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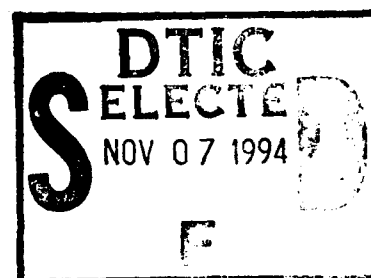


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THESIS



**DISTANCE LEARNING PLAN FOR THE
DEFENSE FINANCE AND ACCOUNTING
SERVICE (DFAS):
A STUDY FOR THE DBMU**

by

Brian D. Steckler
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September, 1994

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This thesis analyzes the requirements and design considerations of a video teletraining (VTT) delivery system for 25 Defense Finance and Accounting Service (DFAS) centers located throughout the continental United States. Current DFAS VTT capabilities are reviewed and included. The study's sponsor, the Defense Business Management University (DBMU), has been tasked by the DoD Comptroller to implement a training program for these centers. The DBMU has identified VTT as an extremely cost-effective option for training personnel at these 25 DFAS satellite activities. The study focuses on current VTT technologies -- both in industry and in the DoD. Basic VTT concepts are presented, evolving VTT standards are discussed, existing DoD VTT infrastructures are outlined, and problem areas such as system interoperability are explored. The study presents recommendations for an immediate DFAS VTT implementation plan using available DoD one-way/two-way satellite and/or two-way/two-way terrestrial distance education capabilities. This thesis also presents a recommendation for integration of a long term VTT network broadcast system including a single site program origination studio.					
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FOR THE DEFENSE FINANCE AND ACCOUNTING SERVICE (DFAS):
A STUDY FOR THE
DEFENSE BUSINESS MANAGEMENT
UNIVERSITY (DBMU)

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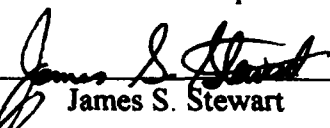
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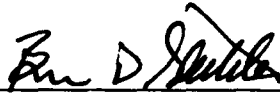
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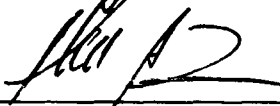
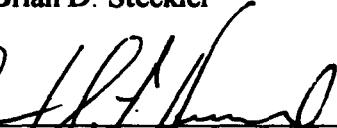
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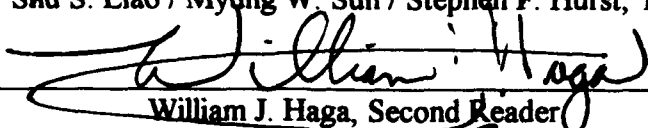
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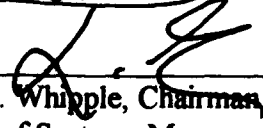

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ABSTRACT

This thesis analyzes the requirements and design considerations of a video teletraining (VTT) delivery system for 25 Defense Finance and Accounting Service (DFAS) centers located throughout the continental United States. The study's sponsor, the Defense Business Management University (DBMU), has been tasked by the DoD Comptroller to implement a training program for these centers. The DBMU has identified VTT as an extremely cost-effective option for training personnel at these 25 DFAS satellite activities.

The study focuses on current VTT technologies -- both in industry and in the DoD. Basic VTT concepts are presented, evolving VTT standards are discussed, existing DoD VTT infrastructures are outlined, and problem areas such as system interoperability are explored. The study presents recommendations for an immediate DFAS VTT implementation plan using available DoD one-way/two-way satellite distance education capabilities. This thesis also presents a recommendation for integration of a long term VTT network broadcast system including a single site program origination studio.

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I. INTRODUCTION

A. OBJECTIVE

This thesis analyzes the requirements and design considerations of a video teletraining (VTT) delivery system for 25 Defense Finance and Accounting Service (DFAS) centers located throughout the continental United States. The Defense Business Management University (DBMU) has been tasked by the Department of Defense (DoD) Comptroller to arrange the development, modification and delivery of high quality finance and accounting training, in the appropriate quantities, at the times and places required to ensure a well-trained work force to support the DFAS centers and satellite activities. DBMU feels that the one of the most cost-effective methods for providing the majority of this training is VTT. This thesis concentrates on issues related to the development and implementation of the VTT portion of an overall training strategy for DFAS center. It will not address mobile training team concepts.

This thesis is a vehicle for the authors to study basic and technical issues regarding all aspects of VTT as they apply to DoD including current technology, evolving VTT hardware and software capabilities, compression algorithm standards, as well as terrestrial and satellite broadcast technologies. We gain familiarity with existing and planned distance learning infrastructures both inside and outside the DoD.

B. BACKGROUND

1. DBMU

a. History

The DBMU was created on 12 December 1992¹ to improve the quality and provide for the efficient delivery of financial management education and training within the DoD financial community, which includes Office of the Secretary of Defense (OSD) fiscal components (comptrollership, analysis, budget, finance, accounting and acquisition). DBMU is a critical component of the DoD strategy to implement improved business management practices.

b. Mission

The mission of the DBMU is to provide for a coherent system of education and training across the DoD to assure the competency and professional development of the financial management work force. DBMU educates and trains personnel in the DoD financial management community for effective service in defense business and financial management to achieve a more efficient and effective use of resources. This is accomplished by coordinating DoD business and financial management education and training programs and tailoring them to support the careers of personnel in business management and financial management positions. DBMU also develops

¹ DBMU Dialog, "*Special First Edition*," Vol. 1, Number 1, October 1993, p. 2.

education training, research, and publication capabilities in the areas of business and financial management.

c. Organization

The DBMU operates under the authority, direction, and control of the DoD Comptroller and is located within the organization of the Defense Logistics Agency (DLA).² The DBMU manages a consortium of DoD educational institutions to provide a coordinated program of competency-based education and training for business and financial management personnel across the DoD. Consortium participants include DoD component education and training institutions, organizations and activities providing courses necessary to satisfy financial management education and training requirements specified by the DoD Comptroller.

d. Management

The DBMU is headed by a president who is the chief executive officer of the university. The DBMU support structure consists of administrators, faculty, staff, and other subordinate organizations as required to accomplish the university's mission. Directly under the DBMU president are Director of Academic Programs and Director of Curriculum Improvement. A Policy Council of senior DoD management officials, named by the DoD Comptroller, provides advice and counsel in overseeing the operations of the DBMU.³ Figure 1 shows

² Defense Management Report Decision (DMRD) 985, Subject: Financial Management Education and Training (FMET), dated 12 December 1992.

the relationship between the DoD Comptroller, DBMU, and the Standing Committee Chairs.

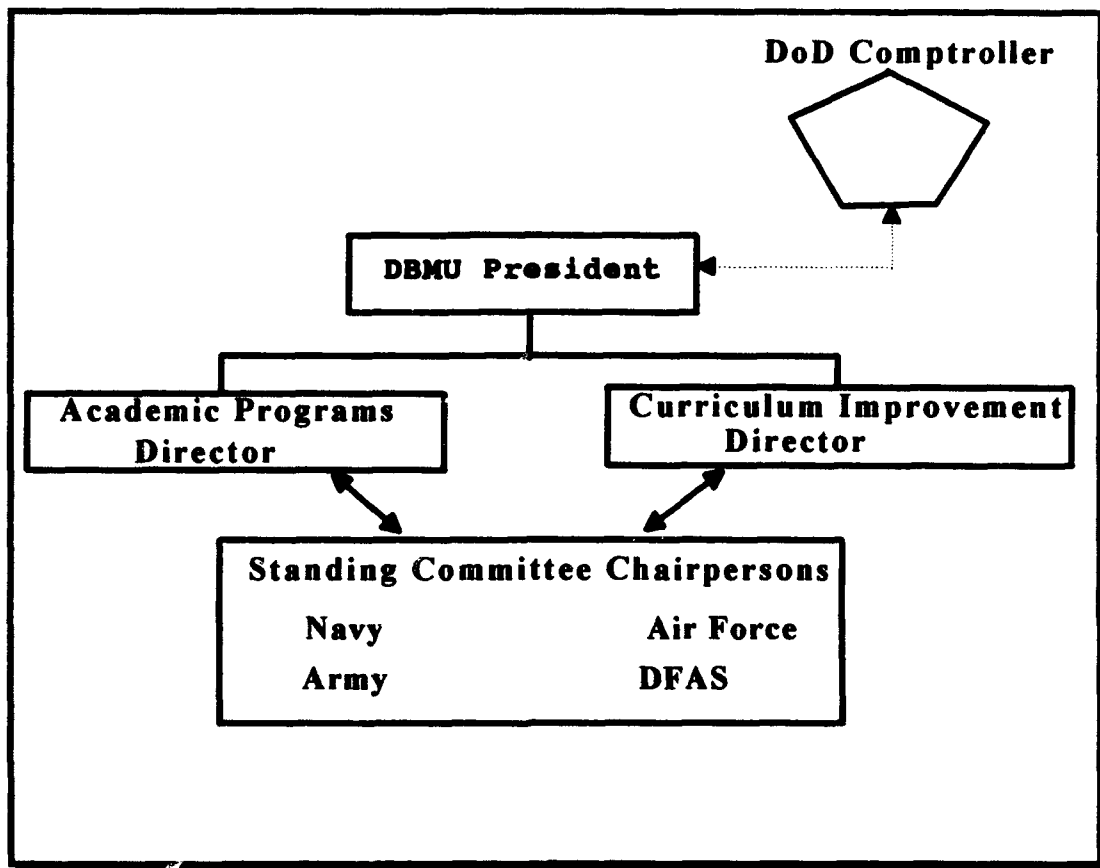


Figure 1. DBMU Organizational Structure

2. DFAS CONSOLIDATION INFORMATION

Deputy Secretary of Defense John Deutch announced on 3 May 1994 a major step in streamlining DoD's financial operations -- naming the 25 locations selected as sites for consolidating nearly 300 of the Department's finance and accounting offices. Deutch said the plan embodies decisions to keep the five

³ DoD Directive (un-numbered draft), Subject: DBMU, dated 24 June 1994.

existing major centers and create 20 new satellite offices. The selected sites are listed below.⁴ Each major site (DFAS Center) is followed by its satellite facilities:

- Denver, Colorado - DFAS Center
 - Gentile Air Force Base (AFB), Ohio
 - Offutt AFB, Nebraska
 - San Antonio, Texas
 - Loring AFB, Maine
 - Norton AFB, California
 - Chanute AFB, Illinois
- Indianapolis, Indiana - DFAS Center
 - Orlando Naval Training Command (NTC), Florida
 - Ft. Sill, Oklahoma
 - Rock Island Arsenal, Illinois
 - Ft. Ord, California
 - St. Louis, Missouri
 - Griffiss AFB, New York
- Cleveland, Ohio - DFAS Center
 - Charleston, South Carolina
 - Norfolk, Virginia
 - Oakland Naval Supply Center (NSC), California
 - San Diego, California
- Columbus, Ohio - DFAS Center
 - Newark AFB, Ohio
 - Pensacola, Florida

⁴ News Release, Office of Assistant Secretary of Defense (Public Affairs), "Department of Defense Announces Major Financial Consolidation," dated 3 May 1994.

