MarCom® Integrated Voice Communication System Enables Tactical Organizations to Communicate Naturally

Tactical organizations such as naval combatant ships communicate in fundamentally different ways than commercial organizations. They require specialized tactical integrated voice communication systems rather than commodity commercial voice systems.

Tactical platforms require tactical and administrative communications

Law enforcement and military platform mission operations are tactical in nature. This involves the CO, XO, engineering officers, warfare officers, NCOs, and many enlisted personnel with a wide variety of job functions including sonar operators, radiomen, gunners, torpedo men, and ESM specialists. Ship operations are also tactical in nature. Navigation, propulsion, damage control, conning, piloting, refueling, air ops, UNREP, and well deck ops are critical to the safety of the ship and support the overall mission of the organization. Support personnel who serve in an administrative role much of the time have collateral duties during emergencies, training and combat.

Tactical communications differ in critical respects

**Time criticality** — In business, time largely means money. In a tactical organization, time means mission success or failure, life or death, and safety of the ship. Someone once asked Admiral Arleigh Burke, based upon his World War II combat experience, what was the difference between a good officer and a great one. His response was "about two minutes"; the reaction time in combat can mean the difference between winning and losing.

**Mission criticality** — Mistakes, errors, and failure to do what is expected can have tragic tactical results. Commercial organizations may also contain tactical groups within their organization. Operating a nuclear power reactor is tactical. Failure to close a valve or failure to disable a transmitter during EMCON has far larger repercussions than failure to respond to a typical E-mail. Tactical groups, whether military or civilian, typically utilize tactical, not commercial communication systems.

**Strictly organized with defined duties and chain-of-command hierarchy** — Each individual has a defined role in the organization, and specific duties during each watch. Each individual is trained on how to react and how to report. Each knows his relationship to the others and how that changes with various evolutions.

**Manned positions, not individuals** — In tactical organizations, many duties need to be done 24 hours a day, 7 days a week. Each day is split into watches. Functions are assigned to positions and different individuals are assigned the position and its duties for each watch period. The people interact with the current watchstander at each position, not fixed individuals.
Point-to-point calls dominate commercial telephone systems

In a business organization, the vast majority of telephone calls are point-to-point calls. One person dials another. Signaling protocols are involved; at the receiving end the phone rings (if not busy) to alert the called party that there is an incoming call that he might choose to answer. There is no assumption that the called party is waiting for the call and will definitely answer. Caller ID and Call Waiting features are explicitly designed to give the called party more information with which to decide whether to ignore an incoming call or put an existing call on hold in order to answer the latest call.

The telephone provides one call at a time. Two-line phones, Caller ID, Call Waiting, and Voice Mail exist because of this basic limitation. None of these features allow the user to listen on one call while talking on another. Instead, they provide information for prioritizing which single call is most important and for enabling the user to return missed calls, if desired.

Conference calls in an office environment

Two types of conferencing occur frequently in a business environment, but they represent a very small fraction of telephone usage.

Ad hoc conferences — are created on the spot. The conference is normally not pre-planned. Typically, only three phones are conferenced (the limit of most commercial PBXs), hence three-way calling. Finally, some systems allow the conference to grow beyond three callers (usually with the addition of a conference bridge) by progressively conferring in one more caller at a time. This type of small conference is normally used when two people on a call need to either consult with a third party or to transfer the conversation to a third party.

Conference call — in a business organization refers to a scheduled meeting by phone. Participants are notified ahead of time that a conference call will take place at a particular time. They are given a number to call for the conference and an access code. Often some participants are collocated around a speakerphone, while others dial in from remote locations. The business or office PBX does not support this kind of conference as a part of its basic hardware and software. Specialized hardware and software enables these conferences and conference calling is often sold as a service.

The conference call is useful but certainly does not exhibit the characteristics needed in a time and mission critical tactical environment. Often, it takes ten minutes or so for most of the participants to join the conference, as meetings rarely start on time. Some people call in before the moderator has joined so they listen to silence and wonder if they are still connected. The quality of the audio and the intelligibility depends upon background noise in the conference room, whether people speak into the speakerphone, and whether remote parties are also using speakerphones or cell phones or both. Often a single party can speak at a time; as the conference server will only allow one party to capture the conference and that voice will be broadcast to all the other parties. Thus, an undisciplined conference call contains a lot of back and forth, “I didn’t get that, please repeat.” Nevertheless, conference calls serve the important function of reducing business travel and saving time and money.
Intercom, netting, and multi-channel monitoring are vital for tactical organizations

Recall the attributes of the tactical organization: time critical, mission critical, strictly organized, defined duties, chain of command, and manned positions rather than individuals. These attributes drive the way tactical organizations communicate. Tactical communications require assured high-quality connectivity, minimal latency, no busy signals, and an expectation that the call will be answered. The standard commercial point-to-point call does not satisfy these criteria and the business conference call even less.

