

# MARINE CORPS TACTICAL SATELLITE COMMUNICATIONS

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## Abstract

A tactical satellite communications exercise using the DARPA Microsats was conducted by Naval Academy personnel at the Quantico Marine Corps Base in Virginia. Midshipmen used a military UHF radio, a modified amateur radio transmitter, and scanner receivers while a station in Annapolis communicated with them. Voice communications were clear and understandable even when the tactical teams were in the woods. Amateur radio operators and scanner enthusiasts around the eastern half of the United States and Canada successfully monitored the Microsat downlinks during the demonstration.

## Introduction

In the United States Marine Corps concept of maneuver warfare, communication plays a key role. The Corps doctrine manual states that "...key people—'actuals'—should talk directly to one another when possible, rather than through communicators or messengers...[they] should communicate orally when possible, because we communicate also in *how* we talk; our inflections and tone of voice."<sup>1</sup> Small satellites in low Earth orbit can provide voice channels to tactical units deployed over large areas; these channels enhance the communications that are required for maneuver warfare. A low Earth orbit allows the use of low-power transmitters and simple antennas that are small and lightweight. Low power transmissions are difficult to locate, so the risk of exposing positions by communicating is greatly reduced.

During November 1991, midshipmen, faculty, and staff of the United States Naval Academy conducted a tactical satellite communications demonstration using the seven DARPA Microsats. Tactical units at the

Quantico Marine Corps Base in Virginia communicated with a command station in Annapolis and with each other. The goal of the demonstration was to show that the Microsats could provide high quality voice communications that would satisfy requirements as stated in Marine Corps doctrine.

## Equipment

The radios and antennas used in this demonstration are detailed in a companion paper<sup>2</sup>. An AN/PSC-3A transceiver with Dorn-Margolin antenna was the primary station in the field at Quantico. The modified Hamtronics transmitter, an AR1000XC scanner receiver, and a mini-blind crossed dipole antenna was the secondary station at Quantico. An AR1000XC receiver with mini-blind antenna was used as a receive-only station while another AR1000XC with discone antenna was used for monitoring the progress of the exercise. The Naval Academy station used a signal generator/power amplifier transmitter and an AR3000 receiver with a roof-mounted crossed-dipole antenna.

## Demonstration Procedure

Before the first satellite pass, the participants and radios were gathered in the center of a helicopter landing zone at Quantico. The midshipmen were assigned in teams of four or five to the AN/PSC-3A, Hamtronics, and receive-only stations. During the first satellite pass, each rig was used to establish contact with the Naval Academy for final checkout, then the team assigned to that rig moved into the woods surrounding the landing zone. The two teams with transmitters maintained contact with the Naval Academy and with each other through the Microsats while the receive-only team monitored the downlink. Sample status reports that were prepared in advance

were read over the satellite channel to test legibility of the signals.

### Demonstration Performance

Shortly after the predicted appearance of the first satellite, a call from Quantico to the Naval Academy with the AN/PSC-3A (see Figure 1) was promptly answered. The Hamtronics transmitter (see Figure 2) also worked well during checkout. With all equipment verified as functional, the three teams began moving in different directions. The receive-only team immediately entered the woods and monitored the downlink for the duration of the exercise. The two transmitters moved initially to the edge of the woods, then as far as 100 meters into the woods to test signal loss due to vegetation.

Throughout the exercise, voice communications were clear and understandable. Both transmitters at Quantico and the one at the Naval Academy had sufficient power to be full quieting in the Microsat receivers. Communications were maintained almost continuously for 52 minutes. While there were still some leaves on the trees, signal loss due to vegetation was not noticeable for any station.

### Ground Tracks

Tracking programs were used to examine timing and elevation of each satellite pass of the demonstration. The satellites moved from North to South over the eastern United States during late afternoon on 16 November 1991. The first satellite, Microsat 7, had a peak elevation of 37° above the horizon to the east. The following satellites appeared at higher peak elevations to the east, then lower elevations to the west. The last satellite, Microsat 1, had a peak elevation of 31° to the west. The satellites were almost evenly spaced, so near-continuous communications were possible. Figure 3 shows the positions of the satellites and their footprints early in the exercise, shortly after Microsats 7 and 3 have passed Quantico. Figure 4 shows the positions of the satellites near the end of the exercise as the last satellite is about to pass to the west of Quantico.

