Military communications — review and survey

J.L. Santoro | J.B. Howe

The trend is toward all-digital satellite links that provide better security, increased survivability, higher reliability, and more capacity.

Military communications networks range in type from standard voice-grade telephone systems to complex data links controlling missiles or remotely piloted vehicles via satellite. Collectively, these networks join our military command and control systems through a kind of global nervous system, delivering intelligence and surveillance information to the National Command Authority and control information to the forces.

Paradoxically, such communications are likely to be disrupted when most needed, since the elements of the system are widely dispersed, often on a global basis, and are thus difficult to defend. The continuing challenge is, therefore, to increase the survivability of the communications links to keep pace with developments in weapons and deployment of forces.

From the viewpoint of today's communication system designer, probably the most important tasks, beyond the continuing effort to improve reliability and data rates, are:

- increase hardening to avoid outages in a nuclear war.
- improve security to evade interdiction and spoofing.*
- add anti-jam capability to overcome electronic countermeasures.
- convert to all-digital transmission, which offers several inherent advantages—improved quality, increased security, and standard methods for handling voice and data.

*In this context, *interdiction* means that an enemy could intercept and understand information in our communication system; *spoofing* means that an enemy could insert false information into our system and deceive us into thinking the information is valid.

This paper surveys the significant present and future military communications networks that have been, and are being, developed in response to these pressures.

In general, any military communications system can be identified as either a common-user network or a dedicated network. Ideally, they should all be standardized, common-user types, but special strategic or tactical field requirements give rise to networks dedicated to a special function. (See Fig. 1.)

Fig. 1
Basic military communications structure. The structure shown was chosen partly for this paper and partly because the networks have really emerged this way in response to global strategic and widespread tactical problems.

Military Communications

- Common User Networks
  - Defense Comm System (DCS)
    - High freq (HF) and tropo
    - Defense Satellite Comm System (DCAS)
    - Autodin
    - Autovon
    - Autosevocom
  - Tri Service Tactical (TriTac)
    - Theatre of operations switched network
    - Nodes within the network
    - Transmission links connecting the nodes
    - Mobile access to the Network
    - Transition configurations
- Dedicated Networks
  - Tactical Systems
    - Army combat radios
    - Tactical satellites
    - Shipborne communications
    - Joint Tactical Information Distribution System (JTIDS)
  - Strategic Systems
    - Seafarer
    - Satellites
    - HF
    - Satin V
    - VLF/LF
    - Tacamo

Common-User Defense Communications System (DCS)

DCS is the "in-place" worldwide system that serves as the foundation for emergency communications while concurrently satisfying normal peacetime needs.

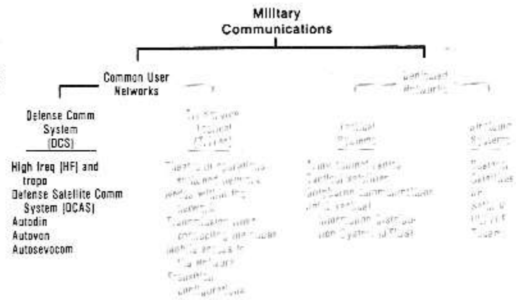
The Defense Communications System (DCS) carries common-user traffic and extends command and control capability throughout the U.S., Europe, and the Pacific; the typical elements of the DCS network are shown in Fig. 2. The DCS uses practically every variety of transmission media, from cable to communication satellites. While 62% of these facilities are leased from commercial common carriers (e.g., AT&T, RCA, Western Union), the government-owned portion represents an investment of about $3 billion. The government owns and operates only a small part of the cable net used for DCS, but owns and operates a substantial number of radio links, especially overseas.

While the current network is based largely on the standard analog 4-kHz telephone channel, the move towards digital transmission is accelerating, for several reasons:

- Digital circuits are amenable to LSI technology, which generally results in lower-cost, more-reliable equipment.
- Digital transmissions can be secured by cryptographic techniques.
- Digital signals can be reconstituted at appropriate relay points providing better quality for long-haul transmissions.

Dependence on high frequency (hf) links is diminishing.

A number of hf links provide long-distance communications, carrying one voice channel or a modest number of teletype or low-speed data channels. Variations in the ionosphere cause relatively poor availability (95-99%) and unpredictable outages in even the best-engineered hf links with adequate frequency assignments. The fading characteristics of the medium, especially the selective fading resulting from multipath transmission, results in relatively high error rates on digital circuits. As a consequence, hf links are being phased out in favor of satellite systems wherever possible. In some cases, hf links will be retained as back-ups to other facilities to reduce vulnerability of the total transmission system.



Troposcatter and line-of-sight communications systems are also being replaced by satellite links.

The bulk of the non-satellite facilities in the government-owned portions of the DCS are multichannel radio-relay systems, either line-of-sight (LOS) operating in the 4- and 8-GHz frequency bands or tropospheric-scatter (tropo) links operating in the 1-, 2-, and 4-GHz frequency-bands. Most of the existing radio relays use frequency division mulitplex (FDM) to handle the standard analog channels. However, FDM is being replaced by digital transmission with new digital modems capable of data rates ranging from 24 kb/s, for what is termed narrowband, to multi Mb/s for wideband multichannel trunking.

While the military's reliance on line-of-sight and troposcatter channels is diminishing as DCS satellite capability increases, some of these facilities will be retained, as in the case of hf, for added survivability through redundancy. Also, line-of-sight microwave links will be used increasingly to connect users and the satellite earth stations. The military will probably also exploit the higher frequencies (above 10 GHz).

Defense Satellite Communications System (DSCS) use is increasing.

The DSCS continues to be a major customer for satellite channels from commercial carriers, and transmission over military-owned and operated facilities has been increasing dramatically. The first satellite for the Defense Satellite Communications System—Phase II (DSCS-II) was launched in 1971. Currently, two geostationary satellites, one over the Atlantic and the other over the Pacific, operating in the 7 to 8 GHz region, handle military traffic.

