A NEW APPROACH FOR IMPROVED TRAINING DEVICE MANAGEMENT, DEVELOPMENT, AND LIFE CYCLE SUPPORT USING DEFENSE DATA NETWORK

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ABSTRACT

A new and innovative approach for improved training device management, development, and life cycle support has become feasible with the advent of the Defense Data Network (DDN). This approach utilizes the DDN and training device computer hardware/software to provide rapid information retrieval among Government and contractor facilities at different geographic locations. Implementation of this concept provides improved management/ technical information availability for training device development and support. Improved visibility of technical progress will result in increased productivity of both Government and contractor personnel. Reduced trainer development risks, maintainment of contract schedule, and resultant cost reductions are expected.

INTRODUCTION

A new and innovative approach for improved training device management, development, and life cycle support has become feasible with the advent of the Defense Data Network (DDN). This approach utilizes the DDN and training device computer hardware/software to provide rapid information exchange among Government and contractor facilities at different geographic locations. This paper presents the Defense Data Newtork, the pilot program initial implementation of DDN at the Naval Training Equipment Center (NAVTRAEQUIPCEN) - the Remote Software Validation Program (RSVP), and NAVTRAEQUIPCEN's anticipated plans for future utilization of DDN.

The pilot program RSVP description includes a discussion of the need, background, concept, implementation, and capabilities. The presentation of NAVTRAEQUIPCEN's anticipated future utilization of DDN includes both internal and external information exchange requirements.

The advent of DDN and its implementation at NAVTRAEQUIPCEN is both a challenge and an opportunity. This paper is intended to share NAVTRAEQUIPCEN's current concepts for utilizing DDN with other Government agencies and with industry in order to optimize productive DDN utilization.

PART I DEFENSE DATA NETWORK (DDN)*

The Defense Data Network (DDN) is a data transmission network established for Department of Defense (DoD) use and is now available for all DoD long distance data transmission throughout the continental United States (CONUS) and in limited overseas locations. The DDN is a packet switching system which provides adaptive routing of messages along with error detection and correction. Research with two data transmission networks, Advanced Research Project Agency Network (ARPANET) and Automatic Digital Network (AUTODIN) II began as early as 1969. In April 1982, the DDN concept was established and patterned after the ARPANET technology. Guidance from the Office of the Secretary of Defense now states:

> "All DoD ADP systems and data networks requiring data communications services will be provided long-haul and area communications, interconnectivity, and the capability for interoperability by the DDN. Existing systems, systems being expanded and upgraded, and new ADP systems or data networks will become DDN subscribers. All such systems must be registered in the DDN User Requirements Data Base (URDB)."

The Defense Data Network is managed by a program office staffed by the Defense Communications Agency (DCA). The military departments Operations and Maintenance (O&M) communications commands serve as representatives of the military DDN subscribers and as agents for operation and maintenance of the DDN equipment colocated with subscribers.

An Overview of the DDN

The DDN is a single, integrated packet-switching network designed to meet the data communications requirements of the DoD. The elements of the network are grouped into two functional areas: (1) the network backbone, which comprises the trunk circuits and packet switches, and (2) the access network, which comprises circuits and interface equipment that enable subscriber computers to connect to the backbone (reference figure 1).

*Information courtesy of Defense Communications Agency.

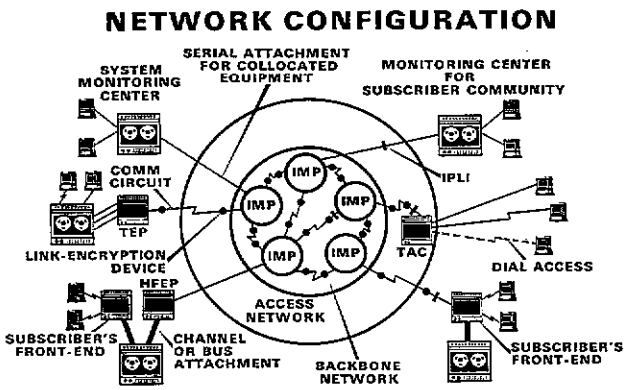

FIGURE 1. DDN Equipment

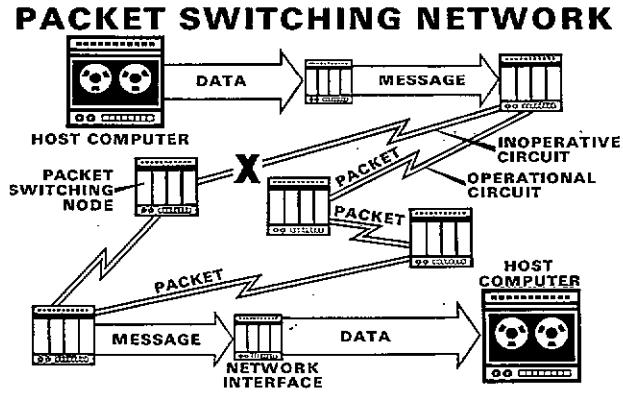

FIGURE 2. A Packet Switching Network

Futhermore, there are also two network-wide functions: (1) monitoring and controlling network performance, and (2) safeguarding the security and privacy of subscriber traffic.