- Kansas City, Missouri - DFAS Center
 - Memphis Naval Air Station (NAS), Tennessee
 - Bluegrass Army Depot, Kentucky

In making this announcement, Secretary Deutch stated:

This consolidation plan is the product of a sound, fair process. It is designed to advance DoD's broader goal to reform its financial management and reduce its cost. It will substantially help us to standardize DoD business practices, modernize support operations, improve customer service, and ensure the integrity of our financial and accounting systems.⁵

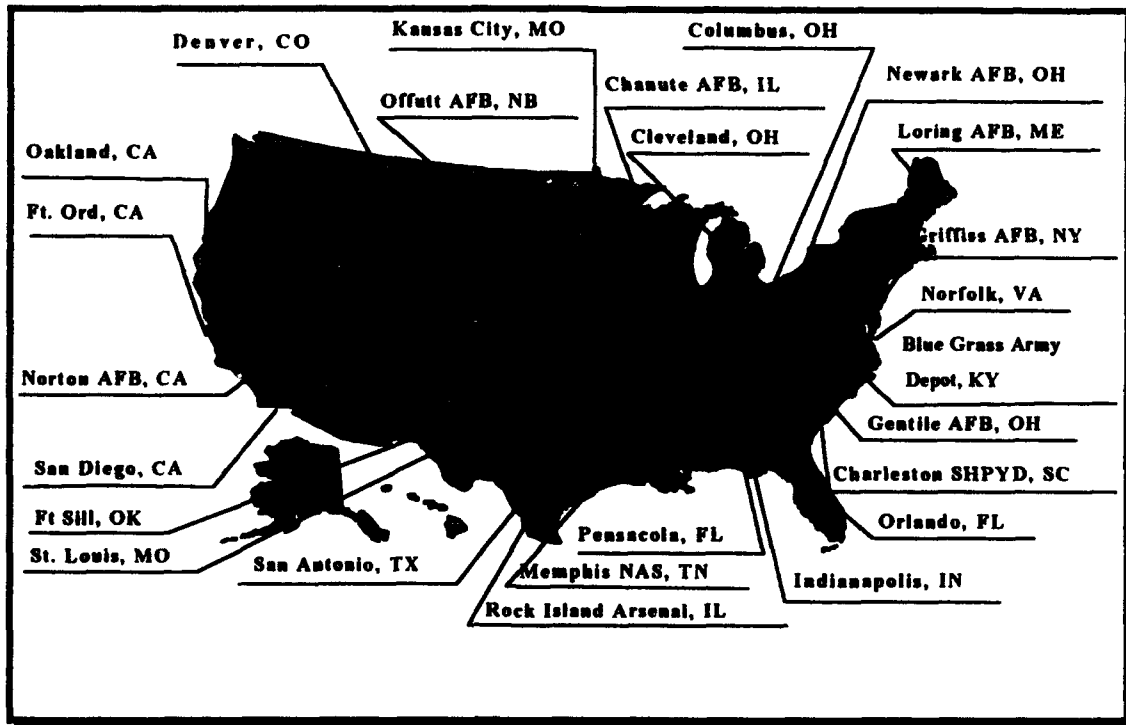


Figure 2. DFAS Site Locations

Figure 2 shows the location of the 25 DFAS centers. These new offices will employ about 750 workers each, providing DoD with the capability it needs to bring its finances in order while achieving economies of scale in the operation of the offices.

This new finance and accounting structure will simplify procedures and reduce the time required to introduce new technology and business practices, while continuing to foster improvements. It will allow DoD to eliminate management layers and restructure to meet changes in mission and customer needs -- supporting President Clinton's goal of creating a government that works better and costs less.⁶

⁶ Ibid.

3. DBMU ROLE IN DFAS TRAINING

Deputy Secretary of Defense John Deutch also announced on 3 May 1994 the establishment of a financial management education and training program. This program will train the DoD financial community of approximately 23,000 employees in newly-developed business processes and automated systems procedures.

To carry out this program, DoD intends to set up the Center for Financial Management Education and Training. It will focus on DoD-wide issues, processes, and systems, not the service-unique training courses offered by the military departments. In addition to its training programs for business processes and automated finance systems, the center will set up a career development center for all supervisory personnel, provide mobile teams to train at DFAS sites, and perform analytical studies in support of future financial training needs, among other functions. The center is expected to employ several hundred people when fully functioning. Depending on the success of the program, the facility could equal the new DFAS centers in size. The Center for Financial Management Education and Training is scheduled to be located in Southbridge, Massachusetts.

The Center and its curricula will be established by the DBMU which will contract with a private organization or university to operate and staff the center. This program is another indicator of the attention being paid to financial

management reform in DoD. This reform is necessary as DoD moves away from the multiple, scattered financial systems of the military departments to a single, integrated Defense Finance and Accounting Service.

DBMU envisions using the Southbridge center for VTT curriculum development (in conjunction with conventional curriculum development) and as a VTT production/broadcast studio. DBMU has made contact with a possible VTC/VTT telecommunications service provider for the Southbridge facility. The Defense Metropolitan Area Telephone System (DMATS) Boston is a DoD activity that has been providing telecommunication services to federal activities in the state of Massachusetts since August 1981. DMATS Boston can provide all services available on the FTS 2000 contract and may be able to assist DBMU in planning, procurement and installation of a VTT studio in Southbridge.⁷

C. THESIS ORGANIZATION

Chapter II discusses technical terminology and concepts relating to VTT and distance learning, as well as government regulations regarding procurement and deployment of VTT hardware, software and content. Chapter III describes each of the U.S. Armed Service's distance learning systems and programs. Chapter IV provides an overview of the 25 DFAS centers, their locations, general VTT requirements, and each DFAS center's VTT requirements. Chapter V presents conclusions and recommendations for both near-term and future VTT

⁷ Telephone conversation between Mr. Al Jarrell, DMATS Boston, and LT Brian Steckler, 29 August 1994.

implementation for the 25 DFAS centers. Appendices include a list of acronyms and point of contact information for the major DoD VTT networks.

II. DISTANCE LEARNING CONCEPTS OVERVIEW

A. VTC/VTI HISTORY AND BACKGROUND

The AT&T research subsidiary, Bell Laboratories, pioneered most of the VTC work between 1924-1964. Video teleconferencing first appeared as early as 1926, when the President of AT&T, Walter S. Gifford, used a VTC to speak with the Secretary of Commerce, Herbert Hoover.⁸

1. Pre-1970

While broadcast television became a major video breakthrough when it was introduced in the 1940s, the next significant video teleconference demonstration occurred nearly a quarter of a century later when AT&T's motion picture telephone was introduced at the 1964 New York World's Fair. Although not practical for that era (at almost \$1,000 per minute for the analog transmission), this event planted the seed of what might be possible some day.⁹

Video signals of the day contained frequencies that were beyond the capabilities of telephone networks. The only emerging technological alternative on the horizon that could provide video teleconferencing with the required

⁸ Jolly, Martin E., *"Video Teleconferencing Feasibility Study at The Naval Postgraduate School,"* Master's Thesis, Naval Postgraduate School, Monterey, California, p. 16, June 1992.

⁹ Portway, Patrick S., *"The Growth of Video Conferencing,"* Technical Guide to Teleconferencing & Distance Learning, p. 2, Applied Business Telecommunications, 1992.

bandwidth was satellite communications. Satellite communications of the period were technically capable; however, the expense was the limiting factor. As a result, growth in VTC and VTT applications during the 1960s was slow.¹⁰

2. The 1970s

In the 1970s, computing power and improved methods for converting analog signals into digital representation made the future seem brighter. The telephone companies began the migration from analog to digital transmission methods. Computer became a household word, with significant advances in processing power, speed and improved methods for sampling and converting analog signals to digital bits. Digital signal processing offered a number of advantages in the area of signal quality and analysis. However, storage and transmission needs still posed significant problems. Digital representations created from an analog signal required more storage and transmission capacity than the original signal. Further advance was checked until reliable digital data compression technology became available.¹¹

¹⁰ Andriole, Stephen J., "Teleconferencing Advances," Signal, p.17, December 1983.

¹¹ Brooksby, Merrill R., "Videoconferencing -- Two Way Interactive Video," in *Technical Guide to Teleconferencing & Distance Learning*, edited by P.S. Portway and C. Lane, p. 61-62, Applied Business Telecommunications, 1992.

3. The 1980s

In the 1980s, the only widely available VTT transmission service was satellite data communications. In 1983, compression techniques were developed so that systems could transmit at near full-motion video. By 1989 performance improvements in video compression techniques permitted transmission of an industry acceptable full-motion video picture (30 frames per second) over telecommunications lines.

Satellite communications of the period were technically mature; however, expense was still the limiting factor. Full-bandwidth satellite transmissions for two-way video teletraining was very expensive: as late as 1983 VTT single system costs were over \$1 million per year.

4. The Early 1990s and Today

In 1990 the international telecommunications standard H.261 for video compression was accepted by the International Consultative Committee for International Telephony and Telegraph and adopted by all major manufactures of video compression equipment. Though manufacturers offer their own proprietary compression algorithms as well, the H.261 standard provides the lowest common denominator for communicating between CODECs of different manufacturers. While very few video teletraining users communicate outside of their own closed networks, the ability to communicate with other systems and other users created a perceived stability in the technology. VTT users now find

that if they purchase additional units or sites from a different vendor, the existing sites will be interoperable with the new sites.

B. VIDEO TELECONFERENCING TERMINOLOGY

1. Video Teleconferencing vs. Video Teletraining

A variety of different terms and acronyms have been used to describe video-related interaction. Some examples are video teleconferencing, videoconferencing, video conference, video seminar, video teleseminar, video training, teletraining, video teletraining, distance learning, distance education, satellite education, and business video. A draft Military Standard on the "Interoperability and Performance Standard for Video Teleconferencing" (MIL-STD-188-331), that was released for private industry comment, provides the following definition of video teleconferencing:

*Two-way electronic form of communications that permits two or more people in different locations to engage in face-to-face audio and visual communication. Meetings, seminars, and conferences are conducted as if all of the participants are in the same room.*¹²

By comparison, video teletraining (or distance learning) is defined as

*The use of teleconferencing point-to-point or multi-point to provide interactive remote site training.*¹³

The majority of DoD teletraining applications include at least one-way video to accompany the audio.

¹² Defense Information Systems Agency Draft Military Standard MIL-STD-199-331 (draft), "Interoperability and Performance Standard For Video Teleconferencing", 10 November 1993.

¹³ Ibid.

2. Video Compression

The National Television Systems Committee (NTSC) standard picture frame consists of 780 horizontal picture elements (pixels) and 480 active vertical lines. If 8 bits are used to represent each pixel for digital transmission, then sending 30 picture frames per second requires a transmission speed of approximately 90 megabits per second (Mbps). Even with digital signal processing, T-1 (1.544 Mbps) telecommunications lines cannot support full motion video transmission (90 Mbps).¹⁵ Therefore, data compression is necessary to make VTT feasible.

Some compression methods take advantage of the similarities of information in the same frame (spatial redundancy) and in similarities between adjacent frames in a group of moving pictures (temporal redundancy). Spatial redundancy permits a small number of bits to describe areas in a picture that are the same color, thereby eliminating the need to individually code each pixel for transmission. To capitalize on temporal redundancy, only the pixels that have changed from one frame to the next are transmitted.

The data compression industry also takes advantage of compression based on limitations of the human eye. The NTSC frame rate for transmitting moving pictures is 30 frames per second. Most motion pictures take advantage

¹⁵ Boyd, Colin, *"To Compress or Not to Compress? – That is the Question,"* Technical Guide to Teleconferencing & Distance Learning, edited by P. S. Portway and C. Lane, p. 52, Applied Business Telecommunications, 1992.

of the fact that the human eye can only discern movement at a rate of about 24 frames per second. Frame rates between 15 and 25 frames per second are considered "smooth" motion. As a result, the compression of motion video at a factor of 2:1 can be achieved by transmitting 15 frames per second instead of 30 frames per second, exploiting the limitations of the human eye.¹⁶

3. Video CODECs

The device that performs the digitization and compression is called coder/decoder (CODEC). The primary CODEC functions are:

- to convert analog signals into digital (code) form prior to transmission and then to reverse the process (decode – digital to analog) for all received signals
- to compress data prior to transmission and to decompress data after it has been received¹⁷

The Common Intermediate Format (CIF) and Quarter Common Intermediate Format (QCIF) are the usual methods used when converting analog video to digital bit stream. Under CIF (sometimes referred to as "full CIF") and QCIF, each frame is divided into Groups of Blocks (GOBs). CIF pictures are divided into 12 GOBs, while QCIF pictures are divided into three GOBs. Once

¹⁶ Ang, Peng H., Ruetz, Peter A. and Auld, David, "Video Compression Makes Big Gains," IEEE Spectrum, p. 16, October 1991.

¹⁷ 1993-1994 Teleconferencing Resources Directory, p.12, Knowledge Industry Publications, Inc., 1994.

this initial division occurs, both the CIF and QCIF GOBs are treated identically as follows:

Each GOB is further subdivided into 33 macroblocks. Each macroblock is further subdivided into six blocks with each block having 64 (8X8) pixels. Four of the blocks provide luminance (brightness) information, while two of the blocks provide chrominance (color) information.¹⁸

After applying the Discrete Cosine Transform (DCT technique to be discussed below), each block is compressed from a range of 512 bits to 25 bits. CODECs achieved a major breakthrough in video compression techniques by employing Discrete Cosign Transform (DCT) coding. DCT is the technology used to exploit temporal and spatial redundancy. DCT transforms a block of pixel intensities into a block of frequency transform coefficients. The transform is applied in turn to new blocks until the entire image has been transformed. At the decoder in the receiver, the inverse transformation is applied to recover the original image.¹⁹ Only by using DCT coding were CODECs finally able to achieve compression ratios capable of transmitting data over T-1 lines.

¹⁸ MITRE, "Video Teleconferencing Standards, An Overview," by Charles King, 3 January 1994.

¹⁹ Jurgen, Ronald K., "An Abundance of Video Formats," IEEE Spectrum, p. 27, March 1992.

