The Need for Proficient Use of High Frequency (HF) Communication within Cavalry Organizations

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1. Introduction

The cavalry squadron provides a significant reconnaissance force while enabling their higher command the ability to decisively employ their maneuver battalions and joint fires at the most advantageous time and place.[1] Furthermore, the cavalry squadron provides security by providing timely, accurate, and relevant combat information. This security gives the higher headquarters an advantage over the enemy in terms of the ability to collect, process, and distribute information as part of shared understanding. One way in which the cavalry squadron accomplishes this is through the employment of observation posts, which present a low signature on the battlefield and dominate through observation of the battlefield. However, an observation post that can see everything is useless and a liability if it cannot report to its higher headquarters.

Sadly, many tactical leaders have failed their Soldiers by briefing a communication plan, which they knew the unit did not possess the capacity or capability to execute[2]. A trend at the National Training Center (NTC) in Ft Irwin, California is for units to develop a communications plan in which frequency modulation (FM) communication is primary, Blue Force Tracker (BFT), Joint Capabilities Release (JCR), or Force Battle Command Brigade-and-Below (FBCB2) are alternate, and Tactical Satellite (TACSAT) or HF communications serve as the contingency or emergency means of communication. Although it briefs well, many units fail to have the proper equipment or training required to incorporate HF communication, despite the fact they have access to the PRC-150 Harris HF radio. After action reviews at all echelons quickly identify challenges with communication and mission command during cavalry operations. The Army can address some of these challenges by using HF communications as a redundant and long-range method of communication. HF radio is a capacity the Army already retains in its inventory and it addresses the frictions points of communication and mission command. However, leaders need to place a command emphasis on this lost skill. This article will discuss the initial growth and development of HF radio, why the Army lost its HF skill, highlight basic information for the tactical HF operator, and explain what the field grade officer needs to know about HF communication. This serves as the starting point for a squadron and troop command team as they attempt to build their HF capability into an executable communication plan.

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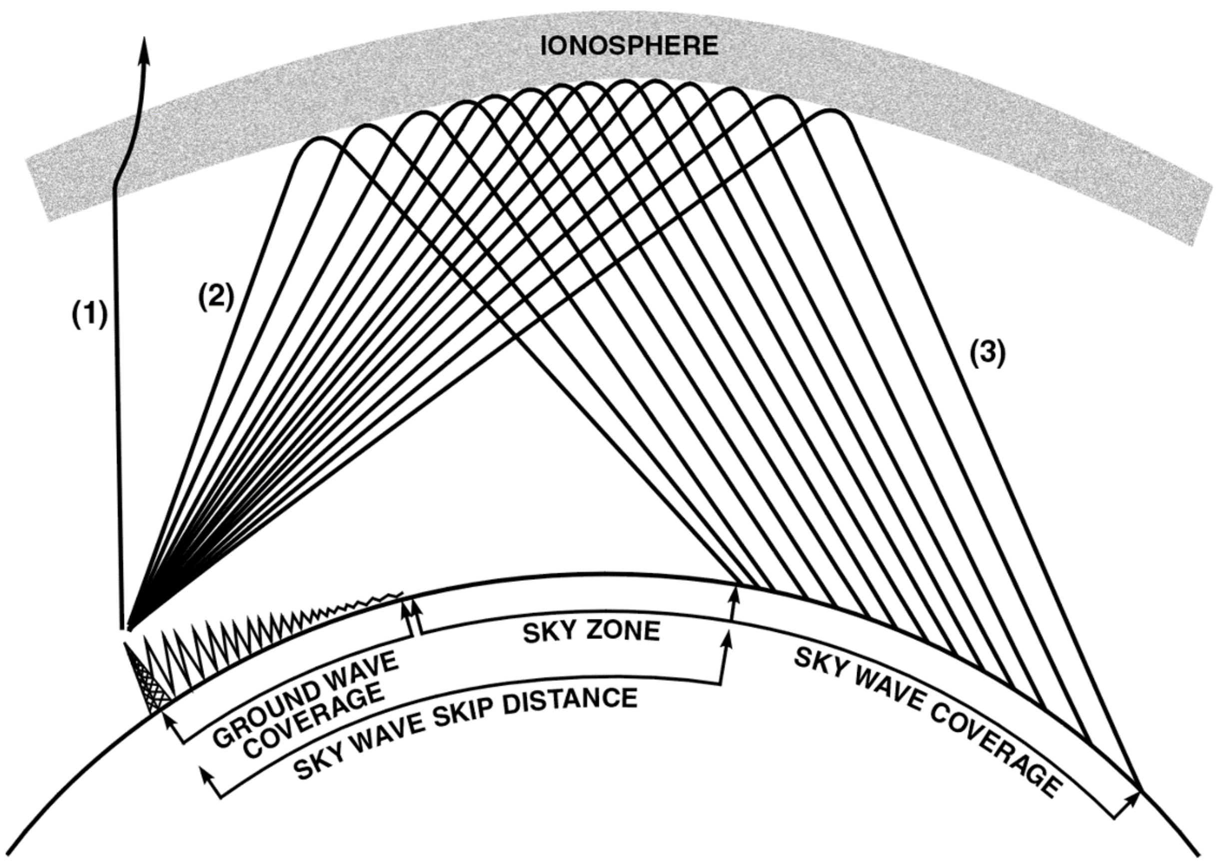
[1] Headquarters, Department of the Army (HQDA), FM 3-20.96, Reconnaissance Squadron, U.S. Government Printing Office (GPO), Washington, D.C., 12 March 2010.