### Monitoring Stations

Two days before the exercise, Naval Academy faculty sent Internet computer bulletins describing the upcoming demonstration and inviting amateur radio operators and scanner enthusiasts to monitor the downlink. Reception reports were requested to be

sent by Internet electronic mail. A total of 12 individuals responded. Their locations (see Figure 5) included North Carolina, Virginia, Maryland, New York, Massachusetts, New Hampshire, Ontario (Canada), New Brunswick (Canada), Ohio, and Minnesota. The station in Minnesota was the most distant at approximately 900 statute miles. While they reported varying amounts of legibility (caused largely by variations in receivers and antennas), many of these individuals accurately reported samples of the transmissions that took place.

### Conclusions

The Microsat demonstration at Quantico proved that tactical satellite communications using low-Earth orbiting spacecraft is feasible. Small radios and non-directional antennas simplify procedures for the units in the field. Spacecraft like the DARPA Microsats can provide the kind of clear voice communications that the Marine Corps requires for maneuver warfare.

### References

1. Warfighting, FMFM 1, United States Marine Corps, 1989. The emphasis is in the original document.
2. W. K. Daniel and R. E. Bruninga, "Navy/Marine Corps Demonstrations of the DARPA Microsats," Sixth Annual AIAA/USU Conference on Small Satellites, Logan, Utah, September 1992

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Figure 1. Operation of AN/PSC-3A Transceiver



