streaming Data	Not Assessed	Not Assessed	**Not Assessed**

Notes

[1] *Webster's Third New International Dictionary*, vol 3, *S to Z* (Chicago, Encyclopedia Britannica, Inc.,1986), 2530.

[2] *Webster's Third New International Dictionary*, vol 1, *A to G* (Chicago, Encyclopedia Britannica, Inc.,1986), 460.

[3] Maj David S. Fadok, *John Boyd and John Warden Air Power's Quest for Strategic Paralysis*, (Maxwell AFB, AL: Air University Press, February 1995), 16.

[4] Maj Mark C. Biwer, "JBS User Questionnaire," 7 January 1997, completed questionnaires from Mostar and USAFE.

[5] Lt Col Young and Maj William Boronow, HQ US European Command, Patch Barracks, GE, interviewed by author, 27 November 1996.

[6] LTC Edward C. Cardon, US Army Europe, Heidelberg, GE, "Predator," E-mail, 11 February 1997.

[7] Boronow, draft memorandum, subject: Command BC2A 0-6 Oversight Visit, 4.

[8] Minutes of the Bosnia Command and Control Augmentation (BC2A) Users' Conference conducted at HQ USAFE, Ramstein AB, Germany, 24-25 September 1996, 1.

[9] HQ USEUCOM/J6, *Concept of Operations BC2A, Annex B*, B-26.

Notes

[10] Beale, 4.

[11] Boronow, draft memorandum, subject: Command BC2A 0-6 Oversight Visit, 1.

[12] Boronow, draft memorandum for record, subject: Trip Report, EUCOM O-6 BC2A oversight trip.

[13] Boronow, draft memorandum, subject: Command BC2A 0-6 Oversight Visit, 1; and Biwer, "JBS User Questionnaire," 7 January 1997, completed questionnaire from USAFE

[14] Boronow, draft memorandum, subject: Command BC2A 0-6 Oversight Visit, 1.

[15] Ibid., 2.

[16] LT Jack Shriver, JAC, RAF Molesworth, UK, "Re: More questions," E-mail, 24 March 1997.

[17] Ibid.

[18] Lt Col Dunn, JAC, RAF Molesworth, UK, interviewed by author, 25 November 1996.

[19] Shawn Beeson, JEWAL, contractor at the JAC, RAF Molesworth, UK, interviewed by author, 25 November 1996.

[20] Boronow, draft memorandum for record, subject: Trip Report, EUCOM O-6 BC2A oversight trip, 3.

[21] Beeson.

[22] JBS files sent log, RAF Molesworth, UK, 27 August 1996 - 2 December 1996.

[23] Beeson.

[24] Notes, BC2A Users' Conference conducted at HQ USAFE, Ramstein AB, Germany, 24-25 September 1996, electronic file titled "userconf.doc."

Chapter 5

Joint Broadcast Service: Lessons Learned and Recommendations

There are a number of critical lessons to be learned from the previous discussion. These lessons are compiled here in conjunction with additional lessons learned which should all be addressed during the development and fielding of the GBS.

Information Management

Although the concept for JBS is “Smart Push” and “Warrior Pull,” the system does not yet support this. Thus, the most critical lesson learned is that the information management function as designed by the EIMC MUST be in place for the JBS to be useful to the warrior, especially for data file transfer. This includes the necessary software, tools and procedures. Without it, the system cannot realistically be used operationally for data products. See the BC2A CONOPS, HQ USEUCOM J-6, 20 September 1996 for details.

Configuration

After information management, the next biggest challenge is integrating the JBS receive sites and the JBS injection points into local US SECRET and NATO LANs where applicable. Once completed, this integration will greatly enhance the JBS sites’ value at both ends of the information cycle. At the start of the cycle, integration will provide the end user the capability to search local information servers for desired products and to search the JIMC catalog (broadcast routinely to the JBS receive sites) for products available for request. At the end of the cycle it eliminates the administrative overhead required to transfer the files and allows the end user to get the desired products quicker. Next, integrating the JAC LAN with the TIS will significantly enhance the JBS responsiveness to RFIs.

Implementation Strategy

The JBS was fielded to 27 operational sites before the necessary functional and maintenance capabilities existed. Except for the Predator UAV video, this resulted in frustration and little operational use due to the lack of automated information management. To alleviate this in the future, GBS implementors should not send equipment into the field without the desired minimum operational user capabilities in place. When the system is finally fielded, testing the system with a limited number of equipment sets at operational sites will resolve unforeseen problems before burdening the user with them.

Operations and Maintenance

The BC2A program arose out of an Advanced Concept Technology Demonstration and was rapidly deployed to support the Bosnia crisis. Given the short time fuse and limited budget, there was not enough time to develop and implement the normal plans for training and maintenance prior to deployment. Based on user feedback, this resulted in the following recommendations from this study.

For training there are two broad topics, the training course and the ability to teach that course to those who need it. Regarding the course, some operators thought the training was marginal.[1] An obvious recommendation is to develop better training materials and system manuals. However, once the training materials are developed, it is difficult to keep operators trained. Currently, operators are rotating to each site on three-month temporary duty assignments. Given the rapid deployment of the system and limited funding, there are currently no permanent billets for the JBS operators. Training was assigned to USAFE which had to quickly ramp up an organic capability and conduct on-site training.[2] As a minimum, operators should be trained before deploying or at least en route.[3]

In addition to training materials, a maintenance concept and procedures need to be developed and followed. Maintenance of the JBS equipment is performed by contractors on site. To keep the operator informed, maintenance workers need to document configuration changes and other maintenance actions, then follow-up by outbriefing users.[4]

Finally, the terminal design needs to take into account expected local conditions to ensure proper operation. All sites in Bosnia are dusty due to dirt roads and traffic which make it difficult to keep the equipment clean.[5]

Warrior Recommended Uses

Appendix H contains tables which identify the streaming data, data, and video products that HQ USEUCOM, the USEUCOM components and the users in the field desire for JBS. These tables can also be used as a basis for GBS. Since new products often require developing interfaces with the sources or for the information itself, these lists should be reviewed and addressed on a case by case basis.