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Defense Communications Systems

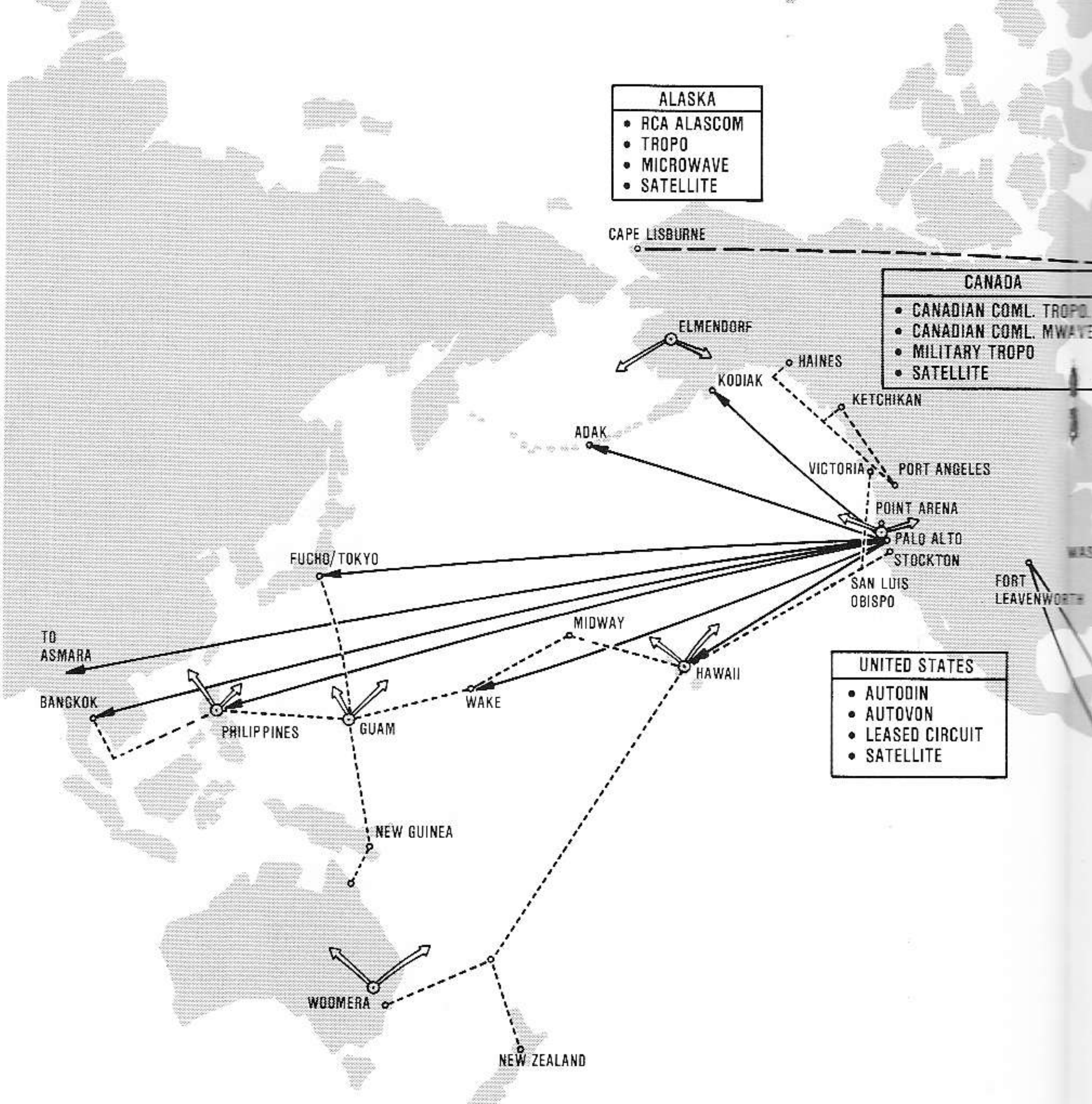
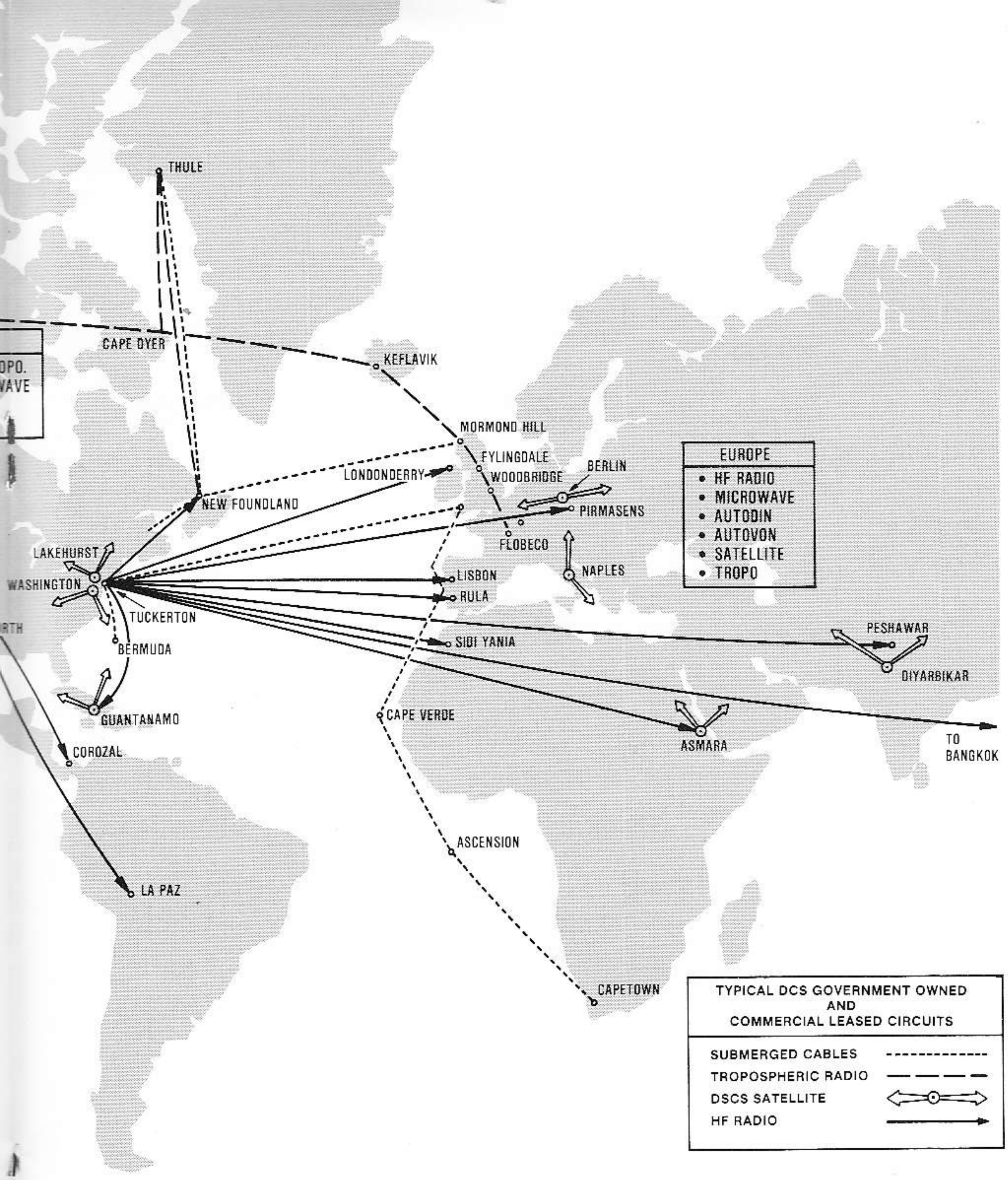


Fig. 2
Defense Communications System (DCS). This common-user system comprises about 42 million miles of various types of circuits (cable, satellite, microwave, etc.) that go to over 1000 locations in 70 different countries.

