Director, Operational Test and Evaluation

Nett Warrior

Initial Operational Test and Evaluation (IOT&E) Report

May 2015

This report on the Nett Warrior system fulfills the provisions of Title 10, United States Code, Section 2399. It assesses the adequacy of testing and the operational effectiveness, operational suitability, and survivability of the Nett Warrior.

J. Michael Gilmore
Director

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Leader with Nett Warrior Moving through Wooded Terrain

Executive Summary

This report provides my operational assessment of the Nett Warrior System. It is based on the results of the Nett Warrior Initial Operational Test and Evaluation (IOT&E) the Army Test and Evaluation Command (ATEC) conducted at White Sands Missile Range, New Mexico, and Fort Bliss, Texas, in May 2014, and at Fort Polk, Louisiana, in November 2014.

System Description

Nett Warrior is a Soldier-worn mission command system that supports the mission of the dismounted combat leader. The Nett Warrior graphically displays the location of an individual leader, other leaders, friendly vehicles, and enemy activity on a digital geo-referenced map image. It is connected through a secure radio to the Soldier Radio Waveform (SRW) network and enables communicate among different echelons using voice, data, and Position Location Information (PLI) messages.

Test Adequacy

The Nett Warrior IOT&E was adequate. ATEC conducted testing in two phases with both a mounted unit and dismounted unit. Both phases were conducted in accordance with a Director, Operational Test and Evaluation (DOT&E)-approved test plan and produced sufficient data to conduct a valid assessment.

Operational Effectiveness

Nett Warrior is operationally effective in mounted formations at platoon and troop level. In dismounted infantry units, Nett Warrior is effective at the platoon level. Nett Warrior demonstrated the capability to provide platoon and company situational awareness and communications to each equipped leader. The system enhances land navigation, message reporting, and command and control. The combat leaders were able to employ Nett Warrior to plan missions, maintain situational awareness, and communicate.

The Nett Warrior is not effective at the company level due to Manpack radio's periodic inability to execute route/retransmission or digitally connect adjacent units. The Manpack radio had a 44 percent message completion rate of PLI that prevented the Company Commander from having full situational awareness of his company during operations.

The Nett Warrior networks internal to the platoon exchanged PLI and digital messages. Platoon situational awareness was effective and reliable. Voice communications with the Nett Warrior system is effective.

Operational Suitability

The Nett Warrior system is operationally suitable and reliable. The user specified a threshold reliability requirement for Nett Warrior of 148 hours Mean Time Between Essential Function Failure (MTBEFF) in order to achieve an 85-percent probability of operating for 24 hours without incurring an EFF. Nett Warrior demonstrated a reliability of 226 hours MTBEFF or an 90 percent probability of operating for 24 hours without incurring an EFF.

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The radio pouch and connector cup provides adequate guard to the leader wearing the Nett Warrior for times when the radio temperature exceeds 120 degrees Fahrenheit.

Recharging batteries to support Nett Warrior is an increased logistical burden. The process to operate four to five generators and associated battery chargers to charge all batteries to equip a light infantry company takes 3 to 4 Soldiers, 12 to 15 hours a day. Charging this increased number of batteries takes Soldiers away from their primary jobs. The infantry unit was not able to charge the batteries required to operate the Nett Warrior system and Manpack radios without augmentation of a 3-kilowatt generator from the battalion headquarters.

Operator training was sufficient for leaders to operate the Nett Warrior throughout the test. Testing identified issues with Manpower, Personnel and Integration (MANPRINT) with the system. The Rifleman Radio demonstrated suitability issues previously observed in separate, prior testing. The Nett Warrior program manager made changes to the Nett Warrior system to mitigate Rifleman Radio suitability issues. The Rifleman Radio is government furnished equipment, and was assessed in testing both as a separate piece of equipment and as a part of the Nett Warrior system. While not meeting requirements, Rifleman Radio demonstrated improved reliability compared to previous test results.

Survivability

The Nett Warrior End User Display (EUD) is survivable against cyber-attacks. The AN/PRC-154A Rifleman Radio is not survivable against cyber-attacks. The Nett Warrior is not survivable in an electronic warfare environment.

Recommendations

The Army should consider the following recommendations. Nett Warrior is one element of a larger network of systems that must function together if the data and information collected by Nett Warrior are to be distributed and used effectively.

- Reduce the number of rapid recoverable events and decrease the number of times Nett Warrior falls out of the network.
- Make the C-4 cable connections more durable.
- Address performance and reliability issues when operating in the rain or in humid conditions.
- Improve the capability to utilize the collaborative planner at the platoon and company level.
- Re-assess the troubleshooting quick reference guide versus a system reboot to fix problems.
- Educate leaders on the limitations of an Army tactical network. They should be taught not to expect the system to work in an operational/deployed environment the same way a smartphone would work with a network of fixed cell towers.
- Continue to investigate and correct problems with unintended Mayday messages populating the networks.

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- Improve SRW network reliability to include Manpack radio route/retransmission capability between platoon and company networks and increasing message completion rate for the Variable Message Format between echelons.
- Investigate adding a display screen to the Rifleman Radio to provide operators with feedback.
- Continue to find solutions to decrease the Rifleman Radio battery temperature to the Military Standard (MIL-STD)-1472G.
- Fully integrate Nett Warrior into combat units:
  - Develop doctrine; employment concepts; and tactics, techniques, and procedures.
  - Address employment of the additional Manpack radio.
  - Teach leaders how the SRW network operates and how to maximize the network to support operations.
  - Incorporate lessons learned from previous testing and training (e.g., light and noise discipline).
- Develop an overall power management system that can support a light infantry company for 72 hours.
- Develop a data collection device that Soldiers can wear to collect data on the Manpack radio and better determine radio performance on the network smartphone.

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Section One
System Overview

System Description

Nett Warrior is a Soldier-worn mission command system that supports the mission of the dismounted combat leader. The Nett Warrior graphically displays the location of an individual leader, other leaders, friendly vehicles, and enemy activity on a digital geo-referenced map image. It is connected through a secure radio to the Soldier Radio Waveform (SRW) network and enables leader communication among different echelons using voice, data, and Position Location Information (PLI) messages.

The Army envisions that Nett Warrior will provide situational awareness and enhanced situational understanding to support faster and more accurate decisions in combat. It is designed to facilitate command, control, and sharing of battlefield information to integrate each leader into the digitized battlefield. The Army intends to use Nett Warrior to provide PLI to dismounted infantry and cavalry leaders down to the team leader level. The central capability of the Nett Warrior system is the ability to display the locations of small unit leaders on a map display. This information can then be shared with other leaders in the network who have a Nett Warrior.

The Nett Warrior base configuration consists of three components: an End User Device (EUD) that processes and displays tactical information and enables user interface with the capability; a network radio that transmits and receives tactical information; and a cable that connects the EUD and the radio. The Nett Warrior program is using an incremental developmental approach in which it plans on testing, purchasing, and fielding a given configuration (EUDs and software) for a set period before moving to the next edition, so that it can take advantage of frequent commercial technology improvements.

Figure 1-1 depicts the Nett Warrior base configuration, showing the radio, cables, EUD, and a conformal battery that provides extra power. The conformal battery worn within the leader's tactical vest provides up to 20 hours of extra power for the EUD and radio. For missions of shorter duration, the conformal battery is not necessary and does not need be carried. The Soldier-worn Nett Warrior system, with batteries, weighs 6.8 pounds.

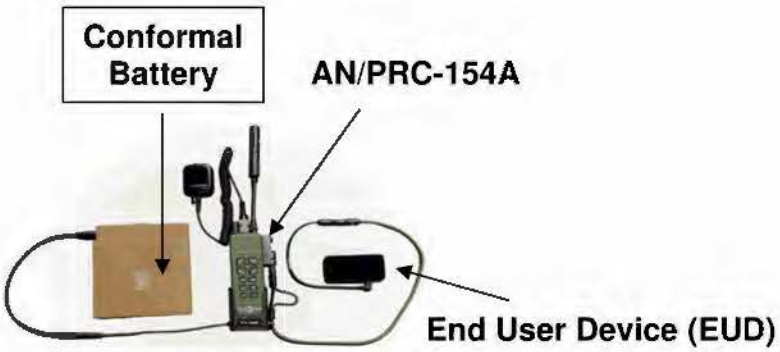

Figure 1-1. Nett Warrior System

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The Nett Warrior system that was tested in both phases of the Initial Operational Test (IOT) consisted of:

- Samsung Note 2 EUD with Otterbox/TYR case and Wamco filter
- AN/PRC-154A Rifleman Radio with IB25 firmware
- "C" Series cable connecting the EUD to the Rifleman Radio
- Soldier Worn Integrated Power System, conformal battery, and Modular Universal Battery Charger (MUBC)
- Nett Warrior 2.0.5 operating software with associated formats and Joint Battle Command – Platform (JBC-P)/Joint Capability Release (JCR) compatibility as a network enabler
- Global Positioning System (GPS) Repeater

The EUD is a commercial smartphone modified for military purposes. The version of the EUD used in the IOT&E was developed by Samsung and is referred to as the Note 2; the specific vendor device may change or be updated every 18 to 24 months as the commercial market produces devices that are more capable. The Army uses a Wamco filter on the EUD to reduce light during nighttime use. The EUD provides GPS location data. A chest mount is provided for the leader to mount the EUD on leader body armor. The chest mount used in the IOT&E consisted of a soft canvas case (TYR case) that attached the EUD to the leader's chest and a hardened outer case (Otterbox case) to protect the EUD. Figure 1-2 illustrates the chest mount configuration.

Figure 1-2. Nett Warrior Chest Mount

The primary communications device for Nett Warrior is the Rifleman Radio (Secret and below). It is government-furnished equipment to the Nett Warrior program. The Rifleman Radio program is undergoing a source selection for a new radio that will be integrated into the Nett Warrior program and tested during Rifleman Radio's IOT&E in Fiscal Year (FY) 16. The

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radio provides voice and digital capabilities for communications and GPS location data. The GPS capability is disabled when connected to the EUD.

There are several options for wearing the radio and placement on the Soldier's body, but the preferred placement is the antenna mounted higher than the shoulder. Many Soldiers chose to wear the radio over their left shoulder (rear) as shown below in Figure 1-3. This configuration was prevalent during Phase I. In Phase II, other Soldiers wore the systems on their front, which degrades radio performance as discussed later in the report.

Figure 1-3. Nett Warrior Radio Worn on Rear and Front

Software components of Nett Warrior provide system functionality and run tactical applications and battle-command software. The software provides the capability to manipulate information on the EUD and send free text and selected pre-formatted digital messages. The Nett Warrior 2.0.5 digital message formats tested in the IOT were:

- K05.1 Position Report – the PLI that provides the GPS location of the Nett Warrior user. Nett Warrior generates and transmits PLI to all Nett Warrior systems on the network.
- K01.01.0 free text – a text message with no specified format other than the length limits.
- K04.01/0 Observation Report – a standard report using the Size, Activity, Location, Unit/Uniform, Time, and Equipment format.
- K07.1 Medical Evacuation Request – standard medical request format.
- K03.06/0 Mayday – emergency message.
- K05.17/3 Overlays – a Joint Photographic Experts Group (JPEG) photo of the screen that would be sent to other leaders, but could not be manipulated or translated onto the map interface. The overlays capability requires further development.
- K04.02 Route Planning
- K05.02/2 Nuclear Biological Chemical (NBC) 1 report
- K05.14 Situation Report

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- K05.19 Entity Data – called "survivability messages" provide supplemental situational awareness information on specified items. These messages are created automatically by other messages. For example, the K04.01 Observation Report will generate a K05.19 message populating an icon on the map. Messages in the K05/19 category include:
  - K05.19/8 Chemlight
  - K05.19/8 Aircraft/Anti-aircraft
  - K05.19/8 Artillery
  - K05.19/8 Dismounted Personnel
  - K05.19/8 Spot Report
  - K05.19/9 Other-Entity Combat Status

The Chemlight (K05.19/8) is a special message that serves a role similar to a physical chemical light that is used to mark the location and status of buildings (e.g., cleared, dangerous). The Nett Warrior digital chemical light is a colored icon (green, blue, yellow, or red) placed at a specific geographic location. It is generated when a leader presses his EUD and it becomes visible on other leaders' EUD screens. It is a Hyper Text Markup Language (HTML) message that does not depend upon JBC-P/JCR for transmission among units, as do the other messages listed, which are in Variable Message Format (VMF).

