COMMUNICATIONS FOR MARINE CORPS TACTICAL
COMMAND AND CONTROL SYSTEMS, SOME CONSIDERATIONS

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Abstract. Two communication systems are used by tactical Marine forces. Single-channel, netted radios are used when mobility is paramount. Telephone switching equipment, multichannel radios and wire lines are used when mobility requirements are less. The latter system has substantially more capacity. New equipments for the latter system will provide the communications required for automated command and control systems now being developed.

Introduction. Tactical military communications are established for the primary purpose of enabling the military commander to exercise command and control of his assigned combat forces, supporting arms and logistics support. The secondary purpose of these communications is to facilitate the transfer of information to support the exercise of command (reference 1, pp 1-5).

Electronic means of communications have surpassed all other forms of tactical military communications in enabling the commander to exercise command and control of forces spread over large areas. As the distances involved have continued to increase, the exercise of command has become more and more dependent upon the return flow of information to the commander by electronic means, and by his capabilities to assimilate that information.

The fundamental requirements for effective tactical communications are reliability, security, speed of service and flexibility. Often these fundamental requirements seem to be mutually exclusive, as do the essential characteristics of being responsive, survivable, economical and simple. Communications capacity or information throughput is also an important consideration.

The demands imposed by differing tactical circumstances have tended to justify development of a variety of types of tactical communications equipment. Current U. S. Marine Corps' communications equipments support two different types of tactical communications systems. These two types of systems have fundamentally different capabilities. They are often used to complement each other as the tactical situation changes.

Single-Channel Netted Radios. Accomplishing a significant movement by any sizable organization requires a substantial amount of prior planning, timely communications or both. If the maneuver is by a military organization and it is opposed by another military organization with all of the means at their disposal, such as is the case in armed conflict, timely communications to all elements of the organization is essential.

For at least the past hundred years, the increasing range, accuracy and lethality of weapons has forced military organizations to adopt more dispersed formations. For roughly the past fifty years, electronics has provided the most effective technology for commanders of these dispersed formations to maintain command and control. This "most effective technology" has been what we now call single-channel netted radios. Marine Corps' communications doctrine, published over the years, has prescribed specific (exact types and composition) radio nets to support tactical operations. The current Marine Corps' doctrine, contained in reference 1, is now more flexible concerning the exact makeup of individual nets (reference 1, p 241).

Generally it can be said that there are three types of radio nets. The first type, which links an organizational headquarters to its subordinate organizational headquarters for all purposes except operational coordination and specific functional reasons, are called Command Nets. Command Nets are hierarchical in nature, with any given command being on two such nets, one linking that command to higher authority and the other linking it to subordinates. The second type, which links operational personnel with their counterparts at the next organizational level, are called Tactical Nets. Operational personnel are directly responsible to the commander for the fire and maneuver of the organization. Tactical Nets, like Command Nets, are hierarchical, with most organizations being on two such nets. The third type of net is not hierarchical, but...
is devoted to a specific function. They are called Functional Nets. Functional Nets allow the personnel involved in specific functions to communicate with other personnel involved in the same functions at all other organizations. Some examples of Functional Nets, with descriptive titles, are: Reconnaissance Net, Naval Gunfire Support Net, Logistics Net, and Meteorological Net. There are many others.

The electromagnetic spectrum of high frequency, very high frequency and ultra high frequency are all used, depending primarily upon the distances required. Spectrum crowding is a substantial problem. Voice, teletypewriter, and CW (Morse Code) are all available, but CW is not widely used (any more). Voice predominates on Tactical and Functional Nets and teletypewriter predominates on Command Nets. Often during active maneuver or violent combat, many nets become overloaded and back-up nets with the same subscribers are activated. Usually each radio station on each radio net is manned by a specially trained Marine radio operator.

The tactical circumstances of the Viet Nam War and the ongoing digital electronics revolution have caused the U. S. military services to renew their interest in automatic switching systems. Several electronic switching equipments were developed in the 1970s and limited quantities of these automatic switching equipments have been fielded and are now in use. The Marine Corps is the only U. S. military service to have substantially satisfied its requirements for automatic tactical switching equipments. Fulfillment of the other services' requirements were postponed until a new system (discussed below) becomes available.

The use of automatic switching equipment is not yet reflected in doctrinal publications such as reference 1. I briefly described the Marine Corps' tactical telephone system in the transitional stage from manual to automatic in reference 2. The current tactical telephone system in the Marine Corps is automatic and very much more convenient to use than the old manual system or single-channel netted radios. I believe this "convenience" factor will cause increased demand for the use of telephone systems in all phases of tactical military operations. This increase in demand, in addition to new requirements discussed below, will place increased emphasis on making the system more mobile. The most significant drawbacks to the current Marine Corps' tactical telephone system are its lack of mobility and its lack of security.

The next generation of tactical switching equipments, the system that will be used by all of the U. S. military services is now being developed by the Joint Tactical Communications or TRI-TAC Program.
References 3 through 6 provide some details of the TRI-TAC switching equipments and rational for their digital nature. TRI-TAC's large digital switch, the AV-TTC-33, has undergone testing and is now in production. Some software improvements must be accomplished before fielding. The smaller or "unit level" telephone switches will enter testing in less than a year. These telephone switching equipments and a number of other complementary equipment developments of the TRI-TAC Program, such as telephones, facsimile machines, cable multiplexing equipments and multichannel radios will provide a telephone switching system that is secure and as mobile as the present telephone system. Some still-in-the-future developments, such as "mobile subscriber" equipments may also help overcome the lack of mobility of the new telephone system.