Earth stations of varying capability have been procured to provide service at 7 to 8 GHz. The larger terminals require carefully prepared large sites and are considered semipermanent installations. They are designed to handle large numbers of channels, are useful in safe areas, and need not be relocated often. To satisfy the needs of smaller, more vulnerable users, a family of truck-transportable terminals has been developed. These terminals are mounted in shelters for 1½ ton or 2½ ton truck transport. Each terminal is self contained and can provide full communications capability less than one hour after arrival at its site.* RCA has a contract for initial production of several terminal configurations for different channel capabilities. Other fixed, shipborne, and airborne stations are also being considered by the military.

*This program was described in Volume 22, No. 1 of the *RCA Engineer* by Tyree, et al, in "Small shf satellite ground terminal developments."



The government has recently started development of DSCS-III to further improve communications for command and control of our military forces. DSCS-III will carry six transponders, and its designers are considering the use of two independent multibeam downlink antennas, with patterns variable from 3.5° to full earth coverage. Existing ground terminals will be used. While DSCS-III is primarily for extension of current capabilities, the influence of digital traffic on military systems will likely cause a trend to time-division multiple-access (TDMA), and demand-assigned multiple access (DAMA) techniques to further increase system flexibility and capacity. Other changes, which include new special-purpose modems, can be expected to decrease the vulnerability of the satellites to jamming.

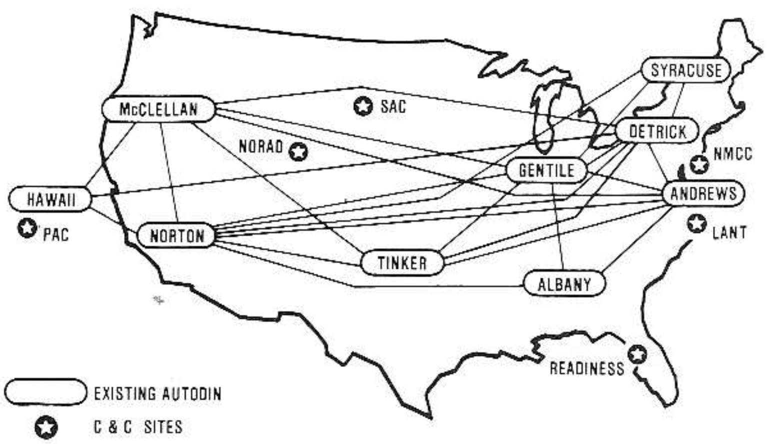


Fig. 3
AUTODIN is the DCS common-user data communication network for the continental U.S. and Hawaii.

Within the DCS, AUTODIN is the common-user data-communications system for the continental U.S. and overseas DOD subscribers.

AUTODIN is a message-switching store-and-forward service with nine switching centers in the U.S. and Hawaii and six centers overseas. (See Fig. 3.) In the U.S., Western Union is the system manager, and RCA supplied the switching equipment. A typical AUTODIN switching center includes controls, modems, and switches. The centers are connected, for the most part, by leased cable and microwave facilities.

The primary function of the AUTODIN I system is to deliver data messages from any terminal to any other terminal in the network. The system normally operates on a first-in, first-out basis but allows high-priority messages to take precedence.

The system handles about 600,000 messages (averaging 2000 characters/message) per day. Approximately 1400 terminals use the switches, with approximately 1150 in the Continental U.S./Hawaii areas, and the remainder in various international locations. Most traffic is narrative or record, which in general is message-structured, and does not require high-speed response.

Packet switching will be used on AUTODIN II.

AUTODIN II is a new development to accommodate the high speed response requirements of interactive subscribers, where terminal and computer response times may be much faster than AUTODIN I. This system will accommodate computer data-base transfers, as well as record traffic.

The approach is to send packets of data constituting either a small part of a message or the total transaction, as distinct from AUTODIN I where an entire message is collected before being routed through the network. Therefore, packet traffic of small transactions can be routed as soon as accepted by the originating packet switch as a burst transmission. AUTODIN I traffic will eventually be phased into AUTODIN II.

AUTOVON is the common-user telephone network that constitutes the backbone voice network for the DCS.

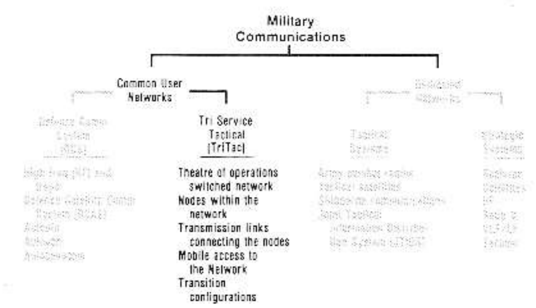
AUTOVON contains fifty-nine automatic switches in the U.S. and Canada, twelve automatic switches overseas, and has approximately 300,000 subscribers. It offers basically standard analog telephone service or priority service for command-control subscribers. In the U.S., the switching centers are connected by leased facilities with the inherent redundancy of the AT&T networks providing automatic alternate routing. The overseas DCS-owned environment results in a thinner connectivity.

In addition to the basic voice service, AUTOVON transmission facilities often act as backbone trunks for the DCS data circuits on a patched basis.

The AUTOSEVOCOM system provides secure voice channels for higher priority users located both in the U.S. and overseas.

The AUTOSEVOCOM (automatic secure voice communications) system presently consists of several automatic and manual switchboards to provide secure voice links for approximately 14,000 users. It can use existing trunking facilities to handle narrowband digitized voice (2.4 kb/s and 9.6 kb/s). It also provides high-quality wideband digitized voice (50 kb/s) over satellite and limited terrestrial trunking connecting local enclaves. The AUTOSEVOCOM system is predominantly a government-owned and -operated network.