Nett Warrior support equipment includes an array of generators and charging devices to recharge the batteries that power the radios and EUDs. Figure 1-4 shows the Nett Warrior 1-kilowatt portable generator and the Modular Universal Battery charger (MUBC). The MUBC is one of several charging sources available for the battery in the Rifleman Radio or conformal battery. Nett Warrior includes a Dell E 6430 Mission Planning Computer for loading maps and conducting planning functions. Select mission planning tasks can be performed on the EUD.

Nett Warrior 1 KW Generator	Modular Universal Battery Charger (MUBC)

Figure 1-4. Nett Warrior Generator and MUBC

Operational Concept of Employment

Nett Warrior is designed to connect small infantry leaders to the tactical internet. The system is to be employed with a variety of Army infantry formations including Stryker,

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mechanized infantry, and light infantry units. The Army envisions units equipped with Nett Warrior will observe, transmit, and subscribe to the situational awareness network services that reside on numerous manned and unmanned platforms. The current concept of operation calls for the Nett Warrior systems to be issued to small unit leaders, including the company command element (commander, first sergeant, executive officer, etc.), platoon leaders, squad leaders, and team leaders.

The Nett Warrior updates and broadcasts PLI every 30 seconds or every time the radio moves at least 10 meters. This location is displayed on the leader's EUD and on the EUDs of other leaders within radio range. Other systems on the network capable of displaying PLI (e.g., Blue Force Tracker), display the Nett Warrior PLI. During missions, knowledge of the location of troops should assist with synchronizing maneuver, calling for artillery fires, and reducing fratricide.

Supporting Communications Network

Nett Warrior is one element of a larger network of systems that must function together if the data and information collected by Nett Warrior are to be distributed and used. Various units within the Army will be equipped with different tactical networks, and Nett Warrior's overall effectiveness is tied to the performance of these networks.

Through the Rifleman Radio, the Nett Warrior interfaces with other SRW radios to a Network Services Gateway, to JBC-P or JCR software in mounted units. Within light infantry units, Nett Warrior interfaces through the Manpack radio to enable network connectivity to the Army's larger network of communication systems.

In the IOT, two different network configurations were tested. In Phase I, a network designed for a mechanized infantry company using JBC-P was tested. In Phase II, with the light infantry unit, connectivity to outside elements was via the Manpack radio. Details of the configurations of these specific networks are described in Section Two of this report.

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Section Two
Test Adequacy

The Nett Warrior Initial Operational Test and Evaluation (IOT&E) was adequate. The Army Test and Evaluation Command (ATEC) conducted testing in two phases with a mounted unit followed by a dismounted unit phase. Mounted unit Phase I was conducted at Network Integration Evaluation (NIE) 14.2 from May 6 – 17, 2014, at Fort Bliss, Texas, in open desert terrain. Dismounted unit Phase II was conducted from November 4 – 15, 2014, at Fort Polk, Louisiana, in dense pine forest terrain. Both phases were conducted in accordance with a Director, Operational Test and Evaluation (DOT&E)-approved test plans and produced adequate data to conduct a valid assessment.

Test Concept

A similar concept for testing was utilized for each phase of the IOT. The primary test unit in Phase I was a Cavalry (CAV) troop consisting of two platoons mounted in Mine-Resistant Ambush Protected (MRAP) All-Terrain Vehicle (M-ATV)/MaxxPro vehicles. In Phase I, the unit conducted offensive and reconnaissance force-on-force missions in three terrain types: desert (open, flat), restricted (rolling hills), and urban against an opposing force (OPFOR). In Phase II, a light infantry company conducted offensive and defensive force-on-force missions in dense, forested terrain typically assigned to dismounted forces. Representative terrain for each phase is shown below.

Figure 2-1. Terrain in Phase I and Phase II

In Phase I, the Soldiers were CAV scouts assigned to C Troop, 1st Squadron, 1st Cavalry Regiment (C/1-1 CAV) from 2nd Brigade/1st Armor Division from Fort Bliss, Texas. In Phase II, the test unit was a light infantry company, A Company, 2nd Battalion, 30th Infantry Regiment (A/2-30 IN), 10th Mountain Division.

In both phases, the OPFOR was the proper size and had weapon systems appropriate for the threat level. During each phase, the units conducted three, 72-hour scenarios. The test team used unit operations orders and fragmentary orders to control the operational scenarios and scope of the exercise. They conducted a mixture of offensive and defensive operations under operationally realistic conditions. Planning operations and small-unit tactical operations were exercised to generate the required data.

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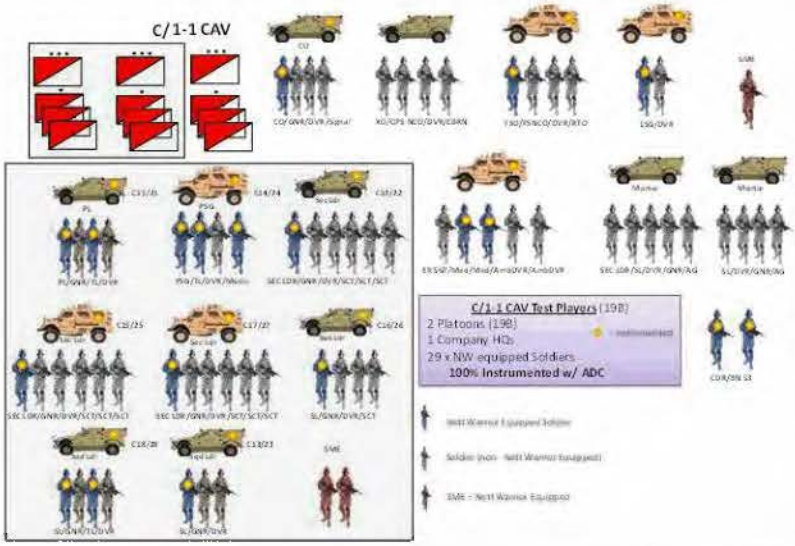
In Phase I, the Army conducted Cooperative Vulnerability Analyses cybersecurity assessments and an adversarial protect, detect, react, and restore assessment. A Continuity of Operations assessment was conducted in Phase II.

For C /1-1 CAV used in Phase I, 12 leaders in each platoon were equipped with Nett Warrior, as were leaders in the troop headquarters. Each MRAP vehicle was equipped to receive Nett Warrior data and transfer it to the Joint Battle Command – Platform (JBC-P) network. Figure 2-2 shows leaders in the platoon formations for the C /1-1 CAV equipped with Nett Warrior systems.



19B	Scout Military Occupational Specialty	DVR	Driver	PL	Platoon Leader
1SG	First Sergeant	ER SGT	Emergency (medical) Sergeant	PSG	Platoon Sergeant
ADC	Android Data Collector	FSNCO	Fire Support NCO	RTO	Radio Telephone Operator
AG	Assistant Gunner	FSO	Fire Support Officer	SCT	Scout
BN S3	Battalion Operations Officer	GNR	Gunner	SEC LDR	Section Leader
CAV	Cavalry	HQ	Headquarters	SL	Squad Leader
CBRN	Chemical, Biological, Radiological, Nuclear	Med	Medic	SME	Subject Matter Expert
CDR	Battalion Commander	NCO	Non-Commissioned Officer	XO	Executive Officer
CO	Company Commander	OPS	Operations		

Figure 2-2. Employment of Nett Warrior within C/1-1 CAV Unit in Phase I

For the light infantry unit used in Phase II, 13 leaders in each platoon were equipped with Nett Warrior, as were leaders in the company headquarters. Figure 2-3 shows the leaders in each of the platoons equipped with Nett Warriors. This unit had no vehicles during movements, though a single company vehicle remained in the rear with the company logistics element.

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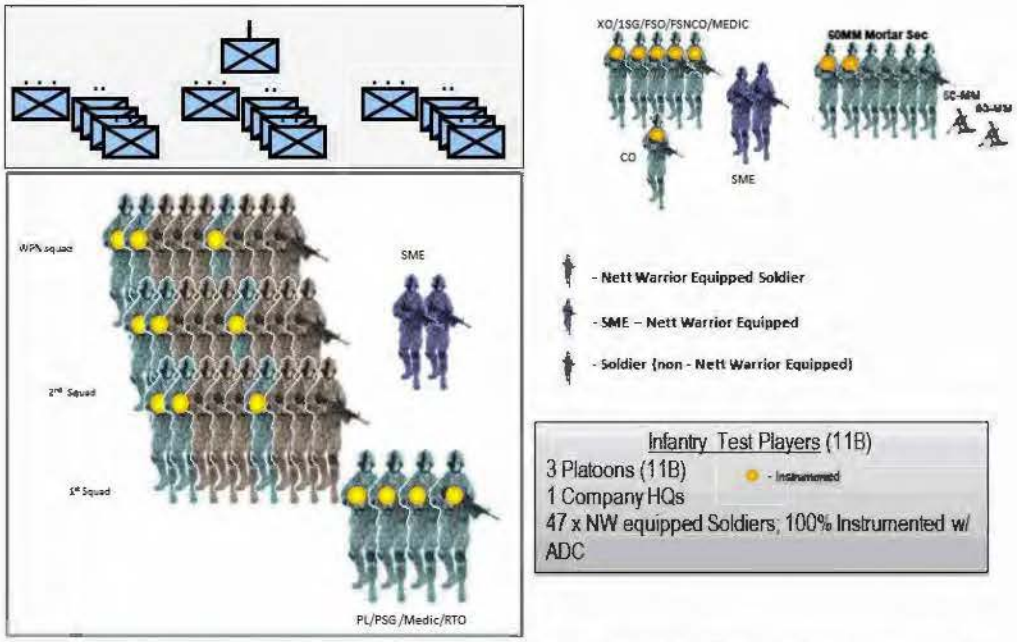

11B	Infantryman Military Occupational Specialty	FSNCO	Fire Support NCO	RTO	Radio Telephone Operator
1SG	First Sergeant	FSO	Fire Support Officer	SL	Squad Leader
60-MM	60 millimeter mortar	HQ	Headquarters	SME	Subject Matter Expert
ADC	Android Data Collector	NW	Nett Warrior	TL	Team Leader
Amb	Ambulance	PL	Platoon Leader	WPN	Weapons
CO	Company Commander	PSG	Platoon Sergeant	XO	Executive Officer

Figure 2-3. Employment of Nett Warrior Systems within the Light Infantry Unit in Phase II

Supporting Network

The Nett Warrior systems under test were one element of a larger network of communications systems. In Phase I at the NIE 14.2 at Fort Bliss, Texas, Nett Warrior was tested in an MRAP-equipped CAV troop. The MRAPs were equipped with JBC-P to support the data connection between platoon, troop headquarters, and higher elements. In Phase II at Fort Polk, Louisiana, Nett Warrior was tested in a dismounted light infantry rifle company. The platoons and company headquarters used Manpack radios for the data connection between the echelons. Planned communication pathways between echelons are described below for each unit.

Phase I, CAV Troop Architecture

Figure 2-4 depicts the company radio networks for C/1-1 CAV. The troop used both Soldier Radio Waveform (SRW) networks and JBC-P satellite connectivity to communicate. Two of eight Manpack radios in each platoon were dismounted radios used to extend the range between dismounted scouts and their vehicles. The radios were not used in route/retransmission mode to pass data between platoon and troop headquarters. Route/retransmission capability is when a two-channel radio receives information on one channel with a set frequency and passes that information to the other channel on a different frequency for transmission. A radio in route/retransmission can pass data or voice, but not both between channels. If data are being route/retransmitted, voice traffic can still be carried on the individual channel.

