Allied C4I Interoperability with the Joint Internet controller

Alfred Mitchell
Science Applications International Corporation
(Advanced Information Technology Group)
4015 Hancock Street
San Diego, CA 92110
Ph: (619) 552-5632
Fax: (619) 552-5672
Email: alfred.w.mitchell@cpmx.saic.com

Abstract

The ability to move tactical data, which includes everything from target/track information to electronic mail, is an ongoing struggle when faced with a multiplicity of national C4I systems. As part of an ongoing experiment in novel ways to provide data connectivity through Advanced Concept Technology Demonstrations, SAIC in conjunction with its principal partner Command System, Incorporated has fostered the development and integration of a system with the potential to bridge this C4I gap. This system is called the Joint Internet Controller. Its development, testing, deployment and operational use are discussed in this paper.

1. Introduction

A Coalition Task Force/Battle Group/Amphibious Ready Group Commander requires the ability to conduct rapid, reliable data communications with physically dispersed forces. These communications must be robust and dynamically reconfigurable, but requiring a minimum of operator intervention for link maintenance. For example, the Coalition Task Force Commander must be able to disseminate the Common Operational Picture to Allied forces who may or may not have compatible C4I computer support systems. He will also need to conduct rapid crisis action planning and coordination between elements of the coalition forces and staffs. This coordination requires the exchange of tactical and planning data between different nation's navies using existing C4I computer systems. The majority of this coordination is now conducted via voice radio/telephone and/or record message traffic/electronic mail. While this is adequate when staffs are inport, or perhaps embarked in ships carrying high-bandwidth satellite communications systems (i.e., CVN/LHD), communicating to Allied/Coalition forces at sea reverts to limited voice radio circuits in most cases. Allied acquisition of high cost satellite systems is not always feasible. Therefore a need exists to provide data capability between existing radio systems in a form that allows each national service use their organic communications systems.

2. Background

While connectivity ashore advances in speed and capacity at high rates, the connectivity between mobile users at sea and in the littoral region remains constrained to essentially already fielded radio systems with audio bandwidths capable of data transmissions in the low (2.4-9.6) kilobits per second speed range. Most foreign navies do not have the resources to field fully compatible

DII COE/JMCIS-like systems and the associated satellite communications equipment that support them. A low-cost, easily installed and operated C4I data exchange system would greatly enhance coalition operations. Since 1995, the Office of Naval Research has supported the development and evolution of a low-cost data networking system that appears to fill this requirement.

The genesis for the Joint Internet Controller (JINC) system arose from the need to provide mobile networking capability for mine detection and clearance assets in a fluid tactical environment such as a forced breach or clearance of enemy minefields. The need to provide an automated data network system for use in individual vehicles and/or individual soldiers was caused by the high volume and precise positioning data required in countermine operations. This requirement was developed as part of new mobile tactical networking technologies for the Joint Countermine Advanced Concept Technology Demonstration (JCM ACTD). The JCM ACTD began operations in the Joint Warrior Interoperability Demonstration 1995 (JWID95) at Camp Pendleton. The initial configuration consisted of seaborne and land mobile elements sending position and countermine data into JMCIS over a common data link. JMCIS OTH-Gold format messages were chosen as the common denominator. The JINC was developed from an existing system created and built by Command System, Incorporated of Fort Wayne, Indiana, to provide the bridge between non-JMCIS systems and the ship-based JMCIS network. Over the three years of development and testing of the JCM ACTD, the JINC system matured into its final Windows version.

The JINC is composed of three elements operating together. These are the host computer (any Windows 95/98/NT system), Command Data Network System (CDNS) software and a Micro-Internet Controller (Micro-INC). The Micro-INC is an OEM card that may be embedded into a computer to provide a two-channel interface to communications equipment. Both channels may connect to either analog or digital radios. Digital radios may use either asynchronous or synchronous data transfer. The Micro-INC monitors network traffic for both data and voice transmissions. If it detects a voice transmission, the Micro-INC will queue data until the voice transmission ends. This provides communications priority to voice while maintaining data integrity. Data rates are dependent on the available bandwidth of the radio system, but range from 2.4 Kbps for analog radios (i.e., HF systems) up to 64 Kbps for modern digital radios (such as the new Harris digital VHF radio). Maximum data rate supported by the Micro-INC is 115 Kbps. The Micro-INC also comes with an embedded GPS card for integrated position reporting (optional). A Micro-INC picture is shown in Figure 1.

