III Corps Systems Architecture Performance Analysis

24 May 2002

Analysis Branch, TRADOC Architecture Integration and Processing Center

US Army Signal Center

Analysis Report

III Corps Systems Architecture

24 May 2002

PREPARED BY:	CERTIFIED BY:	APPROVED BY:
Analysis Branch AIPC	Amy E. Digby Chief, Analysis Branch AIPC	Patricia T. Bray Chief AIPC

Filename: 1dcsa_analysis_report_draft_final_revision_002.doc

DISTRIBUTION STATEMENT:
Distribution limited to AIPC and AMD. Not approved for public release.

III Corps Systems Architecture Performance Analysis
Executive Summary

The primary objective of the III Corps Systems (IIICSA) Architecture Performance Analysis is to support the TRADOC Architecture Management Directorate (AMD) and the Architecture Integration and Processing Center (AIPC) in the validation of the proposed systems architecture (SA). To that end, AIPC representatives from Architecture Development (AD) Branch and Operational Architecture (OA) Cell identified the following study questions relative to the performance of IIICSA:

1) Do TOC to TOC radios have sufficient connectivity and range to support the 3ACR?

2) Do TOC to TOC radios within the 3ACR have sufficient bandwidth to support doctrinal traffic demands?

3) What are the appropriate numbers and assignment of AN/TSQ 158A (EPLRS NCS (A)) and EPLRS Network Manager (ENM) Monitors in the Corps area?

Using a variety of software tools and subject matter expertise, this analysis found that the TOC to TOC radios provide enough connectivity and available bandwidth to support the mission of 3ACR in a generic Kosovo scenario. The analysis also concurs with the current allocation of zero EPLRS Network Control Stations (NCS (A)) and twenty ENM Monitors in the Corps area with the possible exception of the Corps Avenger Battalions.

This analysis makes four recommendations:

1) Recommend architects and proponents review EPLRS allocations (and by extension, ENM allocations) of the S6 section of the HHB 31st ADA Brigade. The S6 template and NOC-V Basis of Issue Plan (BOIP) cause this platform to be allocated unnecessary EPLRS RS.

2) Recommend architects review the systems architecture of the Corps Avenger Battalions with the Air Defense School to ensure that non-divisional air defense missions can be technically supported within the systems architecture of this organization.

3) Recommend that FBCB2, INC, and EPLRS allocations in Tables of Organization and Equipment (TOEs) be re-evaluated for those organizations that do not habitually move into division areas. Some Business Rules used to develop the architecture state that certain units may not move into division areas; however, some of those units are allocated EPLRS radios, INCs, and FBCB2 devices they may never use.

This recommendation likely will necessitate the creation of new Standard Requirements Codes (SRCs) for organizations with instances in both the Corps area and division box. Different SRC numbers could represent the organizations remaining in the Corps area.

4) Recommend that future analyses be allotted time for a more thorough examination.

Perhaps the greatest achievement was the progress made in experiences gained by AD and Analysis Branches. Future analyses will benefit greatly by the experiences gained in the development and analysis of this architecture.

III Corps Systems Architecture Performance Analysis

1. **Introduction.**

1.1. Purpose. The purpose of the III Corps Systems Architecture (IIICSA) Performance Analysis is two-fold. The primary intent of the analysis is to support the TRADOC Architecture Management Directorate (AMD) and the Architecture Integration and Processing Center (AIPC) in the validation of the proposed systems architecture (SA). The secondary purpose of the analysis is to develop and refine the methodology by which the Analysis Branch supports verification of systems architecture products. A key factor is completing the analysis almost concurrently with the development of the architecture products.

1.2. Background.

1.2.1. Statement of problem. Every product needs quality assurance or verification. An important aspect of the architecture development process is the level of analysis applied to the design. Analysis Branch of the AIPC receives a non-deployed view of the architecture, and then deploys this view in accordance with a scenario using specific terrain and operational situation. Analysis of the deployed view is then conducted to gain insight into the architecture. Deficiencies are noted, but the goal is to verify the architecture by subjecting it, in a controlled and structured manner, to virtual stress using a variety of software products. Section 1.2.2 Scope, identifies the problem areas in the approved study plan.

1.2.2. Scope. The primary area of concern of the AIPC is the ability of the 3rd Armored Cavalry Regiment (3ACR) and Digitized Corps networks to support digital enablers relative to the connectivity and bandwidth required. This analysis will focus on:

1.2.2.1. Connectivity and bandwidth of TOC to TOC radios in the 3ACR, and

1.2.2.2. Allocations of Enhanced Position Location Reporting System (EPLRS) Network Control Stations (NCS (A)) and EPLRS Network Manager (ENM) Monitors.

1.2.3. Objective. This analysis will address three study questions, considering one or more essential elements of analysis (EEA) for each question.

1.2.3.1. Study Question 1: Do TOC to TOC radios have sufficient connectivity and range to support the 3ACR?

1.2.3.1.1. EEA 1: What connectivity and range do the TOC to TOC radios exhibit when deployed in a Kosovo scenario?

1.2.3.1.2. EEA 2: How does terrain affect TOC to TOC radio connectivity and range?

1.2.3.2. Study Question 2: Do TOC to TOC radios within the 3ACR have sufficient bandwidth to support doctrinal traffic demands?

1.2.3.2.1. EEA 3: What is the bandwidth requirement of traffic derived from existing Information Exchange Requirements (IERs) in the Army Architecture Repository Management System (AARMS) when augmented with notional IERs, Situational Understanding (SU), protocol overhead, and other requirements?

1.2.3.3. Study Question 3: What are the appropriate numbers and assignments of AN/TSQ 158A (EPLRS NCS (A)) and ENM Monitors in the Corps area?

1.2.3.3.1. EEA 4: What are the optimal numbers and allocations of EPLRS NCS (A) and ENM Monitors necessary to support IIICSA Tables of Organization and Equipment (TOEs)?

1.2.4. Assumptions

1.2.4.1. In the absence of clearly defined doctrine, information provided by subject matter experts (SMEs) is acceptable and valid.

1.2.4.2. The equipment modeled performs in accordance with system operational performance specifications.

1.2.4.3. The Joint Tactical Radio System (JTRS) TOC to TOC radio provides inter-TOC communications in the 3ACR. The current NTDR TOC to TOC radio is sufficient for this analysis.

1.2.4.4. SU traffic is broadcast traffic.

1.2.4.5. All information exchanges documented in AARMS, including Modeling status IERs, represent a valid doctrinal traffic load.

1.2.4.6. All documented data traffic requirements from the 3ACR will traverse the TOC to TOC radios studied in EEA 3.

1.2.4.7. All TOC to TOC radios examined act as NTDR clusterheads, which typically have a much heavier communications burden.

1.2.4.8. All data traffic from TOCs to other TOCs, where each contains at least one TOC to TOC radio, will be transmitted on that radio.

1.2.4.9. TOCs with multiple TOC to TOC radios use only one such radio.

1.2.4.10. Data used to obtain EPLRS and ENM results has not changed significantly since 16 May 2002.

1.2.4.11. The G6 staff at either the Signal Brigade or within the division accomplish adequate EPLRS network planning for corps troops deploying into the division box.

1.2.4.12. Divisional NCS (A) assets provide the required support to the corps troop assets within their division box.

1.2.4.13. ENM Monitors and NCS (A) can only communicate using EPLRS.

1.2.4.14. Corps troop platforms will only use FBCB2 and EPLRS radio sets (RS) when deployed within a division area of operations.

1.2.4.15. EPLRS RS allocated to the Air Traffic Services (ATS) and MP Battalions will receive ENM connectivity from units they support.

1.2.5. References.

1.2.5.1. *Test Plan for Joint Tactical Radio System (JTRS) Step 2C, Draft_2 v9, 6Sep01*, Prepared by BAE Systems Corporation for Project Manager (PM) Tactical Radio Communications Systems (TRCS).

1.2.5.2. *JTRS Operational Requirements Document (ORD) version 3.0*, 11 Feb 2002.

1.2.5.3. *TM 11-xxxx-xxx-12&P, Draft Operator's Manual for Net Control Station, AN/TSQ-158 (V)4, EPLRS Network Manager (ENM)*, 15 March 2002.

1.2.5.4. *Brigade Combat Team EPLRS Network Manager (ENM) Analysis*, 4 May 2001, Analysis Branch, AIPC.

1.2.5.5. 3ACR SA version 1.5, IIICSA versions 0.5, 1.0, and 1.5; IIICSA Business Rules used to develop the architecture (Appendix C); and input from AIPC, proponent schools and centers.

2. **Analysis of the study questions.** For each essential element of analysis, the format will be a description of the methodology employed, a summary of the results, and an analysis of the results.