Conclusion

The DOD is developing GBS to answer the warfighter's critical communications needs. It features high bandwidth, one-way broadcast of multimedia products to forward deployed forces. As part of the proof-of-concept the DOD deployed the JBS to the EUCOM theater of operations to provide limited operational support to the UN peace-keeping effort in Bosnia-Herzegovina. The author developed criteria for evaluating the value of this operational support and used these criteria to determine the value of the video, data file, and streaming data products as of November 1996. This information was summarized in Table 6.

The initial effort was to provide Predator UAV video to forward deployed commanders. The high impact nature of this capability was confirmed on at least two occasions demonstrating the potential for a very high value. However, the success of the peacekeeping mission provided few opportunities for this high value to be realized. No doubt this capability will be highly desired in future military missions.

In contrast, due to the rapid deployment of JBS to support efforts in Bosnia, the concepts, software and tools necessary to effect the "Smart Push" and "Warrior Pull" themes of JBS/GBS for data files lagged far behind the video. As a consequence, the software and tools necessary to implement the information management concept of operations were not available in November 1996. This resulted in generally low usage, impact and value to the user. The one exception was the distribution of large format imagery files to Tuzla, Bosnia-Herzegovina.

From the factors contributing to the assessed value, the most critical lessons learned become apparent. These lessons are the need for software and tools to implement the theater CINC's information management concept; and the need to integrate JBS sites with LANs, DISN and allied systems. Additional lessons learned include the need for improved implementation and operations and maintenance strategies, and recommendations for future products to broadcast via JBS/GBS. The developers of the GBS system need to heed these lessons and closely follow the remainder of the JBS deployment supporting Bosnia to ensure GBS meets the users' needs when it is first deployed.

Notes

[1] Boronow, draft memorandum, subject: Command BC2A 0-6 Oversight Visit, 2,3.
[2] Capt Mitch Maddox, HQ USAFE, interviewed by author, 26 November 1996.
[3] Minutes of BC2A Users' Conference, Atch 1.
[4] Boronow, draft memorandum for record, subject: Trip Report, EUCOM O-6 BC2A oversight trip, 1, 3.
[5] Ibid., 1.

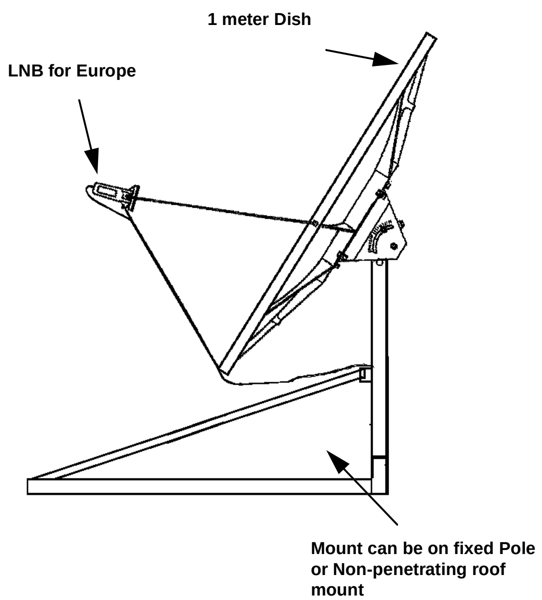
Appendix A

JBS Receive Suite

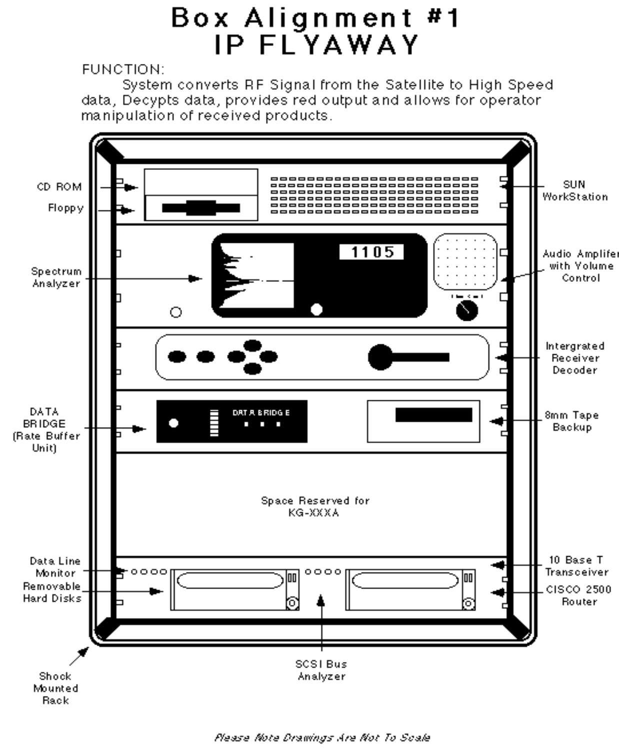
The JBS receive suite is made up of an antenna and several modular units called "flyaway" cases. The desired capability at each site determines which cases are included. Figure 7 shows the antenna and the modular case containing the equipment necessary to receive an IP data stream. Figure 8 shows the video receive flyaway case and the flyaway case housing the monitor for the IP equipment. Not shown is another case containing a 60 Gigabyte small information server.[1]

Deployment Ready JBS Receive Suite
(1 of 2)

Satellite Antenna and associated electronic



Please Note Drawings Are Not To Scale

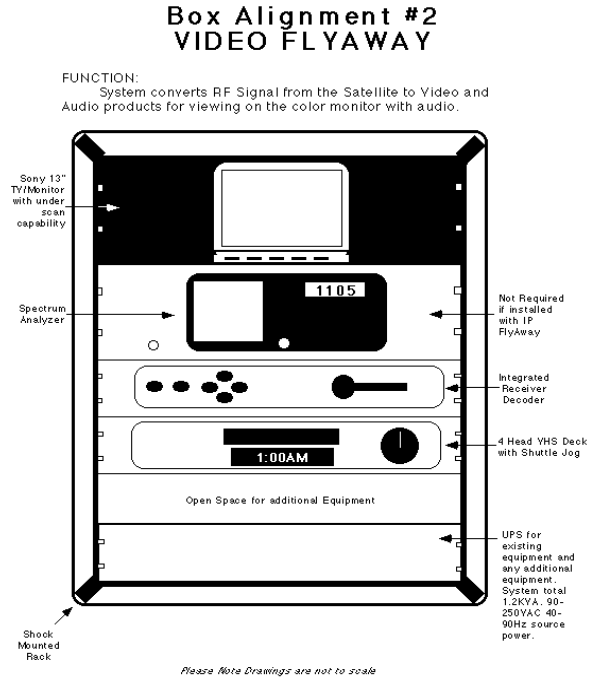


150 lbs (36"H X 24" W X 36" H)