Figure 2. Operation of Handheld Transmitter/Receiver

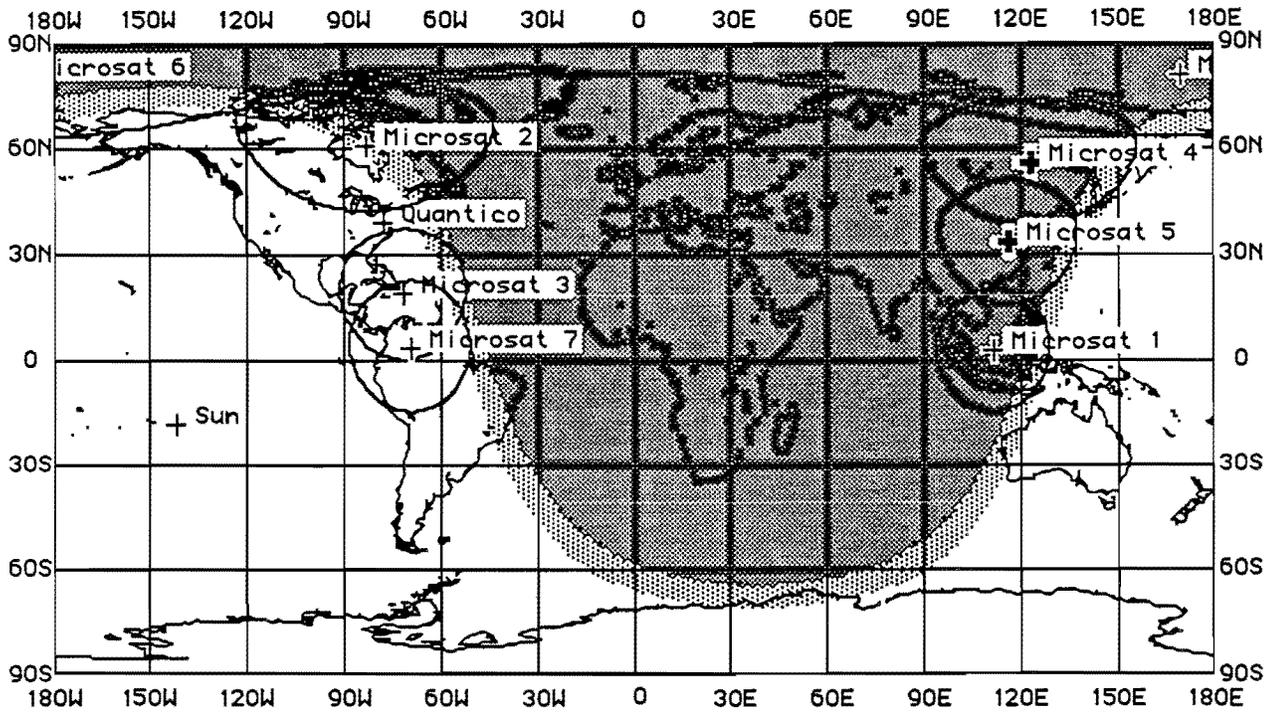


Figure 3. Satellite Positions Early in Demonstration

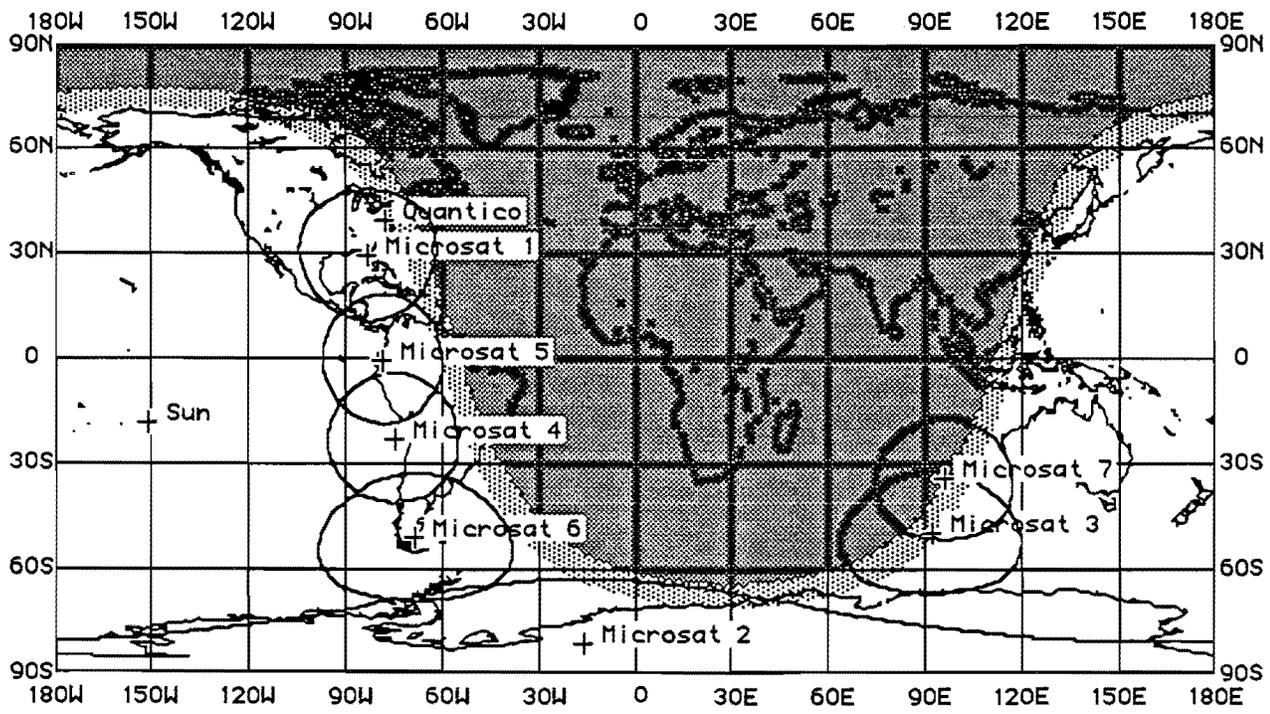


Figure 4. Satellite Positions Late in Demonstration



Figure 5. Locations of Monitoring Stations