2.1. Study Question 1: Do TOC to TOC radios have sufficient connectivity and range to support the 3ACR?

2.1.1. EEA 1: What connectivity and range do the TOC to TOC radios exhibit when deployed in a Kosovo scenario?

2.1.1.1. Method.

2.1.1.1.1. Scenario. The scenario and operational situation use locations, geography, movement, and time selections based on a notional Kosovo scenario. The scenario does not include the effects of electronic warfare (EW) or mutual interference. The 3ACR is deployed on a guard mission in Kosovo in an operational area of 77 x 80 kilometers. The 1st Squadron is deployed to guard the southeast valley while the 2nd Squadron secures the northeast approaches into Kosovo. The 3rd Squadron secures the northern avenue of approach and performs a screen along the western mountains running north to south. The Regimental TOC is deployed north of Kosovo Polje, approximately 5.5 kilometers northwest of Pristina. Logistical support is centrally located near the Pristina airport, while the Aviation Squadron CP is located near an airfield north of Lipjan. While the Air Scouts are screening high ground to the east and west of the Pristina valley, the Air Attack Companies act as ready reaction to support any of the ground squadrons. Figure 1 presents a graphical depiction of the scenario.

This page left blank intentionally

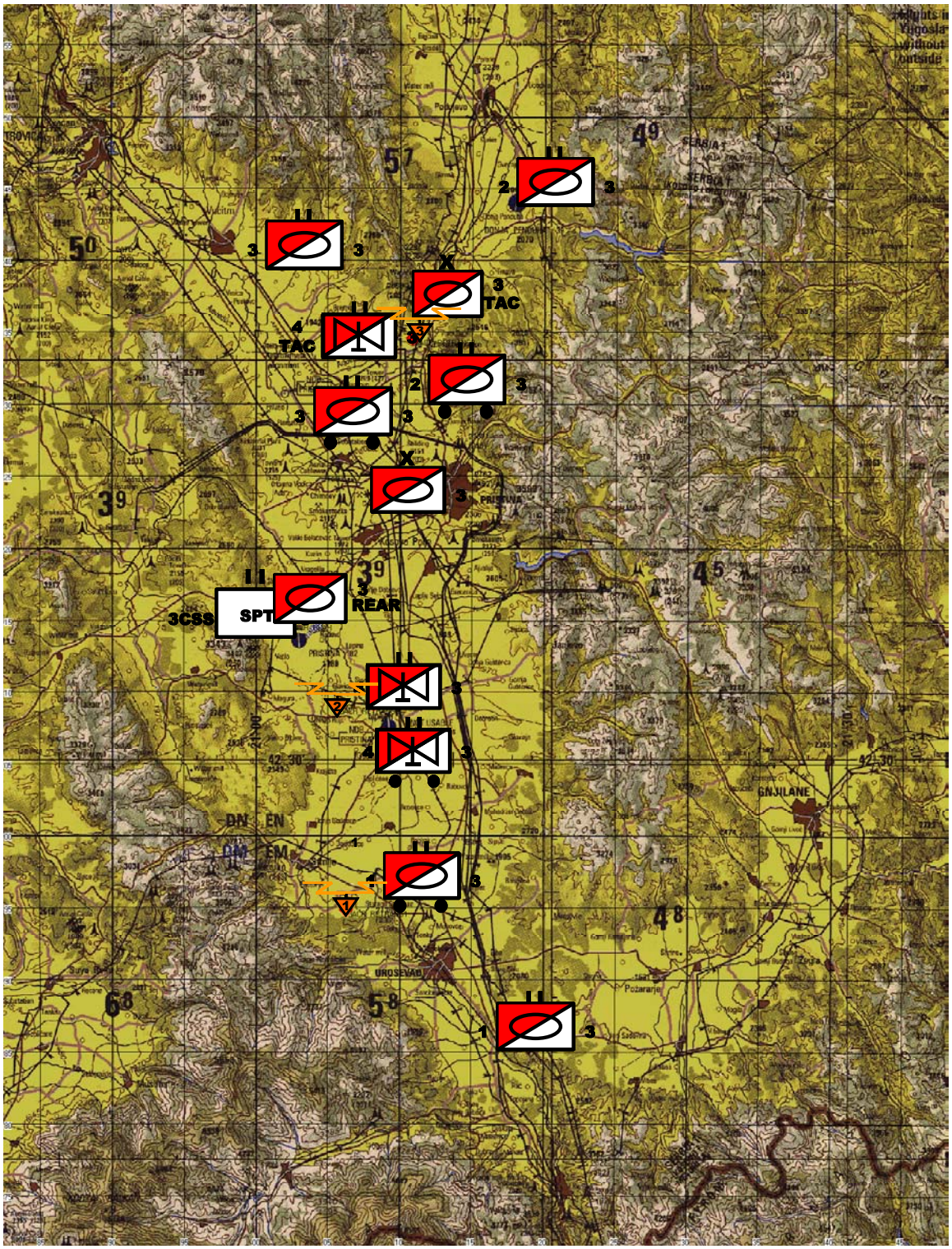


Figure 1. 3ACR Deployed in Notional Kosovo Scenario (TOCs)

2.1.1.1.2. Software. Analysis Branch examined the ability of selected critical TOCs to gain connectivity with each other: 3ACR Regimental TOC, three Squadron TOCS, the Aviation Squadron TOC, and Support ALOC. To measure connectivity, analysts used the Link Assessment Model (LAM). Developed by
2.1.1.1.3. the U. S. Army Materiel Systems Analysis Activity (AMSAA), the LAM is a communications network planning tool which determines probability of communication (PCOM) on selected communications links. The LAM computes propagation loss values for all possible links between radios in a scenario based on a number of controls and values such as background noise level, transmitter system losses, etc. The model uses the Terrain-Integrated Rough-Earth Model (TIREM) along with Defense Mapping Agency (DMA) Digital Terrain Elevation Data (DTED). Information such as link profile, antenna heights, frequency, polarization, surface refractivity, conductivity, humidity, average terrain elevation above sea level and more is passed to the TIREM routines for processing to determine the received signal level for each communications link. The probability of communication for each link is then determined directly from the message error rate (MER) versus the Signal to Noise (SNR) functional relationship.

2.1.1.1.4. Methodology. Parameters to the LAM were: Three meter antennas and 10 watts transmit power on all radios, as well as radio locations and related DTED. The PCOM, the LAM output, represents the probability that two given radios are able to establish a direct physical connection. A PCOM of 0.00 represents a zero probability, 1.00 represents a 100% probability, 0.5 a 50% probability, etc.

2.1.1.1.5. Results.

2.1.1.1.5.1. Figures 2 and 3 show the probability of communication between certain TOC to TOC radios within zero and two hops, respectively. For example, the probabilities of direct communication from the Support ALOC to 1st, 2nd, and 3rd Squadrons are: 0%, 100%, and 0%, respectively.

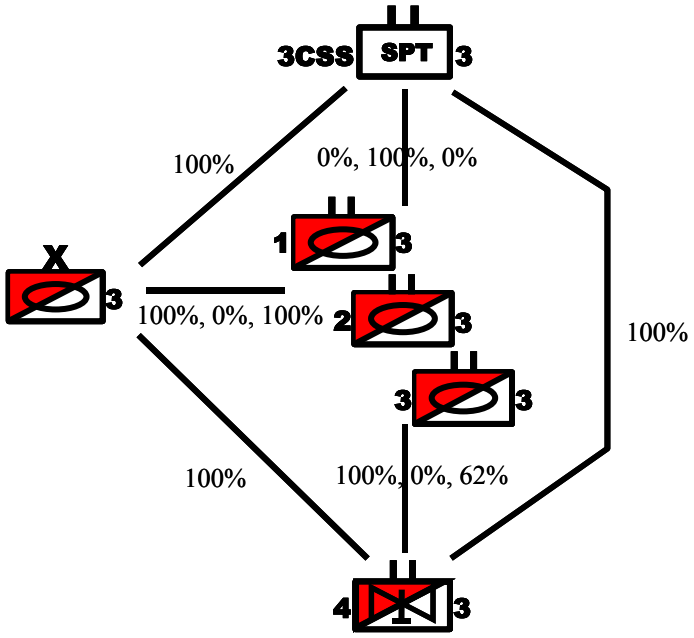


Figure 2. Probability of Direct Communication Between TOC to TOC radios (No Hops)

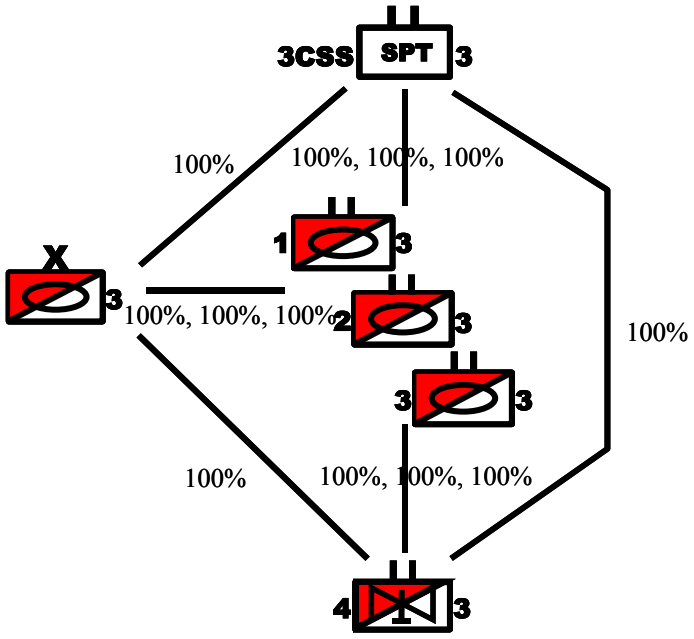


Figure 3. Probability of Communication Between TOC to TOC radios Within Two Hops

2.1.1.1.5.2. Figures 2 and 3 are derived from Tables 1-3, which show the probability of communication between TOC to TOC radios within zero, one, and two hops, respectively.