First and foremost, tactical users need to establish and maintain Situational Awareness (SA). The capability to monitor multiple voice communications channels is key to SA, which comes from knowing what is happening at any site or position with which that position is concerned. What is even more important is the ability for the individual to decide what he needs to monitor at any particular time. In this manner, when not much is happening, the individual listens to everything happening (establishes SA). When things start to heat up the individual drops off the circuits of least concern (maintains SA). When things cool off, additional circuits are again punched up to reestablish an awareness of everything else going on. By having SA, the performance of the individual or team is significantly improved; comparison tests have shown a 200-400% improvement. In addition, the watches remain stimulated and alert. Only an integrated system with multiple channel access offers this tactical advantage.

Tactical organizations make heavy use of intercom calls and nets. Each of these call types offers assured communications on both a technical and organization level. On a technical level, the intercom service or net should always be available independent of anything else going on within the telecommunication system or whatever else the user is doing. On an organization level, the positions communicating with each other are manned by personnel trained and disciplined to constantly support specific communication circuits while standing watch. A variety of intercom circuits and tactical nets exist with characteristics particularly well suited for particular organizational relationships and work environments. The fundamental characteristic of intercom circuits is that the calling party can at any time initiate an intercom call and immediately start talking. The other positions are manned and the intercom is monitored as a matter of discipline. There is no possibility of getting a busy signal or of the called party ignoring the call. The called party has the ability to respond but does so only when necessary.

The Meet-Me net is the basic form of tactical conferencing, more often referred to as netting. Various positions on a ship monitor a particular Meet-Me net throughout an evolution or watch period. Any coordination required among the group is done on that net. Any member can speak on the net at any time knowing the other members are monitoring the net. No signaling is needed. No busy signals are possible. Most ships have as many as twenty different Meet-Me nets defined for coordination of such diverse activities as Gunfire Support, Damage Control, and Sonar Reporting. Meet-me nets are also used routinely to diagnose or repair systems that are distributed around the ship or have components in remote positions. Meet-Me nets often are accessible from Sound Powered Telephones or Net Jackboxes.
Radio nets are an important feature of tactical systems

A radio net is a special form of Meet-Me-Net that includes an interface to an external communications circuit as a member. Users need to monitor radio nets while they are communicating on internal nets and telephone calls. They need to be able to talk on plain or encrypted radio circuits. The user must positively know the security state of the radio circuit and be able to request a change between cipher and plain. Multiple positions must be able to monitor the radio net simultaneously.

The Preset Conference facilitates planning

A Preset Conference has a pre-defined set of members. Anyone on that list may call the Preset Conference number at any time. The system will then call all the members of the Preset Conference. All those that join the conference are able to hear each other in a full-duplex conference.

Tactical nets and conferences have other special characteristics

**Access control** — A tactical communication system has a rich set of access permissions and restrictions for determining which positions have access to which services.

**Tactical control signals** — Push-to-talk, security, and crypto controls and indicators are real-time control signals important to tactical communications. These do not exist in a business PBX environment.

**24/7 Availability** — When the USS Princeton (CG59) hit a mine in the Persian Gulf in 1991, the CO reported the ship would have been lost had the AN/STC-2 IVCS [L-3’s earliest integrated voice system] not remained working to support casualty operations. Tactical voice systems must be robust in the face of power outages, equipment failure, maintenance routines, fires, floods, and battle damage.

**Full duplex allowing interruptions** — Although participants on tactical circuits should follow communications discipline, the circuits are full-duplex. Multiple individuals can speak simultaneously allowing an immediate interruption when urgent situations dictate.

**Low Latency** — The communication system must not introduce discernible latency.

Tactical positions rely on special integrated voice terminals

Telephones are used within tactical organizations, but primarily for positions that have administrative characteristics. A number of specialized terminals support tactical communications. These range from single circuit instruments like Sound Powered Telephones and Net Jackboxes to the Integrated Voice Terminal which supports multi-channel monitoring. Each of these terminals must be suitable for the environment in which they are used and work with the tactical system to support the functionality required. They need to be rugged, support the use of headsets and handsets, support secure communications in some cases, and in many cases support multiple simultaneous voice channels. While tactical terminals have the ability to make telephone calls, telephones certainly do not have the capability to act as tactical terminals.