[2] As observed by cavalry squadron trainers at NTC during DATE rotations.

2. The Growth and Development of HF radio

Guglielmo Marconi discovered the first type of HF radio in 1901. He used a 120-foot wire on a kite and was able to detect telegraphic signals in England from Canada, over 3,000 kilometers away. At the time, Marconi did not understand how the antenna was obtaining a signal around the curvature of the earth. However, by the 1920s, scientists discovered particles in the earth's ionosphere were electrically charged and able to reflect radio waves. Over time, users gained a better understanding of antenna propagation, which is how the antenna radiates signals outward. By the time the Unites States entered World War II, HF radio became the primary means of long distance communication over land, sea, and air.[3]

HF radio uses two types of propagation to communicate; these include ground wave propagation and sky wave propagation (Figure 1.1). Ground wave propagation travels across the surface of the earth either directly or through ground-reflection. The surface of the earth will eventually absorb the radio waves. Radio waves transmitting across all-sea-water can range anywhere from 200-300 kilometers; however, it drastically drops to 30 kilometers or less in rocky, dry, and arid ground. Finally, higher frequencies absorb faster than lower frequencies. Since direct ground waves are straight line-of-sight (LOS), the antennas need to see each other, making antenna height and location critical, especially in mountainous terrain.



[3] Harris assured communications. *Radio Communications In the Digital Age*, Volume 1, HF Technology, Edition 2; October 2005, p. 1-3.

Figure 1-1. Ground Wave and Sky Wave Signals

Sky wave propagation on the other hand, bounces off the ionosphere back to earth, creating a beyond line of sight (BLOS) communication, which is the type of propagation Marconi initially discovered. At certain frequencies, the radio waves refract, or bend, returning to earth hundreds, or even thousands of miles away. The time of day and atmospheric conditions affect which frequency the HF operator needs to use. This is what HF communications are based on. Before automatic link establishment (ALE), HF radio was challenging to use since the operator was required to manually select the frequency since the ionosphere is constantly changing based on time of day and conditions. With ALE technology, multiple frequencies are programmed into the HF radio and ALE automatically selects the best frequency and links on the best HF radio channel. The advent of ALE removed what was once a large technical knowledge requirement for HF employment. Despite these improvements, the Army slowly decreased its use of HF communication.