Plans are now underway to upgrade the system in what is commonly called AUTOSEVOCOM, Phase II. This system will provide a more widespread capacity for digital secure voice channels with better quality for the 2.4 kb/s users and will standardize on 16 kb/s for the wideband users. The present concept is to use upgraded telephone company switches in the U.S. and the newly developed TTC-39 circuit switch for the overseas network. A new digital-access exchange switch is being developed to service local subscribers and act as the junction point to access the main trunking network.



Common-user Tri-service Tactical (Tri-Tac) communications

The Army, Air Force, and Navy have individual and collective responsibilities for defending national security. These "tactical" responsibilities cover a number of potential

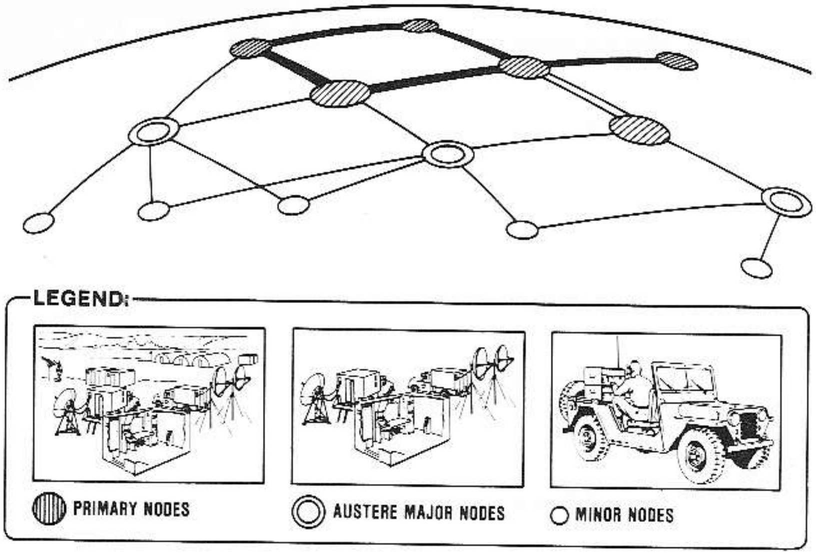


Fig. 4
Typical connectivity model for common-user tri-service tactical communications network. The composite network will service both area and command and control communications. Primary nodes serve the theater of operations headquarters. Austere major nodes and minor nodes are located closer to the battle area.

scenarios ranging from a "show of force" in the Middle East to large-scale combat as in Vietnam and Korea. For land operations, tactical Army and Air Force elements are generally assigned to a joint task force or theater-of-operations. For amphibious assaults, Marine Corps ground and air elements are assigned to an integrated marine amphibious force.

Looking to 1985 and beyond, "common-user" communications equipments for these types of tactical missions will be provided under the Tri-Tac program. The following paragraphs discuss the individual and collective roles of various tactical communications systems covered under the Tri-Tac program.

The theater-of-operations switched network has its primary node at headquarters.

The joint theater-of-operations network is organized as shown in Fig. 4. Major theater headquarters is serviced by the primary node, while tactical units closer to the battle area are serviced by the austere major nodes and minor nodes. The nodes can be located at the base or in the field, depending upon the tactical situation.

Each node in the network provides trunking connections and also serves as the network access point for both switched and dedicated user circuits. The concept illustrated in Fig. 4 projects a mature system in which radio communications also includes satellite terminals. The backbone of each major node is the 300- to 600-line AN/TTC-39 circuit and message switch presently under development. The austere major nodes will use a smaller switch, the AN/TTC-42, providing 75 to 100 lines. Tactical units (minor nodes) will use a 30- to 90-line switch, the SB-3865, for local and access switching.

Superimposed on this theater-of-operations switched network is the Tactical Communications Control Facility (TCCF), which is set up to handle system planning, system control, individual node control, equipment support, and satellite communications control.

Tri-Tac plans for post-1985 satellite communications are based on use of demand-assigned time-division multiple access (DA-TDMA) techniques.

Satellites are inherently limited in the number of simultaneous voice channels (or equivalent data channels) that can be transmitted. Current operation is limited by control and switching technology to dedicated channel assignments. Each network terminal is assigned a fixed number of channels based on the estimated traffic requirements limited by the total satellite capacity. Individual terminals may, therefore, instantaneously require more channels than they have been assigned while other terminals are using less than assigned.

Demand-assigned operation allows, through a control/assignment technique, the assignment of individual channels to each terminal as required. This arrangement requires a control terminal to have knowledge of the current status of all channels and to be able to assign an unused channel upon request to a network terminal. Such an operational approach allows the network to make maximum use of the satellite channels based upon the instantaneous channel requirements of the individual network terminals.

In the Tri-Tac plan, a primary master terminal will be designated to control system access while other terminals are designated as alternate masters. The active "master" terminal will generate frame-synchronization reference bursts; generate and distribute special network control and status information; and monitor and report subsystem performance. The DA-TDMA satellite communications system, however, will not depend entirely on the master terminal station; each terminal will have an internal processor that will perform all critical functions in real-time, independent of the monitor center.

The nodes will be connected by shf satellite communications; single and multihop LOS relay in the vhf, uhf, and shf bands; and single and multihop troposcatter at shf.

The terminals used in the demand-assigned (DA-TDMA) satellite system can generally be located within the nodal perimeters since they do not have the siting constraints of terrestrial-link terminals. Such terminals will be self contained; i.e., they will include all call-processing, preemption routing, and control functions required to set up demand-assigned channels between satellite terminals in cooperation with the associated Tri-Tac switching facilities.