Figure 1. The Micro-INC Data Controller

CDNS software is a mobile networking and command & control system that provides near real-time situation awareness, data exchange and file transfer functions. For JCM ACTD operations CDNS delivered Joint Countermine Application (JCA) data in OTH-Gold format to the various JCA operating nodes. It was also used for DII COE contacts, overlays and opnotes along with still imagery file transfer. The specially designed Message Text Format communications server will handle any formatted text message (i.e., OTH-G or standard AUTODIN format). CDNS software comes in Windows 95/98, Windows CE (in development) and Windows NT versions. This makes the software functional from any standard desktop, laptop or palmtop PC. A diagram of this data flow is shown in Figure 2.

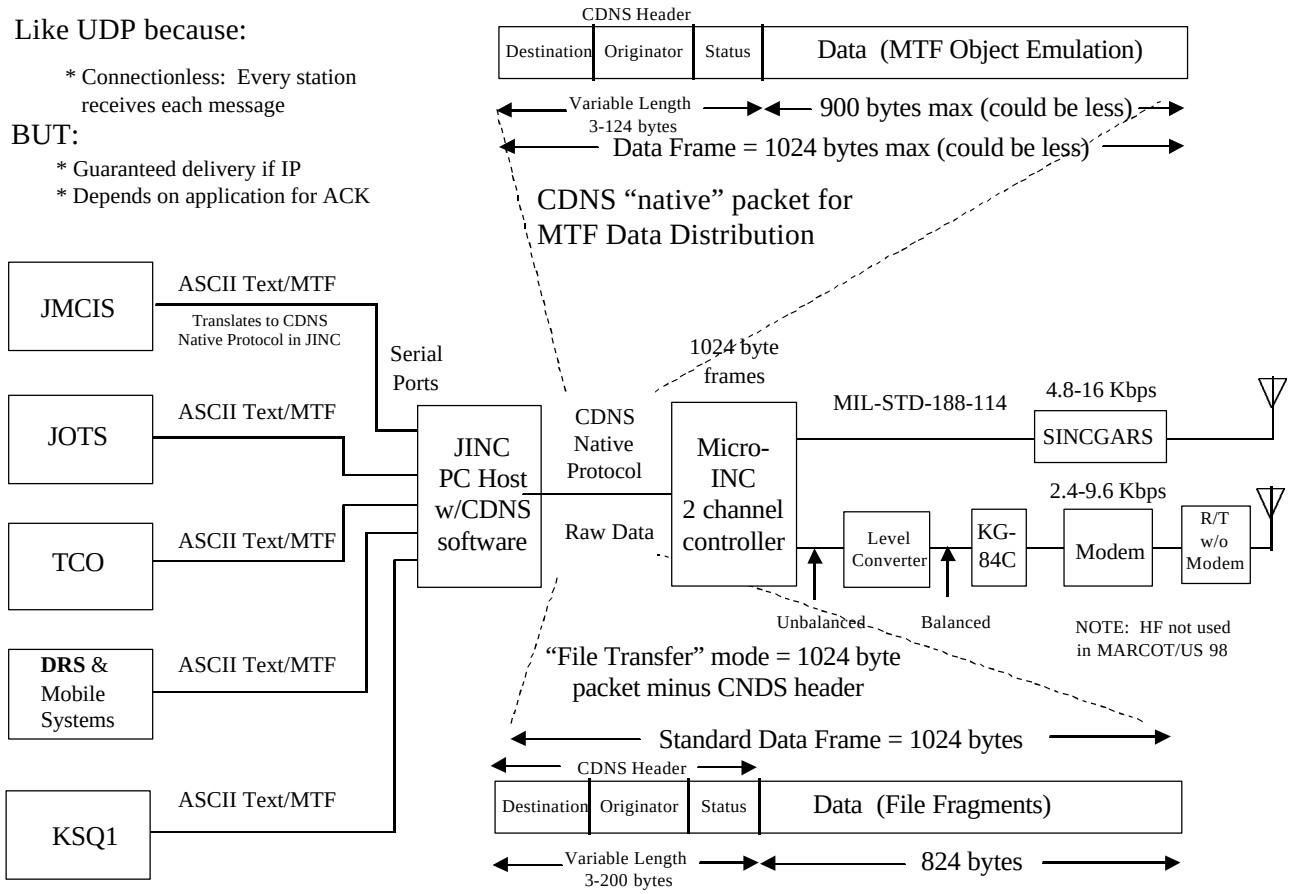

Figure 2. CDNS Data Flow Diagram

This diagram shows one of the principal advantages of the JINC system, namely the ability to link different C4I systems speaking their "native" language regardless of the host or operating system used. This is accomplished by the innovative use of C++ Object Oriented programming to create an object model of each data format. Once created this object may be manipulated (compressed, transmitted, decompressed and re-coded) to match the configuration of the data expectations of the destination host. What this means is that JMCIS data (i.e., OTH-Gold messages) may be sent to and from a JMCIS UNIX system and correctly parsed and displayed on a non-JMCIS platform (i.e., Windows 95/98), for instance a mini-notebook computer like the Toshiba Libretto series.