3. Why the Army lost its HF skill

Although the military used HF radio for tactical and strategic communications for over 90 years, the communication industry started focusing on other technologies after World War II. In the 1960s, satellite technology promised a new form of communication that allowed more channels and faster data transmissions. Satellite technology and the manner in which it creates a connection required less training than HF radio. As a result, HF radio was slowly de-emphasized, it became a backup form of communication, and over time, HF communication has become a lost skill in the Army.[4]

After HF communication skills had already decreased, the Army started to learn the limitations of satellite technology. Limitations of satellite technology included easier jamming relative to HF communication, physical damage to satellites, cost, and limited channels as the infrastructure grew. During the same timeframe, there was an increased interest in HF radios within the civilian world and other military services, which resulted in improvements such as ALE, making HF radio as easy to use as a wireless telephone. Technology that is even more recent includes the Third Generation ALE (3G), which combines ALE and data. This optimizes larger ground mobile networks and new applications like tactical internet, allowing the radio to connect to a laptop and send messages or small pictures using the Wireless Messaging Terminal. 3G networks can also help link and pass data with simpler antennas operating at a low power. The Wireless Messaging Terminal software can be downloaded to a stand-alone computer, with a government e-mail account, through the Harris website at https://premier.harris.com.

Despite these increases in technology, many HF radio operators still perceive HF radio as difficult to use based on a lack of training.[5] Subsequently, many units do not understand the capability of HF communication or the improvements made. Very few Training and Doctrine

[4] Harris assured communications. *Radio Communications In the Digital Age*, Volume 1, HF Technology, Edition 2; October 2005, p. 4.

[5] As observed by cavalry squadron trainers at NTC during DATE rotations.

Command (TRADOC) organizations teach HF radio, of which the Army's Reconnaissance and Surveillance Leader Course teaches the most in-depth course with practical exercises.[6] With such little training emphasis on HF communication, a unit's knowledge and expertise in employing HF radios may be limited to a small number of subject matter experts.

4. HF Basics for the Tactical HF Operator

The employment of HF radio is extremely easy and takes less than 30 minutes to train a radio operator how to place a call. As long as the S6 pre-programs the radio properly, the ALE feature selects the frequency and settings to use so that the HF radio becomes like a telephone, where every radio has its own specific address, much like a telephone number. When the radio is not in use, it scans through the frequencies listening for calls addressed to that specific address. In order to reach someone else, the operator simply selects their pre-programmed ALE address. The radio does all the work of consulting the Link Quality Analysis (LQA) matrix and selecting the best operating frequency. The radio then sends out a brief message to the destination address. When the receiving address 'hears' its address, it stops scanning and stays on that frequency. The two radios automatically conduct a 'handshake' to confirm that a link is established and the radio operators can communicate. Once the two HF operators are done talking, one of the operators will terminate the link and continue to scan, or the radio can be setup to automatically terminate the link and return to scanning after a period of no transmissions.

Where the HF radio operator needs more training and proficiency is with their antenna employment. As discussed earlier, sky wave propagation is what HF communication is based on. Although the HF radio can also communicate by line-of-sight, the sky wave propagation creates the BLOS connection and generates a communication plan that does not require retransmission. It all starts with how the antenna propagates the signal. The angle at which the sky wave enters the ionosphere is known as the incident angle (Figure 1-2). The HF radio operator creates the incident angle based on HF antenna positioning. Compare it to a billiard ball bouncing off the pool table rail, the radio waves reflect the ionosphere at the same angle it hits it. A larger incident angle allows the operator to reach further distances, while a lower incident angle allows the operator to talk to closer units, such as a unit on the other side of a mountain that cannot be reached by LOS due to terrain. This is critical since an incident angle that is near vertical will simply pass through the ionosphere without refracting back to earth. If it is too great, it will be absorbed and not refract. Likewise, if the radio operator is trying to talk to a closer unit, but has a large incident angle, it will shoot over the person they are trying to talk to, preventing communication. This is often referred to as a skip zone.

[6] Discussion at the May 2015 Critical Task Site Selection Board included the possible addition of PRC-150 training for the 19D10 skill level.