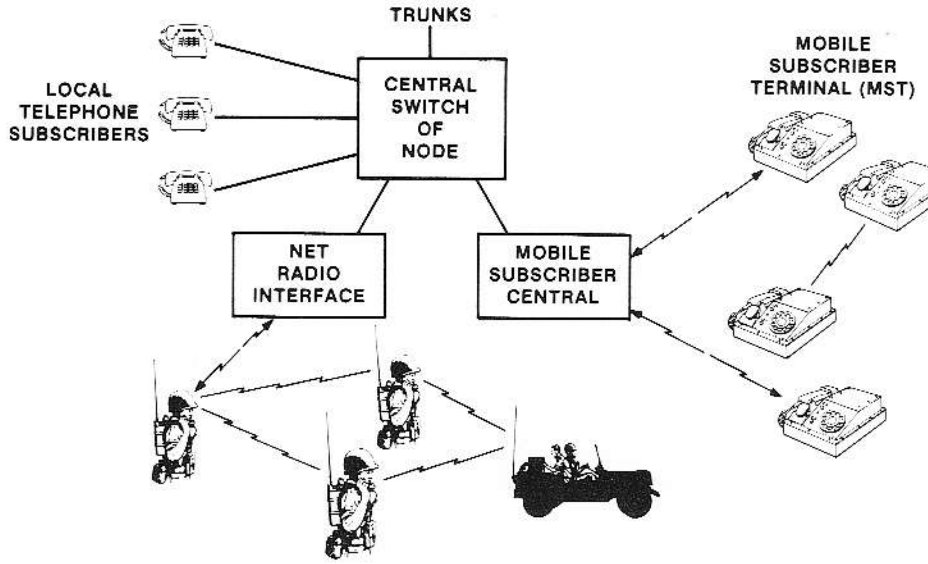


Fig. 5
Mobile subscriber access subsystem. A mobile subscriber can use the Mobile Subscriber Terminal (MST) to communicate directly with fixed or mobile units.

Thus, the satellite subsystem will appear to be transparent to the switching subsystem and, except for satellite-link propagation delays, will impose no unique constraints on other Tri-Tac system elements. In addition to the demand-assigned circuits, the satellite subsystem will be able to accommodate sole-user circuits of preassigned channels by establishing non-preemptable connections between terminal pairs.

The multichannel terrestrial radio terminals associated with a major node may be located 6 to 10 km from the node in an area designated the "radio park."

The Mobile Access Program will extend the tactical switched system to mobile telephone subscribers.

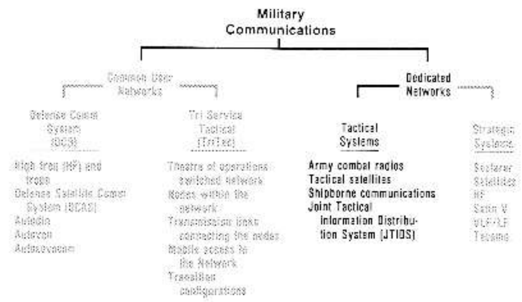
The Mobile Access Program integrates the functions of telephones, telephone switching, radio transmission, communications security, radio-wire integration, and control for mobile subscribers. This requires a family of mobile subscriber equipments arranged typically as shown in Fig. 5. A mobile subscriber equipped with a Mobile Subscriber Terminal (MST) can communicate directly with other fixed or mobile users on the network via the Mobile Subscriber Central. Radios of the SINCGARS variety (described later) will be capable of accessing the network via the Net Radio Interface.

As in DCS, the transition is to an all-digital system.

The preceding paragraphs have provided some insight into the architecture and equipments being developed for tactical communications systems under the Tri-Tac program. The transition from current tactical equipment inventories to the mature Tri-Tac posture will be evolutionary. While each service has its own plans for this transition, the following sequence will generally apply:

1) The initial systems deployed will consist of hybrid analog and digital switching equipments serving analog and digital subscriber terminals with wideband digital transmission links.

2) Later phases will approach (asymptotically) an all-digital system by phase-in of digital subscriber terminals and digital switching capacity and phase-out of analog terminals and switches.



Dedicated Tactical Systems

All military forces have the common problem of providing secure and reliable communications among mobile elements (ships, airplanes, ground vehicles, people) deployed in a given area of operations. The uhf band has been the most common for line-of-sight communications between aircraft and ground elements. For ground mobile elements, the Army has relied on vhf because of its better propagation characteristics in the types of terrain and antenna elevations unique to ground mobile communications. The Navy has relied on hf for non-line-of-sight fleet communications.

Generally, in the past, the military has survived without security or electronic counter-countermeasures in the

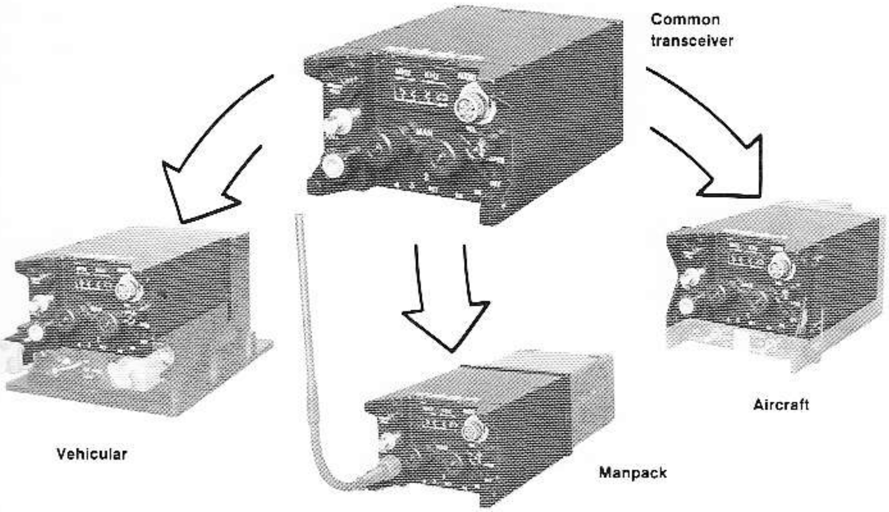
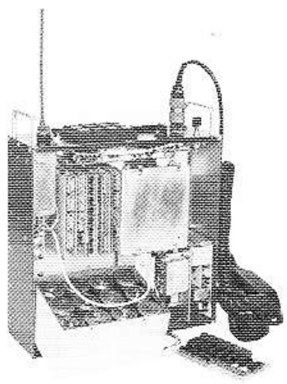


Fig. 6
This RCA-developed transceiver, the AN/URC-78, can be carried by foot-soldier or mounted in a jeep or aircraft.



RCA used the AN/URC-78 type modules to produce a manpack radio (above) that includes a capability for a frequency-hopping anti-jam mode.

tactical environment. However, recent experiences have demonstrated that more sophisticated measures are needed in the future. While these systems are classified as dedicated because of the specific environments in which they must operate, they are not totally divorced from problems of interoperability and must be built to interface with the Tri-Tac systems.

Some of the more advanced systems in operation today or under development to solve the problems inherent in the tactical arena are described in the following paragraphs.

Combat radios are becoming more important as combat becomes more mobile.

Warfare has become increasingly mobile; thus, command and control of the Army combat forces depends more and more on radio communications to replace the traditional wire-tie systems. Radios are carried by infantrymen, are mounted in military vehicles, and are carried aloft in the supporting Army aircraft. All these elements must communicate among themselves and with higher command authorities. For this mobile operation, the Armz primarily uses fm radios in the lower part of the vhf region (30 to 80 MHz). Some radios in the hf and uhf portions of the spectrum are also used for special applications.