The second advantage of the JINC system lies in its ability to provide this data capability to any existing radio system. This is accomplished mostly in the firmware inherent in the Micro-INC data controller. This device actually contains three separate sets of circuitry that allow RF connections via:

- Analog radios, such as standard FM "walkie-talkie's" or cellular phones
- Digital radios, such as those that support MIL-STD-188-114
- Digital computer controlled RS-232 data streams, such as those that feed a number of cryptographic systems.

The choice of which system to select is left to the user. Since the Micro-INC contains two radio ports, it can control two separate radio systems at the same time and link the nets together.

Examples of this configuration during various exercises follow:

- SINCGARS to SINCGARS nets (different frequencies)
- SINCGARS to HF radio nets
- SINCGARS to SATCOM
- SINCGARS to wireless LAN
- UHF (WSC-3) to HF
- HF to HF (different frequencies)
- HF to phone modem
- LAN to LAN to HF
- LAN to LAN to SINCGARS

This versatility in the selection of connection options precludes the need for allied navies to acquire new radio systems to accommodate data links between ships and from ship to shore.

An additional capability added to the JINC system during the late stages of the JCM ACTD was the ability of CDNS software to not only transfer OTH-G messages between DII COE TAC-3/4 systems on ships but also to take those messages and parse them for internal display. CDNS software will take any OTH-G message received and display the track data on a geographical situational awareness plot using MIL-STD 2525 symbology. This means that the allied navy would be able to receive the tactical data and display it correctly as tracks on any Windows-based computer system. Coupled with the automated message handling capability are various pre-formatted messages (in most cases from the mine warfare area) that speed tactical data dissemination. CDNS is easily reprogrammable to accommodate any number of these types of messages.

CDNS software uses AX.25 packet exchange in a peer-to-peer networking scheme that eliminates the need for complex TCP/IP domain name server and network management protocols. When TCP/IP connections are required, CDNS initiates a proxy connection on the LAN side while transferring all data over the RF link to the destination. Acknowledgements are handled within CDNS and relayed to the originating TCP/IP host using a Windows WINSOCK socket interface. This was most recently tested successfully in Exercise Kernel Blitz 99 at Camp Pendleton, California. This greatly reduces network overhead and provides near 90 percent application data throughput over the RF link. Through the use of easily programmable forwarding rules, a true multicast capability exists for multiple addressee automated message distribution requiring only one transmission from the originating station.

3. Technical Approach and Operational Concept

Installation of the JINC system is straightforward. The JCM ACTD shipboard installation consisted of one Windows 95 laptop computer; however any IT-21 Windows NT computer is acceptable. A serial (RS-232) line was connected to an open port on the nearest DII/COE or JMCIS terminal to provide an independent data path (not affected by shipboard LAN configurations and not dependent on LAN access) for OTH-G message distribution. The Micro-INC data controller was mounted either in Radio Central or the Radio Transmitter Room depending on the location of crypto equipment. Data rates depended on the RF system used with

LOS systems such as SINCGARS operating at up to 16 Kbps and HF radio systems normally operating at 2.4 Kbps. The receiving (allied) station requires only a radio, compatible crypto and a Windows-based computer. All shipboard and mobile/desktop computer systems have some form of data output line, usually an RS-232 serial line connection, which can be directly interfaced to the Micro-INC and through it to the radio system. Using the JINC to control packet switching among other radio combinations, the data net can easily take the form of a wireless LAN/WAN for all stations within range.
An automated relay capability, inherent in the networking functionality, would allow linking at sea beyond line of sight ranges as along as any one ship was within at least LOS range of one other ship. Since each Micro-INC is capable of handling two radio interfaces, this allows the introduction of "internet" capability where units using two different frequencies appear as if they were on the same network. An "intranet" function allows automatic relay for units beyond line-of-sight when using LOS radios. This wireless data distribution can integrate coalition Battle Group, Amphibious Ready Group and Mine Countermeasure formations into a series of networked mobile data nets.

This mobile data networking combination has matured over the past three years as part of the Joint Countermine Advanced Concept Technology Demonstration. Under ONR guidance the JCM ACTD successfully participated in Exercise Kernel Blitz 95, Joint Warrior Interoperability Demonstrations (JWID) 95 and 97, CJTFEX 97-3 and MARCOT/Unified Spirit 98. The JINC has already proved capable of data exchange between small units (MCM-1 class vessels, EOD teams, LCAC's, mobile HMMWV's, individual Combat Engineers) and command centers, afloat and ashore (USS Nassau, USS Nashville, USS Gunston Hall, Littoral Warfare Training Center at Camp LeJeune), using JMCIS OTH-G formatted messages. The MARCOT/Unified Spirit 98 exercise was a NATO exercise conducted in Canada.