C. INTERNATIONAL STANDARDS

1. The International Telecommunications Union

The International Telecommunications Union (ITU) is a United Nations organization responsible for the coordination of international telecommunication issues. The ITU has been organized into a new structure that consists of a Standardization Sector, a Radio Communication Sector and a Development Sector. The ITU Telecommunications Standardization Sector (ITU-TSS) is specifically responsible for establishing international telecommunications standards.

The Consultative Committee on International Telephony and Telegraphy (CCITT) was a subsidiary of the ITU. Under the new ITU organization, work formerly performed by the CCITT is now handled by the Telecommunication Standardization Sector (TSS or ITU-TSS). Essentially, CCITT is ITU-TSS and the terms are used interchangeably in contemporary literature.

The National Institute of Standards and Technology (NIST) has adopted ITU-TSS recommendations pertaining to video teletraining and video teleconferencing through Federal Information Processing Standards Publication 178 (FIPS PUB 178). Figure 3 is a summary of FIPS PUB 178 standards that have been accepted and is useful for following explanations of other standards later in the chapter.

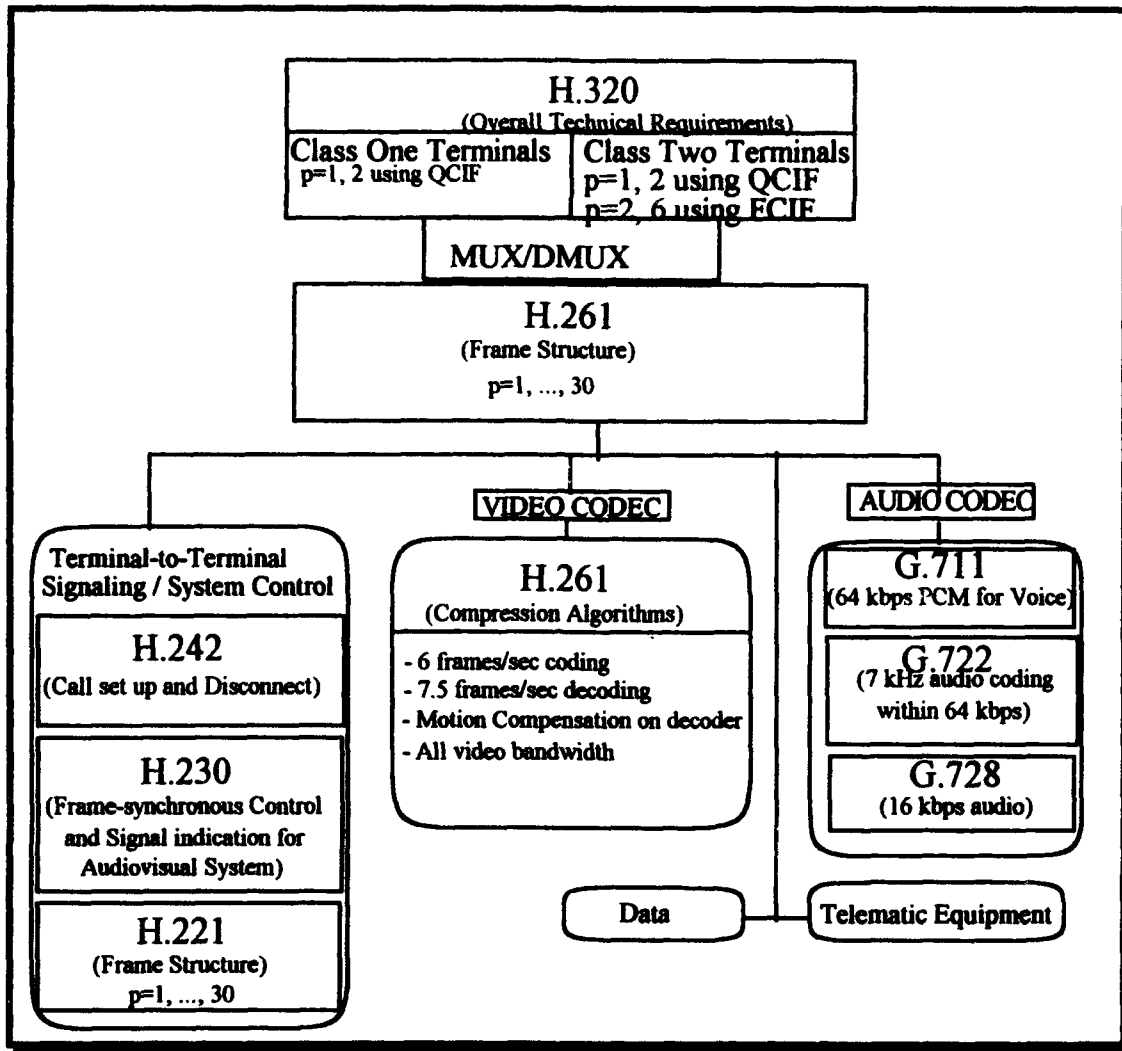


Figure 3. Summary of FIPS 178 Standards²⁰

2. Role of H.320

ITU-TSS Recommendation H.320²¹ refers to a family of standards that govern video teletraining and videophone systems that use CODECs at transmission speeds between 56 thousand bits per second (kbps) and 1,920

²⁰ MITRE, *Video Teleconferencing Standards, An Overview*, King, Charles, 3 January 1994.

²¹ *Narrow-band Visual Telephone Systems and Terminal Equipment*, 1990.

kbps. H.320 prescribes the technical requirements for terminals, multiplexers, signaling, system control, compression algorithms and audio transmissions. H320 became a mandatory standard for the federal government in June 1993 (six months after Federal Information Processing Standards (FIPS) 178 was approved). The H.320 standards listed in Table 1 apply to audiovisual terminals, and the standards for audio-only quality are shown in Table 2.

Table 1. Comparison Levels of H.320 Compliance²²

	Level 1 (Minimum)	Level 2 (Medium)	Level 3 (High)
Frame Format (pixels)	QCIF (176 x 144)	CIF (325 x 288)	CIF (325 x 288)
Frame Speed (frames/sec)	5	up to 15	up to 30
Data Rate	56 / 64 kbps	up to 384 kbps	up to 1.544 Mbps
Motion Compensation	N/A	Limited to (6 x 6) = 36	Full motion (30 x 30) = 900
Pre and Post processing on encoder/decoder	N/A	N/A	Pre and Post processing on encoder/decoder

²² GPT Video Systems, "Take a Better Look at H.320," product brochure by GPT Video Systems, February 1994.

Table 2. H.320 Audio Standards²³

ITU-TSS recommendations	Bandwidth	Bit Rate	Coding Algorithm
G.711	3 kHz	64 Kbps	PCM
G.722	7 kHz	48 Kbps 56 Kbps 64 Kbps	Dual Band, DPCM
G.728	3 kHz	16 Kbps	Low Delay Code excited Linear Prediction
AV. 253	7 kHz	32 Kbps	

The important information provided by Tables 1 and 2 is that different vendors who advertise that they are H.320 compliant may have noticeably different levels of quality from one vendor to the next. H.320 provides for different levels of compliance with respect to compression picture resolution, motion compensation, audio quality and frame speed.

3. Role of H.261

H.261 (referred to as the px64 standard) is an interoperability standard that pertains to communication between CODECs. H.261 guarantees that different CODECs will be able to communicate if they encode and decode video signals according to the standard (H.261) motion video compression algorithm.²⁴

²³ Schaphorst, Richard, notes presented at TELECON XIII, San Jose, California, 10 November 1993.

²⁴ MITRE, *Video Teleconferencing Standards, An Overview*, by Charles King, 3 January 1994.

H.261 prescribes both mandatory and optional formats that provide varying degrees of quality and resolution. Two of those, CIF and QCIF were discussed in detail earlier in this chapter.

Most CODEC manufacturers include both an H.261 standard compression format as well as a proprietary compression algorithm. Often the proprietary algorithm is noticeably better than the H.261 standard. Two (or more) CODECs from the same manufacturer could provide improved performance when operating in the manufacturer's proprietary mode. When two dissimilar CODECs are connected in a video teleconference, they must communicate using the H.261 standard. This assumes that dissimilar modems each have an H.261 standard mode. A widespread DoD example in which this is not the case is the older Rembrandt I model by Compression Labs, Inc. The Rembrandt I is not compliant with the H.261 standard and can only communicate with other Rembrandt I models.

D. INDIVIDUAL VTC COMPONENTS

Any VTC/VTT system typically consists of four fundamental components:

- video facility (consisting of camera, monitors, audio devices, system controlling equipment, still document scanner, video or tape recorder and associated room equipment such as lighting, chairs, desks, etc.)
- CODEC (used to convert analog signals to digital signals, provides compression of data for transmission at sending sites, and decompression at receiving sites)
- transmission network (providing either satellite or terrestrial channels that carry the video signal)
- inverse multiplexer (required to synchronize data transmission when the transmission requires more than two 56 kbps (or 64 kbps) channels).

While the inverse multiplexer is not required for all VTT applications, it appears frequently enough to require inclusion on the list. Satellite VTC/VTT will not use the multiplexer but will instead require equipment dedicated to supporting the satellite link (i.e., amplifiers, upconverters).

The exact equipment of a VTC/VTT suite remains at the discretion of the user. A 1992 survey found that 96% of VTC participants felt that a still-image document transfer capability would improve the quality of the conference.²⁵

²⁵ TeleCons, "*The Drive for Audiographics Standards*," p. 7, 10 November 1993.

E. VIDEO TELECONFERENCING DIRECTIVES

There are numerous guidelines and regulations that affect the procurement and operation of VTC equipment in DoD and the federal government. The following sections summarize existing guidance.

1. FIPS Pub 178

Federal Information Processing Standards Publication 178 (FIPS PUB 178) "Video Teleconferencing Services at 56 to 1,920 kbps" provides guidance related to video conferencing and video telephony. FIPS 178 adopts the following ITU-TSS Recommendations that pertain to VTT:

- H.320. "Narrow-band Visual Telephone Systems and Terminal Equipment, 1990."
- H.221. "Frame Structure for a 64 to 1,920 kbps Channel in Audiovisual Teleservices, 1990."
- H.242. "System for Establishing Communication Between Audiovisual Terminals Using Digital Channels up to 2 Mbps, 1990."
- H.261. "Video CODEC for Audiovisual Services at px64 kbps, 1990."
- H.230. "Frame Synchronous Control and Indication Signals for Audio-visual Systems, 1990."

FIPS 178 includes Military Standards 188-131, "Interoperability and Performance Standard for Video Teleconferencing," as one of its related documents. FIPS 178 was accepted and published by the NIST in December

1992. In June 1993 it became mandatory for all federal departments and agencies.

2. DoD 4640.11

DoD Directive 4640.11 concerns "Mandatory Use of Military Telecommunications Standards in the MIL-STD-188 Series." This directive is designed to ensure interoperability and guarantee performance standards within DoD. The directive mandates use of the MIL-STD-188 series in all DoD component systems and equipment and states:

The MIL-STD-188 series addresses telecommunications design parameters, influences the functional integrity of telecommunication systems and their ability to interoperate efficiently with other functionally similar government and commercial systems, and shall be mandatory for use within the Department of Defense.²⁶

3. DoD 4640.13

DoD Directive 4640.13 was issued in December 1991 by the Assistant Secretary of Defense for Command, Control, Communications, and Intelligence. The directive deals with "Management of Base and Long-Haul Telecommunications Equipment and Services." The directive mandates DoD to be effective and efficient in employing base and long-haul telecommunications and to discontinue using methods and services that are not effective. DoD

²⁶ Department of Defense UNCLASSIFIED Directive 4640.11 to all Department of Defense Components, Subject: Mandatory Use of Military Telecommunications Standards in the MIL-STD-188 Series, 21 December 1987.

common-user systems (i.e., DCTN, NAVNET, AFNet, etc.) are exempt from the requirement to use FTS 2000. Similarly, exempt long-haul telecommunications requirements should normally be handled using one of the common-user systems. New acquisition of long-haul telecommunications are acceptable if the requirements "cannot be satisfied technically, operationally, or cost-effectively by the DoD common-user systems or FTS 2000."²⁷

4. DoD 4640.14

DoD Directive 4640.14 was also issued in December 1991 by the Assistant Secretary of Defense for Command, Control, Communications, and Intelligence. It deals with "Base and Long-Haul Telecommunications Equipment and Services." Although this directive restates much that is in DoD 4640.13, there are some subtle differences. DoD 4640.13 deals with policy, while DoD 4640.14 provides guidelines and "prescribes procedures." Some of the Defense Information Systems Agency (DISA) responsibilities under DoD's 4640.13 and 4640.14 include the following:

- review telecommunications billing arrangements at least annually to rationalize common-user network billing arrangements
- receive requests from DoD components for all long-haul telecommunications equipment and services
- conduct lease vs. purchase comparisons to determine the best acquisition strategy

²⁷ Department of Defense UNCLASSIFIED Directive 4640.13 to all Department of Defense Components, Subject: Management of Base and Long-Haul Telecommunications Equipment and Services, 5 December 1991.

