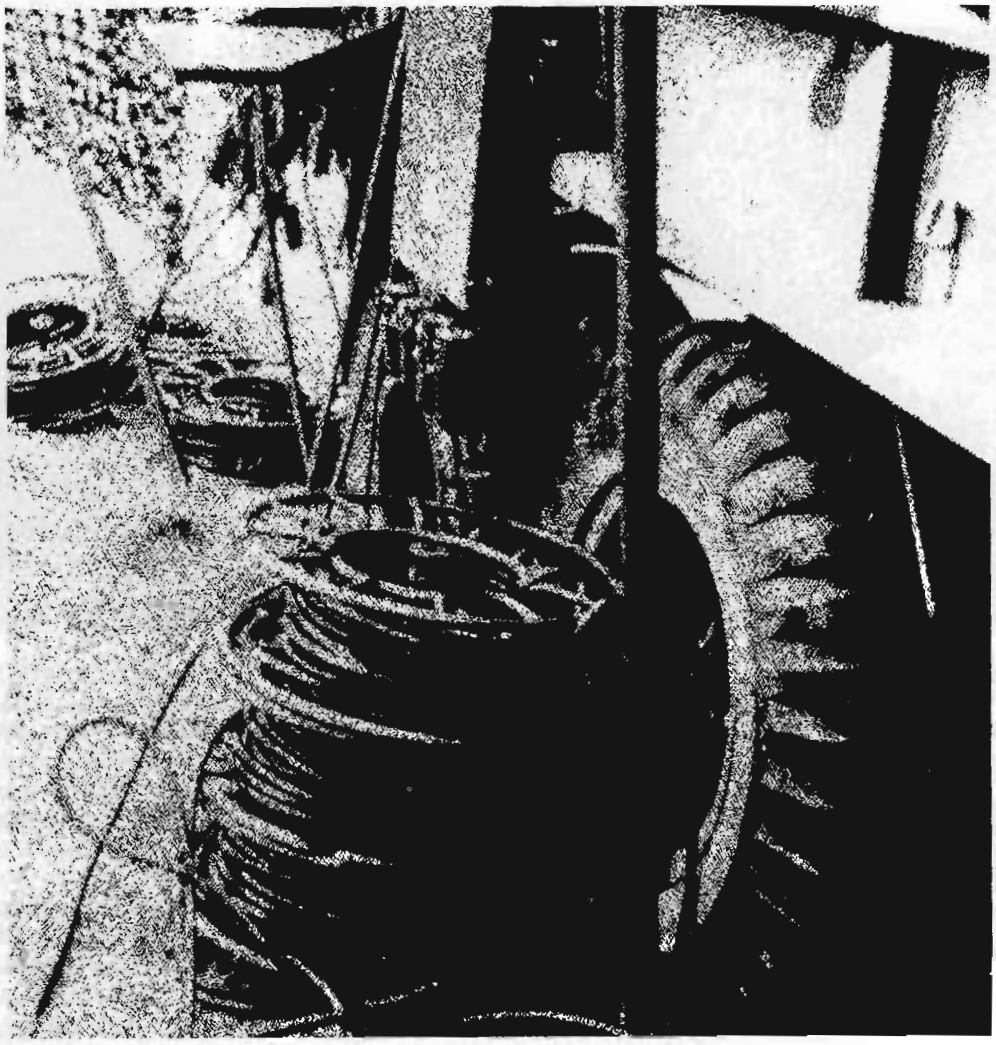


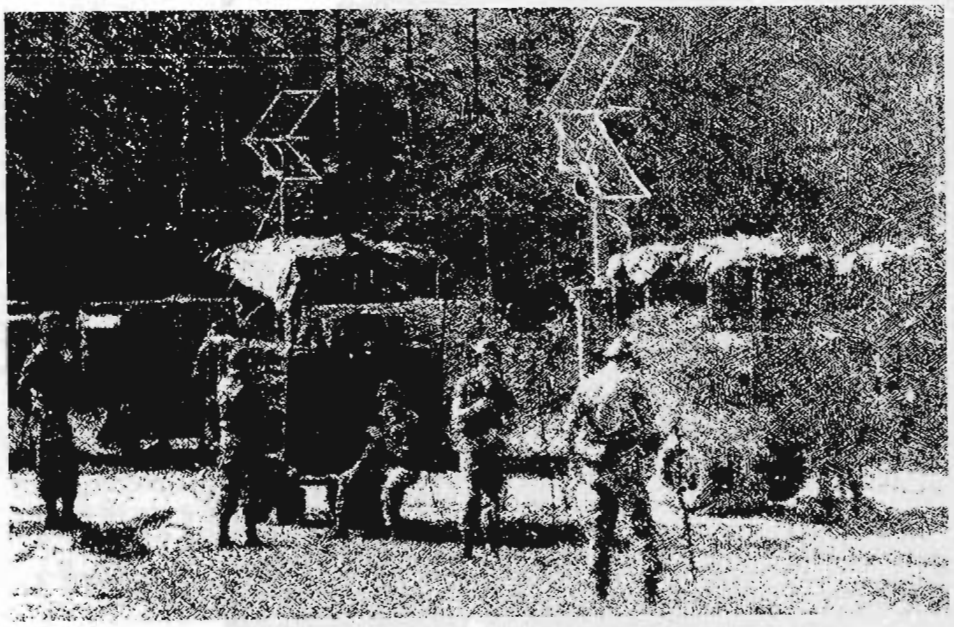
A viable alternative to LOS

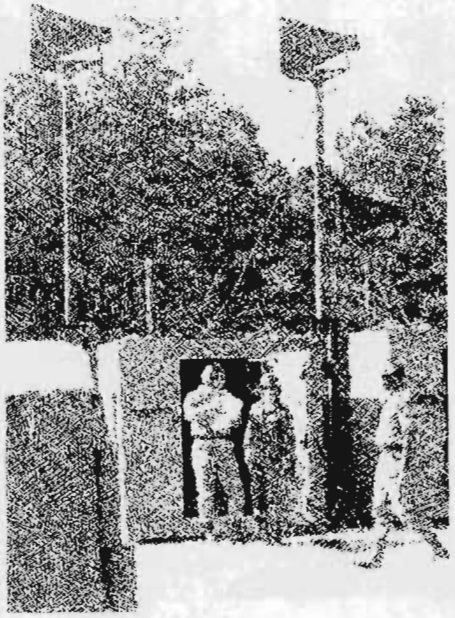
by Capt. Richard S. Hepworth

A resurgence of interest in cable systems must necessarily take place before the next war, as line-of-sight radio probably will not survive a war in Europe. Conversely, cable — especially fiber optic cable — probably will.

The technological advances of the 1970's, particularly in the field of computer and micro-processor sciences, have flooded the modern battlefield with data — all of which must be swiftly channeled to where it can be used. These tremendous quantities of data, whether destined for man or machine, have, in turn, spawned legions of radios and receivers. To husband our resources, the multichannel system was born. These multichannel systems are of critical importance because effective command, control, intelligence and logistic operations simply will not be possible without them. However, despite our dependence upon these systems, they are fatally flawed.

Our infatuation with line-of-sight (LOS) radio for multichannel traffic has





Though LOS radio systems carry the bulk of tactical multichannel traffic, they have two critical deficiencies: they can be easily detected and therefore easily targeted, and they can be damaged by EMP even when an atomic blast is so far away that no other effects of the blast are felt.