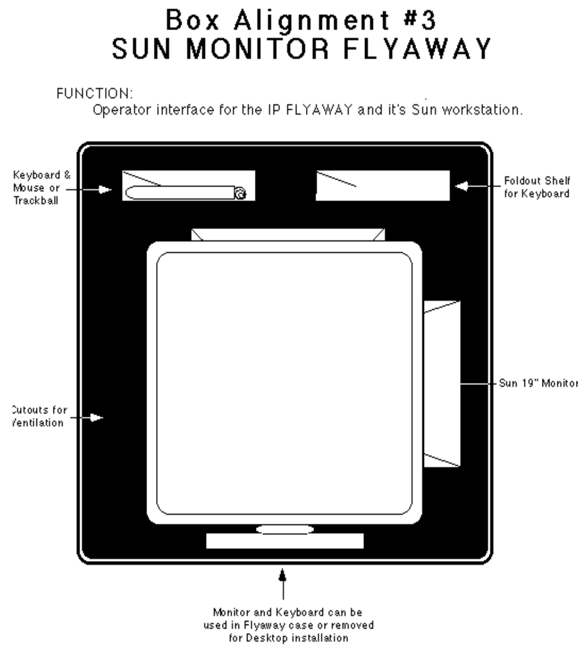
Source: HQ USEUCOM/J6, *Concept of Operations Bosnia Command and Control Augmentation, Annex B, Joint Broadcast System (JBS) Implementation*, 20 September 1996, B-10.

Figure 7. Deployment Ready JBS Receive Suite, Antenna and Alignment 1

Deployment Ready JBS Receive Suite (2 of 2)



150 lbs (36”H X 24” W X 36” H)



75 lbs (36”H X 24” W X 30”H)

Source: HQ USEUCOM/J6, *Concept of Operations Bosnia Command and Control Augmentation, Annex B, Joint Broadcast System (JBS) Implementation*, 20 September 1996, B-11.

Figure 8. Deployment Ready JBS Receive Suite, Alignment 2 and 3

Notes

[1] Maj William Boronow, HQ USEUCOM, “Bosnia Command and Control Augmentation,” undated briefing.