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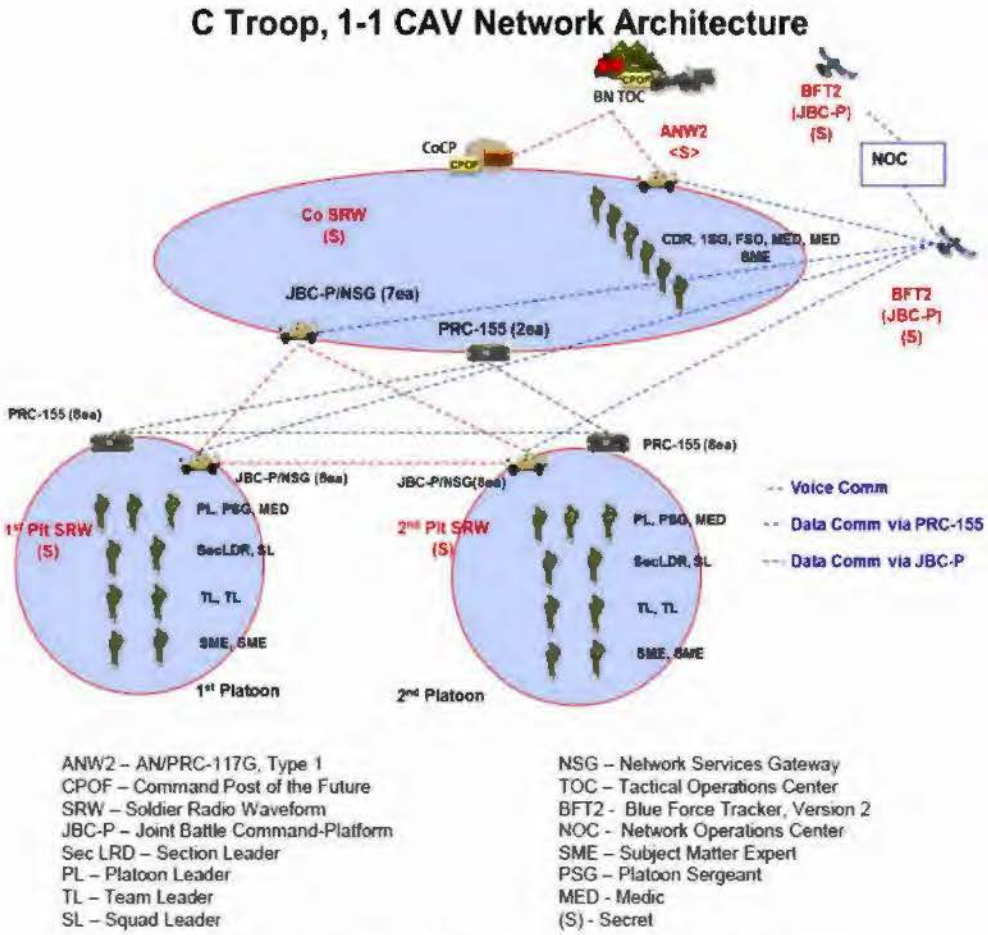

Figure 2-4. Communications Architecture for the CAV Troop

Leaders at platoon level conducted voice communications on the SRW network with both the Nett Warrior's Rifleman Radio and vehicle-mounted Manpack radio. There was a platoon SRW network and troop SRW network. Leaders conducted voice communications between platoon and troop headquarters on the troop SRW network transmitted on the vehicle-mounted Manpack radio, or as required over dismounted man-carried Manpack radios.

Leaders passed digital data at the platoon level over the platoon SRW network with the Nett Warrior's Rifleman Radio and vehicle-mounted Manpack radio. They passed digital data between the platoon and troop echelons through the JBC-P systems. The unit did not use the route/retransmission capability of the Manpack radio's two channels to pass data.

Each of the dismounted leaders with a Rifleman Radio sent a digital message (Position Location Information (PLI), command and control, or survivability) via multicast into the classified platoon SRW network. Multicast is a distribution of messages (one-to-many or many-to-many) addressed to a group of Nett Warrior systems simultaneously on the SRW network. The message was broadcasted to every node in the local SRW network via either the Rifleman or Manpack radio. In the vehicle, the Manpack Radio is connected to the JBC-P, which has the Network Service Gateway (NSG) software loaded. The NSG transferred the PLI message from

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the SRW network to the JBC-P. The vehicle mounted JBC-P broadcasts the message to all JBC-P nodes via satellite.

Within platoons, where vehicles were on the same SRW network, messages were sent using the JBC-P route or via multicast on the SRW network. The Nett Warrior chemlight survivability message, which is not a Variable Message Format (VMF) message, cannot be sent over JBC-P and remains on the original SRW network.

Phase II, Light Infantry Rifle Company Architecture

Figure 2-5 depicts the company radio networks for the A/2-30 IN. The company used SRW networks to pass communications. Soldiers carried the Manpack radios during operations, except for two radios mounted on the commander's vehicle. Within the platoons, one radio was carried by the radiotelephone operator and one was carried by the platoon sergeant. There was a platoon SRW network and a company SRW network. Platoon radiotelephone operators carried the Manpack radio with one channel on the platoon SRW network and the other channel on the company SRW network. The forward observer carried a Manpack radio to execute fire support tasks.

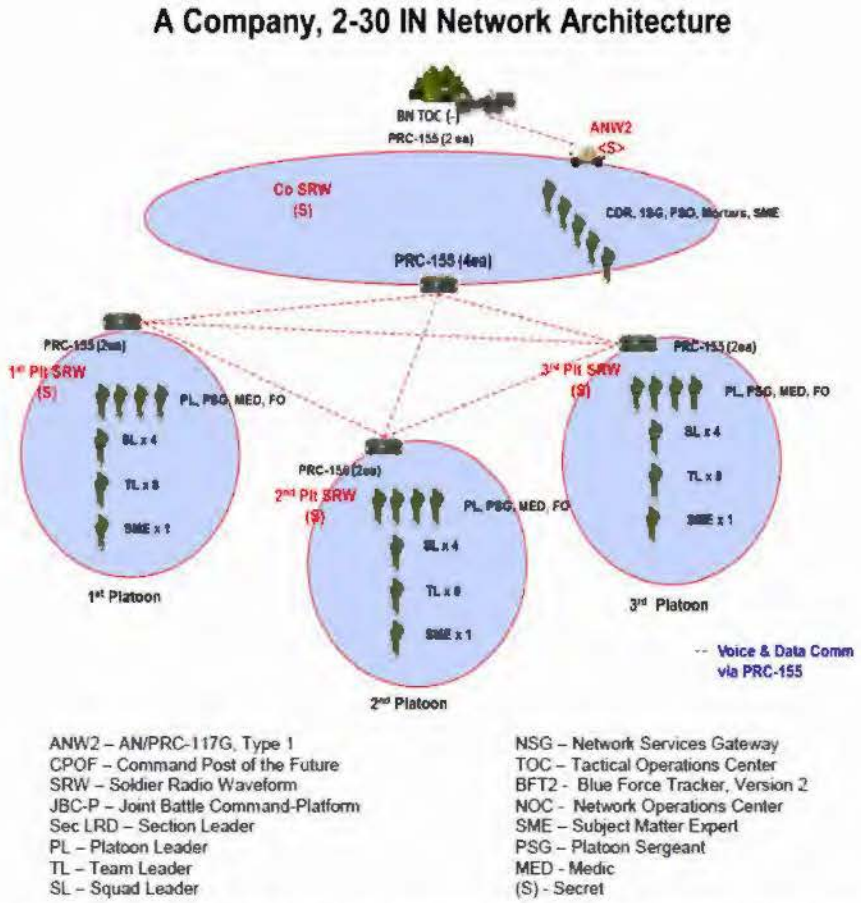

Figure 2-5. Communications architecture for the Light Infantry Company

Leaders at platoon level conducted voice communications on the SRW network with both the Nett Warrior's Rifleman and Manpack radios. Platoon leaders, from their Nett Warrior's

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Rifleman Radio, communicated to their platoons on the platoon SRW network. They also communicated to the company commander on the Manpack radios on the company SRW network. Forward observers communicated to the company fire support officer on the company SRW network in a separate talk group.

Leaders passed digital data at the platoon level over the SRW network with the Nett Warrior's Rifleman Radio and the two Manpack radios within the platoon. They passed digital data between the platoon and company echelons through the Manpack radio using the route/retransmission capability. While data can be passed between different SRW networks using the route/retransmission capability, voice communication cannot be passed using route/retransmission at the same time.

During Phase II, each of the leaders with a Rifleman Radio sent a digital message (PLI, command and control, or survivability) via multicast into the classified platoon's SRW network. The message was broadcasted to every Nett Warrior node in the local SRW network, either via the Rifleman Radio or Manpack radio. If the message had to travel outside the platoon network, the message was passed to the company SRW network using the Manpack radio's route/retransmission capability. All Nett Warrior messages were able to be sent this way including chemlight survivability messages.

Data Collection

Android Data Collection (ADC) software was loaded on the EUDs. The ADC recorded the network digital communications message traffic and such data were harvested from the EUDs daily. The Multiple Integrated Laser Engagement System executed and recorded weapons' engagements. During the daily data harvest, leaders were surveyed for impressions. Every fourth day of the test, the test team conducted an end-of-cycle focus group assessment and additional surveys and debriefings. Reliability scoring conferences were held throughout each phase of the IOT. Following completion of the final events of each phase, the test team convened a force effectiveness panel (called a Blue Ribbon Panel) that consisted of key leaders to evaluate overall mission effectiveness of the unit and contribution of Nett Warrior to mission effectiveness.

Mission effectiveness is determined by how well Nett Warrior contributes to the units' mission success. Mission success was assessed via a Blue Ribbon Panel methodology used by the Army. In this methodology, key players in mission execution (Blue Commander, OPFOR commander, user representative, and imbedded Subject Matter Experts who followed the unit throughout the battle), convene and review each action and counter action during the battle. This review (after the test) is supplemented by Multiple Integrated Laser Engagement System kill data, unit surveys, and real-time observations. The panel then rates how well the Blue and Red Forces performed their assigned missions, and assessed what Nett Warrior contributed to mission success or failure.

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Section Three
Operational Effectiveness

Nett Warrior is operationally effective in mounted formations at platoon and troop level. In dismounted infantry units, Nett Warrior is effective at the platoon level. Nett Warrior demonstrated the capability to provide platoon and company situational awareness and communications to each equipped leader. The system enhances land navigation, message reporting, and command and control. The combat leaders were able to employ Nett Warrior to plan missions, maintain situational awareness, and communicate.

The Nett Warrior is not effective at the company level due to Manpack radio's periodic inability to execute route/retransmission or digitally connect adjacent units. The Manpack radio had a 44 percent message completion rate of Position Location Information (PLI) that prevented the company commander from having full situational awareness of his company during operations.

Voice communications with the Nett Warrior system is effective. The Nett Warrior networks internal to the platoon and those among company headquarters elements exchanged digital messages allowing leaders to communicate and maintain situational awareness. Platoon situational awareness was effective and reliable.

Mission Effectiveness

During Phase I, C/1-1 CAV accomplished 14 of 14 assigned missions. In Phase II, A/2-30 IN accomplished 10 of 12 assigned missions. They did not accomplish two missions due to an instance of fratricide on one mission and capturing the wrong high-value target on another. Nett Warrior was not the cause of the two unsuccessful missions.

Nett Warrior Contribution to Mission Success

Nett Warrior contributed to successful mission accomplishment. The contribution provided by Nett Warrior varied by leader, task, and phase of operation. Nett Warrior's contribution to tasks was assessed based on Army Training and Evaluation Program training standards. During both phases of the test, platoon leaders and commanders indicated Nett Warrior provided situational awareness and communications in directing forces under their control. While leaders assessed Nett Warrior as helpful for all missions, most did not find Nett Warrior essential for completing most tasks. Figure 3-1 below depicts the leaders' assessment of their use of Nett Warrior and its value to task completion in Phase I with the mounted CAV unit.

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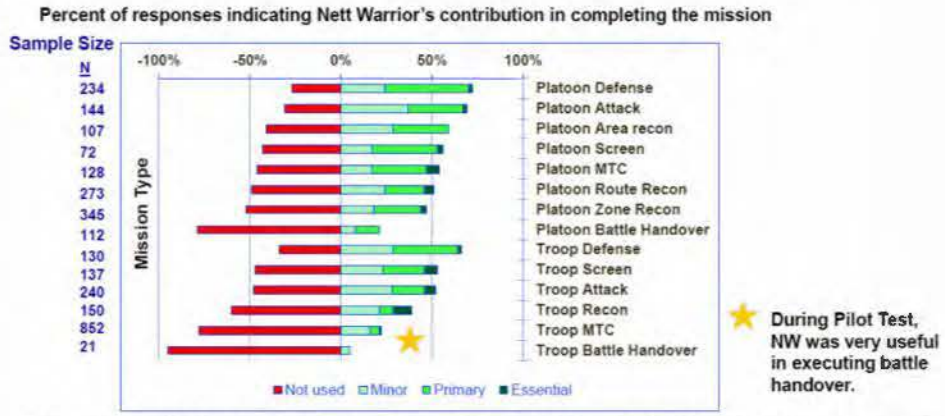

Figure 3-1. CAV Leaders' Assessment of Nett Warrior's Contribution (Phase I)

Shown are the 14 types of missions that were conducted and leaders' assessments of Nett Warrior's relative contribution to successful completion of each type of mission. Unit leaders assessed Nett Warrior as "Primary" or "Essential" on less than 40 percent of total mission sub-tasks over all mission-types.