2.1.1.1.5.2.1. Interpreting the tables. Table 1 shows the probabilities of direct communication. Tables 2 and 3 show the probability of

communication using other radios as intermediate relays or hops. For example, consider the link from 1st Squadron to 2nd Squadron depicted in the Tables 1-3.

2.1.1.1.5.2.1.1. The probability of direct communication is 0.00 from Table 1.

2.1.1.1.5.2.1.2. The probability of communications using exactly one hop is the product of PCOM of 1st Squadron to Relay 1 and the PCOM of Relay 1 to 2nd Squadron. This yields 1.00 X 0.00 = 0.00 (Table 2). Similar calculations using one hop also yield a PCOM of 0.

2.1.1.1.5.2.1.3. Similarly, the probability of communications using two hops is the product of the following PCOMs: 1st Squadron to Relay 1, Relay 1 to Relay 3, and Relay 3 to 2nd Squadron. This yields 1.00 X 1.00 X 1.00 = 1.00. Table 3 shows that the PCOM within two hops between all referenced senders and receivers is 1.00.

Receivers

Senders	RGMT	1SQDN	2SQDN	3SQDN	AVN	SPT	REL 1	REL 2	REL3
RGMT		1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00
1SQDN	1.00		0.00	0.00	1.00	0.00	1.00	0.02	0.00
2SQDN	0.00	0.00		0.30	0.00	1.00	0.00	0.00	1.00
3SQDN	1.00	0.00	0.30		0.62	0.00	0.47	0.00	1.00
AVN	1.00	1.00	0.00	0.62		1.00	1.00	1.00	1.00
SPT	1.00	0.00	1.00	0.00	1.00		1.00	1.00	1.00
REL 1	1.00	1.00	0.00	0.47	1.00	1.00		1.00	1.00
REL 2	1.00	0.02	0.00	0.00	1.00	1.00	1.00		1.00
REL 3	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	

Table 1. Probability of Direct Communication Between TOC to TOC radios (No Hops)

Receivers

Senders	RGMT	1SQDN	2SQDN	3SQDN	AVN	SPT
RGMT		1.00	1.00	1.00	1.00	1.00
1SQDN	1.00		0.00	1.00	1.00	1.00
2SQDN	1.00	0.00		1.00	1.00	1.00
3SQDN	1.00	1.00	1.00		1.00	1.00
AVN	1.00	1.00	1.00	1.00		1.00
SPT	1.00	1.00	1.00	1.00	1.00	

Table 2. Probability of Communication Between TOC to TOC radios Within One Hop

Receivers

Senders	RGMT	1SQDN	2SQDN	3SQDN	AVN	SPT
RGMT		1.00	1.00	1.00	1.00	1.00
1SQDN	1.00		1.00	1.00	1.00	1.00
2SQDN	1.00	1.00		1.00	1.00	1.00
3SQDN	1.00	1.00	1.00		1.00	1.00
AVN	1.00	1.00	1.00	1.00		1.00
SPT	1.00	1.00	1.00	1.00	1.00	

Table 3. Probability of Communication Between TOC to TOC radios Within Two Hops

2.1.1.2. Analysis. Direct communication, that is, connectivity with a radio through no intermediate radios, is not necessary. However, fewer relays reduce latency and risk. Additional radios provide a higher probability of multi-hop capability. Given this scenario, analysts easily created a robust data network in which communication between TOCs was possible within two hops. Out of 30 sender/receiver pairs, 28 were able to communicate within one hop.

2.1.1.3. Recommendation. None.

2.1.2. EEA 2: How does terrain affect TOC to TOC radio connectivity and range?

2.1.2.1. Method.

2.1.2.1.1. Scenario. The scenario was the same Kosovo scenario described earlier.

2.1.2.1.2. Software. The examination of this issue was treated as an extension to that of EEA 1. Using TerraBase II, analysts generated line of site (LOS) fan diagrams of the 3ACR TOC to TOC radios. TerraBase II uses the planning range and antenna height of radios, as well as DTED terrain data and curvature of the earth, to graphically display areas of radio coverage. Figure 4 shows the LOS fan diagrams.

2.1.2.1.3. Methodology. This analysis used a 3 meter antenna height, 15 kilometer planning range, and the same locations and terrain data from EEA 1. Each TOC is the center of a circle of radius 15 kilometers. The color within each circle shows the possible area of connectivity that each TOC to TOC radio may achieve. Darker fans indicate areas of overlapping coverage.

2.1.2.2. Results. Although terrain can have a negative impact on any radio communication, it is not a limiting factor in this scenario. In this scenario, connectivity between all TOCs is possible within two hops.

2.1.2.3. Analysis. The range of TOC to TOC radios possibly can be extended using relays and other radios as intermediate transmission methods. As the area of operations becomes larger and non-contiguous, range may become more of a limiting factor than terrain. In this generic Kosovo scenario, analysts were able to construct a network with reasonable connectivity despite the terrain.

2.2. Study Question 2: Do TOC to TOC radios within the 3ACR have sufficient bandwidth to support doctrinal traffic demands?

2.2.1. EEA 3: What is the bandwidth requirement of traffic derived from existing Information Exchange Requirements (IERs) in the Army Architecture Repository Management System (AARMS) when augmented with notional IERs, SU, protocol overhead, and other requirements?

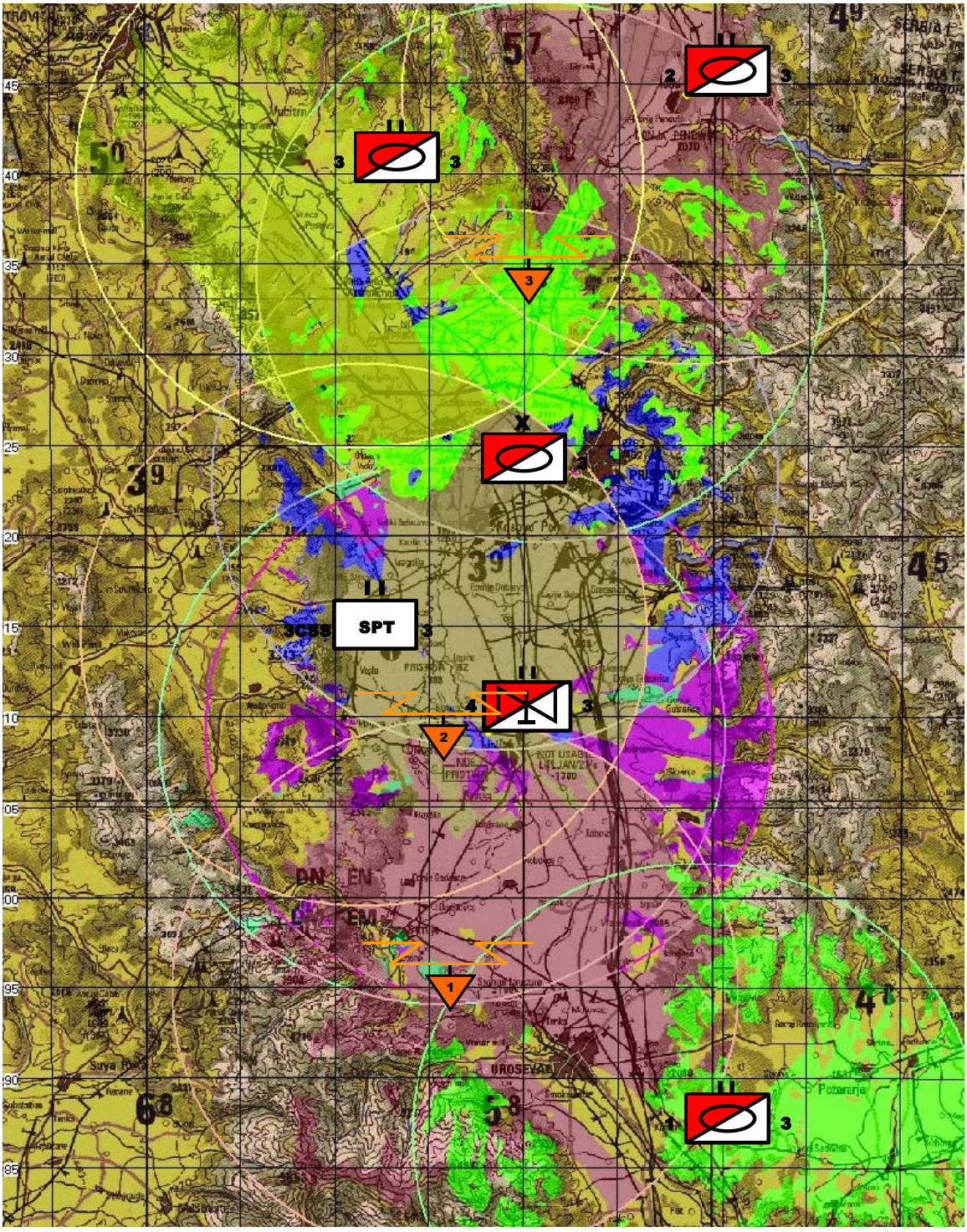
2.2.1.1. Method.