The Backbone

The DDN Backbone is a highly survivable network of about 200 packet-switches located at about 100 sites. The packet-switches are dispersed widely throughout the United States, Europe, and the Pacific. Several packet-switches serve as permanent Monitoring Centers and several mobile reconstitution packet-switches are equipped to operate as Monitoring Centers. The backbone network is a dense trunking grid with many alternate routes, and critical users can be dual-homed to ensure their access to the network.

Each packet switch is a Bolt, Beranek and Newman (BBN) C/30, a microprogrammed minicomputer. The C/30 is a current generation computer designed for unattended operation, easy maintenance, and compatibility with existing ARPANET Interface Message Processor (IMP) packet-switching software.

Most of the backbone transmission links are terrestrial, leased circuits. They are either digital circuits operating at 56,000 bits per second (bps) or analog circuits operating at 48,000 bps overseas and 50,000 bps in the CONUS. Transoceanic links are via satellite.

Packet-switching is a method for handling data as it is transmitted through a communications network (reference figure 2). In a packet-switching network, network components to which subscriber computers and terminals are attached subdivide messages into small packets and then route and otherwise handle each packet as though it were a separate message. Each switching node in a network that handles a packet receives it, checks for and corrects errors, and then either forwards it to another node or collects all of the packets of a message and then forwards the entire message to the addressee.

Some packet switching networks adaptively route packets rather than routing packets along predetermined paths. With predetermined routing, data can not be automatically forwarded if any network component fails that is in the path over which the data must pass in order to reach the addressee. With adaptive routing, such as provided by the DDN, switching nodes route packets around portions of network that are congested or damaged.

DDN's packet-switching is particularly well-suited to military data communications. Unlike circuit and message switching, packet-switching is developed specifically for computer communications. It supports real-time communications, as required by computer systems. It provides high levels of circuit utilization, as required by cost-conscious system designers and managers. Furthermore, because packet-switching nodes typically operate without an attendant and are small, reliable, and inexpensive, they can be installed in large quantities and at many locations, thus providing substantial survivability.

The Access Network

Host (computer) systems are connected to DDN packet-switches through DDN-developed Host Front-End Processors (HFEPs), through DDN-developed Terminal Emulation Processors (TEPs), or directly. The transmission speeds of the host circuits are 2,400 to 56,000 bits per second (bps). Each host system can be directly connected to one or more packet-switches by one or more circuits.

Terminals may be connected to the network either through a Terminal Access Controller (TAC) or indirectly through a host, which is itself directly connected to the network. The TAC will support up to 64 terminals connected to it with either leased or dial-up lines operating at speeds ranging from 100 to 19,200 bps. Each of the TACs will be connected to a packet switch in the network backbone via a leased line operating at 4,800 to 56,000 bps.

Summary

The DDN is designed to satisfy the performance needs of computer system users who require data communication services. The network equipment is designed to minimize delay, detect and correct errors, ensure proper delivery of traffic, and maximize the availability of network services.

Other safeguards that are presently planned include:

- link encryption
- end-to-end encryption
- physical security at sites with packet-switches
- use of a cryptographic authentication protocol, and
- use of only TEMPEST approved equipment

PART II DDN AT NAVTRAEQUIPCEN

Naval Training Equipment Center's Pilot Program - RSVP

The Need

A need for the capabilities of this pilot program originated when a training device prime contractor elected to sub-divide the programming effort to take advantage of software expertise available at other locations. This meant that interdependent software would be developed at three different locations. This decision introduced additional development risk, since the software developed by one contractor would directly affect the others' software, necessitating a rigidly controlled current data base for all design. This concern was expressed by the Government and by the contractor. The delivery schedule for this training device impacts the delivery schedules for many other training devices, since its operation is prerequisite to their operation/delivery. An additional concern was the volume of software documentation to be evaluated by the Government during this development, and the need to do a quality effort with no disruption of the schedule.