- determine whether requirements will be satisfied using DoD common-user systems or FTS 2000
- approve or disapprove all requests from DoD components for exemptions to the requirement to use common-user networks

Organizations which have the following requirements are exempted from mandatory use of DoD common-user systems:²⁸

- communications for real time control (i. e., satellite control, telemetry)
- operational requirements that are less than 1 year in duration
- communications in support of exercises
- base communications and local communications involving locations within the local calling area
- teletype circuits with line speeds of 150 baud or less.

5. Defense Switched Network 1992-1997 Program Plans

The former Defense Communications Agency (DCA), now DISA, promulgated a "Defense Switched Network Program Plan: FY 92-97" in April 1991. In it DISA recognizes DSN as the primary command and control video teleconferencing network in DoD. It officially recognizes the role of the Defense Commercial Communications Office (DECCO) in the telecommunications procurement process. Another action resulting from this DSN program plan is that DISA changed the name of DECCO to DISA Information Technology

²⁸ Department of Defense UNCLASSIFIED Directive 4640.14 to all Department of Defense Components, Subject: Base and Long-Haul Telecommunications Equipment and Services, 6 December 1991.

Procurement Organization (DITPRO). Some of the functions of DITPRO as specified include:²⁹

- establish contractual arrangements with companies in the communication industry for services constituting the Defense Switched Network (DSN) backbone
- pay bills received from vendors supplying DSN backbone service
- bill users of the network on a monthly basis
- provide funds from the Communications Services Industrial Fund (CSIF) to support acquisition of government furnished equipment and leased DSN switches

From a practical standpoint, any new long-haul telecommunication requirements are supposed to be reviewed and approved by DITPRO. This means that any new FTS 2000 requirements, as well as new DSN requirements, are reviewed and approved by DITPRO. DITPRO can conduct solicitations, accept bids from contractors, or provide VTC facilities, equipment, rooms, CODECs, cameras, etc., via other means. Any federal entity is authorized to purchase from the DITPRO contract. DITPRO's fee is two percent of the total value of the awarded contract. DITPRO currently manages approximately 89,000 contracts worth an estimated \$1.4 billion.³⁰

²⁹ Defense Communications Agency, *Defense Switched Network Program Plan: FY 1992-1997*, April 1991.

³⁰ Nerino, Michael P., *"A Comparison of High-end Video Teleconference Alternatives for The Department of Defense"*, Master's Thesis, Naval Postgraduate School, Monterey, California, p. 33, 24 March 1994.

6. MIL STD 188-331 (draft)

Military Standard 188-331, drafted in November 1993, is titled "Interoperability and Performance Standard for Video Teleconferencing" and is intended to address DoD requirements not covered in prevailing VTC standards. While current VTC standards move toward interoperability, they do not address the areas of graphics, data, and security that are of specific concern to DoD.

MIL-STD-188-331 describes both non-secure desktop and videophone applications and all other related VTC systems. The military standard prescribes mandatory items that must be included in future VTC procurements. Some of the mandatory features include:³¹

- full-duplex mode of operation
- transmission speeds between 56 and 128 kbps
- QCIF picture quality and decoding of 7.5 pictures per second, the picture resolution actually requires the video CODEC to provide full-color, near-full motion capability
- freeze-frame video capability
- minimum of one synchronous RS-449 attachment port
- data communications interface to support communications between Data Terminal Equipment (DTE) and Data Communication Equipment (DCE); an EIA-232-D data port is also required

³¹ Defense Information Systems Agency Draft Military Standard MIL-STD-188-331 (draft), Interoperability and Performance Standards For Video Teleconferencing, 10 November 1993.

MIL-STD-188-331 does address such VTC related areas as analog VTC, conference scheduling, multi-point VTC and broadcast modes of operation. DoD circulated the draft military standard among private industry so the private sector might endorse it prior to it being submitted to U. S. and international standards groups for their review. Once the standard is formally approved, exceptions will only be allowed after obtaining a written waiver from DISA.³²

7. The Castleman Memorandum

The Castleman Memorandum (ASD-C3I policy) was released in October 1993. It was formally titled "Department of Defense (DoD) policy for Video Teleconferencing (VTC) Management, Acquisition, and Standards." The memorandum applies to all DoD VTC activities and capabilities that require data transmission rates between 56 kbps and 1.2 Mbps. All DoD VTC services must be "fully operable" with the DISN. DISA is tasked with maintaining a list of acceptable VTC equipment and with providing DoD components with the means for contracting both equipment and services. DISA uses DITPRO to contract for equipment and services. FIPS 178, Interim Planning Standard 187-331 and eventually MIL-STD-188-331 ("Interoperability and Performance Standard for Video Teleconferencing") are all mandatory standards within this policy. The policy mandates using the Joint Worldwide Intelligence Communications System (JWICS) for all intelligence activities that have SCI-secure VTC requirements.³³

³² EDGE, "Video Teleconferencing: Industry Alliance," On & About AT&T, p. 35, AT&T, 15 November 1993.

DISA has developed a voluntary "Video Teleconferencing Requirements Questionnaire" to assist DoD users with determining VTC or VTT requirements.

The questionnaire describes five categories of video teleconferencing:

- **Multi-Point Video Telebroadcast** - This is one-way video/one-way audio (1W/1W) and is typically, but not exclusively, associated with a satellite broadcast
- **Multi-Point Video Teleseminar** - sometimes referred to as "n-way." This is one-way video and two-way audio (1W/2W)
- **Point-to-Point Teletraining** - This is two-way video, two-way audio between two stations (2W/2W)
- **Selective Presence Multi-Point Video Teletraining**³⁴
- **Continuous Presence Multi-Point Video Teletraining**³⁵

Service within the five DISA categories can be provided using satellite or terrestrial communication links. While one user might favor a particular delivery method over the other, both satellite and terrestrial links can be used for any of these five categories.

³³ Department of Defense ASD-C3I Policy Memorandum, Subject: Department of Defense (DoD) Policy for Video Teleconferencing (VTC) Management, Acquisition, and Standards, 26 October 1993.

³⁴ All stations must be capable of two-way video. One station acts as "conference chairman;" this station transmits to all receiving sites and designates a second station that can also be viewed. Receiving sites can select to see either the "conference chairman," or the second station, or both.

³⁵ Each station transmits its own video signal to all other conferees; video from all sites is simultaneously displayed on all screens in a "Hollywood Squares" type arrangement.

8. FTS 2000 Mandatory Use

Public Law 101-136, Section 621, prescribes the mandatory use of FTS 2000³⁶ "to meet Federal telecommunication requirements unless the General Services Administration (GSA) grants an exception." An exception might be granted under several conditions. For example, if a service cannot be provided by FTS 2000 and the agency can conduct a cost-effective procurement through other means, an exception request would likely be approved. A related requirement covers procurement of equipment or services not provided by FTS 2000. There is currently no delegation of procurement authority (DPA) for procurements coincident with a GSA exemption from FTS 2000 use. Procurement requests which are less than \$250,000 must be submitted to GSA Service Oversight Center for the appropriate FTS 2000 Network. Procurements for \$250,000 or more must go through GSA's Authorization Branch (KMAS).³⁷

9. Warner Exemption

The Warner Amendment (Title 10, United States Code, Section 2315) is a modification to the Federal Property and Administrative Services Act (Section III). The Warner Amendment exempts specific types of telecommunications applications from the mandatory use provisions of FTS 2000, if the "function, operation, or use" of those applications:

³⁶ FTS 2000 is a telecommunication service contract established in 1988 to provide long-haul communications for government agencies.

³⁷ "Acquisition of Information Resources, Overview Guide," U. S. General Services Administration, p. 5-7, January 1990.

- involves intelligence activities
- involves cryptologic activities related to national security
- involves the command and control of military forces
- involves equipment that is an integral part of a weapon or weapons system
- is critical to the direct fulfillment of military or intelligence missions

Specifically excluded within this category are applications that involve the procurement of Automatic Data Processing Equipment (ADPE) or services to be used for routine administrative and business applications including payroll, finance, logistics, and personnel management applications.³⁸

³⁸ "Acquisition of Information Resources, Overview Guide," U. S. General Services Administration, p. 3-2, January 1990.

III. DOD TELECOMMUNICATIONS AND DISTANCE LEARNING SYSTEMS AND PROGRAMS

There are numerous DoD organizations and components that employ or support VTT technology. Video teletraining systems and service providers including FTS 2000 and DCTN as well as major DoD satellite networks will be examined. The chapter begins with a summary of major DoD VTT programs in the Army, Navy and Air Force.

A. VIDEO TELETRAINING IN THE DEPARTMENT OF DEFENSE

DoD has four major VTT networks: the Army's Teletraining Network (TNET) and Satellite Education Network (SEN), the Air Force's Air Technology Network (ATN) and the Navy's Chief of Naval Education and Training (CNET) Electronic Schoolhouse Network (CESN). The Naval Postgraduate School's (NPS) VTT system is also included since it is compatible with other DoD VTT systems and is near the Fort Ord, California DFAS site. A summary of these major DoD VTT networks and NPS's VTT system is provided in Table 3. DFAS's current and projected VTC (and possibly VTT) network sites are discussed in Chapter IV.

Table 3. Summary Information for Major DoD VTT Networks

VTT System	TNET	SEN	ATN	CEBN	NPS
DoD Component	Army	Army	Air Force	Navy	Navy
Transmission Medium	Satellite	Satellite	Satellite	Terrestrial	Terrestrial
Common CODEC ⁺	VTel	VTel	CLI ^{\$%}	VTel	PictureTel
Data Rate (kbps)	384	3300 to 6600	3300 to 6600	384	384
Eqpt Owned/Operated ⁺⁺	CO/GO	GO/CO	GO/GO	GO/GO	GO/GO
Analogy/Digital	Digital	Digital	Digital	Digital	Digital
Audio/Video Mode ⁺⁺⁺	2W/2W	1W/2W	1W/2W	2W/2W	2W/2W

⁺ VTel = Video Telecom, CLI = Compression Labs, Inc.

⁺⁺ CO/GO = Contractor Owned/Government Operated
GO/CO = Government Owned/Contractor Operated
GO/GO = Government Owned/Government Operated

⁺⁺⁺ 2W/2W = 2 Way Audio/2 Way Video

1W/2W = 1 Way Audio/2 Way Video

^{\$} Some sites have older CLI/Rembrandt I CODEC's which are not compatible with any other system CODEC's.

[%] Require CODEC only at originating site (studio) and decoder at receive sites.

1. Video Teletraining Network

In 1982 the United States Army Chief of Staff for Training determined that an interactive TV training program for soldiers located in remote locations could reduce travel costs. The Army conducted a review of VTT technology and chose a Williamsburg, Virginia based company, Center for Excellence, to develop a

VTT program. The Center for Excellence was awarded the first contract to provide full-motion analog video one way with two way audio capability via microwave and land line from Ft Lee, Virginia to Ft Eustis, Virginia and five Virginia based Army National Guard sites. The original system was titled "School of the Air" and is now named the Video Teletraining Network (TNET).

There are now 80 TNET sites in the United States with another 22 scheduled to begin operation in 1994. Each site is full-motion, 2W/2W capable. Each site uses Video Telecom (VTel) equipment including VTel's Media Max CODEC and a built-in multimedia PC.

2. Air Force Institute of Technology's Air Technology Network

AFIT conducted it's first VTT session in October 1990 in response to a student training backlog throughout the Air Force. The original course was delivered to six sites with 120 engineering students enrolled. The course was delivered via fiber-optic links using DCTN.³⁹ In June 1992 the Air Force installed National Technological University (NTU) equipment at 18 sites. This required a change from terrestrial based fiber-optic links to satellite transmission mediums and it converted the system from analog video signal to Compressed Digital Video (CDV) signal. The contract with NTU included a provision for satellite uplink capability. AFIT began using NTU as a sole-source provider of CDV to broadcast VTT sessions.

³⁹ Westfall, Philip, "AFIT Provides Satellite Learning For Military," Communications News, p. 22, March 1994.