2.2.1.1.1. Scenario. The scenario was the same Kosovo scenario described earlier.

2.2.1.1.2. Software. Software was Microsoft Access. The metric was bandwidth, defined by bits per second used during the busiest hour (busy hour), used by the TOC

This page left blank intentionally.

Figure 4. Connectivity of TOC to TOC radios



2.2.1.1.3. enclaves containing a TOC to TOC radio. This provides a limited look at the potential performance of the TOC to TOC radios. An OPNET model could provide a more detailed representation of the performance of these radios by accounting for other factors, such as queuing delay, detailed protocol overhead, more specific routing protocol traffic, and message delivery delay.

2.2.1.1.4. Traffic. The study derives traffic from IERs residing in the AARMS database and traffic generated by the Analysis Branch Future Traffic Cell (FTC). The FTC documented hundreds of additional IERs to reflect future doctrinal information exchanges and situational understanding updates. To replicate the effects of movement, the FTC created IERs reflecting situational understanding updates at their highest possible level. The FTC then augmented that traffic with protocol traffic, such as Simple Network Management Protocol (SNMP) and Domain Name System (DNS) protocols from the Digital Capstone Exercise (DCX) Phase 1 exercise (Jan/Feb 01), as well as other protocol traffic from an earlier Brigade Combat Team Analysis, which relied on OPNET simulation runs. The Methodology section (2.2.1.1.4) details the employment of this traffic.

2.2.1.1.5. Methodology.

2.2.1.1.5.1. Established which OPFAC rules own at least one TOC to TOC radio.

2.2.1.1.5.2. Determined the data and live video IERs for all OPFAC rules at each TOC.

2.2.1.1.5.3. Converted Live Video IERs to data IERs. Gave data sizes to these IERs by taking the product of 1000 bits and the IER values for grade of service and video duration.

2.2.1.1.5.4. Reverse the Producer and Consumer OPFAC rules and re-created the IERs in the reverse direction. This reflects the fact that each IER occupies bandwidth on both radios.

2.2.1.1.5.5. Calculated the total daily (24 hour) load, measured in bits, offered by each IER. This is the product of IER values for frequency and message size in bits.

2.2.1.1.5.6. Determined the daily load, measured in bits, offered by each OPFAC rule. This is the sum of a given OPFAC's daily loads offered by each IER.

2.2.1.1.5.7. Computed the daily traffic load, measured in bits, offered by each TOC. This is the sum of the daily traffic loads offered at each rule located at a specific TOC.

2.2.1.1.5.8. Created offline IERs for each TOC which reflected non-IER traffic represented in Table 4.

Protocol	Avg. bits per message	Messages per day	Bits offered per day
Open Shortest Path First (OSPF) [1]	Varies	Varies	43,200,000
Simple Network Management Protocol (SNMP) [2]	82	7,200	590,400
Domain Name System (DNS) [2]	42	11,520	483,840
Radio Internet Group	256	288	73,728

Management Protocol (RGMP) [1]			

1 - From Brigade Combat Team Analysis, AIPC Analysis Branch, conducted using OPNET as primary tool
2 - From the Digital Capstone Exercise (DCX) Phase 1 exercise (Jan/Feb 01)

Table 4. Protocol Traffic Load Offered at Each TOC

2.2.1.1.5.9. Calculated the busy hour traffic load, measured in bits, as 10% of the daily load offered by each TOC.

2.2.1.1.5.10. Compute the busy hour bandwidth needed, measured in bits per second, at specific TOCS. This is a given TOC's busy hour traffic load divided by 3600 (number of seconds per hour).

2.2.1.2. Results. Using 288,000 bits per second as the bandwidth available to a TOC to TOC radio, the expected traffic load will not seriously exercise the network. This analysis concluded that the bandwidth requirement for all TOCs within the 3ACR is below the bandwidth capacity of the TOC to TOC radio. Table 5 shows the average bandwidth required during the busiest hour. Bandwidth reports are included in Appendix A.

TOC	Bits per second required during busy hour
3ACR TOC	48,988
3ACR TAC	3,749
3ACR Command Group	2,927
1st Squadron CTCP	17,791
1st Squadron TOC	29,941
2nd Squadron CTCP	17,791
2nd Squadron TOC	29,941
3rd Squadron CTCP	17,791
3rd Squadron TOC	29,941
Support Squadron ALOC	12,428
Aviation Squadron CTCP	6,406
Aviation Squadron MAIN	18,559
Aviation Squadron TAC	51,956

Table 5. Bandwidth Needed by Each TOC to TOC Radio

2.2.1.3. Analysis and Recommendation. As part of the refinement of the System Architecture Performance Analysis Process, the research conducted in support of EEA 3 presented some issues.

2.2.1.3.1. For this analysis, bandwidth numbers reflect only the size of the requirements (from AARMS, FTC, and other sources) relative to the systems involved. These bandwidth numbers may not reflect the actual bandwidth utilized in the field. For example, the estimates do not reflect traffic a given radio might carry as an intermediate device, that is, traffic from other radios to other radios. Also, as engineering, system-specific, or non-doctrinal changes are employed, needed bandwidth will surely increase. Bandwidth numbers should not stand alone. Exhaustive analysis, which examines a number of performance measures including message completion rate and end-to-end delay times, should support the bandwidth requirement.

2.2.1.3.2. An analysis using the OPNET Modeler environment may yield additional benefit by identifying other network performance issues. Given more time to analyze the performance of the 3ACRSA, this office can provide a higher resolution examination of the TOC to TOC Radio network and results of greater fidelity. As performance analysis becomes an integrated part of the architecture development process, it is imperative to allow enough time during and after development for more exhaustive analyses. Recommend that more time and resources be allowed for a more detailed level of analysis in future architectures.

2.3. Study Question 3: What are the appropriate numbers and assignments of AN/TSQ 158A (EPLRS NCS (A)) and ENM Monitors in the Corps area?

2.3.1. EEA 4: What are the optimal numbers and allocations of EPLRS NCS (A) and ENM Monitors necessary to support IIICSA TOEs?

2.3.1.1. Method.

2.3.1.1.1. Scenario. No specific scenario. A desktop analysis was conducted to determine the answer to this study question.

2.3.1.1.2. Software. Software was Microsoft Access.

2.3.1.1.3. Methodology

2.3.1.1.3.1. Analysis Branch conducted a review of the IIICSA System Architecture Business Rules and the IIICSA netViz diagrams (works in progress). This review determined the current number of ENM Monitors, EPLRS RS, and FBCB2 or Embedded Battle Command (EBC) hosts assigned to III Corps System Architecture organizations. Business rules provided an FBCB2 device and EPLRS RS for those platforms that deployed forward to support divisional organizations. Appendix B contains a breakdown of this review. This analysis divided the troop list into four location/support categories: support for 1st Cavalry Division, support for 4th Infantry Divisions, support for III Corps, and remainder of III Corps Artillery not specifically assigned to support a division. Although the last category was not listed in the Business Rules, this study assumes that these III Corps Artillery units also deploy forward to execute their normal missions.

2.3.1.1.3.2. Corps troop organizations with a possibility of deploying within the division box to support division assets are allocated FBCB2 or other devices using EBC software. Along with theses devices, these organizations also are allocated EPLRS. Using these numbers, it follows that the only time FBCB2/EPLRS assets would be utilized is when those organizations deployed into the division box.

2.3.1.1.3.3. One possible shortcoming to this logic is the Systems Architecture (SA) of the two Air Defense Artillery (ADA) Avenger Battalions. The Business Rules for ADA indicate that neither of the Avenger battalions is habitually assigned missions to support the divisions. Under the operational control of the ADA Brigade, both battalions would likely be assigned air defense missions within the Corps boundaries (division rear boundary to corps rear boundary). The radio net architecture for this battalion (44436F) requires a real-time EPLRS network to distribute air track data to the battalion fire units. Though this data is not specifically identifiable within the Business Rules, the current set of working netViz diagrams for the ADA Brigade does identify this requirement.

2.3.1.2. Results. After a review of the distribution of ENM Monitors, EPLRS, and FBCB2/EBC hosts within IIICSA, the Analysis Branch concurs with the current distribution of ENM Monitors throughout the Corps area. With the possible exception of the two Avenger Battalions, no other requirement for EPLRS NCS (A) within the Corps troop area exists.

2.3.1.3. Analysis and Recommendation.

2.3.1.3.1. Recommend that the EPLRS allocations in the HHB 31st ADA Brigade be reviewed to determine if EPLRS and hence, ENM Monitors are still required. The S6 Section is the only non-relay platform allocated EPLRS; these EPLRS RS likely are not needed. The platform is assigned ISYSCON V4; however, the S6 template and NOC-V Basis of Issue Plan (BOIP) force architects to allocate the platform unnecessary EPLRS RS.

2.3.1.3.2. Recommend that FBCB2, INC, and EPLRS allocations be re-evaluated for some organizations supporting the Corps area with the exception of Attack Helicopter, Signal, and Air Defense units (assuming these units move into the division box). Of the 987 FBCB2/EBC and 1024 EPLRS RS combinations

allocated to units in the Corps area, approximately 602 and 643, respectively, likely will not be used when applying the conventions set forth in the Business Rules. Given that these units' missions involve support of units in the Corps area of operations and that no Corps EPLRS network exists, the need for these devices allocated to these organizations must be re-evaluated.