lead to a wholesale abandonment of cable as a viable multichannel medium. A resurgence of interest in cable systems must necessarily take place before the next war, as line-of-sight radio probably will not survive a war in Europe. Conversely, cable — especially fiber optic cable — probably will.

Line-of-sight radio is vulnerable for several reasons. To understand its most apparent vulnerability, we must first look at the nature of the signal. Unlike the combat net radios that broadcast only as required, LOS radios broadcast continuously — 24 hours a day. The carrier frequency, either VHF or UHF, can be located by direction finding techniques, like any other radio system. Since the signals are directional, they radiate as spokes from the hub of a wheel or, in this case, a tactical headquarters. Because of its unique signature, LOS transmission gives away not only the location of a major signal complex, it also reveals the general location of the headquarters it supports.

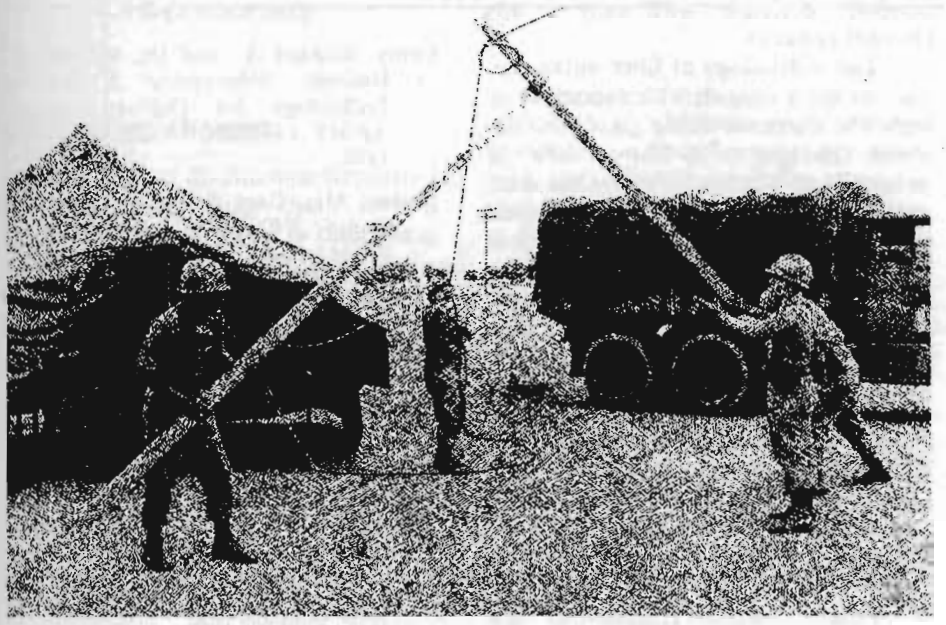
Soviet doctrine concerning electronic warfare is referred to as "radio electronic combat," with emphasis on combat. Once the radio transmitter has been located, it is targeted for destruction. Obviously a unique signature such as a LOS system supporting a major headquarters would be a very lucrative target indeed. Conventional tube or rocket artillery would probably be used to destroy the signal complex and the headquarters it supports.