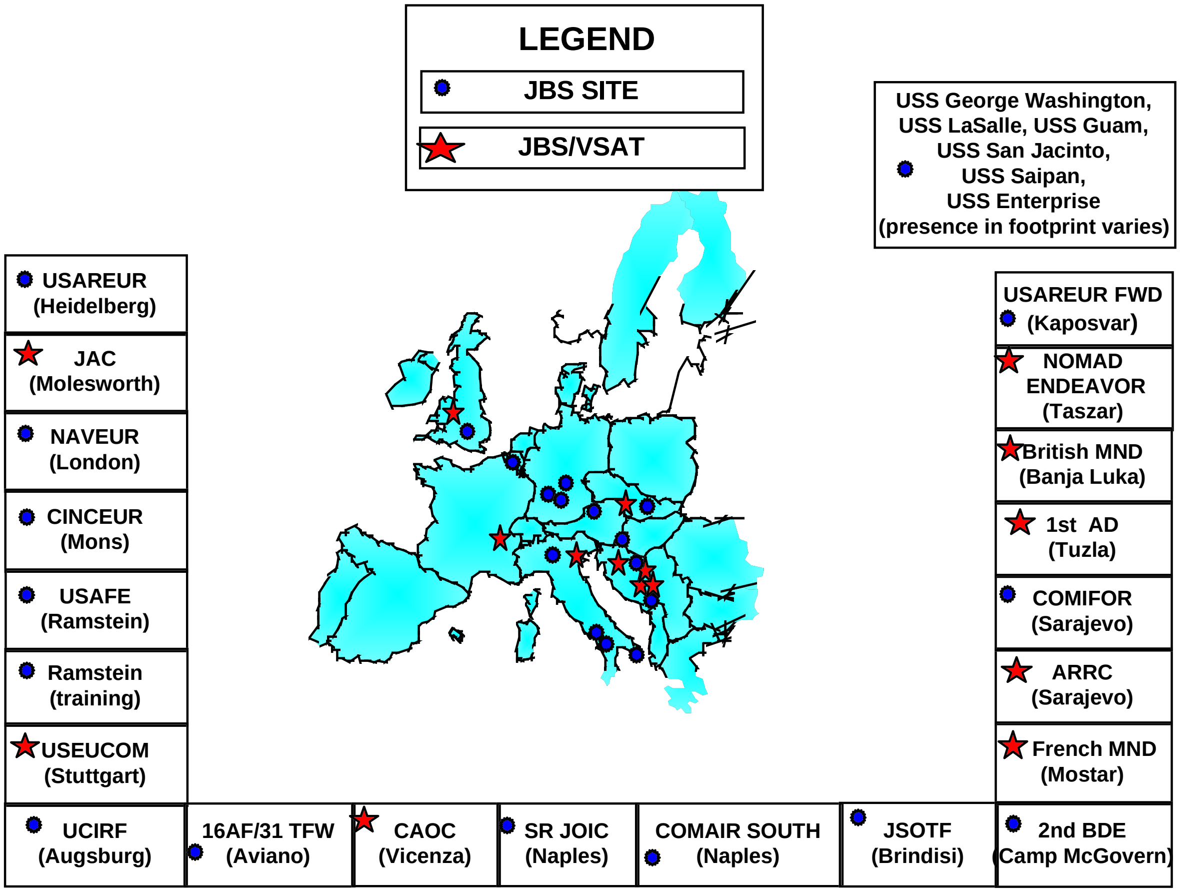
Appendix B

JBS Sites

Table 7. List of 27 JBS Sites

Location	Organization
Augsburg, Germany	UCIRF
Aviano AB, Italy	16th AF/31st FW
Banja Luka, Bosnia-Herzegovina	British MND
Brindisi, Italy	Joint Special Operations Task Force (JSOTF)
Camp McGovern, B-H	2nd Brigade
Heidelberg, Germany	USAREUR and V Corps
Kaposvar, Hungary	USAREUR FWD
London, United Kingdom	USNAVEUR
Mons, Belgium	USCINCEUR
Mostar, Bosnia-Herzegovina	French MND
Naples, Italy	SR JOIC
Naples, Italy	COMAIRSOUTH
RAF Molesworth, United Kingdom	Joint Analysis Center (JAC)
Ramstein AB, Germany	USAFE
Ramstein AB, Germany	BC2ATraining Facility
Sarajevo, Bosnia-Herzegovina	ACE Rapid Reaction Corps (ARRC)
Sarajevo, Bosnia-Herzegovina	COMIFOR
Taszar, Hungary	Nomad Endeavor (Predator UAV)
Tuzla, Bosnia-Herzegovina	1st Armored Division
USS Enterprise	CTF-60
USS George Washington	CTF-60
USS Guam	MARG
USS LaSalle	COMSIXTHFLEET
USS Saipan	CTF61/CTF62
USS San Jacinto	(JWID '95 Demo)
Vaihingen, Germany	USEUCOM
Vicenza, Italy	Combined Air Operations Center (CAOC)

Sources: Maj William Boronow, HQ USEUCOM, “Expected BC2A Sites,” electronic file dated 30 October 1996; and Maj William Boronow, HQ USEUCOM, "Bosnia Command and Control Augmentation," undated briefing



Source: Adapted from Maj William Boronow, HQ USEUCOM, "Bosnia Command and Control Augmentation," briefing, undated .

Figure 9. JBS Site Locations

Appendix C

Value Criteria and Calculations

Table 8 contains a matrix of all possible impact, usage and resulting value assessments. The value is determined by averaging the assessments for impact and usage.

Table 8. Value Calculation Matrix

Impact	Usage	Value
Low	Low	Low
Low	Moderate	Low-Moderate
Low	High	Moderate
Moderate	Low	Low-Moderate
Moderate	Moderate	Moderate
Moderate	High	Moderate-High
High	Low	Moderate
High	Moderate	Moderate-High
High	High	High

Appendix D

JBS Data Timeline Estimates

Based on data from logs of files sent from the JAC in November 1996, the approximate median number of pushed imagery files was 75 per day from the JAC alone (Appendix E, table 13). As noted under Current Operations in chapter 3, the JAC is sending all imagery it produces related to the Balkan Area of Operations to all JBS sites. Data on imagery pushed by the JIMC were not available for November 1996, but based on the JBS user questionnaire (Appendix G, table 16) results from January 1997, it is conservative to say that the JIMC pushed at least 15 imagery files per day.

In addition, numerous weather files were pushed during this time period. Again, details during this time period are not available, but based on the feedback in November 1996 and Appendix G, table 16, it is likely that at least 100 weather files were pushed per day was well.[1] At an average of 4 MB per file, this works out to 760 MB per day sent over the JBS. At the maximum 3 Mbps data rate for the IP channel in use in November 1996, the entire day's scheduled broadcast (not including RFI's) would take approximately 35 minutes. However, based on user feedback, the weather data pushed from the CONUS was mostly unused and only certain imagery files were desired by given site.[2]

Once a JBS site has received all the broadcast files, the end user needs to find the files that interest them. Based on the results of the questionnaire, a more reasonable number of desired imagery files per day is 30 or less (Appendix G, table 16). Assuming only 30 imagery files were desired out of the 190 files pushed, the operator would have to scroll down the RDM and open the meta-data for all 190 files to find the 30 desired files. If it only takes 15 seconds to open the meta-data, decide whether or not the file is needed, and delete it if not needed, it would take an additional 47 minutes to go through all 190 files. This adds up to a total time of over 80 minutes to send and receive desired files. To put this into perspective, the "effective" data rate for this example as defined by equation F.1 in Appendix F is only 202 kbps (0.202 Mbps)!

Notes

[1] Boronow, draft memorandum, subject: Command BC2A 0-6 Oversight Visit, 1.
[2] Ibid.

Appendix E

Theater Injection Logs

Table 9. US Files Transmitted via JBS from RAF Molesworth, UK, Nov. 1996

Date	Time	No.	Type	Size	Destination	Comments
1-Nov	0800Z	33	Image	2-4MB	All	Morning broadcast
1-Nov	0850Z	33	Image	2-4MB	All	Wrap of morning broadcast
2-Nov	0926Z	131	Image	2-4MB	All	Morning broadcast
4-Nov	0945Z	99	Image	2-4MB	All	Morning broadcast
5-Nov	0859Z	29	Image	2-4MB	All	Morning broadcast
8-Nov	1530Z	29	Image	2-4MB	All	Morning broadcast
9-Nov	1630Z	28	Image	2-4MB	All	Morning broadcast
12-Nov	0930Z	5	Image	2-4MB	All	Morning broadcast
13-Nov	0855Z	11	Image	2-4MB	All	Morning broadcast
14-Nov	0935Z	10	Image	2-4MB	All	Morning broadcast
15-Nov	0300Z	17	Image	2-4MB	Sarajevo	Special request (RFI 96319E)
15-Nov	0530Z	20	Image	2-4MB	Sarajevo	Special request (RFI 96319E)
15-Nov	0557Z	2	Image	2-4MB	Sarajevo	Special request (RFI 96319E)
15-Nov	1000Z	8	Image	2-4MB	Sarajevo	Special request (RFI 96319J)
15-Nov	1030Z	8	Image	2-4MB	All	Morning broadcast
16-Nov	0025Z	4	Image	2-4MB	Sarajevo	Special request (RFI 96320D)
16-Nov	1004Z	4	Image	2-4MB	All	Morning broadcast
18-Nov	0900Z	18	Image	2-4MB	All	Morning broadcast
19-Nov	0903Z	12	Image	2-4MB	All	Morning broadcast
20-Nov	0849Z	8	Image	2-4MB	All	Morning broadcast
21-Nov	1017Z	38	Image	2-4MB	All	Morning broadcast
22-Nov	0938Z	9	Image	2-4MB	All	Morning broadcast
25-Nov	0912Z	3	Image	2-4MB	All	Morning broadcast
26-Nov	0904Z	18	Image	2-4MB	All	Morning broadcast
26-Nov	1050Z	7	Image	2-4MB	Brindisi	Special request
26-Nov	1800Z	23	Image	2-4MB	Brindisi	Special request
26-Nov	1815Z	55	Image	2-4MB	Brindisi	Special request
26-Nov	1840Z	1	Image	2-4MB	Camp McGovern	Special request
27-Nov	0953Z	18	Image	2-4MB	All	Morning broadcast
28-Nov	1400Z	42	Image	2-4MB	All	Morning broadcast
29-Nov	1205Z	15	Image	2-4MB	All	Morning broadcast
30-Nov	1105Z	3	Image	2-4MB	All	Morning broadcast

Source: JBS files sent log, RAF Molesworth, UK, 27 August 1996–2 December 1996.