2.3.1.3.2.1. Implementing this recommendation possibly includes the creation of new Standard Requirements Codes (SRCs) to reflect those organizations that do not habitually move into division areas. Certain CS and CSS TOEs have some instances that move into the division box and other(s) that remain in the Corps area. The organizations that remain in the Corps area should be assigned different SRCs to reflect differing requirements for EPLRS RS, FBCB2, and INC. For example, the 468th Chemical Battalion and 2nd Chemical Battalion are instances of TOE 03476F1II. This TOE allocates eight EPLRS RS and six FBCB2 devices to the Chemical Battalions. The 2nd Chemical Battalion moves forward to support the 1st Cavalry Division; thus, it needs EPLRS RS, FBCB2, and INCs. However, the 468th Chemical Battalion remains in the Corps area; thus, it does not require EPLRS RS, FBCB2, INCs, or ENMs. Therefore, the 468th Chemical Battalion should be used as an instance of another SRC.

2.3.1.3.2.2. Appendix B lists those organizations that remain in the Corps Area. It delineates those organizations that could require new SRC numbers or re-evaluation.

2.3.1.3.3. Recommend that the systems architecture of the Corps Avenger Battalions be reviewed with the Air Defense School to ensure that non-divisional air defense missions can be technically supported within the systems architecture of this organization.

3. Conclusion.

3.1. This study achieved the goal of demonstrating the validity of the III Corps Systems Architecture (IIICSA) given the constraints of time on the development and study. The 3ACR TOC to TOC radios possess the necessary connectivity, range, and bandwidth to support military operations. The idea was that if the architecture supported a representative, and admittedly difficult, subset of the corps, then the conclusion would be that the architecture would support the entire corps. Additionally, the study employed a realistic operational situation based upon a Kosovo scenario, where mountainous terrain could greatly reduce line-of-sight communications distance. However, the study concluded that the architecture supported connectivity by showing that a robust data network generally could be established within two hops, i.e., connectivity generally required no more than two intermediate radios. Line of sight fan diagrams showed that the radios possessed sufficient range on difficult terrain. The study found the bandwidth requirement at TOCs to be within the capacity of the TOC to TOC radios. A desktop analysis concurred with the allocation of zero EPLRS Network Control Stations (NCS (A)) and twenty ENM Monitors in the corps area. Recommendations were made consistent with analysis findings.

3.2. Architecture developers and managers realize the need for systematic quality assurance of their final products through comprehensive analysis. The ability to provide this comprehensive analysis in timely fashion was a secondary goal of the study. The relationship developed by the Architecture Development Branch and the Analysis Branch during the course of this study will greatly benefit future studies. A key challenge in completing this and future analyses is that the study must proceed almost concurrently with the development of the architecture products. Another challenge is the development of software for use in the analysis. This study did not make significant use the Army standard communications modeling environment, OPNET.

However, the office continued to build the framework for future studies, assuming the architectures are available in time, to use this tool. Future analyses will be able to address issues of connectivity, capacity, performance, and radio frequency spectrum with communications modeling software.

3.3. Many of the tables in the report were condensed from the following appendices, which, in turn, were generated from the voluminous data of the particular software employed. This data is archived in the Analysis Branch.

This page left blank intentionally

Appendix A
TOC to TOC Traffic Rollup Reports

TOC to TOC Traffic

TOC 3ACR_TOC

Start TOC	3ACR_TOC	End TOC	1_3CAV_TOC	
		Total bits per day		**Busy Hour**
		336,629,952		33,662,995
Start TOC	3ACR_TOC	End TOC	2_3CAV_TOC	
		Total bits per day		**Busy Hour**
		336,629,952		33,662,995
Start TOC	3ACR_TOC	End TOC	3_3CAV_TOC	
		Total bits per day		**Busy Hour**
		336,629,952		33,662,995
Start TOC	3ACR_TOC	End TOC	3ACR_CMD_G	
		Total bits per day		**Busy Hour**
		112,170,048		11,217,005
Start TOC	3ACR_TOC	End TOC	3ACR_TAC	
		Total bits per day		**Busy Hour**
		134,708,352		13,470,835
Start TOC	3ACR_TOC	End TOC	3CSS_ALOC	
		Total bits per day		**Busy Hour**
		134,708,352		13,470,835
Start TOC	3ACR_TOC	End TOC	4_3ACS_CTCP	
		Total bits per day		**Busy Hour**
		52,067,156		5,206,716
Start TOC	3ACR_TOC	End TOC	4_3ACS_MAIN	
		Total bits per day		**Busy Hour**
		320,017,898		32,001,790
Totals	**3ACR_TOC**		**1,763,561,662**	**176,356,166**

3ACR_TOC requires **48,988 bits per second during Busy Hour**

TOC to TOC Traffic

TOC 3ACR_TAC

Start TOC 3ACR_TAC End TOC 3ACR_TOC

		Total bits per day	Busy Hour
		134,964,352	13,496,435
Totals	**3ACR_TAC**	**134,964,352**	**13,496,435**

3ACR_TAC requires **3,749 bits per second during Busy Hour**

TOC to TOC Traffic

TOC 3ACR_CMD_GRP

Start TOC 3ACR_CMD_GRP End TOC 3ACR_TOC

		Total bits per day	Busy Hour
		105,385,248	10,538,525
Totals	**3ACR_CMD_GRP**	**105,385,248**	**10,538,525**

3ACR_CMD_GRP requires **2,927 bits per second during Busy Hour**

TOC to TOC Traffic

TOC 1_3CAV_CTCP

Start TOC	1_3CAV_CTCP	End TOC 1_3CAV_TOC	
		Total bits per day	**Busy Hour**
		126,776,352	12,677,635
Start TOC	1_3CAV_CTCP	End TOC 2_3CAV_CTCP	
		Total bits per day	**Busy Hour**
		104,143,840	10,414,384
Start TOC	1_3CAV_CTCP	End TOC 2_3CAV_TOC	
		Total bits per day	**Busy Hour**
		126,776,352	12,677,635
Start TOC	1_3CAV_CTCP	End TOC 3_3CAV_CTCP	
		Total bits per day	**Busy Hour**
		104,143,840	10,414,384
Start TOC	1_3CAV_CTCP	End TOC 3_3CAV_TOC	
		Total bits per day	**Busy Hour**
		126,776,352	12,677,635
Start TOC	1_3CAV_CTCP	End TOC 3CSS_ALOC	
		Total bits per day	**Busy Hour**
		51,865,920	5,186,592
Totals	**1_3CAV_CTCP**	**640,482,656**	**64,048,266**

1_3CAV_CTCP requires **17,791 bits per second during Busy Hour**

TOC to TOC Traffic

TOC 1_3CAV_TOC

Start TOC	1_3CAV_TOC	End TOC 1_3CAV_CTCP	
		Total bits per day	**Busy Hour**
		129,792,352	12,979,235
Start TOC	1_3CAV_TOC	End TOC 2_3CAV_CTCP	
		Total bits per day	**Busy Hour**
		129,792,352	12,979,235
Start TOC	1_3CAV_TOC	End TOC 2_3CAV_TOC	
		Total bits per day	**Busy Hour**
		166,144,296	16,614,430
Start TOC	1_3CAV_TOC	End TOC 3_3CAV_CTCP	
		Total bits per day	**Busy Hour**
		129,792,352	12,979,235
Start TOC	1_3CAV_TOC	End TOC 3_3CAV_TOC	
		Total bits per day	**Busy Hour**
		166,144,296	16,614,430
Start TOC	1_3CAV_TOC	End TOC 3ACR_TOC	
		Total bits per day	**Busy Hour**
		304,345,850	30,434,585
Start TOC	1_3CAV_TOC	End TOC 3CSS_ALOC	
		Total bits per day	**Busy Hour**
		51,865,920	5,186,592
Totals	**1_3CAV_TOC**	**1,077,877,418**	**107,787,742**

1_3CAV_TOC requires **29,941 bits per second during Busy Hour**

TOC to TOC Traffic

TOC 2_3CAV_CTCP

Start TOC	2_3CAV_CTCP	End TOC 1_3CAV_CTCP	
		Total bits per day	**Busy Hour**
		104,143,840	10,414,384
Start TOC	2_3CAV_CTCP	End TOC 1_3CAV_TOC	
		Total bits per day	**Busy Hour**
		126,776,352	12,677,635
Start TOC	2_3CAV_CTCP	End TOC 2_3CAV_TOC	
		Total bits per day	**Busy Hour**
		126,776,352	12,677,635
Start TOC	2_3CAV_CTCP	End TOC 3_3CAV_CTCP	
		Total bits per day	**Busy Hour**
		104,143,840	10,414,384
Start TOC	2_3CAV_CTCP	End TOC 3_3CAV_TOC	
		Total bits per day	**Busy Hour**
		126,776,352	12,677,635
Start TOC	2_3CAV_CTCP	End TOC 3CSS_ALOC	
		Total bits per day	**Busy Hour**
		51,865,920	5,186,592
Totals	**2_3CAV_CTCP**	**640,482,656**	**64,048,266**