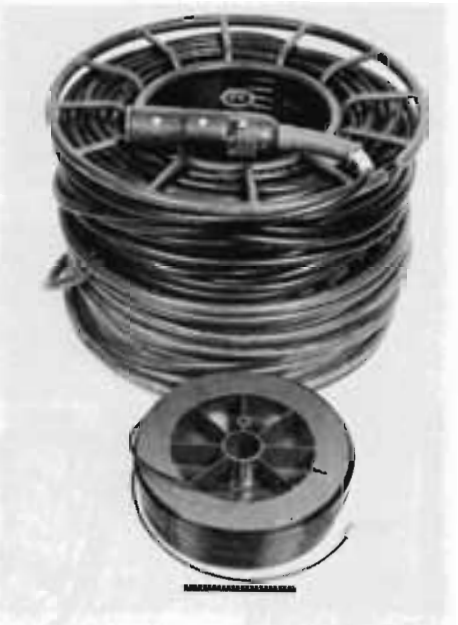
Aside from this weakness, serious consideration must be given to LOS vulnerability on a nuclear battlefield. In the event of a tactical nuclear strike, the LOS radio complex does not even need to be in the target area to be destroyed. The large dish or horn antennas associated with multichannel radio are fragile structures at best. A one-megaton weapon detonated 3.5 miles from a signal complex will produce overpressures of seven pounds per square inch and winds in excess of 225 mph. Considerable damage can be expected for brick and concrete structures at this range. Little imagination is required to assess the damage that would be done to a flimsy dish antenna held in place by a few guy wires.

The close range effects of a nuclear strike are also obvious. With LOS radio, a nuclear detonation even at an extremely long distance from the radio will still inflict grave consequences because of Electromagnetic Pulse or EMP. EMP is a rapid surge of gamma rays which produce energy on the order of 20,000 volts/meter to several hundred thousand V/M depending on the distance and strength of the blast. The extremely fast rise time of EMP, 10-20 nanoseconds, is one reason conventional lightning protection circuits are not effective. This energy enters the radio equipment through the antenna or a metallic cable and damages the electrical components. This damage can occur even if the blast occurs at a distance from which the other effects of the blast are not felt.

Briefly, we have seen that while LOS radio systems carry the bulk of tactical multichannel traffic, they also have a critical deficiency: because they can be detected easily, they can be targeted easily.

The Army's alternative, at the moment, is the metallic twin coaxial





According to fiber optics expert, CWO Richard E. Hogue, there are compelling reasons for using fiber optics. They are small, light, flexible. Weight and size savings over CX-4566 (above) are obvious. Hogue notes that according to one estimate, the B-1 bomber, which has 33 miles of electrical wire of various kinds, could save about 2,000 pounds by using fiber optics.

cable, CX-11230. Unlike radio, cable cannot be jammed and it is extremely difficult to detect. If cable systems were used exclusively in lieu of LOS radios, the friendly multichannel system would be impervious to enemy jammers and invisible to enemy direction finders.

Considering these advantages, one would think cable would be used almost exclusively. However, there is a serious drawback: cable is slow. LOS radio can be put into service in 20 minutes or less (the fact that it sometimes takes 20 hours or more is conveniently overlooked by the pro-radio communications). Unfortunately, cable is never installed in 20 minutes or less and it will always take several hours to install.

Apart from the long installation time, cable has a number of technical drawbacks. The present metallic cable was developed in the early 1950's to handle the emerging multichannel technology. The system was designed for a pulse code at a rate of 2.304 megabits per second, a rate adequate for 48 channels. By today's standards, this is a pitifully low information transfer rate.