Table 10. Statistics of US only files transmitted from RAF Molesworth, UK, November 1996

Statistic	Value
RFI Files	
Total	137.0
Average per request (9 requests)	15.2
Standard Deviation	16.0
Median per request (9 requests)	8.0
Pushed Files	
Total	571.0
Average per day any files sent (22 days)	26.0
Standard Deviation	30.7
Median per day any files sent (22 days)	16.5

Table 11. NATO Files Transmitted from RAF Molesworth, UK, November 1996

Date	Time	No.	Type	Size	Destination	Comments
1-Nov	0952Z	79	Image	2-4MB	All	Morning broadcast
2-Nov	1021Z	183	Image	2-4MB	All	Morning broadcast
4-Nov	1050Z	160	Image	2-4MB	All	Morning broadcast
5-Nov	0939Z	50	Image	2-4MB	All	Morning broadcast
5-Nov	1726Z	85	Image	2-4MB	Vicenza	Special request
6-Nov	1230Z	79	Image	2-4MB	All	Morning broadcast
7-Nov	0826Z	16	Image	2-4MB	All	Morning broadcast
8-Nov	1050Z	3	Image	2-4MB	All	Morning broadcast
12-Nov	1128Z	83	Image	2-4MB	All	Morning broadcast
13-Nov	0930Z	0	----	----	----	5ATAF server down
14-Nov	0945Z	0	----	----	----	5ATAF server down
15-Nov	1730Z	5	Image	2-4 MB	All	Morning broadcast
16-Nov	1015Z	70	Image	2-4MB	All	Morning broadcast
18-Nov	0918Z	146	Image	2-4MB	All	Morning broadcast
19-Nov	1650Z	17	Image	2-4MB	All	Morning broadcast
20-Nov	----	0	----	----	----	LOCE software problem
21-Nov	----	0	----	----	----	LOCE software problem
22-Nov	----	0	----	----	----	LOCE software problem
27-Nov	1715Z	87	Image	2-4MB	All	Morning broadcast
29-Nov	1205Z	36	Image	2-4MB	All	Morning broadcast
30-Nov	1130Z	7	Image	2-4MB	All	Morning broadcast

Source: JBS files sent log, RAF Molesworth, UK, 27 August 1996–2 December 1996.

Table 12. Statistics of NATO files from RAF Molesworth, UK, Nov. 1996

Statistic	Value
RFI Files	
Total	85.0
Average per transmission (1 total)	85.0
Standard Deviation	0.0
Median per transmission (1 total)	85.0
Pushed Files	
Total	1026.0
Average per day any files sent (16 days)	64.1
Standard Deviation	56.4
Median per day any files sent (22 days)	60.0

Table 13. US/NATO statistics of files from RAF Molesworth, UK, Nov. 1996

Statistic	Value
RFI Files	
Total	222.0
Average per transmission (10 total)	22.2
Standard Deviation	25.8
Median per transmission (10 total)	12.5
Pushed Files	
Total	1597.0
Average US + Ave NATO per day	90.1
Standard Deviation	-----
Median US + Median NATO per day	76.5

Appendix F

System Comparison Equations

This appendix develops the general equations used in Chapter 4 to determine when the end user will get the desired data product faster via JBS than with existing systems in theater. The author developed these equations for both the manual warrior push and warrior pull processes as they existed in November 1996.

Manual Warrior Push and Peck Equations

The crux of the discussion of the manual push was that a large number of undesired files were being pushed. In addition, the lack of information management tools caused further inefficiencies which hampered the capability of JBS to get the data to the end user faster than existing systems. Taking into account these inefficiencies, it is instructive to develop two useful equations. The first one determines the "effective" data rate of JBS for manual push which allows for comparison with existing systems' data rates. The second equation is used to calculate how many undesired files can be pushed along with the desired files before using JBS is actually slower than using an existing system such as Intelink-S over the SIPRNET.

In order to develop the desired equations, the necessary parameters are defined in Table 14. Additional clarifying information for these parameters is presented in the remainder of this paragraph. The total number of files transmitted in the JBS manual push scenario is labeled *a*. The files are sent in batches with a varying number of files per batch. This total includes the actual desired files, *b*, plus the number of undesired pushed files, *c*, which can be related as

$$a = b + c .$$

For the comparison system, the total number of files is the same as the desired number of files, so there are no undesired files transmitted. Similarly, the time to open the meta-data, t_o, is not applicable since the operator only received the desired files; he does not have to search one by one through undesired files. Next, the JBS data rate, dy/dt, is equal to the factor, *m*, multiplied by the comparison system data rate. After the equations are derived, this factor can be varied to determined different break-even points for undesired files sent for different ratios of JBS to comparison system data rates. Building on the data rate is the concept of "effective" data rate. For JBS the "effective" data rate is merely the total number of desired megabytes (file size x number of desired files) divided by the total time, t_j, to get the desired megabytes to the end user. For the comparison system the "effective" data rate is equal to the actual data rate since the desired files are going directly to the end user.