A commercial PBX or VoIP Call Manager does not support tactical services

There have been a number of attempts to provide tactical services by marrying a custom integrated terminal to a commercial PBX or VoIP router and Call Manager. The results always compare poorly to a tactical system with tactical functionality designed into the architecture. This derives from the fundamental differences in communication methods illuminated in this brief.
MarCom IVCS supports tactical communications

Successful tactical communication systems start with a tactical architecture built around net calls. Commercial communication systems is optimized for point-to-point telephone calls and fails to address tactical needs.

L-3 based its MarCom IVCS architecture on tactical requirements

- Efficient support for both tactical and administrative users
- Scalability from very small systems to large deck amphibious ships and aircraft carriers
- Approval to Operate with both classified and unclassified unencrypted voice signals
- Support large numbers of large conferences or nets
- Support integrated tactical terminals
- Support a wide variety of voice terminals from many manufacturers and interface technologies
- Ability to be administered as a tactical system by users without extensive training
- Flexibility to interface to, and interoperate with, virtually any voice system
- Operational/environmental requirements reflecting mission critical applications and physical conditions.

MarCom IVCS architecture’s critical features reflect its tactical requirements base

As a result of the requirements listed above and a rigorous system design process, MarCom IVCS today bears little resemblance to a business communications system.

- Every voice output (headset, speaker, or external interface) has access to all voice sources in the system.
- Every voice output is served by summing circuitry to allow anywhere from one to all voice sources to be combined for that user into a composite signal (this could represent one phone call, one net, or as many calls as the user chooses to monitor simultaneously).
- An extensive set of software-controlled call processing and control mechanisms to ensure that each port’s summing circuitry reflects accurately the proper set of voice circuits to be summed based upon operator actions, permissions and restrictions, security rules, call progress tone management, and similar elements.
- Circuit design, physical packaging, cabling construction, and hardware/software techniques to manage multiple aspects of security including crosstalk control, muting, access restrictions, and security-related indicators and controls.
- A System Administration Terminal (SAT) software package that configures a system, directly identifying its tactical elements, services, and features.
- An approach to power distribution that maintains communications in the face of shipboard primary power outages.
- A system of physical packaging, backplane design, and fiber Internodal Trunking that enables multiple physical switches to act as a single system with any interface board type plugged into any slot in any of the four locations.
- A long-term commitment to the tactical communication marketplace with backward compatibility, sustainment programs, and constant technology evolution to protect the value of past investments by our customers.
MarCom IVCS is administered as an integrated tactical system

It may seem obvious that a tactical communication system should have configuration menus that include terms like integrated terminals, Sound Powered Nets, radio nets, Meet-Me Nets, Announcing System access, Classmarks and Class of Service, and Emergency Reporting Nets. These terms are found throughout the MarCom IVCS System Administration Terminal screens. However, in a limited tactical system built around commercial switches, tactical elements must appear to the commercial administration software as if they are commercial elements. An integrated terminal might be configured as multiple telephone ports on a commercial switch and multiple terminal ports on a different radio switch; a terminal failure would show up as a port failure on one of the switches. A limited tactical system has no tactical system administration terminal.

MarCom IVCS, as a Tier 3 tactical system (see SB002 for Tier definitions), provides these benefits in its approach to system administration:

**Transparency** — An integrated terminal is explicitly configured at the system level. This includes the switch ports to which it is connected, the assignment of control keys to intercom, interphone, announcing access, and other functions. It includes assignment of directory numbers to terminals.

**Conference and Net Setup** — These are again explicitly configured at the SAT. The configuration menus allow nets to be named, security assignments to be made, and permanent members to be assigned.

**Reporting and Logging** — Because MarCom IVCS is an integrated system, call logging, event logging, failure reporting, and similar functions can be accomplished for the whole system in tactical language.

**Ease of Training and Operation** — The skill level and training required of the system administrator is significantly lessened in an integrated system because of the tactical language used for configuration and reporting. With a commercial switch based system, it is up to the administrator to keep track of the tactical system and translate it into the terms used by the multiple commercial administration windows.
Active/Monitor operation of MarCom IVCS integrated terminals

The fact that every port of MarCom IVCS has access to all audio sources in the system simplifies the ability of an integrated terminal to monitor as many circuits as the user wants, while talking on a circuit of choice. While concentrating on the operational mission, the user of a MarCom integrated terminal monitors a number of circuits to develop awareness of the situation and in a very natural manner selects one circuit at a time for active communications as often as needed. The tactical hardware and software enabling this natural communications is an architectural feature transparent to the user.