The CAV mission sets did not force the units to dismount from their vehicles such as Troop Screens; leaders relied more on Joint Battle Command – Platform (JBC-P) instead of Nett Warrior for situational awareness. Approximately 75-80 percent of missions were mounted. Leaders at platoon level found Nett Warrior provided greater assistance than leaders at troop level. Leaders summarized this observation by stating, "Net Warrior is a tool, but is only one of multiple tools I have to complete a task."

The Phase II infantry unit's assessment of Nett Warrior contribution is shown below in Figure 3-2. Responses were either "primary" or "essential" on 60 percent of total mission sub-tasks over all mission-types, and played a minor role in most others. Nett Warrior contribution was greater in Phase II with the dismounted infantry unit, which did not have JBC-P as an alternate means of command and control.

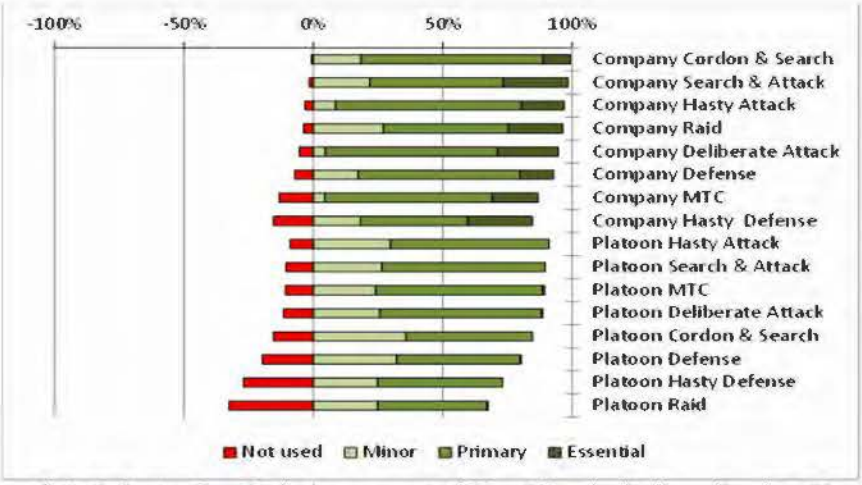

Figure 3-2. Infantry Leader's Assessment of Nett Warrior's Contribution, Phase II

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The infantry mission sets in Phase II, where Soldiers navigated while dismounted, lent themselves to a greater contribution than CAV mission sets, where Soldiers remained with their vehicles. Nett Warrior provided greater assistance at company level than at platoon level in Phase II, with 95 percent of "essential" responses coming from the company level. Ninety-eight percent of "essential" responses at company level were from the company commander.

Overall use of Nett Warrior was high during planning and higher during movement when Nett Warrior was used for navigation. During actions on contact, leaders did not use the EUD for visual situational awareness and relied on the radio. During consolidation and reorganization, leaders used Nett Warrior at all levels. The following sections describe the contribution of Nett Warrior to mission success during each phase of combat.

Planning Tasks

The use of Nett Warrior was high during the planning phase. Leaders within each platoon used Nett Warrior for route planning and for designating planned locations on the map using chemlights that were visible to all leaders within the platoon on their EUDs. These included observation posts, flank security positions, assault positions, support by fire positions, and casualty collection points.

Nett Warrior allowed the company commander to plan the route and movement to the objective. At the platoon level, Nett Warrior was used for numbering buildings, marking routes, and checkpoints that served as a guide to the objective. Platoon leaders used Nett Warrior as a visnal tool to brief the operations order, scheme of maneuver, and concept of operation to all squad and team leaders. Nett Warrior was used to conduct map reconnaissance of the objective and to plan fires.

The collaborative planner, a special feature on the EUD, did not work as expected. This forced the company commander to brief the platoon leaders on the plan from his EUD with them viewing the plan over his shoulder, as shown below in Figure 3-3. Platoon leaders would then enter the key graphic control measures in their EUD.

Figure 3-3. Company Commander Briefs His Leaders

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Commanders did not use the Mission Planning Computer (MPC). The troop commander planned on his JBC-P system and sent orders to his platoon leaders on JBC-P. The infantry commander used his EUD for planning.

Movement to the Objective

Nett Warrior provided a significant capability for land navigation and movement to the objective. The Common Operating Picture (COP) feature enabled the troop commander or infantry commanders to view and track platoon locations. At the platoon level, the land navigation capability assisted platoon leaders in maneuvering their squads. At the squad level, Nett Warrior allowed the squad leader to track the positions of his team leaders and navigate the formation. Leaders valued the enhanced navigation capability of Nett Warrior, especially during night operations or periods of limited visibility.

The tether feature aids in movement once the route is determined and waypoints established. Use of the tether feature allowed platoons to stay oriented on route waypoints to the objective in difficult terrain. Soldiers "tethered" themselves to a location and as they moved, the range and bearing to that location was always visible on their EUDs. The tether feature should not relieve leaders from the responsibility of doing proper map and terrain reconnaissance as part of their route planning.

Command and Control during Enemy Contact

During actions on enemy contact, leaders did not use their EUDs for visual situational awareness at the squad and team level. Soldier feedback indicates during enemy contact, the speed and violence of operations afforded no opportunity to look at the EUDs. Leaders explained the situation by stating "we don't text and drive." They relied on the voice capability of the Nett Warrior during contact to maintain situational awareness and give orders. Leaders out of immediate contact used their Nett Warrior for visual situational awareness to augment what they heard on the radio.

At the platoon level and below, electronic chemlights were used to mark command posts, suspected enemy positions, and support-by-fire positions. Platoon leaders marked outer security areas by dropping virtual chemlights at the required position. In urban areas, leaders used chemlights to distinguish cleared buildings from uncleared buildings. Nett Warrior was used to place vehicles in support-by-fire positions in C/1-1 CAV.

Consolidation and Reorganization

During consolidation and reorganization, leaders used Nett Warrior at all levels. The Nett Warrior COP permitted leaders to see gaps so they could take action to move Soldiers and vehicles to cover them. Leaders used the range fan tool to build hasty direct fire plans to ensure the perimeter was covered by fires. Use of the tether function in Nett Warrior assisted Soldiers in returning to their vehicles in Phase I. Squad and platoon leaders used the Nett Warrior COP to verify all squads were in correct locations.

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Situational Awareness

Nett Warrior improved leader's situational awareness at all levels. To support leader's situational awareness, the Army has specified a system performance metric (Key Performance Parameter (KPP)) that Nett Warrior should show a leader 90 percent of the PLI icons of other leaders in his immediate area. Leaders should see other leaders down two levels, up one level, and horizontal in adjacent unit command positions. During Phase I, Nett Warrior PLI visibility was 91 percent and during Phase II, 55 percent. Nett Warrior did not meet the KPP in dismounted units. It improved the leaders' situational awareness allowing synchronized movement on the battlefield.

To illustrate the concept of seeing two levels down, Figure 3-4 below shows PLI visibility (taken from a deliberate attack in Phase II) available to the 2nd Platoon Leader. Along the left scale are the positions of the individuals that a platoon leader is expected to see in command levels above and those under his control. Across the horizontal bar is the time from receipt of the warning order (FRAGO) until mission completions, 10 hours later.

Shown on the horizontal timeline (green) are the periods the platoon leader could see specific leaders under his command. Lines in red indicate PLI was sent, but not seen by the platoon leader. As shown by the gap, during the 4 to 6 hours before launching the actual attack (FRAGO to Start Point), many leaders did not turn their systems on, or may have been out of range as the leader conducted troop-leading procedures. Beginning at Start Point, the platoon leader begins seeing all the other leaders, except for the 3rd Platoon Leader (red). This was a common occurrence with the third platoon, due to the Manpack radio's inability to provide a digital connection between the units.

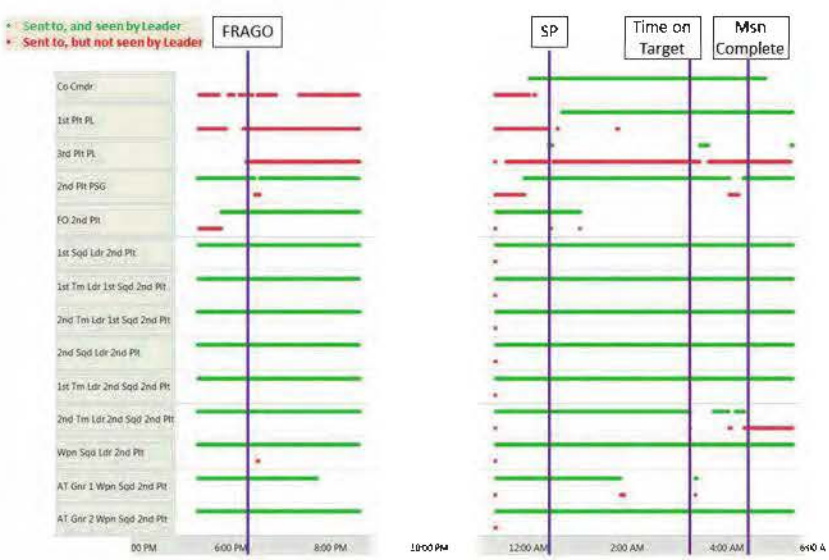

Figure 3-4. PLI Sent to the 2nd Platoon Leader during a Mission on Day 7 (Phase II)

Using a similar methodology, Figure 3-5 shows the percent of PLI that collectively could be seen by all leaders over the 12-day, Phase I test. The ovals show the percent of PLI seen within each unit. The lines with arrows depict the percent of PLI seen by one unit of the other

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adjacent unit. Within units on the same SRW network, the Message Completion Rate (MCR) was 95 percent. When PLI was transmitted between units using the JBC-P, the MCR dropped to 88 percent. Combined PLI MCR for Phase I was 91 percent. Green shading shows the MCR met the requirement.

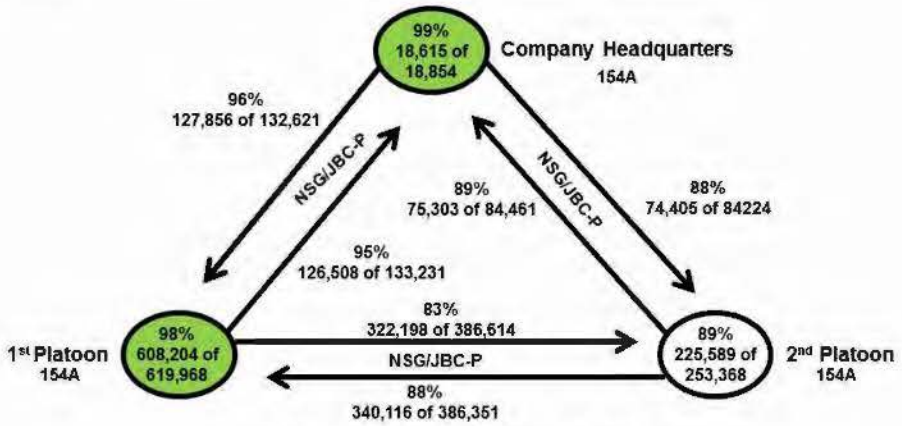

Figure 3-5. PLI Visibility Overall (Phase I)

Ninety-five percent of cavalry leaders in Phase I agreed Nett Warrior improved their situational awareness within and outside their area of operations. As described earlier, within a given unit (oval) all leaders were on the same network. In Phase I, PLI sent between units (arrows) required the JBC-P and Network Service Gateway (NSG) on a Mine Resistant Ambush Protected (MRAP) vehicle to connect between units.

In Phase II, where the Manpack radio provided the digital connection capability between various networks, overall PLI performance was reduced from Phase I. Within the platoon (ovals), units achieved an 87 percent MCR when operating on the same command and control network. Between units, when PLI was transmitted over the Manpack radio, the MCR was 44 percent. Overall, 55 percent of friendly PLI was visible during Phase II, not meeting the requirement of 90 percent.