2_3CAV_CTCP requires **17,791 bits per second during Busy Hour**

TOC to TOC Traffic

TOC 2_3CAV_TOC

Start TOC	2_3CAV_TOC	End TOC 1_3CAV_CTCP	
		Total bits per day	**Busy Hour**
		129,792,352	12,979,235
Start TOC	2_3CAV_TOC	End TOC 1_3CAV_TOC	
		Total bits per day	**Busy Hour**
		166,144,296	16,614,430
Start TOC	2_3CAV_TOC	End TOC 2_3CAV_CTCP	
		Total bits per day	**Busy Hour**
		129,792,352	12,979,235
Start TOC	2_3CAV_TOC	End TOC 3_3CAV_CTCP	
		Total bits per day	**Busy Hour**
		129,792,352	12,979,235
Start TOC	2_3CAV_TOC	End TOC 3_3CAV_TOC	
		Total bits per day	**Busy Hour**
		166,144,296	16,614,430
Start TOC	2_3CAV_TOC	End TOC 3ACR_TOC	
		Total bits per day	**Busy Hour**
		304,345,850	30,434,585
Start TOC	2_3CAV_TOC	End TOC 3CSS_ALOC	
		Total bits per day	**Busy Hour**
		51,865,920	5,186,592
Totals	**2_3CAV_TOC**	**1,077,877,418**	**107,787,742**

2_3CAV_TOC requires **29,941 bits per second during Busy Hour**

TOC to TOC Traffic

TOC 3_3CAV_CTCP

Start TOC	3_3CAV_CTCP	End TOC	1_3CAV_CTCP
		Total bits per day	**Busy Hour**
		104,143,840	10,414,384
Start TOC	3_3CAV_CTCP	End TOC	1_3CAV_TOC
		Total bits per day	**Busy Hour**
		126,776,352	12,677,635
Start TOC	3_3CAV_CTCP	End TOC	2_3CAV_CTCP
		Total bits per day	**Busy Hour**
		104,143,840	10,414,384
Start TOC	3_3CAV_CTCP	End TOC	2_3CAV_TOC
		Total bits per day	**Busy Hour**
		126,776,352	12,677,635
Start TOC	3_3CAV_CTCP	End TOC	3_3CAV_TOC
		Total bits per day	**Busy Hour**
		126,776,352	12,677,635
Start TOC	3_3CAV_CTCP	End TOC	3CSS_ALOC
		Total bits per day	**Busy Hour**
		51,865,920	5,186,592
Totals	**3_3CAV_CTCP**	**640,482,656**	**64,048,266**

3_3CAV_CTCP requires **17,791 bits per second during Busy Hour**

TOC to TOC Traffic

TOC 3_3CAV_TOC

Start TOC	3_3CAV_TOC	End TOC	1_3CAV_CTCP
		Total bits per day	**Busy Hour**
		129,792,352	12,979,235
Start TOC	3_3CAV_TOC	End TOC	1_3CAV_TOC
		Total bits per day	**Busy Hour**
		166,144,296	16,614,430
Start TOC	3_3CAV_TOC	End TOC	2_3CAV_CTCP
		Total bits per day	**Busy Hour**
		129,792,352	12,979,235
Start TOC	3_3CAV_TOC	End TOC	2_3CAV_TOC
		Total bits per day	**Busy Hour**
		166,144,296	16,614,430
Start TOC	3_3CAV_TOC	End TOC	3_3CAV_CTCP
		Total bits per day	**Busy Hour**
		129,792,352	12,979,235
Start TOC	3_3CAV_TOC	End TOC	3ACR_TOC
		Total bits per day	**Busy Hour**
		304,345,850	30,434,585
Start TOC	3_3CAV_TOC	End TOC	3CSS_ALOC
		Total bits per day	**Busy Hour**
		51,865,920	5,186,592
Totals	**3_3CAV_TOC**	**1,077,877,418**	**107,787,742**

3_3CAV_TOC requires **29,941 bits per second during Busy Hour**

TOC to TOC Traffic

TOC 3CSS_ALOC

Start TOC	3CSS_ALOC	End TOC 1_3CAV_CTCP	
		Total bits per day	**Busy Hour**
		51,865,920	5,186,592
Start TOC	3CSS_ALOC	End TOC 1_3CAV_TOC	
		Total bits per day	**Busy Hour**
		51,865,920	5,186,592
Start TOC	3CSS_ALOC	End TOC 2_3CAV_CTCP	
		Total bits per day	**Busy Hour**
		51,865,920	5,186,592
Start TOC	3CSS_ALOC	End TOC 2_3CAV_TOC	
		Total bits per day	**Busy Hour**
		51,865,920	5,186,592
Start TOC	3CSS_ALOC	End TOC 3_3CAV_CTCP	
		Total bits per day	**Busy Hour**
		51,865,920	5,186,592
Start TOC	3CSS_ALOC	End TOC 3_3CAV_TOC	
		Total bits per day	**Busy Hour**
		51,865,920	5,186,592
Start TOC	3CSS_ALOC	End TOC 3ACR_TOC	
		Total bits per day	**Busy Hour**
		136,212,824	13,621,282
Totals	**3CSS_ALOC**	**447,408,344**	**44,740,834**

3CSS_ALOC requires **12,428 bits per second during Busy Hour**

TOC to TOC Traffic

TOC 4_3ACS_CTCP

Start TOC	4_3ACS_CTC	End TOC	3ACR_TOC	
		Total bits per day		**Busy Hour**
		51,865,920		5,186,592
Start TOC	4_3ACS_CTC	End TOC	4_3ACS_MAIN	
		Total bits per day		**Busy Hour**
		126,894,664		12,689,466
Start TOC	4_3ACS_CTC	End TOC	4_3ACS_TAC	
		Total bits per day		**Busy Hour**
		51,865,920		5,186,592
Totals	**4_3ACS_CTCP**	**230,626,504**		**23,062,650**

4_3ACS_CTCP requires **6,406 bits per second during Busy Hour**

TOC to TOC Traffic

TOC 4_3ACS_MAIN

Start TOC	4_3ACS_MAIN	End TOC	3ACR_TOC	
		Total bits per day		**Busy Hour**
		322,983,324		32,298,332
Start TOC	4_3ACS_MAIN	End TOC	4_3ACS_CTCP	
		Total bits per day		**Busy Hour**
		127,340,154		12,734,015
Start TOC	4_3ACS_MAIN	End TOC	4_3ACS_TAC	
		Total bits per day		**Busy Hour**
		217,799,452		21,779,945
Totals	**4_3ACS_MAIN**	**668,122,930**		**66,812,293**

4_3ACS_MAIN requires **18,559 bits per second during Busy Hour**

TOC to TOC Traffic

TOC 4_3ACS_TAC

Start TOC 4_3ACS_TAC End TOC 4_3ACS_CTCP

Total bits per day	Busy Hour
137,886,344	13,788,634

Start TOC 4_3ACS_TAC End TOC 4_3ACS_MAIN

Total bits per day	Busy Hour
1,732,515,012	173,251,501

Totals	**4_3ACS_TAC**	**1,870,401,356**	**187,040,136**

4_3ACS_TAC requires **51,956 bits per second during Busy Hour**

Appendix B

ENM, EPLRS and Host Allocations for the
III Corps System Architecture (IIICSA) Troop List

Organizations remaining in Corps Area

Units not moving forward (may require new SRCs or requirements re-evaluation)

TOE	Organization Title	ENMs	EPLRS	FBCB2/EBC
01402F000	**6 CAV AVN BDE**	**1**	**13**	**9**
01412F000	**63 AVN GROUP**	**1**	**13**	**9**
01406F000	**1ST BN 106 TH AVIATION**	1	17	13
01409F000	AVUM/ 1-106		4	4
	Subtotal	**1**	**21**	**17**
01416F000	**1-244 CAB (CMD AVN)**	1	13	9
01418F000	A CO/1-244 CAB (CMD AVN)		1	1
01418F000	B CO/1-158 CMD AVN CO		1	1
01418F000	C CO/1-244 CAB (CMD AVN)		1	1
01419F000	AVUM/1-244 CAB (CMD AVN)		4	4
	Subtotal	**1**	**20**	**16**
01436F000	**2-142 CSAB**	1	13	9
01307F000	A SPT AVN CO/2-142 CASB		1	1
01307F000	B SPT AVN CO/2-142 CSAB		1	1
01307F000	C SPT AVN CO/2-142 CSAB		1	1
01307F000	D SPT AVN CO/2-142 CSAB		1	1
01439F000	AVUM/2-142 CSAB		4	4
	Subtotal	**1**	**21**	**17**
01426F000	**2-114 ATS BN**		1	
01427F100	F/58 ATS CO		10	10
01427F100	K/185 ATS CO		10	10
	Subtotal		**21**	**20**
01446F000	**3-149 HVY HELO BN**	1	8	4
01447F000	C CO/158 CO		11	11
01447F000	F CO/106TH AV		11	11
01447F000	G CO/149TH AV		11	11
01447F000	G CO/185 CO		11	11
	Subtotal	**1**	**52**	**48**
01949F200	**G/52 AMC**		**3**	**3**