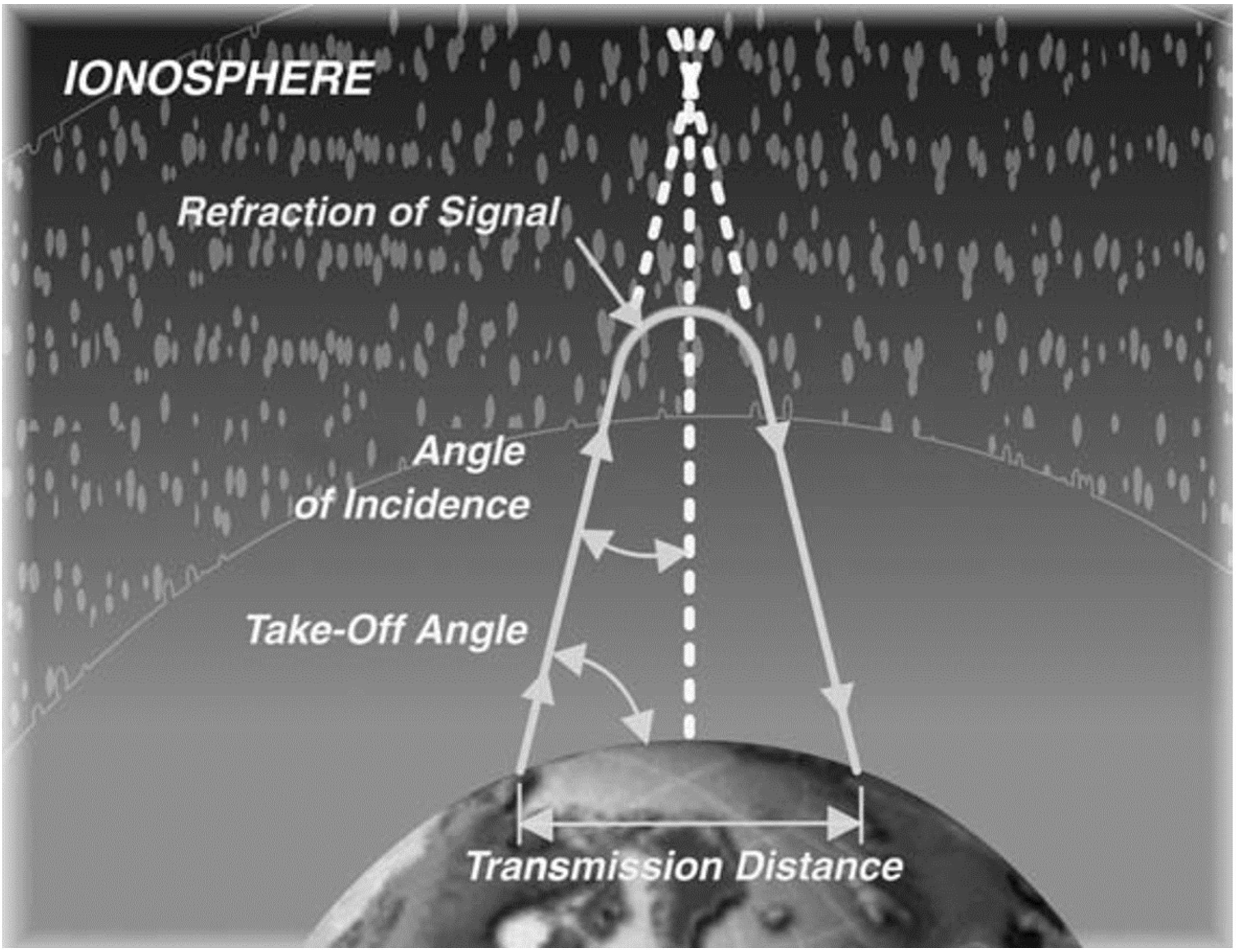


Figure 1-2. Incident Angle

The incident angle is a direct result of the antenna take-off angle. The take-off angle is the angle between the lobe of the antenna and the horizontal plane of the earth (Figure 1-2). Low take-off angles are used for long-haul communications and high take-off angles are used for shorter-range communications. Furthermore, the orientation of the antenna with respect to the ground determines the polarization. Most HF radios are either vertically or horizontally polarized. Vertically polarized antennas give a low-take-off angle and are suitable for ground waves and long-haul sky wave links. Horizontally polarized antennas radiate a high take-off angle and are suitable for shorter-range communications, out to about 500 kilometers. These short-range paths are typically referred to as Near Vertical Incidence Skywave (NVIS) paths (Figure 1-3). Some of the most common antenna configurations for the dismounted tactical HF radio operator include the dipole antenna, inverted “V” antenna, sloping “V” antenna, inverted sloping “L” antenna, the vertical whip and long wire antenna. The operator needs to understand where they are trying to communicate to since most of the common antenna configurations are directional, therefore the antenna needs to radiate towards the general direction of the base station they are trying to communicate with. The base station, typically a command post (CP), also needs to ensure they have both vertical and horizontally polarized antennas established with different orientations to receive as many signals as possible coming from the operators, there-by reducing the limitations of field expedient antennas. Although it is not difficult, antenna employment is probably the most challenging part for the novice HF radio operator and requires the most training. More information on antennas and their employment can be found on the National Training Center Cobra Team milSuite website at https://www.milsuite.mil/book/groups/ntc-cobra-team.