NTU could not offer interoperability across all services. In the interest of inter-service distance learning networking, AFIT's Center for Distance Education (CDE) explored interoperability issues with AT&T, since they are the prime contractor for DCTN. The 1990 DCTN contract provided only fiber-optic video telecommunications with rates of digital compression that did not meet AFIT's requirements.⁴⁰ The CDE requested that AT&T develop a satellite-based capability similar to the NTU model. CDE requested that the capability be added as an option in the DCTN contract. On 1 November 1993 AFIT broadcast its first course on the new DCTN satellite based network, called Air Technology University (ATN), providing DCTN-CDV VTT in both point-to-point and multipoint modes. The system now reaches 69 Air Force bases and is interoperable with the Army's Satellite Education Network.⁴¹

3. Satellite Education Network

The Army Satellite Education Network has been on the air since 8 January 1985. SEN is the oldest continually operational training satellite network in DoD.⁴² SEN was originally developed by the U.S. Army to provide distance learning to educate and train acquisition and logistics personnel. The system is satellite based 1W/2W using compressed digital video. The SEN broadcast

⁴⁰ Mendelsohn, Robyn, *"Neighborhood In The Sky,"* Skynet, p. 12, Spring/Summer 1994.

⁴¹ Westfall, Philip, *"AFIT Provides Satellite Learning For Military,"* Communications News, p. 23, March 1994.

⁴² American Systems Corporation, *"Distance Learning Market Survey,"* p. 7, 8 December 1993.

studios are located at Ft. Lee, Virginia. SEN is fully interoperable with the Air Force Institute of Technology's Air Technology Network and the U.S. Army's TNET.

SEN is capable of broadcasting three courses simultaneously to 102 downlink sites. VTeL Media Max CODEC is used to send digital compressed video rates of 384 kbps or 764 kbps, providing full-motion video. Other equipment includes a built in PC with multi-media (CD-ROM and graphics capabilities, VCR and FAX capability).⁴³

4. CNET's Electronic School House Network

In early 1988 the Navy's Chief of Naval Education and Training (CNET) was looking for an effective means of providing training to a greater number of students with fewer instructors while reducing training costs. To accomplish that goal the CNET Educational Schoolhouse Network (CESN) was established in Dam Neck, Virginia and began transmitting in March 1989 to three east coast sites. In May 1993 the network expanded to the west coast. San Diego, California was selected as the west coast hub.⁴⁴ A driving factor for a VTT need within the Navy was the requirement to provide training to deployed units. That capability was demonstrated when point-to-point VTT sessions were established

⁴³ Telephone conversation between Mr. Kenn Johnson, SEN Director, and LCDR Jim Stewart 12 July 1994.

⁴⁴ "CNET Electronic Schoolhouse Network," Chief of Naval Education and Training information brochure, February 1994.

with the USS Theodore Roosevelt off the coast of Spain in March 1993.⁴⁵ The ten site network is administered from the two primary hubs.

Each hub uses a VTel Digital Video Branch Exchange (DVBX) to link their sites to seven different combinations simultaneously. The system operates at a fractional T-1 rate of 384 kbps. Classroom size at each site is limited to 24 students, who are distributed around high-resolution 40 or 60 inch monitors for viewing. Training aids include state of the art graphics tools, Pen Pal Electronic Annotation Pad, Video Cassette Recorder, VideoShow, Still Image Recorder, and scan converter for computer-based media. Each site is fully capable of originating VTT sessions.⁴⁶

5. Naval Postgraduate School VTT System

The Naval Postgraduate School VTT system began operation in July 1994 primarily to provide education for the Naval Aviation Systems Command (NAVAIR) in Washington, D.C. NAVAIR and NPS conduct quarter-long five-credit hour courses to as many as 25 students per classroom on PictureTel model 4000 systems. NPS has two VTT equipped classrooms and one mobile system that can be used for normal or auditorium sized conferences. NAVAIR has one VTT equipped room in Washington, D.C. and plans to expand their distance learning degree program to other NAVAIR activities such as the

⁴⁵ Stoloff, Peter, *"Cost-Effectiveness of VTT System Alternatives,"* Center for Naval Analysis, p. 15, March 1994.

⁴⁶ "CNET Electronic Schoolhouse Network," Chief of Naval Education and Training information brochure, February 1994.

Patuxent River, Maryland Naval Air Station, (NAS Pax River) and the China Lake, California Naval Warfare Center (NWC China Lake). There are plans to expand the NPS VTT program to the defense medical community as well as to the Defense Acquisition University. NPS also plans to offer VTT and VTC connectivity to other DoD agencies. The system is terrestrial based and uses ISDN at 384 kbps. The FTS 2000 contract provides telecommunications services through AT&T. The NPS/NAVAIR VTT system is 2W/2W point-to-point. A bridge has been purchased to allow multi-point sessions in the future.

The approximate equipment cost per room in the current configuration is \$70,000 plus \$20,000 to modify the rooms to accommodate resident classes. The total estimated system cost (non-recurring) through FY 1994 is \$205,000. Total estimated annual recurring costs are \$18,000 for FY 1994 and \$12,000 for FY 1995.

Each classroom is equipped with 3 large screen video monitors, video cameras, a document camera, microphones, a computer scan converter, a videocassette recorder and a Macintosh computer. Future equipment upgrades include automatic microphone mixing systems with one microphone for every two student seats, a large screen interactive computer display and the Socrates podium system which will allow easy pan/zoom/freeze-frame of speakers at any site, among other capabilities.⁴⁷

⁴⁷ Personal conversation between Mr. Tracy Hammond, NPS Director of Registration and Scheduling and LT Brian Steckler of 23 August 1994.

Since the NPS VTT system is PictureTel equipped, it is compatible with many current DoD VTT and VTC systems.

NPS will use the VTC/VTT system to:⁴⁸

- Conduct research in desktop VTC for U.S. Navy VTC use and recommend policy, technology and possible uses by DoD activities for all Navy, joint and supportive activities.
- Establish continuing education courses available through Distance Learning, keeping NPS graduates current on technology and applications through short courses, instructional conferences, broadcast seminars and computer-based instruction.
- Expose students to sponsors and their associated communities. This has been identified as a recurrent requirement by several sponsors during biennial curriculum reviews and has resulted in considerable expense and coordination setting up visiting speaker programs at NPS.
- Expose more students and researchers to working meetings that travel expense, time and scheduling would have prevented if dependent on physical presence.
- Interface NPS policy makers with Naval Military Personnel Command (NMPC) curricula sponsors and community managers regarding curricula content, academic support, personnel management, budget and other issues.
- Allow economic development and broadcasting of specialized courses such as executive training for NMPC, comptrollership and other programs.

⁴⁸ Superintendent, Naval Postgraduate School letter to Chief of Naval Operations, Subject: Request for Procurement Authority for Video Teleconferencing System, dated 8 December 1993.

- Allow VTC conferences and courses such as the National Defense University Reserve Officer Security Officer Course, Air Force Acquisition Management training courses and selected Navy tele-training courses.
- Allow research sponsors to receive progress reports, to conduct problem resolution meetings and to discuss technology with other labs, universities and contractors and to allow greater access by more team members.

B. FEDERAL TELECOMMUNICATIONS SYSTEM 2000

1. Background

Federal Telecommunications System 2000 (FTS 2000) is a telecommunication service contract that was established in December 1988 to provide long-haul communications for all government agencies. FTS 2000 is managed by the General Services Administration (GSA). The contract consists of two major sub-contracts: AT&T's "A" Network services and Sprint's Network "B" services. GSA directs government agencies to use either AT&T or Sprint networks.⁴⁹

The basic types of services provided by FTS 2000 are:

- Switched Voice Service (SVS) for transmitting voice and data at rates up to 4.8 kbps.
- Switched Data Service (SDS) for dialed-up end-to-end digital data transmission at 56 and 64 kbps.
- Video Transmission Service (VTS) for compressed video and full motion teletraining.
- Packet Switched Service (PSS) for transmitting data in packet format.
- Dedicated Transmission Service (DTS) for point-to-point private line service from analog voice grade up to 1.544 Mbps digital.
- Switched Digital Integrated Service (SDIS) for a combination of services using T-1 or Integrated Services Digital Network (ISDN).⁵⁰

⁴⁹ Data Communications, "Users Rate Long-Distance Carriers: FTS 2000: A Mixed Blessing," p. 92, August 1993.

⁵⁰ Defense Intelligence Agency, Intelligence Planners Communications Handbook, UNCLASSIFIED portion only, BDM International, Inc., p. 6-33, 1991.

FTS 2000 was designed to meet the telecommunications needs of DoD for ten years. It has had to survive numerous attempts by congressional groups to find more technically capable alternatives over the years. The FTS 2000 contract will expire in December 1998 unless an extension is sought and granted.⁵¹

2. Substructure of FTS 2000

FTS 2000 is comprised of service nodes or switches that are interconnected by fiber optic T-3 telecommunication lines providing 44.736 Mbps capacity. FTS 2000 services are accessed via Service Delivery Points (SDP's) usually located at the customer's site. The SDP is the point that separates the portion of the communications connection serviced by FTS 2000 from the portion serviced by the local communications provider, such as the provider of base telephone lines. Users obtain access to FTS 2000 through interfaces that can be provided by Private Branch eXchanges (PBX's) or other vendor provided equipment.⁵²

3. DoD Mandates For Using FTS 2000

Department of Defense agencies requiring point-to-point or multipoint video teletraining at 384 kbps are normally required to use FTS 2000. Organizations needing a waiver in order to be excluded from the FTS 2000

⁵¹ Masud, S.A., "Scott -- 'Mr. FTS 2000' -- Retires with Final Shot at Mandatory Use," Government Computer News, p.3, 10 January 1994.

⁵² Defense Intelligence Agency, Intelligence Planners Communications Handbook, UNCLASSIFIED portion only, BDM International, Inc., p. 6-34, 1991.

mandatory use provision can apply to GSA. Primary reasons for granting exclusions are user requirements that meet Warner Exemption criteria or if user systems require variable bandwidth, such as an organization needing transmission speeds of 384 kbps for one site and 768 kbps for another.⁵³

4. AT&T's "A" Network

a. Overview

Compressed Video Transmission Service (CVTS) is provided by AT&T, which handles sixty percent of the FTS 2000 contract. VTT capability depends on the features that AT&T make available through its contract with GSA. CVTS operates exclusively at 384 kbps and provides both point-to-point and Dynamic Multi-Point (DMP) selection for VTT. DMP allows one site to be seen during multi-point VTT while other sites have audio-only capability. There are two dynamic multipoint modes:

- Lecture Mode in which the lecturer determines the site that will broadcast and the video that the broadcast site will see.
- Voice Activated Switching Mode (VASM). VASM occurs when the video automatically switches to the broadcast site with the highest audio level.⁵⁴

⁵³ U.S. General Service Administration Information Resources Management Service, *"Acquisition of Information Resources, Overview Guide,"* p. 3, January 1990.

⁵⁴ AT&T, *"AT&T FTS 2000 Integrated Custom Network Compressed Video Transmission Service,"* AT&T product information brochure, February, 1994.

Up to fourteen sites can participate in a CVTS teletraining event. One site is the originating site and as many as thirteen sites are considered receiving sites. Thirty one additional site can be connected during one session using AT&T's Global Business Video Service (GBVS) Network. Video Teletraining sessions or events are scheduled through a reservation system. Services are available 24 hours a day and can be scheduled with as little as 30 minutes notice. Sessions scheduled 24 hours or more in advance are guaranteed. The FTS 2000 contract with AT&T requires users to provide training rooms and the associated video equipment. AT&T provides the CODECs and transmission lines.

b. CODEC and Interoperability

The only CODECs available for CVTS VTT are the Compression Labs, Inc. (CLI) Rembrandt II 02 or the Rembrandt II VP. If a site already possesses a different CODEC, they may request a waiver from GSA to use their current CODEC with CVTS.

AT&T's "A" Network can connect to both the Sprint Meeting Channel and AT&T's GBVS via a gateway located in Vienna, Virginia. There are no plans to connect AT&T's "A" Network directly to DCTN. Connection to DCTN is possible via Sprint's Meeting Channel and AT&T's Accunet gateway.⁵⁵

⁵⁵ Telephone conversation between Dr. Jolly Holden, AT&T, and LCDR Jim Stewart, 28 April 1994.

c. Network Costs

Cost for Video Teletraining through AT&T's "A" Network has fixed and variable cost components.

Variable costs are determined by:

- monthly usage rates which is dependent on distance and location (based on minutes per month)
- type of video teletraining being conducted, point-to-point or Dynamic Multi-Point
- line cost based on actual usage and service level (charge per use).⁵⁶

Fixed, both recurring and one-time, costs include:

- connection charge (one-time cost)
- CODEC fee (recurring monthly charge),
- network coordination fee (recurring monthly charge),
- teletraining establishment charge for each location (charge per use)

A sample AT&T "A" Network cost structure (prices include CODEC but exclude other hardware) is:

- One-time Network connect charge: \$2,500 (one-time cost)
- Recurring monthly CODEC fee : \$800/month or \$7,200/year
- Service Ready Maintenance fee: \$525/month or \$6,200/year
- Variable monthly usage costs

Variable costs based on a 1-hour VTT session:

- Point-to-Point session establishment charge: \$15 per site

⁵⁶ AT&T, *"AT&T FTS 2000 Integrated Custom Network Compressed Video Transmission Service,"* AT&T product information brochure, February 1994.

