Sky Satellites: The Marine Corps' Solution to its Over-The-Horizon Communication Problem

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Introduction

During the last three years, the Marine Corps has seen an explosion of Satellite Communication (SatCom) assets being used in places like Iraq and Afghanistan. This increase in demand has caused a critical shortage of radio communication assets that can communicate across long distances and at the same time created a shortage of available radio frequencies for the radios to operate on. SatCom has its shortcomings even though it is more reliable than HF. The current main shortcoming of SatCom is the limited availability of bandwidth for the radio assets to operate on.

Thesis

The Marine Corps needs to find an alternative to High Frequency (HF) and SatCom radio assets to provide long haul communications at the tactical level. That alternative should be Sky Satellite (SkySat) radio assets. SkySat radio assets should be used as the primary means of tactical long haul communications and the Marine Corps' planning, training, and doctrine should reflect this standard. The Marine Corps needs to prepare for tomorrow's wars and these conflicts will look a lot like Afghanistan, Somalia, etc. and not today's Iraq. The Marine Corps' needs to identify a viable Over-The-Horizon (OTH) communication solution and

that solution should be cheap and easy to employ. The need for tactical OTH communications will continue to grow just like the past three years, especially since Marines have identified the future to be distributed operations.

Background

From the 1940s to the late 1980s HF communications was an appropriate solution. However, in today's environment there isn't enough training on atmospheric affects and the employment of HF assets. Therefore our communication operators do not fully understand how to employ HF. The Marine Corps could resurrect the extensive use of HF if it provides the appropriate educational training opportunities. Having effective HF communications is not the stand-alone answer especially when there is something more reliable like SatCom.

SatCom started being utilized in the 1960s and today it is an asset commonly used in the military and private sector due to its reliability. This reliability factor has caused SatCom to be in high demand and the main problem with its use is it limited availability. The availability issue has been compounded over the past two decades as more

applications and radios have been developed to operate on this finite spectrum.[1]

The Marine Corps defines operations at the strategic, operational, and tactical levels. When somebody talked about tactical communications in the past, they were referring to less than a 50 mile radius. In the Marine Corps today we have infantry battalions spread over 900 miles using tactical communications. This is analogous to an infantry battalion having one company deployed to New York City, and another company deployed to Charleston, South Carolina. HF assets fall short of tactical requirements with the above scenario especially when there is terrain included like the mountains of Afghanistan with their 15,000 feet elevation.

Radio Fundamentals

The flattest terrain on earth is the ocean. A person will be able to see 21 miles before the curvature of the earth interrupts their line-of-sight if they were to stand at sea level and look towards the horizon.

The basic principle of radio wave propagation is similar to throwing a stone in a pond and seeing a ripple effect across the surface of the water. An antenna is similar to

[1] Robinson Jr., Clarence A. “Robust Satellite Capacity Grows.” *Signal*, December 2005, 35-39.

where the stone entered the water and the ripples represent the radio waves emitting from the radio's antenna. Ground waves and sky waves are the two modes of propagation. The propagation names describe how the radio waves travel.

When a person is talking about sky waves, they are talking about distances beyond 50 miles. It is possible to talk father with a ground wave but a person would need to make adjustments to the height of their antenna, radio power output, etc. to counter the curvature of the earth. Additionally, two radios can talk to each other if their antennas can physically see each other and nothing is blocking their line of sight.

While ground waves travel along the surface of the earth, sky waves reflect off the sky or what is also known as the ionosphere. The ionosphere is broken into four layers that start around 25 miles and end in the vicinity of 400 miles above the earth's surface. Radio operators use the ionosphere like a mirror to reflect the radio waves to a distant station. This is the extreme basics of HF communication.[2]

The first key difference between HF and SatCom is that SatCom uses a space based satellite orbiting the earth

[2] Harris Corporation, RF Communications Division. "*Radio Communications in the Digital Age, Volume One: HF Technology*." May 1996.

instead of the ionosphere to relay the radio waves vice reflecting them from the sky. The second key difference is that satellites operate 300 to 12,000 miles above the earth’s surface.

Now a person might be thinking that this sounds simple. What they also need to understand is that the density of the four layers in the ionosphere change as they are heated and cooled from the rotation of the earth in reference to the sun. Radio operators also have to deal with geomagnetic, solar radiation storms, and radio black outs to further complicate things. Communicators adjust their antennas, power output, and radio frequency to compensate for these atmospheric conditions.

SatCom has to deal with similar problems. As long as two antennas can see each other they will communicate and with SatCom this is especially true but a communicator also has to deal with the problem of attenuation due to the extreme distances that the satellite orbits the earth. The only way to overcome the attenuation is by increasing radio power output or the gain of the antenna. SatCom also has to deal with atmospheric conditions like solar radiation storms.

Recommendation

The U.S. Air Force has been recently experimenting with SkySat communications. SkySat communications are basically

satellites deployed in the realm of near space. The Air Force defines near space as 65,000 feet to 325,000 feet above earth.[3] The SkySat composition thus far has been a hydrogen balloon similar to a weather balloon with a payload consisting of a tracking device, parachute and tethering system, and two AN/PRC-148 radios set to repeater mode.

The beauty of this system is its simplicity, ease of use, and affordability. SkySat combines the advantages of both SatCom and HF in one package. You end up with a platform that uses SatCom's reliability and ease of use along with HF's low price tag.

The Air Force's current experiments have yielded a SkySat system that weighs in at six pounds, operates on three watts, and successfully relays radio waves more than 400 miles. More importantly the current system uses radios that are already fielded within the Marine Corps and this leads to easy adaptability.

The two drawbacks to SkySat is the potential for air currents to blow them far enough to make recovery impossible. This disadvantage can be marginalized because of the low cost of the SkySat system compared to launching

[3] Lawlor, Maryann. "Near Space Fills Communications Gap." Signal, November 2005, 25-29

and maintaining Satellites. The other disadvantage would be the compromise of crypto radio fills normally associated with all military radios. This concern is non-existent because the AN/PRC-148's don't use crypto when they are set in the repeater mode. This allows users on the ground to employ their radios in today's conventional terms using crypto and still use SkySat.

The Air Force is planning to conduct further experiments with SkySat and sensors flown in near space at the Joint Expeditionary Force Experiment next spring. The Marine Corps needs to become a stakeholder at this experiment and become an active participant. Making SkySat a joint endeavor will aid in lowering the overall cost of the program and help expedite the fielding of SkySat into the operating forces.

Conclusion

There is a need to resurrect the use of HF communication within the Marine Corps. HF should not be use as the primary means of tactical long haul communications but it does have a place as a secondary or redundant communications path. The Marine Corps should utilize its SatCom assets in support of operational and strategic operations. Finally, the Marine Corps needs to join forces with the Air Force and piggy-back on their efforts

experimenting with SkySat communications. The Marine Corps has a requirement for OTH communications at the tactical level and SkySat has the potential to fill that need.

Word Count 1376

Notes

1. Robinson Jr., Clarence A. “Robust Satellite Capacity Grows.” *Signal*, December 2005, 35-39.

2. Harris Corporation, RF Communications Division. “*Radio Communications in the Digital Age, Volume One: HF Technology*.” May 1996.

3. Lawlor, Maryann. “Near Space Fills Communications Gap.” *Signal*, November 2005, 25-29.

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