Table 14. Parameters for Manual Warrior Push Equations

Parameter	JBS	Comparison System
Total number of files transmitted	a	b
Number of desired files transmitted	b	b
Number of undesired files transmitted	c	----
Time to open meta-data for each file transmitted	t_o	----
Average size of files transmitted (MB)	f	f
Data rate where *m* is a constant	$dy/dt = m \cdot dr/dt$	dr/dt
Effective data rate	dx/dt	dr/dt
Time to transmit all files in a batch to end user	t_j	t_c

Given these parameters, the first equation to derive is the JBS "effective" data rate. From our previous definition, it is represented as

$$dx/dt = \frac{b \cdot f}{t_j}.$$

Next, the total time, t_j, is defined as

$$t_j = \frac{a \cdot f}{dy/dt} + a \cdot t_o.$$

Substituting for t_j in the "effective" data rate equation and algebraically reducing results in

$$dx/dt = \frac{(dy/dt) \cdot b \cdot f}{a(f + t_o \cdot (dy/dt))}.$$

Finally, substituting for a to get the "effective" data rate equation for the manual push scenario

$$\text{JBS "effective" data rate} = dx/dt = \frac{(dy/dt) \cdot b \cdot f}{(b+c)(f + t_o \cdot (dy/dt))}. \quad \text{(Equation F.1)}$$

This equation is now used as a basis to derive the desired formula which calculates the maximum number of undesired files, *c*, which can be transmitted by JBS along with the desired files, *b*, before using JBS is actually slower than using an existing system. This transition occurs when the "effective" data rates of JBS and the comparison system are the same, $dx/dt = dr/dt$. Substituting for dx/dt and dy/dt in equation F.1 and solving for *c* results in the desired equation

$$c = \left(\frac{m \cdot b \cdot f}{f + t_o \cdot m \cdot (dr/dt)} - b \right) \qquad \text{(Equation F.2)}$$

Manual Warrior Pull Equations

The relevant aspect of the manual warrior pull was the lack of a LAN connection between the JAC and the JBS equipment at the injection point at RAF Molesworth, UK. Taking this into account, it is instructive to develop several useful equations. As was the case with the manual push scenario, the first one determines the "effective" data rate of JBS which allows for comparison with existing systems' data rates. The second equation permits one to calculate the maximum time allowed to transfer requested files to the JBS equipment before it would be faster to use the comparison system. The next equation is used to calculate the minimum number of files in a batch which must be sent to get the files to the end user quicker using JBS than using the comparison system.

In order to develop the desired equations, the necessary parameters are defined in Table 15. These parameters the same as those in Table 14 except for the total number of files transmitted, *a*, and the time to transfer files from JAC to JBS equipment, t_{tr}. This time is not applicable to the comparison system since it is connected directly to the source system.

Table 15. Parameters for Manual Warrior Pull Equations

Parameter	JBS	Comparison System
Total number of files transmitted	a	a
Time to transfer files from JAC to JBS equipment	t_{tr}	----
Average size of files transmitted (MB)	f	f
Data rate where *m* is a constant	$dy/dt = m \cdot dr/dt$	dr/dt
Effective data rate	dx/dt	dr/dt
Time to transmit all files in a batch to end user	t_j	t_c

Given these parameters, the first equation to derive is the JBS "effective" data rate. From our previous definition, it is represented as

$$dx/dt = \frac{a \cdot f}{t_j}.$$

Next, the total time, t_j, is defined as

$$t_j = \frac{a \cdot f}{dy/dt} + t_{tr}. \qquad \text{(Equation F.3)}$$

Substituting for t_j in the "effective" data rate equation and algebraically reducing results in

$$\text{JBS "effective" data rate} = dx/dt = \frac{(dy/dt) \cdot a \cdot f}{a \cdot f + t_{tr} \cdot (dy/dt)}. \qquad \text{(Equation F.4)}$$

This equation is now used as a basis to derive the desired formula which permits one to calculate the maximum time allowed to transfer requested files to the JBS equipment before it would be faster to use the comparison system. This transition occurs when the “effective” data rates of JBS and the comparison system are the same, ${dx}/{dt} = {dr}/{dt}$.

Substituting for ${dx}/{dt}$ and ${dy}/{dt}$ in equation F.4 results in

$$ {dr}/{dt} = \frac{m \cdot (dr/dt) \cdot a \cdot f}{a \cdot f + t_{tr} \cdot m \cdot (dr/dt)}. $$

Then, solve for t_{tr} to get the maximum transfer time

$$ t_{tr} = \frac{a \cdot f(m-1)}{m \cdot (dr/dt)}. \qquad \text{(Equation F.5)} $$

In addition, solve for a to derive the equation to determine the minimum number of files in a batch which must be sent to get the files to the end user quicker using JBS than using the comparison system

$$ a = \frac{t_{tr} \cdot m \cdot (dr/dt)}{f \cdot (m-1)}. \qquad \text{(Equation F.6)} $$

The last equation of interest is to solve for m in terms of the JBS data rate, ${dy}/{dt}$ and independent of the comparison system data rate, ${dr}/{dt}$. Remembering our definition of ${dy}/{dt}$,

$$ {dy}/{dt} = m \cdot {dr}/{dt}, $$

${dr}/{dt}$ needs to be defined in terms of other parameters. Since the data rate is equal to the total number of bytes divided by the total time to transmit those bytes, it is represented as

$$ {dr}/{dt} = \frac{a \cdot f}{t_c}. $$

Substituting this equation for dr/dt in the equation for dy/dt and solving for the total time results in

$$t_c = \frac{m \cdot a \cdot f}{dy/dt}.$$

The factor, *m*, at which the comparison system is as fast as JBS occurs when the total time to transfer the data using either JBS or the comparison system is the same, $t_j = t_c$. Using equation F.3 for t_j results in

$$\frac{a \cdot f}{dy/dt} + t_{tr} = \frac{m \cdot a \cdot f}{dy/dt}.$$

Finally, solve for *m* to obtain

$$m = 1 + \frac{t_{tr}(dy/dt)}{a \cdot f}. \qquad \text{(Equation F.7)}$$

Appendix G

JBS User Questionnaire

A JBS user questionnaire, dated 7 January 1997 was broadcast to all JBS receive sites in January 1997. The questionnaire was designed to obtain information regarding intra-theater and inter-theater data to support a different research topic than the value to the warrior topic developed in this study. Unfortunately, despite USEUCOM/J6 endorsement, only four of 27 sites responded, and at best, only three had usable data, requiring modification of the planned topic. Even the data from these three sites is partially suspect since there is some evidence that the instructions were not followed in every case. Despite this uncertainty, some data can be extracted for use in this study and is presented in table 16. The actual questionnaire follows table 16.