- **Dynamic Multi-Point**

Origination site: \$15 per site

Each additional site: \$57 per site

A sample set of calculations for Switched Digital Integrated Service (SDIS) telecommunications line costs with the FTS 2000 Network "A" contract using Ft. Eustis, Virginia as the broadcast site is provided in Table 4.

Table 4. Sample FTS 2000 Network "A" Costs⁵⁷

	384 kbps	768 kbps	1,544 kbps
Cleveland, OH	\$ 47	\$ 95	\$ 182
Columbus, OH	\$ 45	\$ 90	\$ 172
Denver, CO	\$ 51	\$ 102	\$ 200
Indianapolis, IN	\$ 47	\$ 93	\$ 180
Kansas City, MI	\$ 51	\$ 101	\$ 194

A point-to-point connection between Ft. Eustis, Virginia and Denver, Colorado using 768 kbps would cost \$117 (\$15 for session establishment plus \$102 line costs). Cost estimates for DMP service with Ft. Eustis, Virginia as the originating site and five other remote sites is more complicated. There is a \$15 DMP Originator fee plus \$57 per non-originator site ($5 \times \$57 = \285 total) plus AT&T's Dynamic Multi-Point connection cost of \$332, for a total session cost of \$632 per hour.⁵⁸

⁵⁷ Telephone conversation between Mr. Gary Haddox, GSA and LCDR Jim Stewart, 9 August 1994.

⁵⁸ AT&T, "AT&T FTS 2000 Integrated Custom Network Compressed Video Transmission Service," AT&T product information brochure, February 1994.

5. Sprint's "B" Network

a. Overview

Sprint's portion of FTS 2000, also known as the "B" Network, consists of approximately forty percent of the FTS 2000 contract. There are currently no DoD units using Sprint's "B" Network.⁵⁹ On 1 January 1994, Sprint switched from a 768 kbps system to exclusive use of 384 kbps on it's Compressed Video Transmission Service (CVTS). The speed change provides interoperability with AT&T's "A" Network.

Sprint's Network is designed for point-to-point VTT services, though multipoint capability exists through a gateway to Sprint's Meeting Channel. Other networks accessible to Sprint's "B" Network are DCTN and AT&T's Accunet, through Sprint's Meeting Channel gateway.

VTT sessions are scheduled via reservation. Reservations can be guaranteed if made more than 24 hours in advance. All training sessions are subject to availability. Reservations can be made up to one year in advance.

GSA's FTS 2000 contract with Sprint requires users to provide training rooms and associated video equipment. Sprint provides CODECs and transmission lines. Users supply training facilities and all additional VTT equipment.

⁵⁹ Telephone conversation between Mr. Peter Wilson, DECCO and LCDR Jim Stewart, 8 August 1994.

b. CODEC and Interoperability

The only CODEC available for CVTS VTT is CLI's Rembrandt II VP. If a user has a different CODEC they may request a waiver from GSA to use their existing CODEC with CVTS. One difference between Sprint and AT&T is Sprint's "Beta Test Option." The Beta Test Option allows users to test their equipment for FTS 2000 compatibility.⁶⁰

c. Network Costs

A sample of associated costs for Sprint's "B" Network with Beta Test Options and the FTS 2000 contract (excluding hardware) are:

- One-time Network connect charge: \$1,100 (first year only - per site)
- Recurring monthly CODEC fee: \$2,200/month or \$26,400/year
- Monthly Service Ready Maintenance fee: \$300/month or \$3,600/year
- Variable monthly usage costs

An example of variable monthly usage costs, based on a one hour VTT session is \$15 per site (point-to-point session RSVP per location, per conference. The Network "B" cost structure does not use the dynamic multi-point option found in Network "A."

⁶⁰ Telephone conversation between Mr. Tim Young, GSA, and LCDR Jim Stewart, 29 August 1994.

A sample set of FTS 2000 Network "B" VTT telecommunication line costs using Ft. Eustis, Virginia as the broadcast site is provided in Table 5. Network "B" does not offer 768 kbps or T-1 (1.544 Mbps) data rate packages.

Table 5. Sample FTS 2000 Network "B" Costs⁶¹

	384 kbps	768 kbps	1.544 Mbps
Cleveland, OH	\$ 369	n/a	n/a
Columbus, OH	\$ 371	n/a	n/a
Denver, CO	\$ 391	n/a	n/a
Indianapolis, IN	\$ 324	n/a	n/a
Kansas City, MI	\$ 313	n/a	n/a

A point-to-point connection between Washington, DC and Denver, Colorado would cost \$406 (\$15 for session establishment plus \$391 line costs). Cost estimates for DMP service with Washington, DC as the originating site and five sites as remotes sites is more complicated. There is a \$15 DMP Originator fee for each site plus Sprint's DMP connection cost of \$1,063, for a total session cost of \$1,138 per hour.

6. FTS 2000 T-1 Service

a. An Alternative to AT&T and Sprint Networks

An alternative to CVTS is full T-1 or fractional T-1 service under the FTS 2000 contract. Fractional T-1 service refers to using a fraction of the 1.544

⁶¹ Telephone conversation between Tim Young, GSA and LCDR Jim Stewart, 29 August 1994.

Mbps of bandwidth available on a T-1 line. Fractional T-1 lines are usually in increments of 56 or 64 kbps.

b. FTS 2000 Fractional and Full T-1 Costs

Costs associated with CVTS via fractional or full T-1 lines through the FTS 2000 contract are:

- one time service charge to connect each node
- monthly fixed charge for generation and discontinuance based on distance and type of service

A sample cost structure using T-1 lines between Ft Eustis, Virginia and San Diego, California is:

- connection cost for initial service: \$2000 per site or \$4,000 for first year
- monthly line charge:

T-1	\$7,275/month or	\$87,300/year
768 kbps	\$5,625/month or	\$67,500/year
384 kbps	\$3,750/month or	\$45,000/year

These costs are for SDIS and do not include CODEC. For the purpose of comparison with other telecommunication alternatives the cost of CODEC must be considered in addition to line costs. Costs provided above are only for those two sites only. Additional monthly line charges are simple to compute -- the additional line costs are based on distance. Multi-point control

units that can accommodate 16 sites cost \$89,500. The majority of DoD common user networks have multipoint control units within their infrastructure.

7. Video Teletraining via FTS 2000 Using Satellite

AT&T does not offer satellite services within its FTS 2000 contract. AT&T could provide such service, but contract renegotiation would be required. If amended, AT&T's FTS 2000 contract could provide wideband service including satellite compression techniques. This would provide near full motion video quality at 3.3 Mbps. Coverage includes all of North America, the Caribbean, Alaska, and Hawaii.⁶²

Sprint's "B" Network capabilities have been hindered by the same contract restrictions that have affected AT&T's service. However, as a result of special contract authorization for proof of concept "beta testing," Sprint is providing the Internal Revenue Service (IRS) with wideband video satellite service. The system uses one-way video and two-way audio. The IRS is the only government organization using both compressed video and wideband service through the FTS 2000 contract.⁶³

⁶² Telephone conversation between Dr. Jolly Holden, AT&T, and LCDR Jim Stewart, 22 June 1994.

⁶³ Telephone conversation between Kevin Lasher, Sprint, and LCDR Jim Stewart, 24 June 1994.

C. DEFENSE COMMERCIAL TELECOMMUNICATIONS NETWORK

1. Background

The Defense Commercial Telecommunications Network (DCTN) is the largest DoD common-user network. It was established in March 1986 to meet DoD command and control network requirements. The contract was awarded for a ten year period with AT&T, under the management of the Defense Communications Agency (DCA), which is now the Defense Information Systems Agency (DISA).⁶⁴ One of the principal objectives DoD stated in the Request For Proposal (RFP) was to ensure availability of a wideband capacity that could meet the needs of National Command crisis and emergency conditions.^{65 66}

DCTN was originally used as an inter-service communications link to support various components, or "communities of interest" within DoD that required frequent interactive high-speed data transmission. The first DCTN user was the Army Materiel Command (1986). DCTN soon began to provide services to the Air Force Logistics Command, Air Force Systems Command, Naval Air Systems Command and the Strategic Defense Initiative (SDI) Command.⁶⁷

⁶⁴ Grossman, Larry, *"Face to Face,"* Government Executive, p. 42, June 1991.

⁶⁵ Gold, Elliot M., *"Industry-wide Video Networks Thrive,"* Networking Management, p. 60, November 1991.

⁶⁶ AT&T, *"Command and Control That Stands The Test of Time,"* Special Edition of Government Issue, AT&T's Newsletter for its Federal Government Customers, Edited by Regina Esposito, July 1993.

⁶⁷ Gold, Elliot M., *"Industry-wide Video Networks Thrive,"* Networking Management, p. 60-62, November 1991.

DoD is now attempting to extend the DCTN contract until 1996, since DCTN did not officially start until the first circuit was purchased in 1986. Sprint is contesting the extension request, contending that DCTN has gone beyond the original scope of the contract for several reasons. The original contract called for a maximum of 14,000 circuits and was to be used for command and control purposes. By 1991 there were over 66,000 circuits and there are over 80,000 circuits now. Sprint also contends that services being provided under the original contract have exceeded the contract's original specification regarding services. The system was originally specified as a Command and Control network, but is now being used for basic administrative services and as such those services should be opened for bid by commercial vendors, according to Sprint.⁶⁸

2. DCTN Services

Currently DCTN provides the following services:

- integrated voice, data, and multi-point video in a digital network
- single point of contact for end-to-end service with centralized operation and maintenance
- integrated, centrally controlled, all digital network
- reconfigurable network capacity to meet user demand
- secure transmission via digital encryption standard (DES)
- protection of satellite links for network privacy⁶⁹

⁶⁸ Network World, "Sprint Sues Defense Dept. Over DCTN," p. 4, 11 July 1994.

⁶⁹ Defense Intelligence Agency, Intelligence Planners Communications Handbook, UNCLASSIFIED portion only, BDM International, Inc., p. 6-16, 1991.

3. DCTN CODEC and Interoperability

DCTN was originally a satellite based network. As land lines became more abundant and more affordable, the network evolved from satellite based to primarily terrestrial based fiber optics links.

VTT through DCTN is based on CLI products, so there is a preponderance of CLI devices throughout the network. VTC can occur between CLI and non-CLI systems if both systems are operated in standard mode. Sessions operating in standard mode require all participating sites to discontinue using proprietary CODECs and to use CODECs that are compliant with H.261. This requirement may result in poor video quality for some sites. There is one notable exception: the Rembrandt I CODEC, which is not H.261 compliant. As a result the Rembrandt I is not interoperable with any system in use by DoD.

Links to other networks are provided by two gateway connections. One for the west coast is located in the Los Angeles area of California. The gateway for the east coast is located in the Washington, D. C. area. Currently there is no direct gateway connection between DCTN and FTS 2000. DCTN and FTS 2000 can conduct VTT sessions only by accessing Sprint's Meeting Channel gateway.

DCTN's Network Control Center (NCC) is located in Danville, Virginia. The NCC schedules use of over 140 DCTN video rooms throughout the United

States, including Hawaii. Currently there are no services to Alaska, though connection is possible through special arrangements with other VTT systems.⁷⁰

4. DCTN Scheduling Considerations

DCTN was contracted as a command and control network. As such, it must be operated within the guidelines provided by the Warner Amendment for exceptions to mandatory FTS 2000 use. Current video applications utilizing DCTN include: Command and Control, Distance Learning, Project Administration, Crisis Management, Contract Administration, and Recruiting.⁷¹ Sprint is contesting DoD's request for a contract extension. Stating "The Department of Defense has failed to remain within the Warner Amendment guidelines as set forth by congress."⁷² The Warner Amendment, enacted in 1981, exempted DoD from the Brooks Act for certain applications such as Command and Control, intelligence activities, cryptologic activities and embedded weapon systems. Sprint's contention is that DoD has abused the Warner Amendment by authorizing applications to fall within it's guidelines that do not meet them. As a result, programs should have been for competitively bid were not.

⁷⁰ Fuller, Carol, *"FTS 2000 Network Video conferencing Service Attracting Major Users,"* Teleview, 1st/2nd Quarter 1991, p. 1-5, 1991.

⁷¹ AT&T, *"DCTN Features and Functions,"* AT&T product information brochure, February 1994.