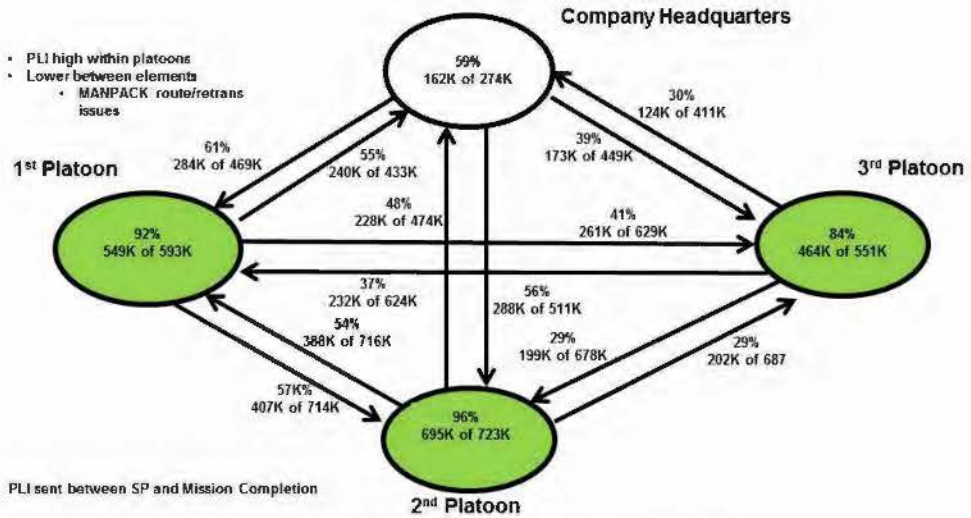

Figure 3-6. PLI Visibility Overall (Phase II)

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Elements within a platoon could see each other during most periods of mission execution. PLI passed between platoons through the Manpack radio was sporadic. Future versions of the Manpack radio must improve the passing of PLI in its route/retransmission mode.

Although the PLI did not always meet Army requirements, the leaders said Nett Warrior improved their situational awareness. The percentage of time a leader sees those in his interest group at least once during a 5-minute bin between Start Point and Mission Completion in Phase II is shown in Table 3-4. Each leader shown on the left of the table has an interest group of 8 to 10 other leaders they are expected to see. The columns refer to a given mission. The numbers in the table show what percentage of the time each key leader (company commander and each platoon leader) saw a subordinate at least once in a 5-minute interval.

Table 3-4. Phase II: Overall PLI Visibility

	Mission Number												
Leader	R1MT	R2HA	R2RD	R3DA	R4SA	R5CS	R6RD	R7DA	R8MT	R9CS	R9HA	R10AD	**Total**
Co CDR	76%	66%	42%	41%	70%	58%	38%	69%	73%	75%	67%	58%	**63%**
1st PL	91%	85%	68%	55%	80%	82%	79%	76%	77%	68%	76%	47%	**66%**
2nd PL	91%	X	X	67%	89%	89%	86%	81%	92%	81%	92%	77%	**84%**
3rd PL	90%	75%	74%	X	78%	73%	54%	71%	61%	70%	63%	42%	**60%**

(Note: 'X' means leaders were not on the network during that mission)

In general, most leaders could see members of their interest group at least once during any 5-minute period. Leaders were able to maintain situational awareness with the observed PLI, though it did not meet requirements. Eighty-eight percent of the dismounted leaders agreed Nett Warrior increased their situational awareness within and between their platoon areas of operations.

Digital Communication

The Nett Warrior networks internal to the platoon and those among company headquarters elements exchanged digital messages allowing leaders to communicate and maintain situational awareness. Nett Warrior did not exchange to standard, digital messages between platoons and company command elements that required the Manpack radio as an outside enabler. Voice communication with Nett Warrior was effective.

Another Army KPP is that Nett Warrior must provide digital data exchange among networked leaders within each leader's area of operations (the Army did not specify a numerical requirement). Command and control and survivability messages were the two message types of interest. Tahle 3-5 shows the number and types of messages sent by various elements during Phase I with Nett Warrior. Note, during Phase I, the unit had access to both JBC-P and Nett Warrior to send messages between leaders.

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Table 3-5. Phase I: Digital Messages sent with Nett Warrior

Msg Fmt	Msg Name	By Co	By 1st Platoon	By 2nd Platoon
K01.01	Free Text	23	53	106
K03.06/0	Mayday	9	12	9
K04.01	Observation Report	5	7	33
K04.02	Land Route Report			
K05.02/2	NBC 1			
K05.14	Situation Report	2	0	17
K05.17/3	Overlay	0	0	1
K05.19/5	Chemical, Biological, Radiological, Nuclear (CBRN)			
K05.19/8	Aircraft/Antiaircraft			
K05.19/8	Artillery			
K05.19/8	Chemlight	36	3,343	1,231
K05.19/8	Dismounted Personnel			
K05.19/8	Spot Report			
K05.19/9	Other – Entity Combat Status			
K05.19/10	Other – Medical Evacuation (MEDEVAC)			
K07.01	MEDEVAC Request			

The K05.19/8 Chemlight (a survivability message) was the most frequent digital message type, with over 4,500 such messages sent to designate buildings, routes, and areas of special interest. The chemlight stayed within the echelon that created the chemlight on that SRW network (i.e., 1st platoon chemlight stayed in 1st platoon).

In Phase II, the number of messages sent increased, as the unit was dependent on Nett Warrior for situational awareness and command and control. Shown below in Table 3-7 is the number of messages composed and sent by various leaders within different command levels. The columns show the number of messages composed and sent by leaders within the echelon.

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Table 3-7. Phase II: Digital Messages sent with Nett Warrior

Msg Fmt	Msg Name	By Co	By 1st Platoon	By 2nd Platoon	By 3rd Platoon
K01.01	Free Text	18	70	164	175
K03.06/0	Mayday	10	8	1	7
K04.01	Observation Report	5	4	5	13
K04.02	Land Route Report				2
K05.02/2	NBC 1	1			
K05.14	Situation Report				4
K05.17/3	Overlay	1	1	1	
K05.19/5	Chemical, Biological, Radiological, Nuclear (CBRN)	1			1
K05.19/8	Aircraft/Antiaircraft	2			1
K05.19/8	Artillery	4	9	22	12
K05.19/8	Chemlight	118	97	452	336
K05.19/8	Dismounted Personnel	1		4	8
K05.19/8	Spot Report	10	3	4	6
K05.19/9	Other – Entity Combat Status	2	6	31	3
K05.19/10	Other – Medical Evacuation (MEDEVAC)	3		4	
K07.01	MEDEVAC Request			2	1

Soldiers predominately used free-text messages and chemlight messages that require a touch on the EUD screen. Over 90 percent of the digital messages were free text (427) or chemlights (1,003). The pre-formatted messages shown are more cumbersome to use and were not adaptable to the unit's Standard Operating Procedures (SOPs).

Command and Control Messages

Each message identified above may have been sent from one leader to over 25 to 35 other leaders. For purposes of computing MCRs, one message sent is counted as 25 to 35 messages possibly received. When counted this way, within each platoon, up to 145 messages were sent internally to the platoon, but only 10 to 15 were sent between platoons and company headquarters, as shown by the arrows. Leaders used the vehicle-mounted JBC-P system to send digital messages, since most operations in Phase I were conducted mounted.

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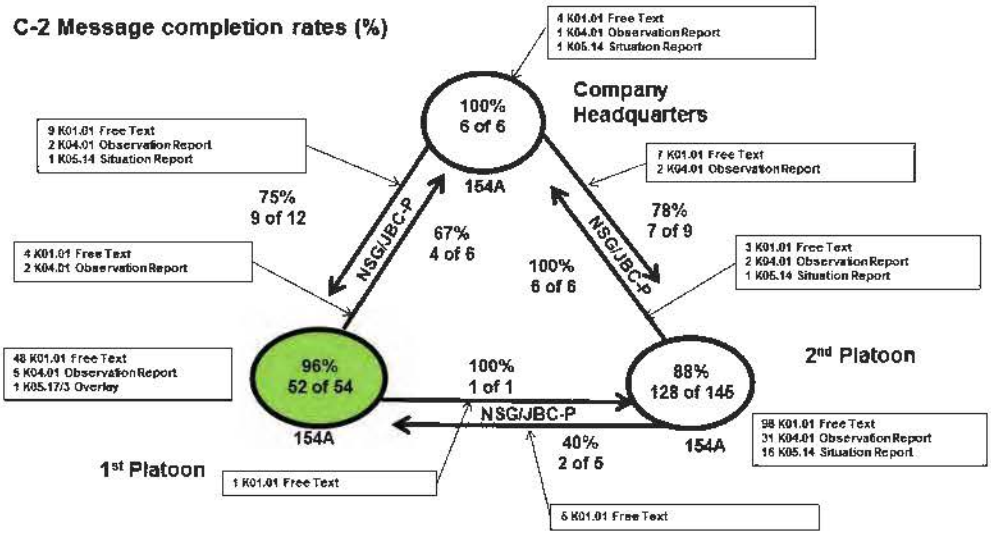

Figure 3-6. Command and Control Message Traffic (Phase I)

Overall, 88 percent of all digital messages reached intended recipients. Figure 3-6 shows a 90 percent MCR inside units with a single network and a 74 percent MCR between units that traveled over the JBC-P. Message transfer was successful within the platoon level, which involved the Nett Warrior and platoon SRW network. Between platoons, transfer involved the JBC-P and other radios as discussed in the network overview (Figure 2-4).

In both phases of test, 1,482 mayday messages (K03.06/0) were sent by the Nett Warrior and JBC-P system without the operator's knowledge. During JBC-P testing at Network Integration Evaluation (NIE) 14.2, there were over 900 occurrences of spontaneous messaging. These messages were sent multiple times distracting the operators. As such, the messages are shown in this table (Tables 3-5 and 3-7) to point out that they were passed through the network, but unintentionally so. Despite two software patches to fix this problem, Soldiers continued to experience phantom mayday messages during NIE 15.1. The JBC-P report from NIE 15.1 states, "While phantom mayday messages continued, units reported they did not send any intentional mayday messages during NIE 15.1. The problem of self-generated mayday messages must be fixed and verified in an operational event prior to fielding JBC-P Software Build 6.0."

The issue with mayday messages in Nett Warrior Phase I and II testing is a long-standing problem. The Nett Warrior and JBC-P program managers are aware of the problem. Mayday messages are not used in subsequent analyses in this report.

Figure 3-8 below depicts command and control messaging capability demonstrated in the Phase II. Overall, 91 percent of intended recipients received the transmitted messages, with a 94 percent MCR inside units with a single network and a 69 percent MCR between units that used the Manpack radio to connect different networks. Messaging capability (e.g., free text and formatted) worked well within each platoon, but less so between units (similar to the behavior of PLI data discussed earlier in Phase II).

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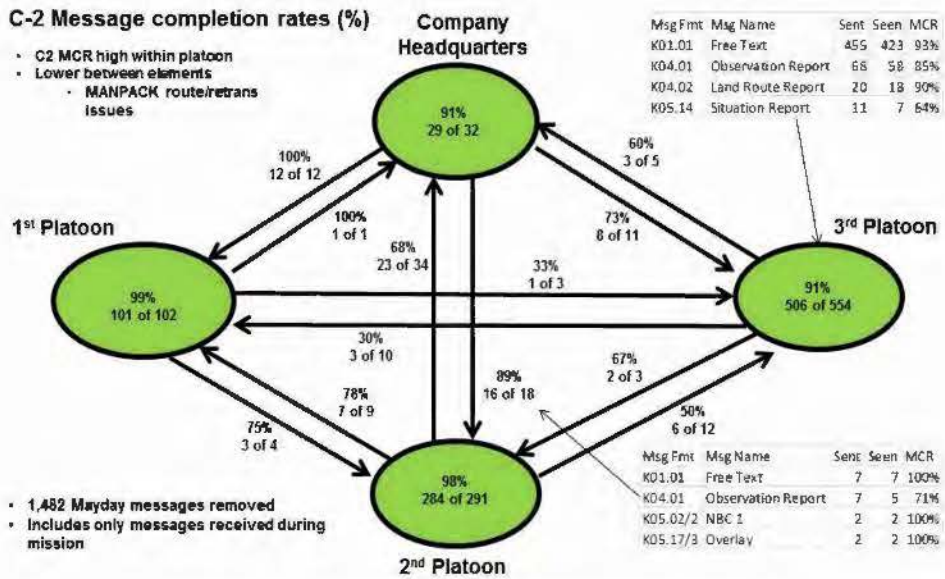

Msg Fmt	Msg Name	Sent	Seen	MCR
K01.01	Free Text	455	423	93%
K04.01	Observation Report	68	58	85%
K04.02	Land Route Report	20	18	90%
K05.14	Situation Report	11	7	64%

Msg Fmt	Msg Name	Sent	Seen	MCR
K01.01	Free Text	7	7	100%
K04.01	Observation Report	7	5	71%
K05.02/2	NBC 1	2	2	100%
K05.17/3	Overlay	2	2	100%

Figure 3-8. Command and Control Messages (Phase II)

Overall, 979 digital messages were passed within the units (ovals) among leaders on the same network and 122 messages between units (arrows). Performance between nodes suffered from the poor Manpack radio digital connection between units. Most messages were free text, though pre-formatted reports were passed. These included ammo, casualties, equipment reports, and standard observation reports. Observation reports were sent between units with a 70 to 85 percent success rate.