Background - Simulation System Utilizing RSVP

The simulation system in which this pilot program, RSVP, has been implemented is the Environmental Generation and Control System (EGCS), and is to be located in the training complex, Tactical Advanced Combat Direction and Electronic Warfare (TACDEW). The EGCS is an environment simulator which provides a simulated natural, electronic, and tactical "world" in which the warfare control centers (CICs) can engage in complex wargames.

The natural environment consists of the entire spherical earth, ocean, coastal outlines, clouds, weather fronts, winds, icebergs, whales, kelp, . . .

The electronic environment includes electronic emitters, jamming devices, voice communications, data links, . . .

The tactical environment consists of 22 operational CIC ship mockups, 2,000 simulated tracks which may be designated as friendly, hostile, neutral, aircraft, missiles, surface ships, subsurface ships, sonobuoys, . . .

Complete CIC teams (up to 20 trainees) may be trained in each of 22 operational mockups simultaneously, either independently, or in combination. Appropriate weapon systems (missiles, guns, etc.) and sensor (radar, sonar, etc.) controls and indicators are fully activated by trainers under EGCS control.

From its inception, the EGCS was known to be an ambitious undertaking which was certain to provide both the developing contractor, and the Government with many predictable technical as well as managerial challenges. One of those challenges not initially predicted was that of contractors developing software at three geographically isolated locations. The software to be developed would be contained in the same computer system, but more importantly, it would be highly interactive. The system software development was known to be a formidable task (estimated in excess of 100,000 HOL instructions). The computer system architecture necessary to execute the software and provide the appropriate interfaces represents state-of-the-art in the hardware selected, its application, and in its connectivity.

The magnitude of the software effort, the geographic isolation of the software developers, and the state-of-the-art design of the computer architecture introduced development risk which provided an opportunity for NAVTRAEQUIPCEN to exercise management originality. NAVTRAEQUIPCEN, working closely with the development contractor and the Defense Communication Agency (DCA), evolved the Naval Training Equipment Center's pilot system, the Remote Software Validation Program (RSVP).

The Concept/Implementation/Capabilities

The new concept, making use of the training device hardware (simulation computer for storing data), software (tools to provide data search and access), and the Defense Data Network (DDN - means for transporting data to distant locations), offers an original concept designed to provide relief for the areas of concern. The pilot program, by interconnecting the three software development sites, effectively "moves" them all to one location. Since the DDN provides real time interactive response, computer terminals 3000 miles away perform as though they

were actually at the computer site, with no detectable operation delays. The implementation and proper use of this concept will give better visibility by improving currency and availability of management and technical information for training device development and support. This improved visibility of technical progress, predictably will result in increased productivity for both Government and contractor personnel, reduced trainer development risk (technical and schedule), and resultant cost reductions.

The RSVP consists of simulation computers located in San Diego, California and Amherst, New Hampshire; remote terminals located in Great Neck, New York and in Orlando, Florida, all of which are capable of high speed interactive data exchange by means of the DDN. The RSVP system with connections indicated is shown in figure 3. This system provides advantages to the contractor and to the Government which include: (1) assurance that the prime and two sub-contractors are using a current common design data base, (2) interactive software development, (3) sharing computer resources, (4) continuous availability of latest software for design and review, (5) spreading Government documentation review period, relieving peak manpower resource demands and improving review quality; (6) minimizing inefficiencies due to the East/West Coast three-hour time differences. In addition to the direct benefits for software development, spin-off benefits already provided by RSVP are electronic mail services and advanced technical reporting.

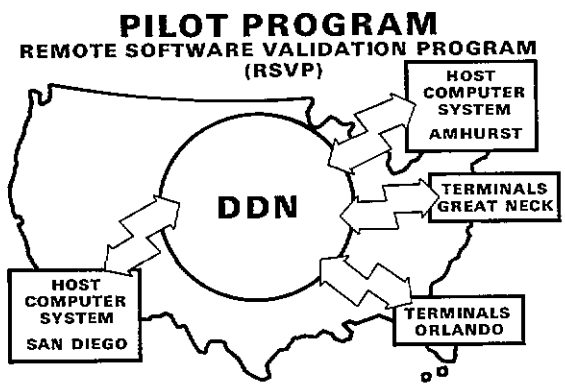

FIGURE 3. Remote Software Validation Program RSVP

Implementation Steps

The elements necessary to implement the RSVP were:

- simulation computer
- computer readable trainer software documentation and technical data
- remote data terminals (where simulation computers are not available) and,
- a long distance digital data transmission system - DDN (with necessary hardware and driver software).

The simulation computers were available early in the program, as were the remote terminals.

NAVTRAEQUIPCEN and the development contractor recognized the development risk, and early in the program the contractor began to develop data and documentation in computer readable form. The development contractor also recognized the benefits of incorporating special software "hooks and handles" to facilitate data search, selective retrieval, and to aid in subject matter traceability, both to the Government and to the contractor.