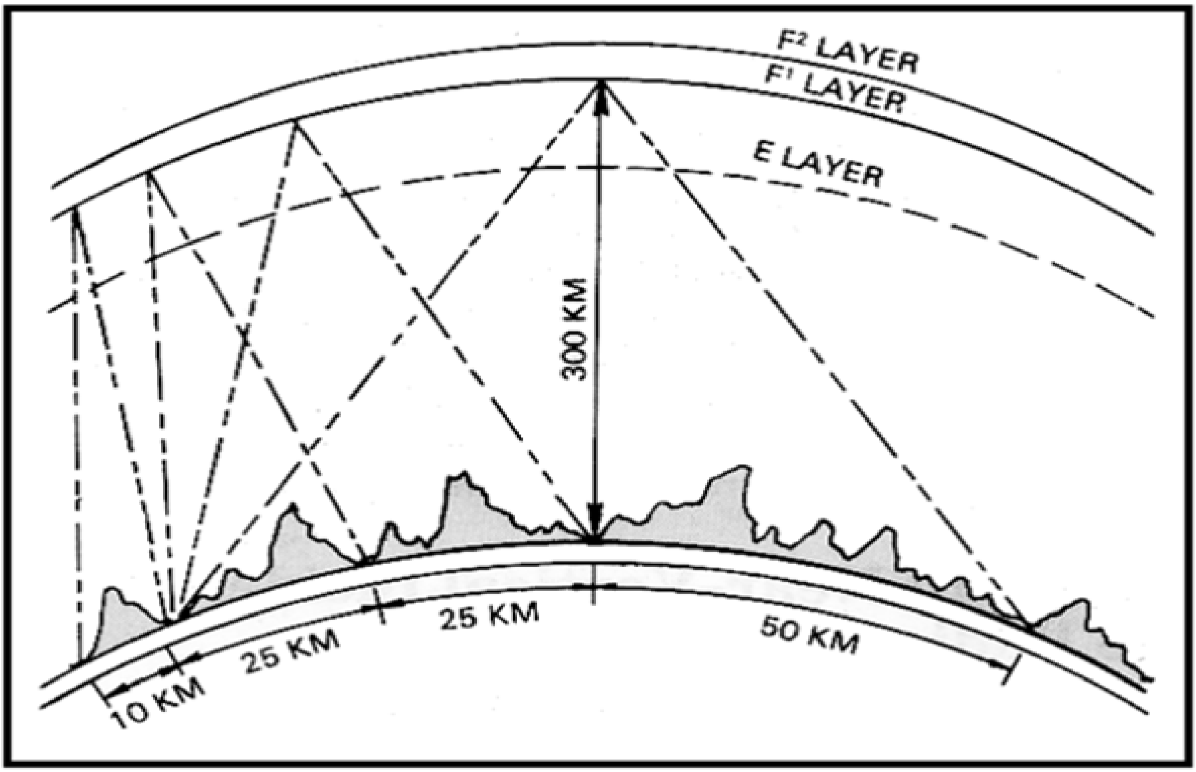


Figure 1-3. NVIS Concept

5. What the Field Grade Officer needs to know about HF Radio

As field grade officers manage their staff, they need to have a general understanding of how the S6 establishes the HF network. A field grade does not necessarily need to know how to establish the network, but they need a general understanding of how it works and common challenges. A common error is that the S6 simply goes to the frequency manager and asks for a generic range of frequencies without doing any frequency analysis to determine a good range.[7] The S6 analysis should begin with a propagation prediction program called Voice of America Coverage Analysis Program (VOACAP). This program predicts the performance of frequencies throughout the day based on the HF radio location and a specified type of HF radio. In addition, they should query space weather through the National Oceanic and Atmospheric

[7] As observed by brigade communication trainers at NTC during DATE rotations.