⁷² Messmer, Ellen, *"Sprint Sues Defense Department over DCTN,"* Network World, p. 4, 11 July 1994.

All services provided by DCTN must be scheduled through DITPRO.⁷³ Each DoD component uses DCTN to fit their own requirements and have their own procedures for submitting new VTC requirements to DCTN.⁷⁴ Twenty four hour video teletraining is possible through DCTN. Reservations are required and are made via the Network Control Center (NCC). DCTN guarantees availability if given at least one hour advance notice. Video provided is non-preemptible, meaning that a VTT session cannot be interrupted by a higher priority request for transmission lines.⁷⁵

5. DCTN Equipment Considerations

DCTN does not automatically provide customers the required VTT equipment. DECCO has negotiated a Communications Service Authorization (CSA) with AT&T to provide a wide range of VTC services and equipment for DCTN users. New users are under no obligation to use the CSA provided the equipment is fully compatible with DCTN.

The proprietary CODEC for DCTN is the CLI Rembrandt series. There are three basic systems ranging in price from \$29,000 to \$45,000. The standard

⁷³ U.S. General Services Administration, Information Resources Management Service, Acquisition of Information Resources and Overview Guide, p. 3-2, January 1990.

⁷⁴ Fuller, Carol, "FTS 2000 Network Video conferencing Service Attracting Major Users," Teleview, 1st/2nd Quarter 1991, p. 1-5, 1991.

⁷⁵ AT&T, "DCTN Features and Functions," AT&T product information brochure, February 1994.

video system also comes with 60 options, including multipoint capability, picture quality, camera capability, and audio/graphics options.

One of the more important options is varying levels of CODEC conversions. Different levels of CODEC capability and compatibility are provided by different option packages. Organizations must avoid using the older CLI Rembrandt I model since it is not compliant with the FIPS 178 mandated CODEC standard, H.261.

6. DCTN Cost Considerations

DCTN provides a firm-fixed price, dedicated service.⁷⁶ The site pays a fixed monthly fee regardless of the number of calls, distance between sites, or the amount of connect time. There may be a cost component associated with distance and time if the site is not co-located with a node. This fee method generally supports high usage DCTN rates. There are four primary associated costs:

- Average one time hook-up fee and network installation: \$22,000
- One time multipoint capability installation: \$ 3,000
- Recurring monthly line charges which are based on bandwidth and the distance from the user to the nearest DCTN node.
- Monthly line charge.

⁷⁶ A node is an addressable unit in a network, which can be a computer workstation or some type of communications control unit.

Monthly line charge is based on bandwidth as shown below:

- T-1 \$8,000 per month or \$96,000 per year⁷⁷
- 768 kbps \$6,000 per month or \$72,000 per year
- 384 kbps \$3,500 per month or \$42,000 per year⁷⁸

Assuming the user is co-located with the DCTN node, total costs would be as follows:

- T-1 \$121,000 for the first year and
 \$96,000 for each additional year
- 768 kbps \$97,600 for the first year and
 \$72,000 for each additional year
- 384 Kbps \$67,600 for the first year and
 \$42,000 for each additional year⁷⁹

Each link is reviewed by DECCO before assessing monthly charges. There are instances of facilities within 15 miles of a node paying identical rates to a facility collocated with that node. DCTN monthly charges are reviewed annually to ensure rates are competitive with other industry communication offerings.⁸⁰

⁷⁷ Monthly T-1 line charge range between \$8,000 and \$20,000 depending on the distance between a site and the nearest DCTN node. The median cost is \$10,500 per month.

⁷⁸ This doesn't account for the cost associated with the distance between the user and the DCTN access node. Each bandwidth has associated costs per mile.

⁷⁹ Listed cost do not include DECCO's 2% administrative fee or the cost of VTT equipment.

⁸⁰ AT&T; "DCTN Features and Functions," AT&T product information brochure, February 1994.

7. DCTN Satellite VTT

DCTN satellite implementation is designed to support a one-way video, two-way audio topology (1W/2W). Although DCTN theoretically could support two-way video, two-way audio (2W/2W), 2W/2W has not been implemented due to higher costs. The Air Force Institute of Technology Air Technology Network and the Army Satellite Education Network are the heaviest users of DoD satellite VTT. Both systems use Compressed Digital Video Service (CDVS) which digitizes and compresses a NTSC standard television signal from 90 Mbps down to a user-selected 3.3 or 6.6 Mbps.

D. VIDEO TELETRAINING VIA SATELLITE

Satellite video teletraining (VTT) has had wide scale use in DoD for many years. Networks such as the Army Video Teletraining Network (TNET), AFIT's ATN, and the Army's SEN all employ satellites to provide VTT. The Navy's Chief of Naval Education and Training (CNET) Electronic School House Network (CESN) has converted to a 100 percent terrestrial VTT system. CESN no longer uses its satellite VTT system, but has maintained the capability.⁸¹

1. Advantages of Satellite VTT

There are several situations where satellite VTT provides an attractive alternative to terrestrial point-to-point VTT systems. Satellite VTT is particularly attractive when:

- a remote location has communications requirements that do not justify the expense of installing a dedicated terrestrial (land-line or line-of-sight microwave) connection
- a temporary location that does not have convenient access to a terrestrial connection
- applications involve frequent multipoint video connections
- training must be broadcast to many sites simultaneously from a central location
- training requires non-preemptible service
- sites approach 100% usage rates

⁸¹ Personal conversation between LCDR Scott Shephard, CESN, and LT Brian Steckler, 16 March 1994.

The last three items are not unique to satellite VTT. For example, non-preemptible service could be provided between two sites via dedicated terrestrial line. These conditions are often handled more conveniently and less expensively by using satellite communications.

2. Disadvantages of Satellite VTT

a. Satellite Coverage

A key consideration for any VTT decision is geographical coverage. VTT satellite systems "foot print" is primarily restricted to the continental United States (CONUS), though some systems do cover Alaska, Hawaii, and the Caribbean basin. Coverage can be a limiting factor if the desired site is not within the "foot print" of the satellite system providing coverage.⁸²

For example, the Army's SEN provides coverage to all of North America, including Puerto Rico and the U. S. Virgin Islands via an AT&T TELSTAR 401 satellite.⁸³

The Army's TNET system provides coverage in CONUS and Hawaii through Oklahoma State University. Oklahoma State University has leased satellite time from Hughes Satellite Corporation, it then turns around and leases

⁸² Hughes Computer and Telecommunications Station (HCTS) Pensacola, Florida, UNCLASSIFIED facsimile, "1993 NAVNET Backbone," 14 February 1994.

⁸³ Telephone conversation between Kenn Johnson, SEN Director, and LCDR Jim Stewart, 15 July 1994.

time to other organizations in order to recover costs, TNET is one such organization.⁸⁴

b. Frequency Selection

Another issue concerning satellite VTT is frequency selection for uplink and downlink signals. The frequencies used for satellite communications fall in the Super High Frequency (SHF) range, 3 Ghz to 30 Ghz.⁸⁵ Commercial video programming, including VTT transmissions, transmit on the C and Ku satellite bands. The C band is typically 6 Ghz uplink and 4 Ghz downlink. The Ku band is typically uplinked at 14 Ghz and downlinked at 12 Ghz.⁸⁶ Current VTT systems favor the Ku band because it uses less satellite transponder bandwidth and is less susceptible to terrestrial microwave interference. The drawback of Ku band is interference caused by heavy rainfall at either the uplink or downlink location.

c. Equipment Requirements

Video Teletraining satellite equipment consists of a network control center used to monitor the status of all sites in the network and coordinate reservations, a Very Small Aperture Terminal (VSAT) antenna, communication

⁸⁴ Telephone conversation between Walter Breckons, TNET Director, and LCDR Jim Stewart, 14 July 1994.

⁸⁵ Defense Intelligence Agency, *Intelligence Planners Communications Handbook*, UNCLASSIFIED portion only, BDM International, Inc., p. 2-15, 1991.

⁸⁶ Freeman, Roger L., *Telecommunication Transmission Handbook*, 3rd ed., John Wiley & Sons, Inc., p. 367, 1991.

lines (cable, fiber, or microwave) that tie a site to an uplink or downlink point, and a CODEC. Basic equipment includes:

- **Very Small Aperture Terminal (VSAT):** This is a small satellite dish usually 1.2 to 1.8 meters in diameter used to receive high speed data transmission and transmit slow-speed data. A VSAT uplink for compressed video via C-Band frequencies use a dish approximately 4.5 meters in diameter.
- **Satellite:** An electronics re-transmission device serving as a repeater normally placed in orbit around the earth in geostationary orbit to receive and re-transmit electromagnetic signals. Satellites normally receive signals from a single source and re-transmit them over a wide geographic area.
- **Satellite Receiver:** A microwave receiver is capable of receiving satellite transmitted signals, down-converting, and demodulating those signals, and providing a baseband output (video, audio). Most receivers are frequency agile (capable of multiple band reception, like both the C and Ku-band).
- **Basic Receiver System:** Low cost system with limited reception (one satellite and one band). Antennas are usually fixed in place and tuning capability may be limited.
- **Motorized Receiver System:** Receives programs on different satellites by adjusting the dish position. Motorized systems are often associated with mobile sites.⁸⁷
- **Transponder:** Takes a received signal from an antenna at the uplink frequency, heterodynes (mixes) it to the downlink frequency, and amplifies it before transmitting back to earth. Satellites have 12 or more

⁸⁷ Lane, Carla, "Distance Learning Resource Network Technology Resource Guide," Far West Laboratory, p. 6, October 1993.

transponders, each with the capacity for one color TV signal and two audio channels.⁸⁸

CODEC compatibility is essential to interoperability among many sites. Many VTT systems, such as the Army's TNET ensure compatibility by requiring remote sites to use the same equipment. Other systems, such as DCTN, employ a variation to the standard CODEC implementation scheme in order to provide one-way only video transmission. Instead of CODECs, an encode only device is provided at the uplink site. Downlink sites use an Integrated Receiver/Decoder (IRD) to decode signals. The IRD has no uplink capability.

3. Satellite VTT Costs

Initial uplink costs constitute the largest portion of satellite video expense. A 2W/2W, single channel, uplink site costs approximately \$275,000 (depending on equipment purchased). All sites with a 2W/2W system would be required to purchase the uplink portion. Systems that are 1W/2W must purchase only one uplink site. Downlink-only sites are considerably less expensive. The primary factors that affect the cost of a satellite VTT system are:

- equipment needs (lease versus purchase considerations) for uplink
- initial number of channels required
- satellite time
- maintenance and network support
- equipment needs (lease versus purchase considerations) for downlink

⁸⁸ Schweber, William, *"Electronic Communication Systems,"* Prentice-Hall, p. 603, 1991.

a. DCTN-CDV System Costs

DCTN-CDV systems (ATN and SEN) are 1W/2W. The costs for satellite time on a per hour basis depends on the number of broadcast hours per month. Costs are applied for each hour of actual use, completely independent of the number of receive sites. There is no limit to the number of sites that can receive a broadcast signal as long as the sites are within the satellites footprint. Satellite usage costs range from \$185 to \$335 per hour and are based on total number of hours used in a month. The more the system is used in a given month the lower the average cost per hour for that month.

Uplink costs (one time charge):	<u>6 channel ATN⁸⁹</u>	<u>2 channel SEN⁹⁰</u>
▪ Purchase equipment (redundant) ⁹¹	\$1,257,400	\$1,072,900
▪ Site Survey	\$ 8,400	\$ 8,400 ⁹²
Recurring Charges (monthly rate x 12):		
▪ Maintenance	\$ 96,804 ⁹³	\$ 44,004
▪ Network Management	\$ 10,800 ⁹⁴	\$ 10,800
▪ Satellite Time ⁹⁵	\$ 33,000	\$ 33,000

⁸⁹ Telephone conversation between Major Phil Westfall, Director AFIT Center for Distance Education and LCDR Jim Stewart, 11 July 1994.

⁹⁰ Telephone conversation between Kenn Johnson, SEN Director, and LCDR Jim Stewart, 15 July 1994.

⁹¹ Redundant systems include duplicate hardware that provides redundancy in the event of component failure, resulting in a 99.5% reliability rate.

⁹² Prices are valid until December 1994. Cost of site survey is based on 1993 average cost of site surveys.

⁹³ $((\$1,467 \text{ base rate} + \$1,100 \text{ per channel per month}) \times 12) = \$96,804$ for six channels and \$44,004 for two channels.