01949F300	**D/137 AMC**		**4**	**4**
01949F400	**M/158 AMC**		**2**	**2**
01949F500	**F/135 AMC**		**4**	**4**
01549FA00	**AVIM AUG TM (MED EVAC)**		**1**	**1**
01569FA00	**AVIM AUG TM (HVY LIFT)**		**1**	**1**
03472FIII	**460TH CHEM BDE**	**1**	**7**	**5**
03476F1II	**468TH CHEMICAL BN**	1	8	6
03427FIII	704 NBC RECON CO		29	29
03467FIII	340TH SMOKE/DECON CO		29	29
03467FIII	370TH SMOKE/DECON CO		29	29
03467FIII	TBD#1 SMOKE/DECON CO		29	29
03477FIII	13 BIDS CO		11	11
03477FIII	310 BIDS CO		11	11
	Subtotal	**1**	**146**	**144**
05402FIII	**420TH ENGR BDE**	1	7	5
05473FIII	671 ENGR CO		23	23
	Subtotal	**1**	**30**	**28**
10426FIII	**165TH POL SUPPLY BN**		**16**	**16**
10466FIII	**419TH WATER SUPPLY BN**		**6**	**6**
19472FIII	**89 MP BDE**		**6**	**5**
19476FIII	**607 MP BN**		4	4
19477FIII	133 MP CO		31	31
19477FIII	302 MP CO		31	31
19477FIII	340 MP CO		31	31
19477FIII	423 MP CO		31	31
19477FIII	812 MP CO		31	31
	Subtotal		**159**	**159**
19886FIII	**11 MP BN (CID)**		**4**	**3**
19883FIII	**38 MP DET (CID)**		2	2
19887FAII	38 MP DET (CID) SEC A TM		4	4
19887FBII	38 MP DET (CID) SEC B TM		4	4
	Subtotal		**10**	**10**
19883FIII	**43 MP DET (CID)**		2	2
19887FAII	43 MP DET (CID) SEC A TM		4	4

19887FBII	43 MP DET (CID) SEC B TM		4	4
	Subtotal		**10**	**10**
19883FIII	**48 MP DET (CID)**		2	2
19887FAII	48 MP DET (CID) SEC A TM		4	4
19887FBII	48 MP DET (CID) SEC B TM		4	4
	Subtotal		**10**	**10**
19883FIII	**78 MP DET (CID)**		2	2
19887FAII	78 MP DET (CID) SEC A TM		4	4
19887FBII	78 MP DET (CID) SEC B TM		4	4
	Subtotal		**10**	**10**
19883FIII	**90 MP DET (CID)**		2	2
19887FAII	90 MP DET (CID) SEC A TM		4	4
19887FBII	90 MP DET (CID) SEC B TM		4	4
	Subtotal		**10**	**10**
33737FIII	**315 PSYOP CO**		**12**	**12**
34428F2II	**B CO/221 MI BN**		**20**	**20**
41702FIII	**321 CA BDE**	**1**	**2**	
41706FIII	**490 CA BN (GP)**	**1**	**2**	
44412FIII	**31 ADA BDE**	**1**	**4**	
63426FIII	**232ND CS BN**		**3**	**3**
	Units not moving forward Subtotal	**12**	**643**	**602**

Organizations remaining in Corps Area

Units that may move forward or have need for EPLRS connectivity

TOE	Organization Title	ENMs	EPLRS	FBCB2/EBC
01482F000	**385 ATTACK REGT**	**1**	**13**	**9**
01486F100	**1-6 ATK BN**	1	20	16
01487F100	A CO/1-6 ATK BN		1	8
01487F100	B CO/1-6 ATK BN		1	8
01487F100	C CO/1-6 ATK BN		1	8
01489F100	AVUM/1-6 ATK BN		4	4
	Subtotal	**1**	**27**	**44**
01486F100	**3-6 ATK BN**	1	20	16
01487F100	A CO/3-6 ATK BN		1	8
01487F100	B CO/3-6 ATK BN		1	8
01487F100	C CO/3-6 ATK BN		1	8
01489F100	AVUM/3-6 ATK BN		4	4
	Subtotal	**1**	**27**	**44**
01486F100	**8-229 ATK BN**	1	20	16
01487F100	A CO/8-229 ATK BN		1	8
01487F100	B CO/8-229 ATK BN		1	8
01487F100	C CO/8-229 ATK BN		1	8
01489F100	AVUM/8-229 ATK BN		4	4
	Subtotal	**1**	**27**	**44**
11402F2II	**3 SIG BDE**	**2**	**2**	
11437F1II	**SPT CO/16 SIG BN (AREA)**		2	
11467F1II	A CO/16 SIG BN (AREA)		2	
11467F1II	B CO/16 SIG BN (AREA)		2	
11467F1II	C CO/16 SIG BN (AREA)		2	
	Subtotal		**8**	
11437F1II	**SPT CO/57 SIG BN (AREA)**		2	
11467F1II	A CO/57 SIG BN (AREA)		2	
11467F1II	B CO/57 SIG BN (AREA)		2	
11467F1II	C CO/57 SIG BN (AREA)		2	
	Subtotal		**8**	
11437F1II	**SPT CO/212 SIG BN (AREA)**		2	
11467F1II	A CO/212 SIG BN (AREA)		2	
11467F1II	B CO/212 SIG BN (AREA)		2	
11467F1II	C CO/212 SIG BN (AREA)		2	
	Subtotal		**8**	

11447F1II	**SPT CO/136 SIG BN (SPT)**		1	
11467F1II	A CO/136 SIG BN (SPT)		2	
11467F1II	B CO/136 SIG BN (SPT)		2	
	Subtotal		**5**	
44436F1II	**3-265 ADA**	1	23	23
44437F1II	A BTRY/3-265 ADA		35	33
44437F1II	B BTRY/3-265 ADA		35	33
44437F1II	C BTRY/3-265 ADA		35	33
	Subtotal	**1**	**128**	**122**
44436F1II	**4-200 ADA**	1	23	23
44437F1II	A BTRY/4-200 ADA		35	33
44437F1II	B BTRY/4-200 ADA		35	33
44437F1II	C BTRY/4-200 ADA		35	33
	Subtotal	**1**	**128**	**122**
Corps area units needing EPLRS Subtotal		**8**	**381**	**385**
	CORPS Area Total	**20**	**1024**	**987**

Organizations moving forward to provide support to the 1st Cavalry Division

TOE	Organization Title	ENMs	EPLRS	FBCB2/EBC
03476F1II	**2D CHEM BN**	1	8	6
03427FIII	392 NBC RECON CO		29	29
03457FIII	45 RECON/DECON CO		21	21
03467FIII	181 SMOKE/DECON CO		29	29
03467FIII	327 SMOKE/DECON CO		29	29
	Subtotal	**1**	**116**	**114**
05412F2II	**937TH ENGR GRP**	1	11	9
05473FIII	74TH ENGR CO		23	23
05473FIII	814 ENGR CO		23	23
	Subtotal	**1**	**57**	**55**
05416FIII	**62ND ENGR BN (HVY)**	1	20	19
05417FIII	226 ENGR CO (CBT)		20	20
05417FIII	A CO 62 ENGR BN (HVY)		20	20
05417FIII	B CO 62 ENGR BN (HVY)		20	20
	Subtotal	**1**	**80**	**79**
05426FIII	**724TH ENGR BN (WHL)**	1	20	19
05423FIII	68 CBT SPT CO		19	19
05427FIII	A CO/724 ENGR BN (WHL)		24	24
05427FIII	B CO/724 ENGR BN (WHL)		24	24
05427FIII	C CO/724 ENGR BN (WHL)		24	24
	Subtotal	**1**	**111**	**110**
05436F3II	**489 ENGR BN (MECH)**	1	24	23
05423FIII	568 CBT SPT CO		19	19
05437F3II	CO A 489 ENGR BN		31	31
05437F3II	CO B 489 ENGR BN		31	31
05437F3II	CO C 489 ENGR BN		31	31
	Subtotal	**1**	**136**	**135**
05436F3II	**5TH ENGR BN (MECH)**	1	24	23
05423FIII	116 CBT SPT CO		19	19
05437F3II	A CO 5 ENGR BN (MECH)		31	31
05437F3II	B CO 5 ENGR BN (MECH)		31	31
05437F3II	C CO 5 ENGR BN (MECH)		31	31
	Subtotal	**1**	**136**	**135**
06402FIII	**17 FA BDE**	**1**	**9**	**3**
06456FIII	**3-18 FA BN (155 SP)**		13	8
06457FIII	A BTRY/3-18 FA (155 SP)		21	19
06457FIII	B BTRY/3-18 FA (155 SP)		21	19