In general, the combat radios are used to establish nets connecting each commander with his subordinate commands. The required range varies from one or two kilometers for the lower echelons up to forty kilometers or more for higher echelons.

More than ten years ago, the Army recognized the need to develop a new family of combat radios to

- improve spectrum use;
- enhance communications security;
- reduce vulnerability to enemy intercept, jamming, and deception;
- increase operating life; and
- ease logistic support.

To achieve these goals, the Army initiated a number of systems studies and advanced development programs. One of these programs produced the AN/URC-78, an RCA-developed transceiver about half the size and with longer life than the AN/PRC-77, the present standard radio. An important feature of this development is that the basic transceiver can be used as the central element in vehicular or airborne systems, as shown in Fig. 6. RCA subsequently used the AN/URC-78 type modules to develop and demonstrate a combat radio that included a frequency-hopping anti-jam mode.

The Army is now proceeding with the development of a Single Channel Ground Air Radio System (SINCGARS) at vhf, which is based on the results of these systems studies and advanced development programs.

Many of the communications requirements of the tactical users could be satisfied more effectively if they could take advantage of satellite communications.

The backbone multichannel transmission to and from field forces can be handled by shf satellites, analogously to the DCS. In fact, the small terminals described earlier are planned for use by the Army and Air Force. Other terminal equipments have been designed for large naval vessels. However, the size and cost of such terminals exclude many users at the present time who need such a capability. These users are typically small, mobile, and numerous, with a relatively small communications demand.

For such users, satellite communications must be at lower frequencies, where small, lower-cost equipment becomes practical. The military uhf band (225 to 400 MHz) was selected for this type of service. Initial experiments using the M.I.T. Lincoln Laboratory Experimental Satellites demonstrated the feasibility of uhf satellite communications for small mobile platforms, including aircraft, ships, and land vehicles. Later experiments under the joint-forces TacSatCom program, which incorporates both uhf and shf capabilities, also demonstrated this capability.

perspective

What is RCA's role?

RCA has been a major supplier of military communications equipment, systems, and studies virtually since RCA started manufacturing radio equipment in the early 1930s. Much of the work at Government Communications Systems is classified, and therefore cannot be mentioned here. However, the military communications systems listed below have all been developed by RCA, and provide some measure of our involvement.

HF Radios

AN/ARC-21
AN/ARC-65
AN/ARC-142
AN/ARC-161
AN/URC-88
AN/ARC-170
AN/ARC-185

Line-of-sight and troposcatter links

AN/GRC-50
AN/TRC-97
AN/TRC-97A

SHF satellite communications terminals

AN/TSC-85(V)2
AN/TSC-93
AN/TSC-94
AN/TSC-86( )

Strategic systems

Minuteman SCN
Sanguine
Integrated radio room (IR^2) for *Trident*

Switching systems

AUDODIN I
AUTOSEVOCOM
Integrated Circuit & Message Switch (ICMS)
Integrated Voice Communication System (IVCS)
Automatic Data Processing—Telecommunications (ADPT)

UHF radios

AN/ARC-34
AN/ARR-69
Time Division Data Link
AN/ARC-143
AN/ARC-143B (LOS & SatCom)

Army combat radios

AN/PRC-8, 9, 10
AN/PRC-25
AN/PRC-77
AN/URC-78

As a result of these experimental programs, the military has procured the FltSatCom satellite, which is scheduled for orbital operation in late 1977. This bird will carry repeaters for both the Navy Fleet Satellite Communications (FltSatCom) System and the Air Force Satellite Communications (AFSatCom) System. User terminal equipment for these systems has also been developed. The Navy is presently using uhf repeaters aboard the Maritime Satellite (MariSat) while waiting for FltSatCom to become operational.

The trends one may expect in this area in the future are similar to those for shf satellites:

- transition toward all-digital secure transmission;
- provision of antenna nulling and signal processing in the satellite to provide anti-jam capabilities; and
- demodulation and time-division multiple access and switching in the satellite to interconnect various uhf nets, uhf and shf users, broadcast transmissions, and conference calls.

With each new satellite system success, the demand for satellite channels will increase. The vulnerability of the satellite, however, both to jamming and to physical attack, will require that the other tactical communications modes be retained.

Shipborne communications are changing in response to tactical needs.

The Navy Tactical Data System (NTDS) was developed in response to the complex high-speed problems of directing a Naval task force in modern tactical combat. The system uses hf and uhf links to transfer important voice and data communications among ships in a task force via a polling scheme controlled by a master ship equipped with computers and displays.

The Common-User Digital Information Exchange Subsystem (CUDIXS) and the Submarine Satellite Information Exchange Subsystem (SSIXS) are link-control subsystems of the Navy's Fleet Satellite Communications (FltSatCom) program and are designed to speed the exchange of messages between ships at sea and shore-based stations. FltSatCom will afford more reliable communications over a much larger area than does the present hf system used by the Navy. The better quality (i.e., greater bandwidth, less "noisy") circuits provided can also permit signaling at a high transmission rate for the same or a lower error rate. A satellite channel can therefore permit one shore-based station to serve a large geographic area and, by time-sharing the use of the channel and signaling at a high rate, serve a much larger population of users.

New developments are underway to include anti-jam and low-probability-of-intercept capabilities.

The Joint Tactical Information Distribution System (JTIDS) is a secure information exchange.

Over the past 20 years, the military services have sought to develop a flexible jam-resistant secure digital information system to include location and identification information.

This effort culminated recently in the Joint Tactical Information Distribution System (JTIDS) program. The first phase of the program will be aimed simply at developing a system to distribute information in support of tactical missions. The second phase will include research and development to expand the information distribution capabilities and to add the location and identification functions to the system.

Basically, the JTIDS net serves as an information bus, where each user can select the specific information required for his part of the mission from the total. Thus, each user transmits important mission information to the bus, and receives only that portion of it required for his part of the mission. Some users may be largely information suppliers (e.g., forward air controllers, surveillance radars), others may be principally users (e.g., tactical aircraft, SAM sites), while still others (e.g., tactical air control centers) may both use and provide substantial information to the bus.