Review of available digital data transmission systems resulted in the selection of the newly evolving DDN. DCA (DDN administrator) personnel contributed their technical expertise in validating the Naval Training Equipment Center's design, expediting access approval, and by providing DDN interfacing technical requirements, to complete the RSVP system design.

The RSVP became one of the first multi-computer, multi-remote terminal access systems to be approved and operational on DDN in all the military services. The RSVP came as a result of the workable design of RSVP, the advantages it promised to provide, the combined efforts and cooperation of NAVTRAEQUIPCENs management, DCA, Chief Naval Education and Training, Naval Telecommunications, and the unyielding efforts of a dedicated NAVTRAEQUIPCEN project team.

The RSVP is viewed by NAVTRAEQUIPCENs management as the beginning of a possible trend in the way NAVTRAEQUIPCEN manages trainer system developments in the near future.

Future - Management of Training Systems & DDN

Approximately 100 new training devices are added to the Naval Training Center's inventory annually. The sophisticated training devices currently under development by Naval Training Equipment Center contractors are highly software intensive. The resulting documentation for this software and for other engineering data produced is voluminous. Typically, the Government review period ranges from 30-90 days, and in order to meet contract review schedules, peak manpower resources must be applied. These recurring peak manpower demands can be reduced drastically, or eliminated, by spreading the Government review cycle over virtually the same period that the contractor uses in trainer software development. The extended review period has become feasible with the advent of DDN, coupled with the early availability of development data in the simulator computer. (Since the DDN is a digital data

transmission system, only computer readable data can be made available for review via DDN). This extended and more effective review period will be possible with contractor developed data designed in computer readable form, and by providing the simulation computer with DDN access. It is implicit that NAVTRAEQUIPCEN will have the necessary equipment and DDN interconnection to receive this data.

NAVTRAEQUIPCEN operations are becoming more automated and heavily computer oriented. Plans are now underway at NAVTRAEQUIPCEN to implement comprehensive data communication systems within NAVTRAEQUIPCEN and, utilizing DDN, to all required external agencies/sources. While policy regarding the use of DDN for training system development has not been established, NAVTRAEQUIPCEN will have facilities to accommodate that capability.

NAVTRAEQUIPCEN - New Horizons

Internal Data Distribution

The DDN data communication capability will be provided within NAVTRAEQUIPCEN for Engineering, Research, Logistics Departments and Management, which represent the heavy density user traffic, and to others as required. Each department and subsets thereof, has unique communications requirements based on the particular external agencies with which they do business. NAVTRAEQUIPCEN's internal data distribution system for DDN accessed data has been designed. A major DDN multi-computer access capability is scheduled to be installed in the Orlando area, by DCA, to accommodate NAVTRAEQUIPCEN's requirements early in 1985.

Three major DDN access connections will be provided by DCA as indicated below:

- Central System - Engineering, Logistics, Management (and others as required) will be provided direct DDN access at individual workstations. The central system users will constitute the vast majority of individual users at NAVTRAEQUIPCEN. In order to assure rapid/uninterrupted access for the large number of users, a broad band local area network will be used for internal data distribution. Central system users will also be provided access to mass data/archival data stores and storage services as described below.

- Mass storage and archival data bank information, will be retained at NAVTRAEQUIPCEN. Information retrieval and designated data storage services will be provided for central system users for:

  (1) frequently accessed data available over DDN - to eliminate duplicative data traffic

  (2) NAVTRAEQUIPCEN internally generated/accessed data and,

  (3) archival data bank information

  These services will be provided initially with a 3 (expandable to 16) computer system, with appropriate mass storage.

- NAVTRAEQUIPCEN's Research Department has completed final plans for interfacing a two computer system with DDN via a dedicated high-speed circuit. Mass data/archival data stores and storage services will be available for the Research Department. Data will be distributed internally via a LAN and to distant locations by means of fiber optic links. Fiber optic links include a link to the engineering facility to provide a training capability for the new ADA language.

NAVTRAEQUIPCEN's DDN access now includes the ESVP (operational since late 1983) and will include connections at each of NAVTRAEQUIPCEN's regional offices.

NAVTRAEQUIPCEN's External Data Distribution/ Information Retrieval

DDN access will provide NAVTRAEQUIPCEN with a new dimension in availability and currency of data and information. Figure 4 indicates existing, planned, and anticipated DDN users with which NAVTRAEQUIPCEN will exchange data. In consideration of the relatively recent activation of DDN, and the DODs strong guidance for its use, it can be expected that most military agencies and installations will become subscribers.