Survivability Messages

Survivability messages are a special form of digital message. They provide information on enemy, obstacles, and terrain, and are placed by a leader in his area of operation. They could be generated by a command and control message to be viewed by a leader's unit to understand the enemy situation. To support a leader's situational awareness, the Army has specified a system performance metric that Nett Warrior should show a leader 90 percent of all information on enemy, obstacles, and terrain placed by leaders in his area of operations. Nett Warrior survivability messages improved leader's situational awareness.

Survivability message performance in Phase I is shown in Figure 3-9. The intended recipient received 95 percent of survivability messages within platoons operating on a single network, meeting the 90 percent requirement. Most messages (85 percent) were chemical lights to identify routes and buildings. Performance was degraded (49 percent MCR) when the JBC-P was required to connect adjacent units in Phase I. Combined survivability MCR in Phase I was 71 percent.

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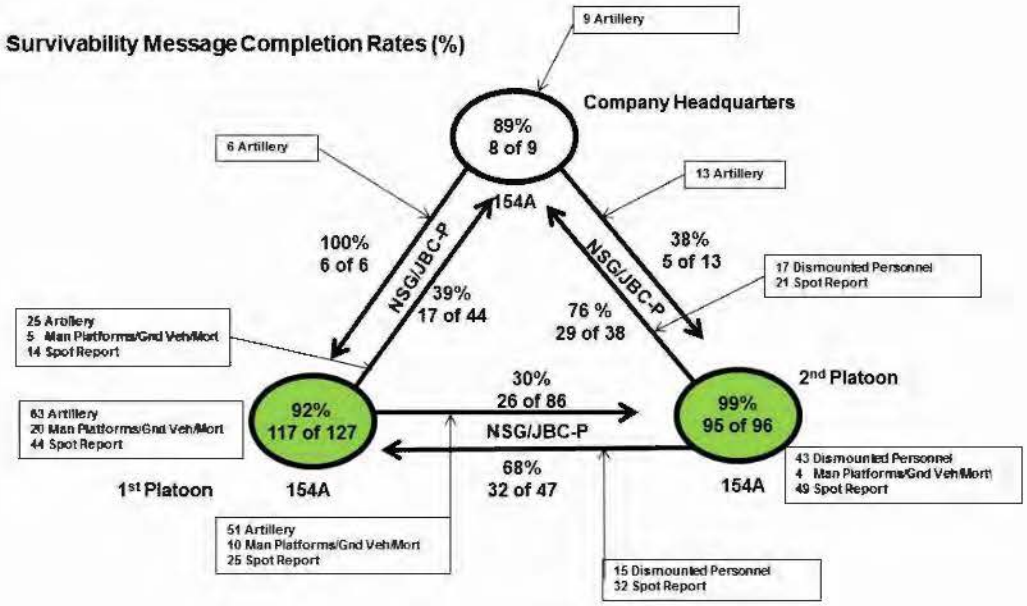

Figure 3-9. Survivability Messages (Phase I)

Message traffic in Phase II is shown in Figure 3-10. Overall, the intended recipient received 72 percent of survivability messages, with a 95 percent MCR inside units with a single network, and a 63 percent MCR between units that used the Manpack radio to connect different networks. Most survivability messages (89 percent) were chemlights.

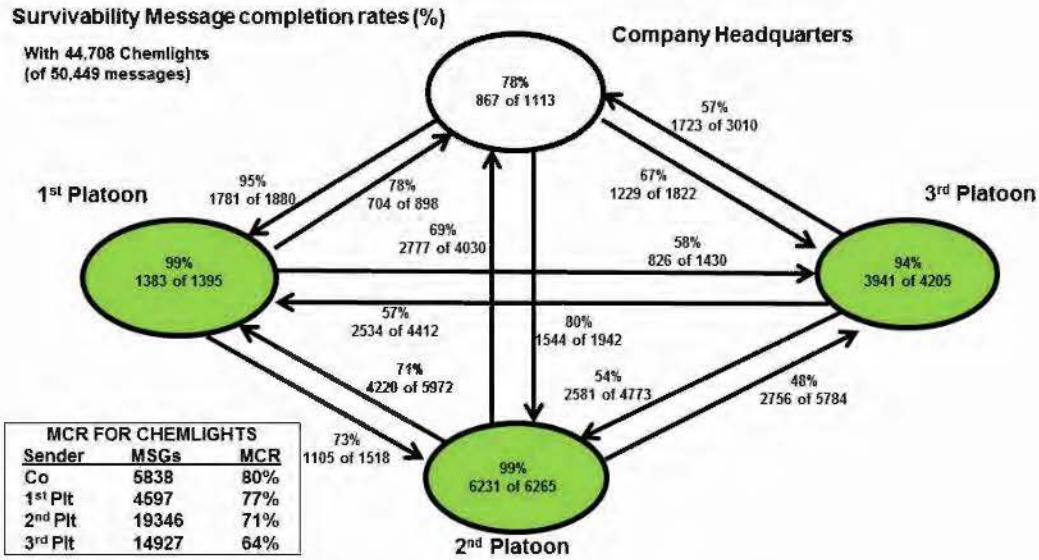

Figure 3-10. Survivability Messages (Phase II)

Overall distribution of PLI, command and control messages, and survivability messages was effective within platoon. Internally to the platoon the Rifleman Radio was used for digital and voice communication. The most prevalent message distribution problem was connecting the platoons with each other. Connecting platoons requires an outside enabler—either JBC-P for mounted units or the Manpack radio for dismounted forces. Improvements to both JBC-P and

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Manpack connections between echelons are required to improve Nett Warrior's communications and reporting capability between units.

Voice Communications

The Nett Warrior must provide for voice exchange among networked leaders within the leader's area of operations, though no specific numerical range requirement is prescribed. Voice communication with Nett Warrior was effective. Leaders relied on voice communications during contact with the enemy to gain and maintain situational awareness. Figure 3-11 depicts the leaders' subjective assessment of voice data exchanged during Phase I in NIE 14.2.

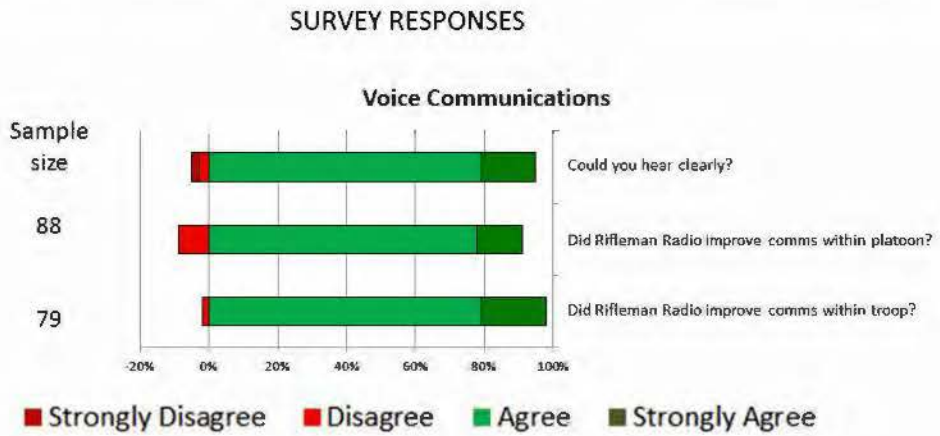

Figure 3-11. Voice Communications Assessment (Phase I)

Soldiers indicated the communications with the Rifleman Radio were good. Soldier-reported communication distance was 500 to 1,000 meters unobstructed, but less than 500 meters when line-of-sight was blocked, which is satisfactory. When needed during Phase I, leaders used a dismounted Manpack radio on the platoon network to extend the range of the network aiding in communications. Soldiers reported the Rifleman Radio improved their communications.

Similar results were observed in Phase II, however, over shorter distances restricted by the dense terrain. Voice communication was effective and satisfactory. In Phase II, Subject Matter Experts (SMEs) assigned to each unit measured voice performance at random intervals and ranges. Voice quality measured at range bands are indicated below by colors (Figure 3-12).

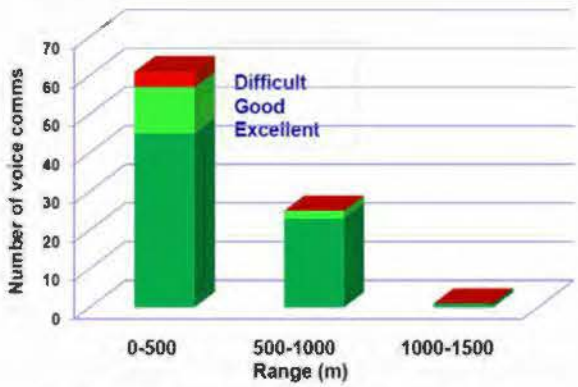

Figure 3-12. Measured Voice Quality (Phase II)

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As shown, two-thirds of voice communications measured were less than 500 meters (180 meters average range). Most communications (94 percent) were rated as "good" or "excellent" over all ranges in woodlands. In the dense pine forest of Fort Polk, elements of the unit tended to stay within 1 kilometer as they progressed through the mission. Platoon communications on the platoon SRW network were aided by three Manpack radios on the platoon network. Within the ranges experienced, Nett Warrior voice communications were excellent.

Voice communications with Nett Warrior is still the preferred means to transmit information at the platoon and company level. The availability of a digital text means for communicating has permitted leaders to use voice less often, according to 30 percent of Soldiers surveyed.

Radio Effectiveness

Nett Warrior is one element of a larger network of systems that must function properly if the data and information collected are to be distributed and used effectively. Two radios are key to a proper network and Nett Warrior performance: the Rifleman Radio, government furnished equipment to the Nett Warrior program, and the Manpack radio, a two-channel radio that connects Nett Warrior systems between unit echelons at the company and below level. Performance of these two radios in the network is discussed below.

Rifleman Radio Performance

The radio provided voice communications across the platoon's Area of Operations. The leaders indicated the communications with the Rifleman Radio were good. In Phase I and in open terrain, digital messages (PLI, command and control messages, etc.) were sent and received successfully at ranges up to 5 kilometers. Voice data were sent and received at ranges of up to 2 kilometers with 80 percent success. During Phase I, platoon networks were aided by vehicle-mounted Manpack radios. In Phase II and in more dense pine forest terrain, most digital traffic was less than 100 meters, while voice data were sent and received successfully out to 1 kilometer. In both test environments, communications were good, until a feature (terrain, building, etc.) blocked the line-of-sight.

The leaders' key concern was that the Rifleman Radio provided them with inconsistent communication and the range did not support their operations in Phase I with the mounted unit. As discussed later, the Nett Warrior would drop out of the network, causing leaders to execute troubleshooting procedures to bring the system back into the network. Other concerns with the radio were: lack of a screen; inaccessibility and difficulty carrying on the body with other equipment; noisy audio alerts; and awkward talk-selector buttons.

Manpack Radio Performance

Test units were not able to maintain the data route/retransmit function between SRW networks to pass data between company and platoon networks. The Manpack radio is needed to provide connectivity between infantry platoon and company SRW networks. They were tested in the Manpack FOT&E in NIE 14.2 and found to be not effective for dismounted operations.

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This assessment is the result of the SRW not providing sufficient range to support dismounted company- and platoon-level operations.

In Phase II of the Nett Warrior IOT, leaders passed digital data between the platoon and company through the Manpack radio using the route/retransmission capability. Data can be passed between different SRW networks using the route/retransmission capability of the radio, but voice communication cannot. Manpack radios were not instrumented for voice or data retransmission with dismounts in their FOT&E or Nett Warrior's IOT&E. Soldiers carrying the radios are shown in Figure 3-13.

Figure 3-13. Soldiers Carrying Manpack Radios in Phase II

Earlier figures (3-6, 3-8, and 3-10) illustrated problems of digital messages connecting between platoons, where less than 50 percent of PLI data were transferred through Manpack radios to adjacent units. Lack of Manpack radio instrumentation limited DOT&E's ability to establish the cause of Manpack radio's inability to pass digital messages through route/retransmission in the company formation. Possible issues that affected performance include:

- SRW waveform has poor range when interrupted by line-of-sight obstacles.
- Soldiers would not always initiate route/retransmission function on the radio following a reboot.
- Soldiers sometimes installed the incorrect antenna for specified frequency band (Ultra High Frequency versus Very High Frequency).

The Army should develop an instrumentation suite to capture Manpack radio performance (or a follow-on radio) to better understand the radio's dismounted shortcomings.