The basic element of JTIDS is a single secure time-division net, with time slots allocated among the users in accordance with their needs. The time-slot concept is illustrated in Fig. 7. The system is designed with all necessary control logic at the user terminal, allowing the net to be controlled from any station. Each time slot contains a synchronization burst, the transmitted information, and a guard period. The individual bursts employ spread-spectrum techniques and error-correction coding, to afford protection against jamming. JTIDS operates from 962 to 1215 MHz, a band currently occupied by the location and identification systems TACAN and IFF. However, the JTIDS signal design permits compatible operation with those other services. The range of the net can be extended beyond line-of-sight by aircraft relay, and the relay function can be assumed by any terminal.

The basic technology required to implement JTIDS exists, and rapid advances in solid state technology, in particular, make such a system feasible for many applications. However, there remains a significant challenge to drive the cost and size down to a sufficiently low level that more universal use becomes economically and operationally attractive.

Jack Santoro, as Manager of Systems Engineering, is responsible for military system development for Government Communications Systems.

Contact him at:
Systems Engineering
Government Communication Systems
Government Systems Division
Camden, N.J.
Ext. PC-3117

Joe Howe, as Chief Engineer for Government Communications Systems, directs RCA's design and development efforts on military communications equipment.

Contact him at:
Engineering
Government Communications Systems
Government Systems Division
Camden, N.J.
Ext. PC-2646

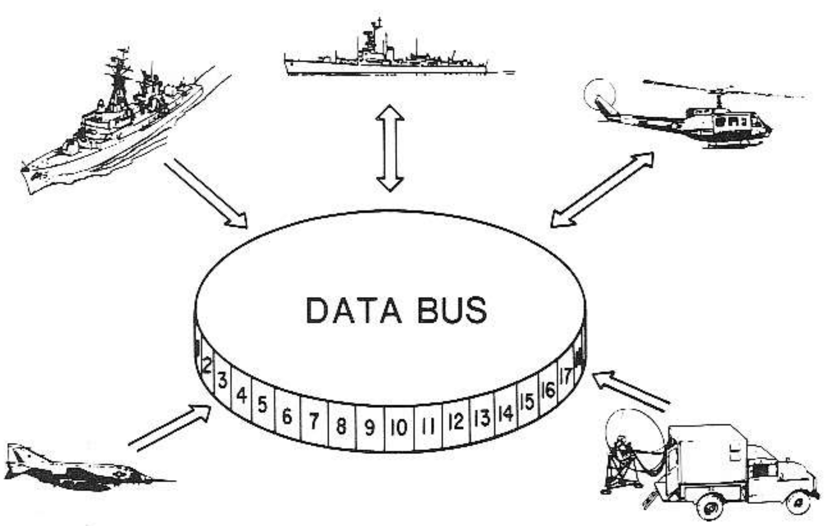


Fig. 7
JTIDS data bus concept. Timeslots are allocated to users based on need.

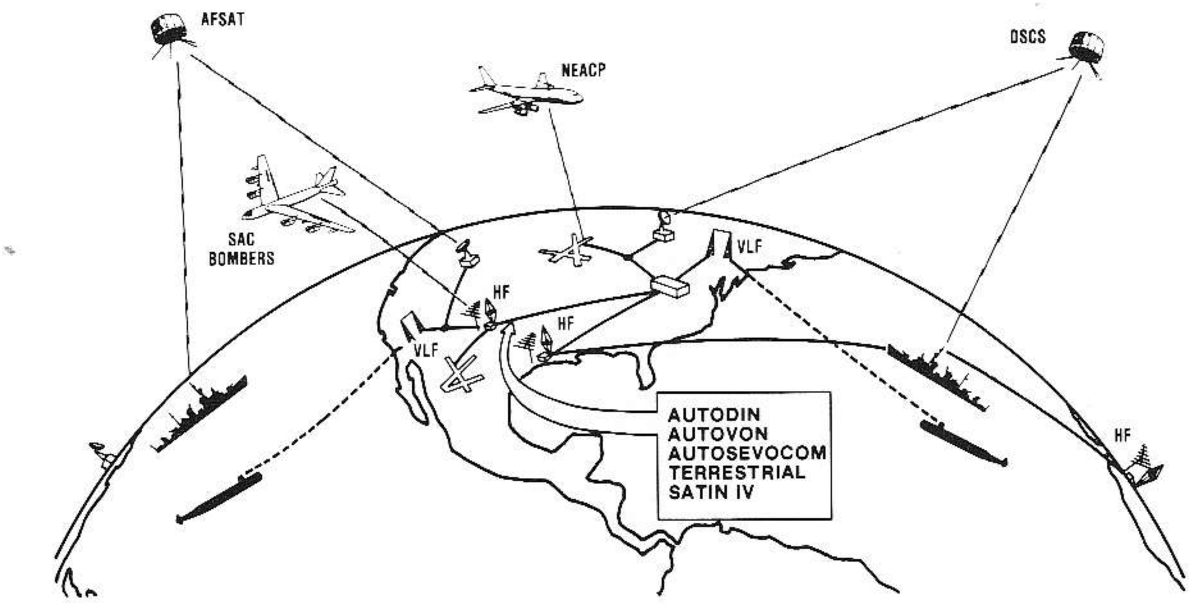
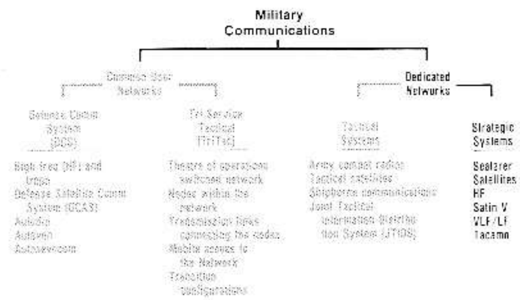


Fig. 9
Typical strategic communications network.