Table 16. JBS User Questionnaire Selected Results

Location	Weather Files Pushed per Day (4 MB)	Imagery Files Pushed by JIMC per Day (4 MB)	Imagery Files Recvd per Day (4 MB)	Streaming Data Rcvd/Desired
Ramstein AB, GE	59[a]	16	16	Yes/Yes
RAF Molesworth, UK	100	26	35	-------
Mostar, B-H	25	24	24	Yes/Yes

Source: Maj Mark C. Biwer, “JBS User Questionnaire,” 7 January 1997, completed questionnaires.

[a] Equivalent 4 MB files. Completed questionnaire reported 471, 0.5 MB files.

JBS User Questionnaire

User Location (Please fill in):____________________

1. The following table requests information on various types of data that your command currently receives or desires to have to help with your mission. Please fill it out as best you can. The second and last columns are the most critical. If you answer "Yes" in either of these columns for a given type of data (you currently receive it or would like to receive it via JBS or GBS), please provide your best estimates for the third, fourth and fifth columns. In the third, fourth and fifth columns, DO NOT include any JBS files that are being pushed to you that you do not require. For the third column "Average number of files received per day", if you do not receive a certain type of data every day, then divide one file by the number of days between files to provide a fraction. For example, if you only receive one U2 imagery file per week, then 1/7=0.14. (Some estimates are already filled in. If you feel they are unrealistic, please provide your estimates)

Data Type	**Do you currently receive via any method? (Yes/No)**	**Average number of files received per day (U/S/TS*/ Rel-NATO)***	**Average file size? (MB)**	**Ave. % files CONUS source/ Ave. % files Theater Source (%)**	**Do you desire to receive via JBS or GBS*? (Yes/No)**
Imagery:					
NITF/TIF files			4		
Multi-Spectral files			30		
Chip-Chunk (FACPAC)			500		
U2					
Broad Area Imagery (Eagle Vision)					
Predator Freeze Frame					
Video Clips					
JSTARS MTI/SAR data				0/100	
SIGINT: Binocular, TRAP, TIBS					
MC&G Products					
Weather Images					
Common Operating Picture					

Data Type	Do you currently receive via any method? (Yes/No)	Average number of files received per day (U/S/TS*/ Rel-NATO*)	Average file size? (MB)	Ave. % files CONUS source/ Ave. % files Theater Source (%)	Do you desire to receive via JBS or GBS*? (Yes/No)
Database updates: Intel, Logistics, Personnel,					
ATM/ATO				0/100	
TMD Warning Messages					
Blue Dart					
Standard STACCS Applications					
INSUM					
SITREP					
Order of Battle Display					
Briefings:					
Chairman's Daily, J3 Daily				100/0	
SHAPE, IFOR				0/100	
ARRC				0/100	
Current Events:					
Early Bird		1/0/0/0		100/0	
Stars & Stripes		1/0/0/0			
Others: Please Specify					

* Enter estimate of numbers files of each of the following classification levels (Unclassified/US Secret/US Top Secret/NATO Secret). Although JBS does not support US Top Secret, the GBS Program will carry data up to this classification level.

2. Referring to your answers in the previous table, do you currently have sufficient communications infrastructure (not including JBS) to provide all types of required data when needed? ☐ Yes ☐ No

3. The following table requests information on real-time video/audio feeds that your command currently receives or desires to have to help with your mission. Please fill it out as best you can. The second and last columns are the most critical. If you answer

"Yes" in either of these columns for a given type of data (you currently receive it or would like to receive it via JBS or GBS), please provide your best estimates for the third and fourth columns. (Some estimates are already filled in. If you feel they are unrealistic, please provide your estimates)

Video Type	**Do you currently receive via any method?** **(Yes/No)**	**Average length of video received per day?** **(Hours)**	**Source Location?** **(Theater or CONUS)**	**Do you desire to receive via JBS or GBS*?** **(Yes/No)**
Currently Available:				
Predator UAV			Theater	
CNN		24	CONUS	
AFRTS		24	CONUS	
Future Possibilities:				
P3 Video Downlink				
Combat Camera				
F-16 Gun Camera				
ARL Downlink				
Grey Wolf Downlink				
Defense Intelligence Network				
Training Videos				
Pioneer				
Apache				
Other: Please Specify				

4. The following table requests information on various types of data that your command currently produces and desires to send out in theater via JBS or GBS. Please it fill out as best you can. The second and last columns are the most critical. If you answer "Yes" in either of these columns for a given type of data (you currently send it or would like to send it via JBS or GBS), please provide your best estimates for the third and fourth columns. (Some estimates are already filled in. If you feel they are unrealistic, please provide your estimates).

Data Type	**Do you currently send via any method?** **(Yes/No)**	**Average number of files sent per day** **(U/S/TS*/ Rel-NATO)***	**Average file size?** **(MB)**	**Do you desire to send via JBS or GBS*?** **(Yes/No)**
Imagery:				
NITF/TIF files			4	
Multi-Spectral files			30	
Chip-Chunk (FACPAC)			500	
U2				
Broad Area Imagery (Eagle Vision)				
Predator Freeze Frame				
Video Clips				
JSTARS MTI/SAR data				
SIGINT: Binocular, TRAP, TIBS				
MC&G Products				
Weather Images				
Common Operating Picture				
Database updates: Intel, Logistics, Personnel,				
ATM/ATO				
TMD Warning Messages				
Blue Dart				
Standard STACCS Applications				
INSUM				
SITREP				
Order of Battle Display				
Briefings:				
J3 Daily				
SHAPE, IFOR				
ARRC				
Others: Please Specify				

* Enter estimate of numbers files of each of the following classification levels (Unclassified/US Secret/US Top Secret/NATO Secret). Although JBS does not support US Top Secret, the GBS Program will carry data up to this classification level.

5. The following table requests information on real-time video/audio feeds that your command currently sends out or desires to send out to other theater assets. Please it fill out as best you can. The second and last columns are the most critical. If you answer "Yes" in either of these columns for a given type of data (you currently receive it or would like to receive it via JBS or GBS), please provide your best estimates for the third and fourth columns. (Some estimates are already filled in. If you feel they are unrealistic, please provide your estimates)

Video Type	**Do you currently disseminate via any method?** **(Yes/No)**	**Average length of video produced per day?** **(Hours)**	**Do you desire to send via JBS or GBS*?** **(Yes/No)**
Currently Available:			
Predator UAV			
CNN		24	
AFRTS		24	
Future Possibilities:			
P3 Video Downlink			
Combat Camera			
F-16 Gun Camera			
ARL Downlink			
Grey Wolf Downlink			
Defense Intelligence Network			
Training Videos			
Pioneer			
Apache			
Other: Please Specify			

6. Please list any critical assumptions you have made in determining your estimates that may be needed to properly interpret the results.