06457FIII	C BTRY/3-18 FA (155 SP)		21	19
06459FIII	SVC BTRY/3-18 FA BN		8	8
	Subtotal		**84**	**73**
06466FIII	**1-12 FA BN (MLRS)**		17	11
06467FIII	A BTRY/1-12 FA (MLRS)		17	14
06467FIII	B BTRY/1-12 FA (MLRS)		17	14
06467FIII	C BTRY/1-12 FA (MLRS)		17	14
	Subtotal		**68**	**53**
06466FIII	**5-3 FA BN (MLRS)**		17	11
06467FIII	A BTRY/5-3 FA (MLRS)		17	14
06467FIII	B BTRY/5-3 FA (MLRS)		17	14
06467FIII	C BTRY/5-3 FA (MLRS)		17	14
	Subtotal		**68**	**53**
06402FIII	**212 FA BDE**	**1**	**9**	**3**
06456FIII	**2-5 FA BN (155SP)**		13	8
06457FIII	A BTRY/2-5 FA (155 SP)		21	19
06457FIII	B BTRY/2-5 FA (155 SP)		21	19
06457FIII	C BTRY/2-5 FA (155 SP)		21	19
06459FIII	SVC BTRY/2-5 FA BN		8	8
	Subtotal		**84**	**73**
06466FIII	**2-18 FA BN (MLRS)**		17	11
06467FIII	A BTRY/2-18 FA BN (MLRS)		17	14
06467FIII	B BTRY/2-18 FA BN (MLRS)		17	14
06467FIII	C BTRY/2-18 FA BN (MLRS)		17	14
	Subtotal		**68**	**53**
06466FIII	**6-32 FA BN (MLRS)**		17	11
06467FIII	A BTRY/6-32 FA BN (MLRS)		17	14
06467FIII	B BTRY/6-32 FA BN (MLRS)		17	14
06467FIII	C BTRY/6-32 FA BN (MLRS)		17	14
	Subtotal		**68**	**53**
19476FIII	**720 MP BN**		4	4
19477FIII	401 MP CO		31	31
19477FIII	410 MP CO		31	31
19477FIII	411 MP CO		31	31
19477FIII	64 MP CO		31	31
19477FIII	855 MP CO		31	31
	Subtotal		**159**	**159**
33737FIII	**320 PSYOP CO**		**12**	**12**
41706FIII	**418 CA BN (GP)**	**1**	**2**	
	1st Cavalry Division Support Total	**9**	**1267**	**1163**

Organizations moving forward to provide support to the 4th Infantry Division

TOE	Organization Title	ENMs	EPLRS	FBCB2/EBC
03476F1II	**450TH CHEMICAL BN**	1	8	6
03437FIII	46 MECH SMOKE CO		29	29
03457FIII	44TH RECON/DECON CO		21	21
03467FIII	304TH SMOKE/DECON CO		29	29
03467FIII	398TH SMOKE/DECON CO		29	29
03477FIII	TBD#2 BIDS CO		11	11
	Subtotal	**1**	**127**	**125**
05412F2II	**493RD ENGR GRP**	1	11	9
05473FIII	200 ENGR CO		23	23
05473FIII	652 ENGR CO		23	23
	Subtotal	**1**	**57**	**55**
05416FIII	**980 ENGR BN (HVY)**	1	20	19
05417FIII	A CO 980 ENGR BN (HVY)		20	20
05417FIII	B CO 980 ENGR BN (HVY)		20	20
05417FIII	C CO 980 ENGR BN (HVY)		20	20
	Subtotal	**1**	**80**	**79**
05426FIII	**841 ENGR BN (WHL)**	1	20	19
05423FIII	952 CBT SPT CO		19	19
05427FIII	A CO/841 ENGR BN (WHL)		24	24
05427FIII	B CO/841 ENGR BN (WHL)		24	24
05427FIII	C CO/841 ENGR BN (WHL)		24	24
	Subtotal	**1**	**111**	**110**
05436F3II	**478TH ENGR BN (MECH)**	1	24	23
05423FIII	842 CBT SPT CO		19	19
05437F3II	A CO 478 ENGR BN (MECH)		31	31
05437F3II	B CO 478 ENGR BN (MECH)		31	31
05437F3II	C CO 478 ENGR BN (MECH)		31	31
	Subtotal	**1**	**136**	**135**
05436F3II	**875 ENGR BN (MECH)**	1	24	23
05423FIII	258 CBT SPT CO)		19	19
05437F3II	CO A 875 ENGR BN		31	31
05437F3II	CO B 875 ENGR BN		31	31
05437F3II	CO C 875 ENGR BN		31	31
	Subtotal	**1**	**136**	**135**
06402FIII	**45 FA BDE**	**1**	**9**	**3**
06456FIII	**2-222 FA BN (155 SP)**		13	8
06457FIII	A BTRY/2-222 FA (155 SP)		21	19

06457FIII	B BTRY/2-222 FA (155 SP)		21	19
06457FIII	C BTRY/2-222 FA (155 SP)		21	19
06459FIII	SVC BTRY/2-222 FA BN		8	8
	Subtotal		**84**	**73**
06466FIII	**1-158 FA BN (MLRS)**		17	11
06467FIII	A BTRY/1-158 FA BN (MLRS)		17	14
06467FIII	B BTRY/1-158 FA BN (MLRS)		17	14
06467FIII	C BTRY/1-158 FA BN (MLRS)		17	14
	Subtotal		**68**	**53**
06466FIII	**1-171 FA BN (MLRS)**		17	11
06467FIII	A BTRY/1-171 FA BN (MLRS)		17	14
06467FIII	B BTRY/1-171 FA BN (MLRS)		17	14
06467FIII	C BTRY/1-171 FA BN (MLRS)		17	14
	Subtotal		**68**	**53**
06402FIII	**75 FA BDE**	**1**	**9**	**3**
06456FIII	**1-17 FA BN (155 SP)**		13	8
06457FIII	A BTRY/1-17 FA (155 SP)		21	19
06457FIII	B BTRY/1-17 FA (155 SP)		21	19
06457FIII	C BTRY/1-17 FA (155 SP)		21	19
06459FIII	SVC BTRY/1-17 FA BN		8	8
	Subtotal		**84**	**73**
06466FIII	**1-77 FA BN (MLRS)**		17	11
06467FIII	A BTRY/1-77 FA (MLRS)		17	14
06467FIII	B BTRY/1-77 FA (MLRS)		17	14
06467FIII	C BTRY/1-77 FA (MLRS)		17	14
	Subtotal		**68**	**53**
06466FIII	**6-27 FA BN (MLRS)**		17	11
06467FIII	A BTRY/6-27 FA (MLRS)		17	14
06467FIII	B BTRY/6-27 FA (MLRS)		17	14
06467FIII	C BTRY/6-27 FA (MLRS)		17	14
	Subtotal		**68**	**53**
10414FIII	**157TH FLD SVC CO**		**2**	**2**
19476FIII	**759 MP BN**		4	4
19477FIII	220 MP CO		31	31
19477FIII	300 MP CO		31	31
19477FIII	59 MP CO		31	31
19477FIII	977 MP CO		31	31
19477FIII	984 MP CO		31	31
	Subtotal		**159**	**159**

33737FIII	**361 PSYOP CO**		**12**	**12**
41706FIII	**451 CA BN (GP)**	**1**	**2**	
	4th Infantry Division Support Total	**9**	**1280**	**1176**

III Corps Artillery assets assigned to corps support but likely located very near the division boxes.

TOE	Organization Title	ENMs	EPLRS	FBCB2/EBC
06403FIII	**III CORPS ARTY**	**1**	**20**	**3**
06413FIII	**231 TAD/III CORPS ARTY**		**2**	
06402FIII	**214 FA BDE**	**1**	**9**	**3**
06466FIII	**1-14 FA BN (MLRS)**		17	11
06467FIII	A BTRY/1-14 FA BN (MLRS)		17	14
06467FIII	B BTRY/1-14 FA BN (MLRS)		17	14
06467FIII	C BTRY/1-14 FA BN (MLRS)		17	14
	Subtotal		**68**	**53**
06466FIII	**2-4 FA BN (MLRS)**		17	11
06467FIII	A BTRY/2-4 FA BN (MLRS)		17	14
06467FIII	B BTRY/2-4 FA BN (MLRS)		17	14
06467FIII	C BTRY/2-4 FA BN (MLRS)		17	14
	Subtotal		**68**	**53**
06466FIII	**3-13 FA BN (MLRS)**		17	11
06467FIII	A BTRY/3-13 FA BN (MLRS)		17	14
06467FIII	B BTRY/3-13 FA BN (MLRS)		17	14
06467FIII	C BTRY/3-13 FA BN (MLRS)		17	14
	Subtotal		**68**	**53**
	Corps Artillery Totals	**2**	**235**	**165**

Appendix C
List of IIICSA Business Rules

Document	Date
Business Rules-1DC ADA Brigade v2 .doc	11/28/01
Business Rules-1DC Armored Cavalry Regiment v2.doc	03/25/02
Business Rules-1DC Artillery v2.doc	12/14/01
Business Rules-1DC Aviation Brigade v2.doc	11/28/01
Business Rules-1DC Chemical Brigade v2.doc	11/28/01
Business Rules-1DC Civil Affairs Brigade v2.doc	11/28/01
Business Rules-1DC Engineer Brigade v2.doc	11/28/01
Business Rules-1DC Finance Group v2.doc	11/28/01
Business Rules-1DC HHC v2.doc	11/28/01
Business Rules-1DC MEDCOM v2.doc	11/28/01
Business Rules-1DC MI Brigade v2.doc	11/28/01
Business Rules-1DC MP Brigade v2.doc	11/28/01
Business Rules-1DC Personnel Group v2.doc	11/28/01
Business Rules-1DC Signal Brigade v2.doc	11/28/01
Business Rules-1DC Support Command v2.doc	11/28/01
Business Rules-1DC Tac PSYOP Bn v2.doc	11/28/01

There are no additional recommendations to be made other than those already mentioned. Future quality-oriented analyses should begin early in the SA development phase and include a totally comprehensive review of the SA, time permitting.