Administration (NOAA), located at http://www.swpc.noaa.gov/, in order to predict the impact of space weather on HF communication. Only after the S6 has conducted these two analyses should they engage the frequency manager for allocation of HF frequencies, and even then, the analysis should be redone every 30 days. Although this should be done at the brigade level, battalion and below should validate what the brigade S6 selected for frequencies and should know how to create their own plan if needed.

Upon allocation of frequencies, the S6 at either brigade or battalion level, will input their frequencies into the Harris radio programming software. This software is available from https://premier.harris.com/rfcomm/, after registering with a government e-mail account. Using this software, the S6 generates either an ALE or 3G HF network, and programs which radios will be on the network, along with the associated radio name. It is important that the S6 coordinates with the S4 to understand the quantity and type of HF radios within each troop so that each radio is assigned an address and name, there-by building the HF signal operating instruction (SOI). Once the S6 finishes building the network in the programming software, they can digitally validate the plan, and compare it to their VOACAP prediction. If the network was created properly, the screen shot of the validated plan and the screen shot of the VOACAP prediction will be a near match (Figures 3.1 and 3.2). During the mission analysis brief, these two screen shots can be briefed side-by-side to show that the S6 has conducted the proper analysis required and that the plan has been validated. Ultimately, these screen shots demonstrate to the commander that the correct frequencies were requested from the frequency manager, allowing for communication over the course of 24-hours. The brigade or battalion S6 then programs all of the radios with the plan they created using the Harris programming software. If the network is not properly created, or if the plan is not validated, the tactical HF radio operator will struggle at using HF communication and may not be able to communicate at all due to programming errors.