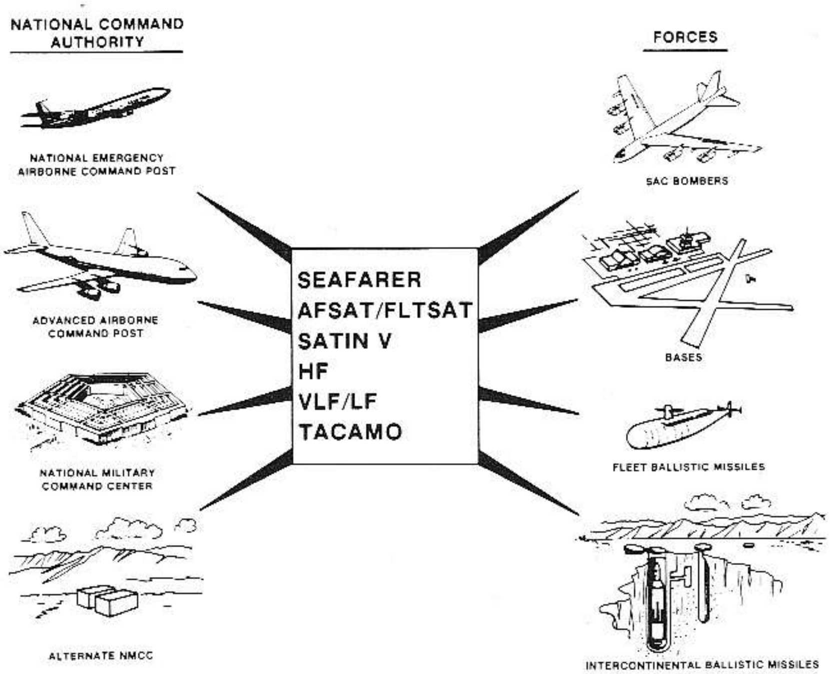


Fig. 8
These dedicated stratetic systems connect the National Command Authority with weapons systems and forces.

Dedicated strategic systems

Strategic networks assure communications between the National Command Authorities (NCA), the Joint Chiefs of Staff, and the commanders who need to execute integrated operational plans and other time sensitive operations. These systems allow the NCA to go directly to the forces as well as to the unified and specified commanders as shown in Fig. 8. A discussion of these dedicated stategic systems would be too lengthy for this paper, since they are so many and so varied. For completeness, however, several typical strategic systems are listed below:

- The National Emergency Airborne Command Post (NEACP) that can remain airborne over the U.S. for long periods of time, providing survivable communications with the other strategic networks.
- The Advanced Airborne Command Post (AABNCP) is an extension of NEACP using a 747 aircraft for expanded capability.

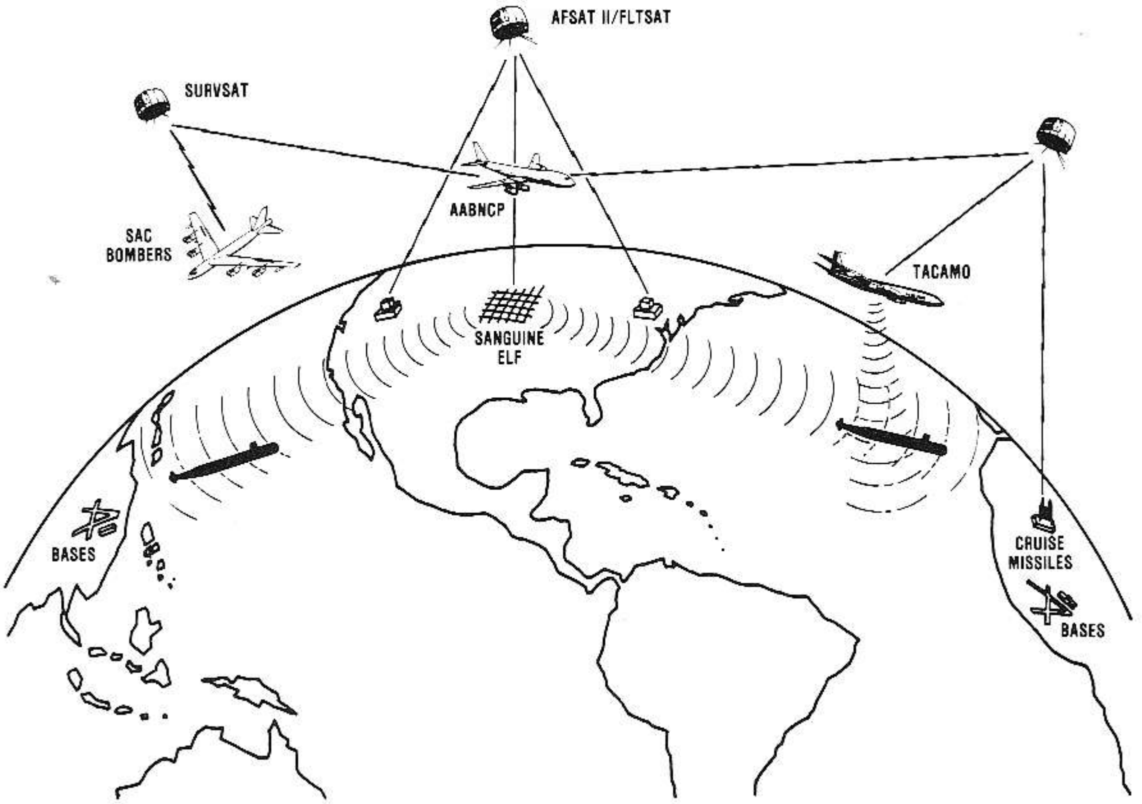


Fig. 10
For the future, the strategic communications network presents a changing picture, with primary emphasis on survivability.

- The Seafarer system (formerly Sanguine) that will provide (if implemented) survivable long range communications via extremely low frequency buried transmitters. The buried antennas will extend over large land areas.
- The Satin IV system for the Strategic Air Command (SAC) will be a totally automated data communications network linking SAC bases with each other and with missile sites.
- The very low frequency system, both ground based and airborne, will deliver messages to strategic elements on a global basis.
- Satellites and hf radio have obvious strategic applications.

The dedicated strategic systems will be interwoven into the AUTODIN, AUTOVON, and AUTOSEVOCOM types of common-user nets to use the redundant connectivity provided by them.

These dedicated systems are illustrated in Figs. 9 and 10 and are part of what is known as the World Wide Military Command and Control Systems (WWMCCS).

Concluding remarks

All-digital communications systems are the wave of the future. Three reasons are:

Cost: With the standard LSI packages proliferating, digital equipment becomes less expensive to buy and to maintain. Digital systems also have inherently more capacity per channel and thus are less expensive to operate.

Performance: Total link performance is independent of distance since digital signals can be regenerated as often as necessary; noise and distortion in an analog system are cumulative. Furthermore, digital systems can handle voice, facsimile, teletype, and computer data in a single transmission.

Security: This growing military need is more easily satisfied with a common digital standard.

For these reasons, the military communications users are replacing their analog systems with digital ones. The changeover is evolutionary. Thus, for a considerable period of time, older analog systems will coexist with digital ones. However, since operating in this transition is costly—more costly than all-digital or all-analog operation—we can expect the military to move to digital systems as fast as judiciously possible.

Survivability of our communications in the case of nuclear weapons effects or electronic countermeasures is becoming increasingly important. This is very costly to achieve, but new technology now available will allow more rapid growth in this area also. Again, it will be an evolutionary process.