Appendix H

Warrior Recommended JBS Uses

This section identifies the streaming data, data, and video products that HQ USEUCOM, the USEUCOM components and the users in the field desire for JBS (see tables 17, 18 and 19, respectively). These tables can also be used as a basis for GBS. Since new products often require developing interfaces with the sources or for the information itself, these lists should be reviewed and addressed on a case by case basis. The "Recommended By" column identifies the USEUCOM component which recommended that product to be broadcast over JBS, and the "Desired By" column indicates the JBS receive site(s) which desires that capability. Unfortunately, despite USEUCOM/J6 endorsement, only 4 of 27 sites responded to the JBS User Questionnaire prepared by the author, with only three being usable. So the "Desired By" column should not be construed to mean the users in the field do not desire those capabilities which do not have any sites listed. At best this column could be a starting point for which products to add next if not already provided.

Table 17. Recommended Broadcast Products: Streaming Data

Data Type	Recommended By:	Desired By:
SIGINT:		
Binocular	USAFE, NAVEUR	USAFE, Mostar
TRAP		USAFE
TIBS	USAFE, NAVEUR	USAFE

Sources: Maj William Boronow, HQ USEUCOM, no subject, electronic file titled "tgtapps.doc," undated; author's collation of JBS User Questionnaire responses.

Table 18. Recommended Broadcast Products: Data

Data Type	Recommended By:	Desired By:
Imagery:		
NITF/TIF files	USAFE, NAVEUR	USAFE, Mostar
Multi-Spectral files		
Chip-Chunk (FACPAC)		
U2	USAFE, NAVEUR	Mostar
Broad Area Imagery (Eagle Vision)	USAFE, NAVEUR	
Predator Freeze Frame		
Video Clips	SOCEUR	
JSTARS MTI/SAR data	USAFE, NAVEUR	
MC&G Products	USAFE, NAVEUR, HQ EUCOM	
Weather Images		USAFE, Mostar
Common Operating Picture	USAFE, NAVEUR	
Database updates: e.g., Intel, Logistics, Personnel	USAFE, NAVEUR	
ATM/ATO	USAFE, NAVEUR	Mostar
TMD Warning Messages	USAFE, NAVEUR	
Blue Dart	USAREUR	
Standard STACCS Applications	USAREUR	
INSUM		
SITREP		
Order of Battle Display	HQ EUCOM	
3D Models of Facilities	SOCEUR	
Briefings:		
Chairman's Daily, J3 Daily		USAFE
SHAPE, IFOR		
ARRC		
Current Events:		
Early Bird		USAFE, Mostar
Stars & Stripes		USAFE, Mostar

Sources: Maj William Boronow, HQ USEUCOM, no subject, electronic file titled "tgtapps.doc," undated; author's collation of JBS User Questionnaire responses.

Table 19. Recommended Broadcast Products: Video

Video Type	Recommended By:	Desired By:
Currently Available:		
Predator UAV	USAFE, NAVEUR	USAFE, Mostar
CNN	USAFE, NAVEUR	USAFE, Mostar
AFRTS		USAFE, Mostar
Future Possibilities:		
P3 Video Downlink		USAFE, Mostar
Combat Camera		USAFE, Mostar
F-16 Gun Camera		USAFE, Mostar
ARL Downlink	USAFE, NAVEUR	USAFE
Grey Wolf Downlink	USAFE, NAVEUR	USAFE
Defense Intelligence Network	HQ EUCOM	USAFE
Training Videos	HQ EUCOM	USAFE, Mostar
Pioneer		USAFE, Mostar
Apache		USAFE, Mostar

Sources: Maj William Boronow, HQ USEUCOM, no subject, electronic file titled "tgtapps.doc," undated; and author's collation of JBS User Questionnaire responses.

Glossary

ATM	Asynchronous Transfer Mode
AFRTS	Armed Forces Radio and Television Service
BC2A	Bosnia Command and Control Augmentation
BMC	Broadcast Management Center
CAOC	Combined Air Operations Center
CIA	Central Intelligence Agency
CNN	Cable News Network
COE	Common Operating Environment
COMIFOR	Commander, Implementation Force
CONOPS	Concept of Operations
CONUS	Continental United States
DBS	Direct Broadcast Service
DII	Defense Information Infrastructure
DISA	Defense Information Systems Agency
DISN	Defense Information Systems Network
DMA	Defense Mapping Agency
EIMC	EUCOM Information Management Center
EUCOM	European Command
GBS	Global Broadcast Service
GCCS	Global Command and Control System
IFOR	Implementation Force
IP	Internet Protocol
IPA	Image Product Archive
JAC	Joint Analysis Center
JBS	Joint Broadcast Service
JIMC	Joint Information Management Center
JOC	Joint Operations Center
JORD	Joint Operational Requirements Document
kbps	kilobits per second

LAN	Local Area Network
MB	Megabyte
Mbps	Megabits per second
MND	Multi-National Division
MSE	Mobile Subscriber Equipment
NATO	North Atlantic Treaty Organization
NPIC	National Photography Intepretation Center
NSA	National Security Agency
OODA	Observe-Orient-Decide-Act
PIP	Primary Injection Point
RDM	Receive Data Manager
RF	Radio Frequency
RFI	Request For Information
SIPRNET	Secret Internet Protocol Router NETwork
SFOR	Sustainment Force
TBM	Transmit Broadcast Manager
TIBS	Tactical Information Broadcast Service
TIM	Theater Information Manager
TIP	Theater Injection Point
TIS	Theater Injection Site
TRAP	Tactical Related APplications
UAV	Unmanned Aerial Vehicle
UFO	UHF Follow-On
USNIC	United States National Intelligence Cell
VTC	Video Teleconference
VSAT	Very Small Aperture Terminal

Intelink-S. A web browser based search and retrieval system used for intelligence data up to the US SECRET classification level.

LOCE. A classified NATO communication system

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