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Section Four
Operational Suitability

The Nett Warrior system is operationally suitable and reliable. The user specified a threshold reliability requirement for Nett Warrior of 148 hours Mean Time Between Essential Function Failure (MTBEFF) in order to achieve an 85-percent probability of operating for 24 hours without incurring an EFF. Nett Warrior demonstrated a reliability of 226 hours Mean Time Between Essential Function Failure (MTBEFF) or a 90 percent probability of operating for 24 hours without incurring an EFF.

The radio pouch and connector cup provides adequate guard to the leader wearing the Nett Warrior for times when the radio temperature exceeds 120 degrees F.

Recharging batteries to support Nett Warrior is an increased logistical burden. The process to operate four to five generators and associated battery chargers to charge all batteries to equip a light infantry company takes 3 to 4 Soldiers, 12 to 15 hours a day. Charging this increased number of batteries takes Soldiers away from their primary jobs. The infantry unit was not able to charge the batteries required to operate the Nett Warrior system and Manpack radios without augmentation of a 3-kilowatt generator from the battalion headquarters.

Operator training was sufficient for leaders to operate the Nett Warrior throughout the test. Testing identified issues with Manpower, Personnel and Integration (MANPRINT) with the system. The Rifleman Radio demonstrated suitability issues previously observed in separate, prior testing. The Nett Warrior program manager made changes to the Nett Warrior system to mitigate Rifleman Radio suitability issues. The Rifleman Radio is government furnished equipment, and was assessed in testing both as a separate piece of equipment and as a part of the Nett Warrior system. While not meeting requirements, Rifleman Radio demonstrated improved reliability compared to previous test results.

Reliability

The Nett Warrior is reliable. As described in Section One, the Nett Warrior base configuration is the radio, cables, End User Device (EUD), and conformal battery. The user specified a threshold reliability requirement for Nett Warrior of 148 hours MTBEFF in order to achieve a 85-percent probability of operating for 24 hours without incurring an EFF. Nett Warrior demonstrated a reliability of 226 hours MTBEFF or a 90 percent probability of operating for 24 hours without incurring an EFF. Essential functions are the capability to successfully navigate, communicate, and survive, and an EFF is a failure of the system that degrades an essential functional to an unacceptable level. Table 4-1 shows the reliability results from Phase I and Phase II of the Initial Operational Test (IOT). In both phases, the system exceeded user requirements.

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Table 4-1. Nett Warrior Mean Time Between Essential Function Failure (MTBEFF)

IOT Phase	Operating Hours	Number of EFFs	MTBEFF	80% Confidence Limits
Phase I	4,446	11	404	268 - 633
Phase II	6,839	39	175	142 - 219
IOT Totals (I and II)	11,285	50	226	184 - 274

Table 4-2 lists the EFFs recorded during each phase of testing at Fort Bliss and Fort Polk. During Phase I at Fort Bliss, the EUD or Rifleman Radio's most prevalent failures were lost communications, lost Position Location Information (PLI), or network recovery. Leaders did not perform system troubleshooting in accordance with the troubleshooting guide. Many Soldiers deferred maintenance while on missions until a tactical pause or period of data harvest.

Table 4-2. Nett Warrior Essential Function Failures (EFFs) during the IOT

Subsystem	Phase I (Ft. Bliss)	Phase II (Ft. Polk)	Total
EUD	5	18	23
EUD Battery		1	1
Rifleman Radio		4	4
Rifleman Radio Battery		5	5
C-4 Cable		10	10
C-1 Cable		1	1
Operator	3		3
Network	3		3
Total	11	39	50

In Phase II, new failure modes were discovered as the systems operated in more challenging environments (e.g., thick pine forest and rain). The main reliability issue during Phase II were EFFs due to severe rain during the first four days of the test. Various configurations of Nett Warrior have been tested over the past eight years, but this was the first rain since the Limited User Test conducted at Fort Lewis in 2006.

Following a severe rainstorm at Fort Polk on the night of November 5/6 there were 27 EFFs. The rain caused failures to both the EUD and C-4 cable. Moisture and water affected performance during this mission. Aside from the effects of the rain, other failures in Phase II were at failure rates comparable to earlier testing concerning lost communication, lost PLI, and network connectivity.

Other malfunctions affect leaders' perception and utilization of the systems. Problems corrected within 5 to 10 minutes are Rapidly Recoverable Events (RREs), per the failure definition/scoring criteria for the system. During Phase I, there were 10 RREs, most of which were related to no PLI or lack of connectivity to network.

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During Phase II, 56 RREs were recorded, most of which occurred during the rainstorm in Cycle A. There were 26 instances during that phase where the system experienced a fault that required some corrective action. The rain caused EUDs to shut down or execute un-commanded functions (e.g., close map) that resulted in RREs. The RREs did not influence mission performance or unit effectiveness, but required action by the leader to correct the RRE.

Maintenance and Repair Parts

There was little unscheduled maintenance time accumulated on the systems during either phase of the IOT. In Phase I, there were 39 hours of maintenance downtime (in 4,446 operating hours) and in Phase II, a total of 25 hours unscheduled downtime of 6,839 operating hours. In Phase I, most systems had less than 30 minutes of downtime and two to three systems accumulated more than 5 hours. At Fort Bliss, there were 11 repair parts used (6 cables, 2 EUDs, 2 Rifleman Radios, and 1 antenna). All replacement parts were received from unit supply.

In Phase II, most downtime occurred in Cycle A, following the rainstorm. During both phases, leaders did not reference the Quick Reference Guide (QRG) for troubleshooting. Instead, they often resorted to rebooting the EUD and/or radio, despite inclusion of additional corrective actions in the QRG (e.g. checking cables or power cup charging status). Rebooting reduced downtime per incident in half, but confounded resolution of Reliability, Availability, and Maintainability scores as the root cause, could not always be determined.

Table 4-3 below lists the repair parts replaced during Phase II. As shown, 40 repair parts were replaced—four times as many as in Phase I. The more stressing environments in Phase II (forested terrain and weather) were major contributors.

Table 4-3. Nett Warrior Repair Parts (Phase II)

Part Name	Reason Replaced	Quantity Replaced	Part Disposition
C-4 Cable	Broken / Damaged	15	Turned in to Supply
Conformal Battery	Depleted	8	Turned in to Supply
AN/PRC-154A Battery	Depleted	8	Turned in to Supply
EUD	Damaged	6	Turned in to Supply
C-1 Cable	Damaged	2	Turned in to Supply
AN/PRC-154A Pouch	Damaged	1	Turned in to Supply
Total		40	

C-4 cables connecting the EUD and Rifleman Radio and batteries were the most frequent category of replaced parts. Five of six damaged EUDs were due to severe rain on November 5/6. The other EUDs remained in use after drying out the next day. Unit Prescribed Load List quantities were sufficient to accommodate component failures during Phase II. All replacement parts were received from parts on hand in unit supply.

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Rifleman Radio Battery Temperatures

In Phase I, all 29 Nett Warrior equipped leaders reported Rifleman Radio batteries overheated during focus groups. This heat shortened and rapidly depleted the battery life, and led to loss of network connectivity and system shutdown. Multiple instances of temperatures in excess of 120 degree F were noted for the Rifleman Radio, creating a potential burn risk. Military Standard (MIL-STD)-1472G states that equipment which—in normal operation—exposes personnel to surface temperatures greater than 120 degrees F for prolonged contact or handling shall be appropriately guarded. Of the 19 measured temperatures taken in Phase I, 17 were in excess of 120 degrees F (the safety specification).

In Phase II, a deliberate attempt was made to measure temperatures of the EUD and Rifleman Radio batteries. Over 570 measurements (each for the Rifleman Radio and EUD) were taken at the end of each mission. Figure 4-4 shows a histogram of these measurements. During Phase II, the EUD batteries' temperature averaged 73 degrees while Rifleman Radio batteries averaged 86 degrees. There were 5 of 570 of Rifleman Radio measurements in excess of 120 degrees F, the safety specification. The difference in the temperatures compared to Phase I can he attrihuted to lower ambient temperatures in Phase II (42 to 66 degrees average daily temperatures) than in Phase I (75 to 85 degrees averages).

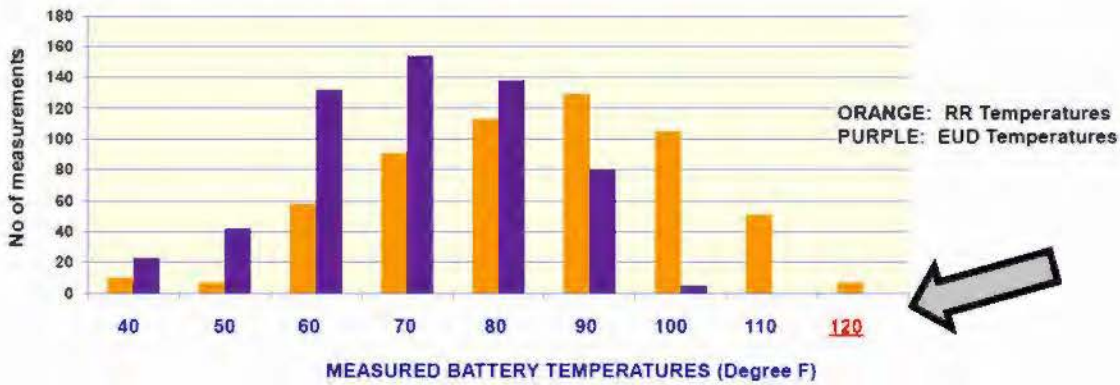

Figure 4-4. Battery Temperatures (Phase II)

The Rifleman Radio battery in the Nett Warrior configuration is safe. The radio pouch and connector cup provide adequate guard to the leader wearing the Nett Warrior for times when the radio temperature exceeds 120 degrees F. The Rifleman Radio is government furnished equipment to the Nett Warrior system. The Nett Warrior program manager should continue to look for a radio that does not have the tendency to rise above 120 degrees F and continue to ensure the guard capability of the radio pouch protects the wearer from excess heat.

Power Management

Recharging batteries to support Nett Warrior is an increased logistical burden. Nett Warrior program provides sufficient chargers to the unit. However, there is not enough power generation capacity to support a light infantry company to recharge the Nett Warrior and Manpack radio batteries without augmentation from higher headquarters.

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The Nett Warrior system contains three batteries: the EUD battery, the Rifleman Radio battery, and the conformal battery. Figure 4-2 below depicts the interconnectivity of these three batteries. The Rifleman Radio is the primary consumer of electrical power for Nett Warrior. The Nett Warrior EUD uses the Samsung rechargeable battery that is constantly being recharged by the Rifleman Radio battery, which has a nominal charge of 8 hours. A conformal battery worn by the leaders provides a trickle charge capability to the two other batteries. The conformal battery is expected to last 18 to 24 hours.

In Phase I, battery recharging in C/1-1 Cavalry (CAV) used vehicle power and multiple recharging options (e.g., vehicle 110 volts outlet). Figure 4-2 also depicts the primary source of charging power, the Modular Universal Battery Charger (MUBC) connected to the Mine Resistant Ambushed Protected (MRAPs). A portable 1-kilowatt generator was available, but was not used in Phase I since unit leaders believed vehicle power available on the MRAPs was sufficient.

Nett Warrior Batteries	Modular Universal Battery Charger (MUBC)

Figure 4-2. Nett Warrior Batteries and Battery Charging Assets in Phase I

During Phase I, there were multiple instances of inadequate battery power resources. As shown in Figure 4-2 above, only two of three conformal battery charging ports were available if the leaders were charging Rifleman Radio's batteries. The program manager issued battery chargers to the unit in accordance with the basis-of-issue plan, but the unit chose to use two of four chargers in the platoon vehicles due to 110-volt outlet availability. The mounted units need to develop Standard Operating Procedures (SOPs) to maximize the use of all of the issued chargers and to improve battery-charging efficiency.

Leaders noted dissatisfaction with the Rifleman Radio battery's operating time in focus group discussions, as it was not consistent (2 to 6 hours versus 4 to 8 observed earlier in developmental testing). This required leaders to carry two batteries (primary and spare) to meet mission requirements. This did not affect mission effectiveness as mission requirement kept the unit close to vehicles. Post-test analysis showed that by design, the Rifleman Radio battery stops accepting a charge at 118 degrees F. However, the conformable battery is still pushing a charge to the radio. The battery was depleting without gaining a charge decreasing its expected mission life. To correct this issue, the program manager adjusted the temperature at which the conformal battery stops charging the Rifleman Radio battery to 140 degrees.