Tactical nets, conference features, and custom interfaces

MarCom IVCS software is under the control of L-3, so it is easy to tailor new functionality each time an application needs something different from the standard features. The product line philosophy is that such tailoring is always accomplished as an addition to the set of features that becomes available to any present or future customer using the latest software. As a result, the set of tactical features available to all keeps growing. Solution Brief SB002 covers tactical services and features in more depth, but here are a few of the most important.

Internal nets and conferences — The primary distinction between nets and conferences is that nets generally have no signaling. Users monitor or join nets as a function of their job or watch standing duties. Conferences use telephone conventions but have multiple participants.

Meet-Me Nets support coordination of specific shipboard activities. Damage Control, and Replenishment nets are typical examples. MarCom IVCS allows Sound Powered Telephones, Net Jackboxes, dial telephones, integrated terminals, and Dual Digital Jackboxes to interoperate smoothly with nets ranging in size from just a few terminals to sixty or even more.

Preset Conferences and Command Nets are variations on a single theme. These conference types have a predetermined set of members. When any member of a particular conference initiates the conference, all members are automatically called and they answer if available. Note the distinctly telephone call characteristics. Terminals might be busy. Users answer if available.

Emergency Reporting Nets have features of both telephone calls and nets and demonstrate the advantage of having control of system hardware and software. Emergencies are reporting by calling the emergency number from any terminal on the ship. This begins like a telephone call. However, the destination terminal for the call is a pre-designated Responsible Dial Terminal which varies depending on the evolution of the ship. In the event of a second emergency call (to the same emergency number), the existing call becomes a Meet-Me net allowing the participants to handle both emergencies simultaneously.

Radio Nets — In many applications, MarCom IVCS interfaces directly to strings of external communications equipment with MarCom IVCS as the host of radio nets. This allows multiple integrated terminals and a voice recorder port to share the radio circuit. The MarCom IVCS radio net is a subset of a larger, dispersed net across potentially many platforms and shore facilities with RF links connecting the platforms and facilities. MarCom IVCS also supports connectivity with external radio switches using ISDN PRI trunking and SPAWAR defined protocols. In this case, integrated terminals make individual radio calls to a radio net hosted by the external radio switch. MarCom IVCS retains responsibility for managing Red/Black isolation and proper controls and indicators at the integrated terminal for any encryption in the external radio net.

Radio Progressive Conference (RPC) — This feature allows two or more RF radio nets to interoperate with MarCom IVCS serving as the gateway between or among the RF radio nets.

Standard and custom interfaces — High density cards in MarCom IVCS accommodate common standard interfaces (POTS, ISDN BRI and PRI, and VoIP). Highly flexible cards accommodate the not-so standard analog interfaces to radios, cryptos, voice recorders, speakers, Sound Powered Telephones, Net Jackboxes, and a variety of custom Military equipment.
MarCom IVCS has earned the trust of its users

On a ship with numerous legacy communication systems, a system will not be used unless it is reliable and well maintained and can be trusted in a crisis with life and mission at stake. It takes attention to detail to earn trust.

- Terminals are powered from sources that are backed up with Uninterruptible Power Supplies. This gives the crew time to address casualty situations.
- MarCom IVCS equipment not only has very low failure rates, but redundancy of critical elements assures that no single failure can take down a significant portion of the system.
- The Human Machine Interface of the integrated terminals is so intuitive that on-the-job training is sufficient and most users never attend a training session.
- The consistency of the HMI and the use of a single terminal allows the user to focus on the mission and communicate naturally, as needed to carry out mission duties.
- Earning Approval-to-Operate across multiple platforms and JTIC certification for Information Assurance and Interoperability contribute to the trust of MarCom IVCS

Long term commitment to maritime communications is valuable

As described in SB005, L-3 has been in this same market niche for upwards of 70 years. Technology changes. Employees change. Nevertheless, saltwater flows in the veins of the business culture and lessons learned are passed down. The operational knowledge of tactical communications that drives the design and maintenance of all L-3 integrated systems is difficult to equal anywhere else. The result benefits the users of our systems as they perform their missions at sea everyday.