These new switching equipments are stored program controlled electronic circuit switches. In addition to providing digital voice communications using CVCN modulation at 16 and 32 kbs, the system is amenable to providing good quality digital paths for other purposes, such as digital data communications. These digital data paths can be established either through the circuit switches (by dialing) or directly (and permanently) connected. The Marine Corps is currently planning upon using the smaller of the new switches, as soon as they become available, to overcome the security shortcomings of the present telephone system and also to provide a digital communications network upon which to overlay the communications for a group of developments which are discussed below.

Detailed planning for the introduction of new communications equipment into the Marine Corps is contained in reference 7. Reference 7 is updated every year or so to reflect current status of equipment developments, budgeting and other "facts of life".

The new (TRI-TAC) multichannel switched system can be summarized as providing very rapid communications, being very economical to operate, very high in capacity and very flexible and secure; reasonably survivable; but not simple nor mobile.

Command and Control Systems. The electronics revolution in the Marine Corps has not been confined to communications, but has also included the entire spectrum of command and control systems.

The commanding officer of a military unit has always been totally responsible for that unit, what it does and does not do. To assist the CO, as military organizations have become more complex, military staffs have been created. Generally speaking, specific staff officers deal with and advise the CO on specific organizational functions, such as personnel, logistics, communications, intelligence and operations. Also, generally speaking, with the continuing increase in complexity of military organizations, staff officers have developed staff organizations to come with the complexity, and they tend to establish centers for the technical management and coordination of their individual specialities. These centers accomplish technical computations, maintain situation maps, inventories and lists, accomplish coordination and advise the commander.

The Marine Corps is always working toward improving these centers functioning, including through the use of automation. Many of the functions are amenable to automation using digital electronics. At least since the "systems" approach has been in vogue in DoD, these centers have been called command and control systems. Currently there is a series of programs underway in the Marine Corps to develop improvements to these command and control systems. As a group, these programs are called Marine Tactical Command and Control Systems (MTACCS). The title, acronym and a short identification of the purpose of each of the MTACCS programs is provided at the end of this paper. Details and current status of the MTACCS Programs is contained in reference 8. Reference 8 is updated every year or so, as circumstances require.

Communications for MTACCS. From a communications planning standpoint, each MTACCS can be considered as a number of centers that exist at various locations, needing to communicate with other centers at other locations. For each system, connectivity diagrams and communications volume information can be developed. Viewing the communications requirements for MTACCS from this perspective, the architectural concept of the TRI-TAC Program were evaluated to determine how to best satisfy the MTACCS communications requirements. The following points summarize the conclusions reached in the early 1970s. It is extremely gratifying to see publications, such as references 9, 10 and 11, some published years after we groned with the issues, come to the same general conclusions. These conclusions seem to be "universal" enough to apply to all "command and control" systems, be they associated with banks, airlines or rental car companies or military combat systems.

- Commuter power is cheaper than transmission media.
- Automating a distributed system increases the amount of communications required.
- Automated systems communications requirements seem to naturally consist mostly of short messages at frequent intervals.
- The characteristics of the communication requirements (short and frequent) precludes using direct telephone circuits.

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• Lower capacity, full period circuits are to complicated and inflexible to be an effective solution.

• The automated systems should be designed to use the existing communications and not "be free" to develop their own.

• The systems must be designed to degrade gracefully as the communications degrade.

These conclusions caused the Marine Corps, the smallest of the four U.S. military services, to advocate and subsequently assume responsibility for accomplishment of the TRI-TAC Program. This data switch will be fully compatible with the new multichannel switched communications system, utilizing the same digital channels and TRI-TAC communications security equipments, ADCCP.

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### Title Acronym

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<tr>
<td>Marine Integrated Fire and Air Support System</td>
<td>MIFASS</td>
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<td>Tactical Combat Operations</td>
<td>TCO</td>
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<td>Tactical Air Operations Central - 1985</td>
<td>TAOC-85</td>
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<td>Marine Air-Ground Intelligence System</td>
<td>MAGIS</td>
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<td>Position Location and Reporting System</td>
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<td>Marine Integrated Personnel System</td>
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Purpose

- To coordinate the control and use of supporting arms (mortars, artillery, naval gunfire and close air support) in combat.
- To automate the operational control of tactical units in combat.
- To manage airspace including the control and coordination of intercepter aircraft and surface-to-air weapons in combat.
- To collect and rapidly process all types of data about the enemy and to provide intelligence to the tactical forces in combat.
- To provide real-time, three dimensional position and identification information of friendly units to friendly units in combat.
- To provide integrated manpower management in garrison and combat.
- To provide automated logistics management in garrison and combat.

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### References

1. FMFM 10-1, Communications; Department of the Navy, Headquarters Marine Corps; Washington, DC 20380; June 1976
2. Huebner, Ray E; The Marine Corps Tactical Telephone System; SIGNAL; May/June 1978; pp 88-94
5. Gallagher, Edward F; The Military goes Digital; IEEE Spectrum; February 1977; pp 42-46
6. Huebner, Ray E. and Wright, Brian T; Bridging the Gap - Analog to Digital (PRD-STD 1003) link protocol and a simple message format to provide near real-time data communications to all of the MTACCS.
7. The switch, nomenclatured the AV/GYC-7, is under development by ITT Defence Communications Division at Nutley, NJ. An AV/GYC-7 will consist of three 90 round boxes that will be capable of withstanding the military environment. The AV/GYC-7 is being designed to handle 30 data messages per second with a 100 millisecond cross office time.
8. I believe we have found the way to minimize the increased communications required by the automated command and control systems, while providing them with effective communications. And I believe that the new automated command and control systems will significantly enhance the capabilities of the U.S. military forces.