Following the conclusion of JCM ACTD demonstrations in June 1998, the JINC was again selected as the data link system for the Joint Medical Operations – Telemedicine ACTD to provide the capability to pass patient medical and in-transit visibility messages from the "far forward" Echelon I corpsmen all the way back to fleet hospitals. The first demonstration of this capability was presented in Exercise Kernel Blitz 99 in April 99 at Camp Pendleton. During this exercise the latest upgrade to JINC connectivity saw the incorporation of the "socket" interface allowing a JINC system (in radio spaces) to relay data received over HF and SINCGARS nets directly to the ship's medical spaces via the installed ship's LAN.

Independent of these exercises, Command System, Incorporated began State Department approved international sales of this software/firmware combination. JINC capability has now been sold to Canada, Australia, and Singapore with more nations expressing interest, particularly in South America. This burgeoning interest in a versatile networking tool offers the possibility of linking disparate data systems in a common net using a common medium of data exchange. Therefore, in a typical Coalition naval operation, a JINC supported network might look like the diagram in Figure 3.

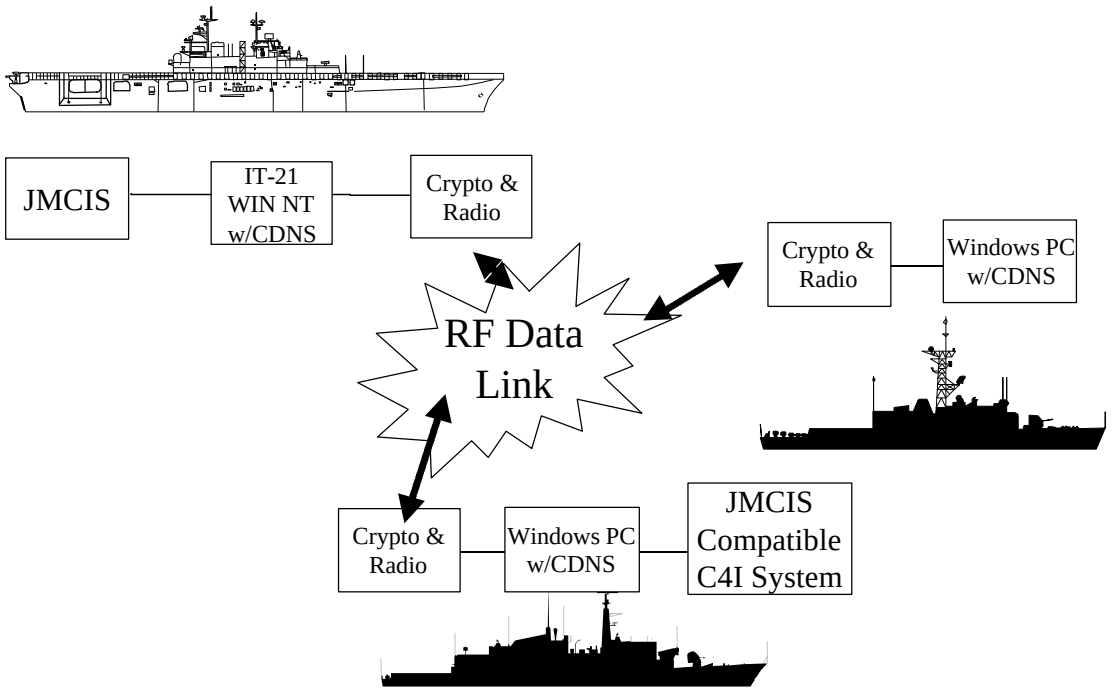

Figure 3. Possible Data Link Configuration in a Coalition Environment

4. Conclusion

The requirement for a low-cost mature tested C4I data distribution and display capability appears to be met by the JINC system. There are many advantages for proposing an implementation of this coalition capability on the JINC. These include:

a. Low acquisition cost, generally around $5K for a complete system
b. Coalition connectivity via existing computer systems
c. Security (JINC is tested with most common crypto devices)
d. Jam resistance (Frequency hopping waveform when supported by the radio system. JINC has operated with SINCGARS in a frequency-hopping mode.)
e. Economy of RF spectrum (Avoids use of already crowded satellite systems)
f. Ease of installation (Use existing computers)
g. The ability of the JINC to inter-network over numerous RF media.
h. Exportability (State Department export licenses are already in place for most Allied nations.)