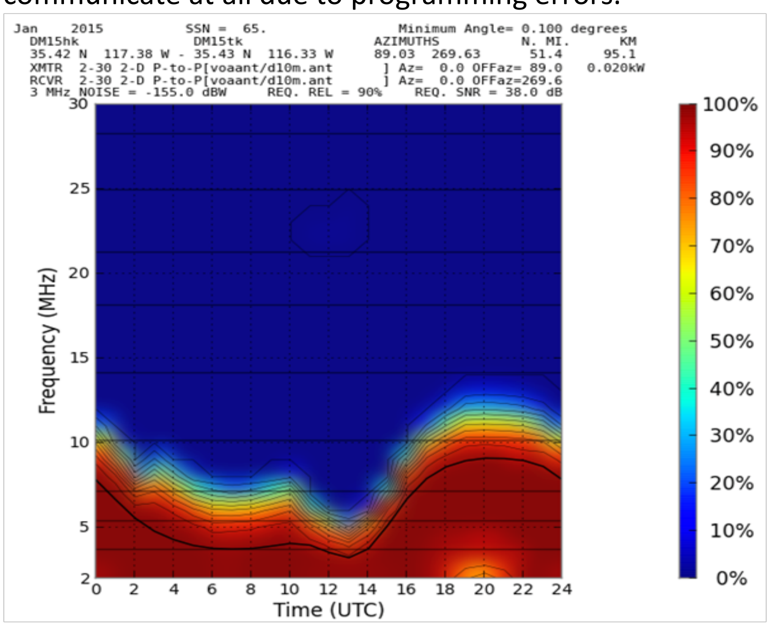


Figure 1-4. VOACAP Prediction

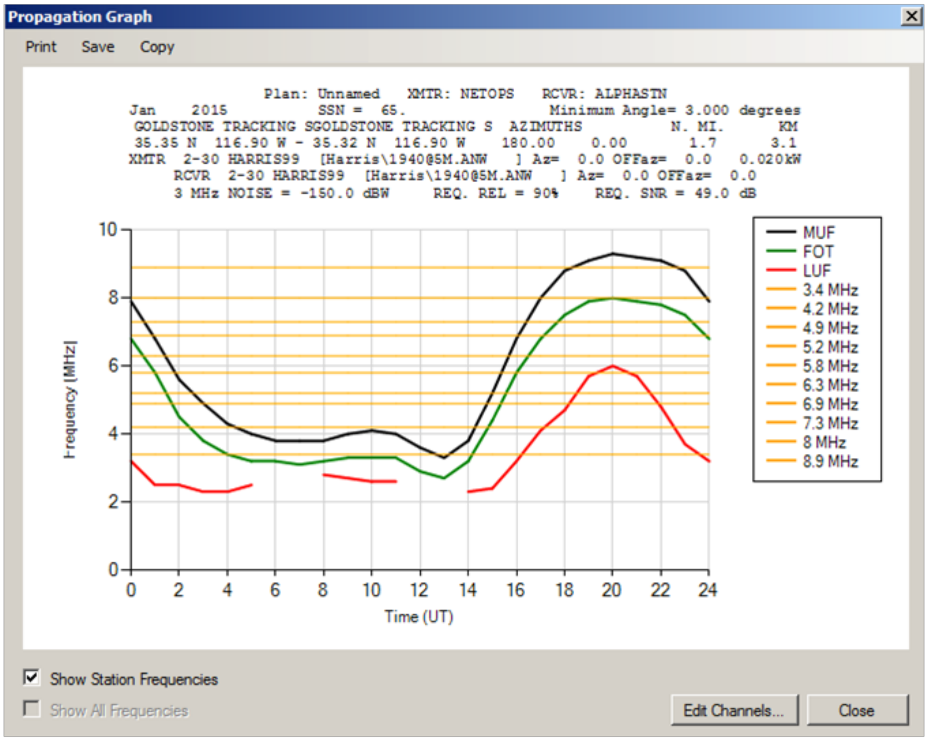


Figure 1-5. HF Network Plan Validation

6. Getting Back to the Basics

As BG Quintas, the previous commandant of the U.S. Army Armor School, highlighted, there has been an over-reliance on technology contributing to mission command challenges for the cavalry squadron.[8] FM frequencies only transmit a limited distance. Bridging that gap requires the employment of retransmission teams, which adds additional security requirements. In addition, retransmission teams can become a single point of failure when they encounter technical issues or the enemy destroys them. Communication for a cavalry scout is essential. If a cavalry scout cannot report what he sees, he is ineffective and a liability on the battlefield. Furthermore, they are unable to achieve effects on the enemy through the use of indirect fires because they cannot communicate the fire missions. By ensuring command emphasis on HF communication and addressing its critical shortfalls within a unit, cavalry organizations will be able to develop a more comprehensive and executable communication plan, while protecting Soldiers lives, enhancing mission command, and increasing mission success.

An additional resource that can be used for training and understanding of the use of communications equipment is the Center for Army Lessons Learned (CALL) Handbook 14-07, Radio and Systems Operators Handbook produced in collaboration with the Cyber Center of Excellence. The link to the product is https://www.jllis.mil/index.cfm?disp=cdrview.cfm&doit=view&cdrid=83143 where it is uploaded to the Joint Lessons Learned Information System. Hardcopy publications of the handbook can also be order through the CALL website https://call2.army.mil/rfp/default.aspx using the

[8] Armor Mounted Maneuver Journal, *Commandant's Hatch: Cavalry Update*, BG Lee Quintas, July-September 2014, p. 2-6.

RFI or Requests PUBs section. CALL would like feedback from anyone who uses the handbook so they can make the next version better at the Contact CALL link https://call2.army.mil/links/contact.aspx.

CPT Michael L. Hefti currently serves as an observer, coach, trainer for the Cobra Team, who oversees cavalry squadrons rotating through NTC, Ft Irwin, CA. Previous duty assignments include BDE Plans Officer, Troop Commander, Cavalry Squadron Plans Officer, HHT/Troop XO, and Platoon Leader with deployments to both Afghanistan and Iraq. CPT Hefti's military schooling includes Maneuver Captain's Career Course, Cavalry Leader's Course, Scout Leader's Course, Ranger School, and Armor Officer Basic Course. He holds a Bachelor of Arts degree from Minnesota State University – Mankato in law enforcement and is working on a graduate degree from the American Military University in criminal justice. His awards and honors include the Bronze Star with two oak-leaf clusters, Meritorious Service Medal, Combat Action Badge, 2013 General Douglas MacArthur Leadership Award, LTC Keith Antonia Officer Leadership Award, Order of St. George, and the Draper Leadership Award.