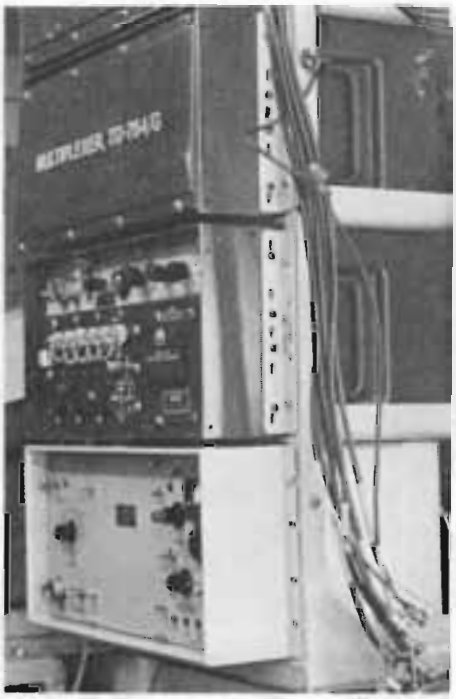
The present cable is supplied on reels that weigh over 100 pounds a piece and hold only a quarter mile of cable. The system requires an unattended repeater every mile and it cannot exceed 40 miles without a manned repeater station to clear and boost the signal. Additionally, communications over metallic cable is plagued by other gremlins in the form of ringing, echoes and cross talk.

Perhaps the most damning feature of the present system is that it is much more likely to be damaged or destroyed by friendly elements than by enemy interdiction. Cables are torn up by friendly tactical vehicles and damaged by the cable teams themselves as they work to install or recover the cable quickly.

Even with these drawbacks, however, the tactical advantages of cable cannot be ignored: cable cannot be monitored by enemy radio equipment, nor can it be jammed. Cable will operate where line-of-sight radio signals simply will not go (through thick foliage or in mountainous terrain, for example). This advantage frees the communicator from his dependence upon using hill tops for LOS relay stations or terminals. Hill tops are often used as artillery registration points and may be targeted by the enemy just in case something is up there.

The fiber optic cable that is under consideration for replacement of the present metallic coaxial cable retains the major benefits mentioned, but is also immune to many problems that plague both radio and cable systems available today.

The first advantage revolves around the revolutionary idea that the conduit is glass, not metal. A glass transmission medium is dielectric; that is, it will not pass an electric current and is, therefore, immune to lightning and other electrical surges. The electromagnetic pulse produced by a nuclear detonation and the related Transient Radiation Effects on Electronics associated with EMP are eliminated. Glass simply will not transmit this energy into the communication equipment connected to it. A glass cable will not short-circuit, requires no electrical ground and is immune to the effects of varying voltage



The prototype of the fiber optic modem MD-1062( )/GAC-1 (bottom unit) serves as a fiber optic terminal or as an interface between a conventional PCM/TDM system and the fiber optic system. (US Army photograph)

potentials along its path. The ringing, echoes and cross talk associated with metallic cable are virtually non-existent in fiber optic cable.

In addition to the many positive advantages of a dielectric medium, fiber optic cable is ideally suited for digital communication, making it the perfect interface for battlefield computers. The use of computers and other sophisticated devices on the battlefield has expanded communications requirements dramatically. Current requirements under the TRI-TAC architecture call for 1144 channels and fiber optic cable is capable of handling this requirement, while CX-11230 is woefully deficient with only a 48-channel capacity.

The technology of fiber optics has also meant a considerable reduction in size. The diameter of the glass conduit, about the size of a human hair, is protected by a mat of fibers of the same material found in a bullet proof vest. This gives the cable a much greater crush tolerance while reducing its size and weight. A standard cable reel holds a mile of CX-11230 or one kilometer of fiber optic cable. This means the cable will be easier to handle and reductions in installation and recovery times can be expected. Also helping to cut installation time is the fact that the new cable requires a repeater once every eight kilometers (about five miles) as opposed to the present limit of one a mile.

Finally, when considering the enemy's doctrine in radio electronic combat, remember that cable, although slower to install than radio, is undetectable at long range. Fiber optic cable is even more invisible because it does not produce an electromagnetic field and consequently cannot be detected even at a range of a few feet. Since it cannot be detected, it cannot be targeted, so the communications complexes and the headquarters they support are protected. Fiber optic cable eliminates many of the problems associated with both LOS radio and present cable systems. Although it cannot be installed as fast as radio, it can be installed faster than metallic cable and is considerably more durable.

In conclusion, based on our doctrine of multichannel communications and the enemy doctrine of radio electronic combat, we can expect multichannel LOS radio systems to be swiftly eliminated by a determined and capable enemy. We must face up to this fact and realize that relying solely upon LOS radio for multichannel communications is untenable. Fiber optic cable can provide a safe, secure system for battlefield communications in the future. However, we must learn to work with cable, especially fiber optic cable today. We must develop an alternative to LOS radio before we are surprised by its vulnerability on the battlefield.

The alternative is as clear as glass.

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