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In Phase II, the dismounted test unit was issued four 1-kilowatt generators as part of Nett Warrior basis-of-issue plan. Three to four Soldiers staffed the company recharging station that was located in the rear with the company supply vehicles about 5 kilometers from the unit. The average time to charge a Rifleman Radio battery was 3.6 hours, while a conformal battery took 4.5 hours. The Soldiers took 12 to 15 hours to charge the batteries required to meet the company's requirement for next mission. They obtained an additional 3-kilowatt generator from battalion when the 1-kilowatt generators were found not capable of charging the Nett Warrior system batteries and the Manpack radio batteries due to reliability issues and increased load of the Manpack radio batteries. The light infantry unit estimates it would need seven to eight generators if 1-kilowatt generators were sole source of power. To keep up with the demand, the 3-kilowatt generator was operating at maximum power, which is not recommended for extended periods. To mitigate power generation issues, the unit scavenged power from buildings and vehicles as mission allowed.

The process to operate 4 to 5 generators and charge all batteries to equip a light infantry company is an additional logistical burden to the unit. The charging of batteries is an additional duty to Soldiers assigned to the field trains who have their own duties (supply, armorer, communication) to support the company. When the battalion is deployed, those field train Soldiers take on increased duties, which have now been further increased with the need to charge batteries to support the Nett Warrior. Even though the charging batteries can be left unattended for extended periods, they still need to be monitored and changed, which takes time and distracts the Soldiers from other assigned duties.

Figure 4-3 depicts the charging layout at the company logistics site with four 1-kilowatt generators (left-most portion of left figure), and the one 3-kilowatt generator (upper center of left photo), plus multiple MUBCs in use charging Rifleman Radio, conformal, and Manpack radio batteries. The right figure illustrates the distribution concept where the charged batteries were returned to the unit for re-distribution to the leaders. This occurred once per day.

Nett Warrior Battery Charging Layout	Charged Batteries Ready for Distribution

Figure 4-3. Phase II Battery Charging Assets

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The Army needs to examine the overall power management system that supports a light infantry company for 72 hours and develop an SOP for the battery charging capabilities for dismounted units and mounted units.

Training

New equipment training (NET) provided to leaders was effective for operation and maintenance of Nett Warrior. The training developed over the past eight years focused on individual training in the classroom. The trainers thought it was easy to teach new users, while those previously trained required an abbreviated refresher course. Soldiers gave the NET high marks, but stated they would prefer more hands-on, practical exercises and less classroom time.

Over one-half (26) of the leaders who participated in Phase II had no prior Nett Warrior experience. Others had one to two years of experience, while all had considerable experience with smartphones. The NET was effective for training on system operations and maintenance of systems, though maintenance procedures were not always followed (i.e., reboots). Soldiers were provided a pocket-sized abbreviated user's quick reference guide (QRG) on maintenance procedures, but they frequently skipped steps and simply re-booted the EUD and radio to correct any problems. The Army should reassess the procedures in the QRG versus rehooting as the standard procedure for taking correction action to system faults.

Another related training issue is a lack of understanding of how the network and network radios work. Leaders are not aware of the means to maximize the effectiveness of Nett Warrior and the Soldier Radio Waveform (SRW) network, such as placing one Soldier outside of a building to maintain connectivity to those inside during clearing of urban sites. A lack of understanding with the Manpack radio in Phase II led to some route/retransmission issues, particularly between platoons, when Soldiers did not understand the proper placement of the Manpack radios in the formation. Future leader training should include how the network works, how voice and data travel across the network, and how all network radios work. They should be taught not to expect the system to work in an operational/deployed environment the same way a smartphone would work with a network of fixed cell towers.

During Phase II of the IOT, there was a Communications Security (COMSEC) changeover, requiring parts of the unit to change security codes on their radios. COMSEC security key changeover was difficult and time consuming. The test unit erased the COMSEC key and network plan from the radios of the 1st Platoon and reloaded the radios to using the Secure Key Loader. The total time to load one platoon was 1 hour, 33 minutes, with an average time of 5 minutes per radio. Soldiers need to be trained on COMSEC in the NET or other training exercises in order to employ Nett Warrior.

Manpower, Personnel and Integration (MANPRINT)

Despite the Nett Warrior being effective and reliable, the leaders did not believe the Nett Warrior system was acceptable for combat in its current configuration due to the Rifleman Radio. Only thirty-two percent of leaders in Phase I and 22 percent in Phase II would accept the system for combat in its current configuration. There are some Manpower, Personnel and

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Integration (MANPRINT) issues associated with the radio and leaders would rather employ a two-channel radio instead of the single channel Rifleman Radio. A two-channel radio was not part of the system under test. A two-channel radio is an objective requirement for future Rifleman Radio requirements.

The EUD is effective and easy to use. The Rifleman Radio is not suitable. The radio lacks a display screen for showing connectivity, battery life, and charging status information. These issues were observed in the Rifleman Radio IOT&E. Radio placement on the rear of the shoulder to improve line-of-sight to other radios was inconvenient for battery replacement, adjusting the volume, and changing talk groups. The Nett Warrior program manager made changes to the Nett Warrior system to mitigate Rifleman Radio suitability issues. The Nett Warrior program manager developed an antenna extension cable to allow users to place the antenna on the back shoulder, giving the operator convenient access to the radio. Leaders chose from different antenna placement configurations to prevent interference with the rucksack and personal comfort. The Army has recognized suitability issues with the Rifleman Radio and has started an acquisition process to replace it.

Placement of the Rifleman Radio with the antenna on the body (high or low) affected electromagnetic interference between the EUD and radio. Electromagnetic interference from the Company Command Network interfered with EUD functions such as showing the close map dialogue box. This was observed on leaders who had their radio antenna close to the EUD. This interference was not observed when the antenna was worn on the shoulder with the body shielding the EUD from the antenna.

Chest placement of the EUD is satisfactory. The EUD Otterbox screen is difficult to keep dust-free. Scratched screens make it difficult to see icons as shown in Figure 4-5. The screens of the actual Samsung EUD scratch less than those of the protective Otterbox. The scratches degrade visibility, as does screen glare during daylight. To accommodate night usage, the program manager provided a Wamco night filter that works when used, but many leaders preferred not to use them due to convenience and storage accessibility. Screen brightness at night remains a concern, but is alleviated by proper light discipline and using the EUD's dimmer control.

Soldiers' perspiration created the same problems created by rain. Moisture drops on the display acted as a command press and initiated select EUD functions.

The capacitive gloves issued by the program manager did not work as envisioned. Leaders complained about the difficulty in using the EUD when wearing the gloves. The leader had to remove the gloves from the hand manipulating the EUD to ensure he was entering correct information (see Figure 4-5). While not tested in the current phases, this would obviously be an issue in colder weather.

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Nett Warrior Scratched Screens	Capacitive Gloves

Figure 4-5. Nett Warrior EUD MANPRINT Issues

Other aspects of Nett Warrior (weight, form, and fit) were acceptable to leaders. Over 90 percent indicated that weight (6.8 pounds, including batteries) was acceptable, while 60 percent thought the general fit was acceptable. Map quality and zoom capability were great improvements over the operational utility shortcomings identified in earlier NIE exercises. The display size of the EUD was rated as optimum. Over 90 percent of respondents agreed the Nett Warrior display provides an effective zoom in/out capability.

Rifleman Radio Reliability

During the Phase II IOT, the Army measured the reliability of the Rifleman Radio as a standalone item to inform their material release decision on the radio. The Rifleman Radio is government furnished equipment, assessed in Phase I of the IOT as part of the Nett Warrior system. In Phase II, the Rifleman Radio was examined as a separate piece of equipment and as a part of the Nett Warrior.

While not meeting requirements, Rifleman Radio reliability has improved, demonstrating a MTBEFF of 328 hours, with a 248-441 hour 80 percent confidence interval. This translates into a 93 percent chance of completing a 24-hour mission without a failure. The Rifleman Radio has a requirement to complete a 24-hour mission 95 percent of the time without an EFF, which translates into an MTBEFF of 477 hours. This is an improvement from performance in previous testing in its IOT&E at Network Integration Evaluation (NIE) 12.1, where it produced an MTBEFF of 150 to 175 hours versus a requirement of 477 hours.

In Phase I, although many of the issues voiced by leaders were related to the radio, reliability was improved from previous testing of the radio. Of the 11 EFFs scored in Phase I against the system, none were identified as a failure of the radio, even though there were issues between the radio and network. Of the 10 RREs, one-half were related to the radio losing connectivity to the network. Connectivity was regained within 5 to 6 minutes, resulting in an RRE, instead of an EFF, per the failure definition/scoring criteria. Damaged antennas during ingress/egress of the Mine Resistant Ambush Protected (MRAP) vehicles were an issue. Of the 11 repair parts replaced in the Phase I test, two Rifleman Radios had to be replaced during 4,455 hours of operations with the Nett Warrior system.

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Further development of the Rifleman Radio is being exercised under a full and open competition. A Request for Proposal was issued in January 2015. The new radio emerging from this program will require a new DOT&E-approved Test and Evaluation Master Plan and IOT&E.

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Section Five
Survivability

Cybersecurity, Information Assurance, and Electronic Warfare

The Nett Warrior End User Display (EUD) is survivable against cyber-attacks. The Rifleman Radio is not survivable against cyber-attacks. The Nett Warrior is not survivable in an electronic warfare environment.

The Army Research Laboratory, Survivability/Lethality Analysis Directorate and Threat Systems Management Office conducted cybersecurity, Information Assurance, and threat computer network operations testing against Nett Warrior during Phase I of the Initial Operational Test (IOT). Information Assurance testing was not repeated in Phase II. Results are documented in the attached classified annex. The cybersecurity assessments examined Cooperative Vulnerability Analyses, identifying high and medium risks that were briefed to the program manager. An adversarial protect, detect, react, and restore analyses were also conducted in Phase I.

A continuity of operations assessment was conducted in Phase II at Fort Polk. During this exercise, leaders demonstrated they are able to wipe clean and render inoperable a compromised Nett Warrior system that is in radio range. Four different Nett Warrior systems from the unit were remotely zeroized. The task was done individually and then on all systems simultaneously. It was performed point-to-point and through Manpack radios.

Compromises to Unit Location

Thirty percent of Soldiers agree Nett Warrior increases the likelihood of location compromise to an enemy. The program manager mitigated brightness to low risk by adding a translucent screen filter (Wamco) to the EUD for use during nighttime operations. During testing, the plastic filters did not remain attached to the EUD and were misplaced or lost when not in use. Leader enforcing light discipline at night further reduces this risk. During both phases of test, no opposing force (OPFOR) Soldier reported the Nett Warrior screen glare compromised the test unit.

Microphone noise from the Nett Warrior can compromise Soldiers at night. Soldiers complained about the Rifleman Radio voice alerts as a second source of potential compromise to unit location. The radio issues verbal alerts during set-up and other alerts when batteries are low and the network is ready. The alerts are audible at a distance, with OPFOR reporting the transmissions can be heard from 100 meters away. Among the OPFOR, 36 percent say they could detect Nett Warrior Soldiers via the noise from their hand microphones.

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Section Six
Recommendations

Recommendations

The Army should consider the following recommendations. Nett Warrior is one element of a larger network of systems that must function together if the data and information collected by Nett Warrior are to be distributed and used effectively.

- Reduce the number of rapid recoverable events and decrease the number of times Nett Warrior falls out of the network.
- Make the C-4 cable connections more durable.
- Address performance and reliability issues when operating in the rain or in humid conditions.
- Improve the capability to utilize the collaborative planner at the platoon and company level.
- Re-assess the troubleshooting quick reference guide versus a system reboot to fix problems.
- Educate leaders on the limitations of an Army tactical network. They should be taught not to expect the system to work in an operational/deployed environment the same way a smartphone would work with a network of fixed cell towers.
- Continue to investigate and correct problems with unintended Mayday messages populating the networks.
- Improve SRW network reliability to include Manpack radio route/retransmission capability between platoon and company networks and increasing Message Completion Rate for the Variable Message Format between echelons.
- Investigate adding a display screen to the Rifleman Radio to provide operators with feedback.
- Continue to find solutions to decrease the Rifleman Radio battery temperature to the Military Standard (MIL-STD)-1472G.
- Fully integrate Nett Warrior into combat units:
  - Develop doctrine; employment concepts; and tactics, techniques, and procedures.
  - Address employment of the additional Manpack radio.
  - Teach leaders how the SRW network operates and how to maximize the network to support operations.
  - Incorporate lessons learned from previous testing and training (e.g., light and noise discipline).

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- Develop an overall power management system that can support a light infantry company for 72 hours.
- Develop a data collection device that Soldiers can wear to collect data on the Manpack radio and better determine radio performance on the network smartphone.

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