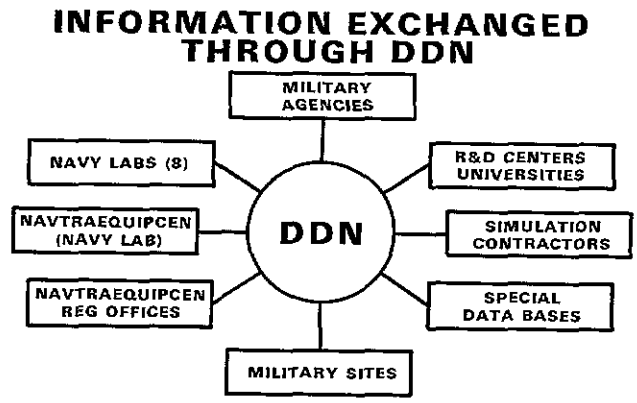

FIGURE 4. NAVTRAEQUIPCEN/DDN Subscribers

It appears that within DoD, DDN will do for computer data exchange, what the telephone has done for voice communications.

NAVTRAEQUIPCEN's experience with DDN has been limited to the pilot program, RSVP, and during that short period, many applications have already proven successful. A listing of some of the applications already in operation and many of the planned uses are shown for the various departments/functions at NAVTRAEQUIPCEN in Figure 5. The list of applications represents an initial effort at defining anticipated uses for DDN, and it is fully expected that actual use and evaluation will expand and modify NAVTRAEQUIPCEN's applications. Additional applications, methods for implementation of those indicated, as well as cautions to be observed, will be examined by industry and by NAVTRAEQUIPCEN as this new concept becomes a reality throughout NAVTRAEQUIPCEN.

NAVTRAEQUIPCEN/DDN APPLICATIONS
Examples for Consideration and Expansion

Engineering

Shared computer resources
Software development
Software evaluation
Software Documentation searches
(With appropriate software "hooks and handles" incorporated in design)
Interactive software development
Coding reviews/audits
Bulk data transfers
Information retrieval
Technical reporting
Assess contractor progress
Multi-site software development
Electronic mail

Research

Computer technology
Computer graphics
CGI research
Visual technology
Trainer technology research

Logistics

Remote software modification
Automatic Test Equipment - Central Library
System documentation - including archieval stores
Spares/Supplies - Navywide
Configuration management
Data base source library
Quick response regional office support

Management

Current Status Reports
Scheduling/Changes
Manloading
Project Management
Spread sheets

FIGURE 5. NAVTRAEQUIPCEN/DDN Applications

Conclusions

The advent of DDN and its implementation at NAVTRAEQUIPCEN provides a vast variety of opportunities and technical/managerial challenges. Effective planning and productive exchange of ideas between the participating parties will maximize proper implementation and minimize problems. The purpose for the RSVP was to alleviate the recognized potential problems of (1) increased development risk due to the development of common interactive software at divergent locations, (2) criticality of schedule due to the effect on other systems/schedules, and (3) difficulties in providing meaningful, timely Government review of a large volume of contractor developed software. Although conclusive end results are not visible due to the relatively short period of operation of the RSVP, most of the originally predicted capabilities have already been demonstrated, and include:

- shared computer resources
- on-line software development
- software evaluation
- software documentation searches
- interactive software development
- bulk data transfers
- assess contractor progress, and,
- multi-site software development

Each of these new capabilities contribute toward accomplishing the original goals of this program. The side effects of RSVP have been the evolution of electronic mail services and advance technical reporting, both of which contribute to project currency and visibility. New applications which further contribute to a more efficient operation for the contractors and NAVTRAEQUIPCEN can be expected to evolve as the system use continues. The RSVP effort will continue as a pilot program through trainer system delivery and benefits as well as problems/potential problems will be recorded.

As presented, NAVTRAEQUIPCEN expects extensive utilization of DDN in the future. Plans are now underway to provide comprehensive data communications systems utilizing DDN resources within NAVTRAEQUIPCEN and to all required external agencies/sources.

The intent of this paper is to introduce the training device industry to a new management concept which may be a trend in the way NAVTRAEQUIPCEN manages trainer development. Now, while NAVTRAEQUIPCEN's application of DDN technology is in its infancy, is the appropriate time for both NAVTRAEQUIPCEN and industry to cross-pollinate opportunistic ideas as well as realistic precautions. This paper introduces a new approach for improved training device management, development and life cycle support, using DDN.

The degree of success of this concept will be determined to a large extent, by the innovativeness and the cooperation exhibited between NAVTRAEQUIPCEN and the training device community.

ABOUT THE AUTHORS

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