⁹⁴ $(\$900 \text{ per month} \times 12 \text{ months}) = 10,800$

⁹⁵ Based on medium usage rate of 150 hours/month: $(150 \text{ hours/month} \times \$220/\text{hour}) = \$33,000$

IV. DFAS VTC NETWORK

A. EXISTING VTC SITES

DFAS has a limited VTC network, with sites primarily configured for small group conferences. The network could be adapted to double as a VTT capable system while a more suitable VTT network is developed. The DFAS VTC network consists of eight sites, five at major DFAS centers, two at DFAS headquarters, and one in Pensacola, Florida. One of these existing sites (Cleveland DISO Satellite, Bratenahl, Ohio) was a DFAS site when VTC equipment was initially installed. It is now a DISO site vice a DFAS facility, and therefore will likely not be part of the final DFAS VTC configuration.

Eighteen more DFAS systems are scheduled to come on-line by the end of fiscal year (FY) 1996. The primary purpose of the VTC network will be to provide management with video teleconferencing opportunities to reduce travel costs. The network could be used to meet some financial management training requirements at DFAS sites, but some site room configurations would require modifications for training (i.e., remove conference tables, replace with student desks, and install more microphones). The DFAS sites that are currently VTC capable and their configurations are:

- **DFAS Headquarters, Arlington, Virginia**
 - Model: PictureTel System 4000
 - Number of rooms: 1
 - Number of seats: 20
 - Average hours used per week: 20
 - Point of contact: Ms. Mary Marks (703) 602-3748; DSN 327-3748

- **DFAS Columbus Center, Columbus, Ohio**
 - Model: PictureTel System 4000
 - Number of rooms: 1
 - Number of seats: 16
 - Average hours used per week: N/A (completed acceptance testing 25 August 1994)
 - Point of contact: Mr. David Holderby (614) 692-2255; DSN 850-2255

- **DFAS Cleveland Center, Cleveland, Ohio**
 - Model: PictureTel System 4000
 - Number of rooms: 1
 - Number of seats: 30
 - Average hours used per week: 18
 - Point of contact: Ms. Pat Allen (216) 522-5511; DSN 580-6866

- **DFAS Indianapolis Center, Indianapolis, Ohio**
 - Model: PictureTel System 4000
 - Number of rooms: 1
 - Number of seats: 30
 - Average hours used per week: 25
 - Point of contact: Ms. Paula Fruin (317) 542-2143; DSN 699-2143

- **DFAS Denver Center, Denver, Colorado**
 - Model: PictureTel System 4000
 - Number of rooms: 1
 - Number of seats: 20
 - Average hours used per week: 25
 - Point of contact: Mr. Ed Ording (303) 676-7461; DSN 926-7461

- **DFAS Financial Systems Activity, Pensacola, Florida**
 - Model: PictureTel System 4000
 - Number of rooms: 1
 - Number of seats: 16
 - Average hours used per week: 5
 - Point of contact: Mr. James Welch (904) 452-2990; DSN 922-2990

- DFAS Kansas City, Kansas City, Missouri
 - Model: PictureTel System 4000
 - Number of rooms: 1
 - Number of seats: 20
 - Average hours used per week:
 - Point of contact: Ms. Renee Everage (816) 926-7102; DSN 465-7102

The DFAS VTC system is a terrestrial based, 112 to 384 kbps, 2W/2W capable network using ISDN telephone lines. Peripheral equipment is different at each site. Common equipment includes 35 inch dual monitors, white board, document camera and a monitor setup with personal computer access point. AT&T provides ISDN circuits under the FTS 2000 contract. VTC session reservation and control functions are provided by the DFAS headquarters.⁹⁶ PictureTel System 4000 units are installed at the eight operational sites. The VTC systems are government owned (purchased via the GSA schedule on the FTS 2000 Network "A" contract), and government operated by local site government employees.

Although video teleconferencing is the primary function of the DFAS VTC system, there are some DFAS training programs that hope to use the system's capabilities to decrease travel requirements. One such program, the DFAS Intern Program, has used the system for very limited training (1 to 2 hours of VTT per month at the Kansas City site for example). The DFAS Intern Program produces approximately 25 interns annually through a two year program of

⁹⁶ Telephone conversation between Ms. Mary Marks, DFAS Headquarters and LT Brian Steckler, 26 August 1994.

primarily soft-skill financial management topics such as Defense Business Operating Funds (DBOF) and unit costing. The program's interns travel once a quarter to sites other than their "home site" for on-the-job training.⁹⁷

B. PLANNED DFAS VTC SITES

Thirteen DFAS VTC sites are scheduled for installation in FY 1995 and the remaining 5 sites will be operational by the end of FY 1996. The identities of the FY 1995 and FY 96 sites and their schedules is not available due to contract negotiations and pending announcements. These 18 sites are scheduled to have PictureTel System 4000's installed and will have peripheral equipment similar to the existing sites. DFAS estimates for total equipment cost per site are \$45,000. Operating costs will vary based on usage per site and number of multi-site sessions, but DFAS has estimated a total communications cost of \$175,000 for the eight existing sites in FY 1994. Maintenance costs for the eight existing DFAS VTC sites average \$4,500 per year and depend on individual site negotiated maintenance contracts.⁹⁸

⁹⁷ Telephone conversation between Mr. James Lamb, DFAS Kansas City and LT Brian Steckler, 26 August 1994.

⁹⁸ Facsimile correspondence from Mr. Wayne Bodle, DFAS Headquarters to Mr. Stephen Hurst, DBMU, 5 August 1994.

V. CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

The research conducted for this thesis reveals that DFAS has a limited VTC network that can be adapted to provide VTT services in parallel with the VTC program. Of the 25 DFAS centers, there are now seven that conduct VTC using terrestrial based 2W/2W systems. There are plans to install similar equipment at the remaining 18 DFAS centers over the next two years (FY95 and FY96). DFAS has not identified specific training or VTT based requirements for the 25 centers but has determined that some level of VTT capability will be necessary to meet both near and long term distance learning needs. In addition to the DFAS VTC network, there are four mature and capable DoD VTT networks which DFAS can use as VTT service providers, at least until a DFAS VTT network can be developed.

B. RECOMMENDATIONS

1. General Comments

This thesis contains recommendations for both near and long term consideration. There are many evolving systems and standards within the VTC and VTT fields. Of critical importance is that decision makers know which of these systems are currently available, which are compatible with existing DFAS

VTC sites, and which are (or will be) compatible with emerging industry standards that will define future DFAS VTC/VTT system design.

2. Short Term Recommendations

a. Determine DFAS VTT Requirements

The first priority for DBMU's development of a DFAS distance learning program is to determine both the overall and specific training requirements at each of the 25 DFAS facilities. Once overall training estimates are made, the DBMU can begin to design curriculum with VTT as a possible delivery method. Hand in hand with VTT requirements identification, the DBMU must coordinate with DFAS managers who have cognizance over existing and planned VTC installations to avoid unnecessary cost overlaps, system incompatibilities and scheduling conflicts.

b. Upgrade Current DFAS VTC Sites

If a determination is made that the existing seven DFAS VTC facilities have a demand for distance learning, we recommend that the facilities (including room layouts and equipment such as microphones and monitors) be either modified to accommodate students, or moved to another location on-site if physical space precludes using rooms as combination VTC/VTT facilities. If other VTC room modifications are planned for other reasons (such as DFAS realignment or physical plant adjustments) we recommend both DFAS and DBMU consider near and long term requirements.

c. Utilize Existing DFAS VTC System Until VTT System in Place

Our research has shown that some DFAS sites are using existing VTC rooms for limited VTT sessions. Room configurations are predominantly set up for conferences, but some DFAS employees have been linking with other DFAS sites for VTT sessions. The research⁹⁹ has also shown that some sites are under-utilized and others are "booked" most of the time for VTC. We recommend that DBMU work with DFAS VTC coordinators to determine actual VTC and VTT requirements at all sites and to explore ways to allow both types of interactive video sessions until a permanent VTC/VTT network is developed.

3. Long Term Recommendations

a. Develop a Network with Maximum Compatibility and Capacity

There is no central, official DoD-wide VTC/VTT coordinating activity for telecommunications requirements, equipment purchases or scheduling. The primary reason for a lack of central authority is the diversity of specialized training and video conferencing needs of DoD services and components. This lack of a central authority makes it imperative that DBMU and DFAS develop a system that will be compatible not only throughout the 25 DFAS sites, but eventually throughout the DoD financial management community. The best way to do this is to comply with ITU-TSS and FIPS 178 guidelines, i.e., to ensure interoperability among the DFAS sites, DBMU and DFAS should require

⁹⁹ Telephone conversation between Mr. James Lamb, DFAS Kansas City and Lt Brian Steckler, 26 August 1994.

compliance with px64 standards, which will ensure a "least common denominator" for data rates among the sites.

In addition to compatibility issues, DBMU should expect the demand for both VTC and VTT to grow significantly in the future. Costs for student travel and resident courses at remote facilities continue to climb. The 25 DFAS centers are expected to employ as many as 750 personnel, many of which will find more and more reasons to have face-to-face meetings and/or obtain instruction from distant sites. DBMU should consider designing several parallel VTC and VTT rooms at each location (if justified by demand), and should ensure that the systems have identical telecommunications and equipment configurations. At the very least, multiple channel down link capability at all sites should be explored.

b. Develop a VTT Origination Facility at Southbridge

Under DBMU guidance, the planned Center for Financial Management Education and Training in Southbridge, Massachusetts will be the primary curriculum development site for all DFAS courses. A logical extension of this role is for DBMU to create a complete center for all aspects of video teletraining curriculum development at the Southbridge facility. Such a location should be used as both a VTT session origination (broadcast) facility and as a VTT instructor training site. In addition, the Southbridge facility should be designed

as a complete broadcast, course development and distribution facility for all forms of technology based education.

c. Develop an Interoperable VTT Network

There are many choices for DoD organizations looking for VTC and VTT equipment and technologies. We recommend that DBMU help ensure that DFAS VTC/VTT systems remain as versatile as possible by designing (or redesigning if necessary) their networks to be DCTN satellite, 1W/2W capable (to allow linking to systems such as SEN and ATN) as well as terrestrial based, 2W/2W over FTS 2000 circuits (to allow linking to CESN and other DFAS sites). Another consideration is that other connectivity requirements may develop in the future. If the VTC/VTT network is designed to be flexible, connectivity to other government agencies and DoD contractors will be possible as well as with commercial systems such as the Sprint/Kinko PictureTel based 384 kbps VTC network that has over 300 facilities throughout the United States.

d. Develop a DoD Financial News Network

The final recommendation is for DBMU to use the Southbridge Center to develop a DoD-wide Financial News Network. Implementation of a Financial News Network will allow rapid, efficient dissemination of DoD financial information from the same location that is responsible for ensuring that DoD agencies remain abreast of constantly evolving fiscal policies. We recommend, as with the DFAS VTT network recommendations, that this Financial News

Network be compatible with the DFAS VTC/VT network and other major DoD VTT systems (SEN and ATN for 1W/2W systems; CESN and TNET for 2W/2W systems).

APPENDIX A.

LIST OF ACRONYMS AND ABBREVIATIONS

The following is a summary of acronyms and abbreviations used in this thesis.

ADPE	Automatic Data Processing Equipment
AFB	Air Force Base
AFIT	Air Force Institute of Technology
AFnet	Air Force Integrated Data Telecommunications Network
ALMC	Army Logistics Management College
ARPA	Advance Research Projects Agency
ASD-C3I	Office of the Assistant Secretary of Defense - Command, Control, Communications and Intelligence
ATN	Air Technology Network
AT&T	American Telephone and Telegraph
BRI	Basic Rate Interface
CCITT	International Telegraph and Telephone Consultative Committee
CDE	Center for Distance Education
CDV	Compressed Digital Video
CD-ROM	Compact Disc-Read Only Memory
CESN	CNET Electronic Schoolhouse Network
CIF	Common Intermediate Format
CLI	Compression Labs, Inc.
CNET	Chief of Naval Education and Training
CNO	Chief of Naval Operations
CODEC	Coder/Decoder
CONUS	Continental United States
CSA	Communications Service Authorization
CSIF	Communications Service Industrial Fund

CVTS	Compressed Video Transmission Service
DBMU	Defense Business Management University
DCA	Defense Communications Agency
DCE	Data Communication Equipment
DCT	Discrete Cosign Transform
DCTN	Defense Commercial Telecommunications Network
DDN	Defense Data Network
DECCO	Defense Commercial Communications Office
DES	Digital Encryption Standard
DFAS	Defense Finance and Accounting Service
DIA	Defense Intelligence Agency
DISA	Defense Information Systems Agency
DISN	Defense Information System Network
DISO	Defense Information Systems Office
DITPRO	DISA Information Technology Procurement Organization
DLA	Defense Logistics Agency
DMP	Dynamic Multipoint CVTS Service
DNCC	DCTN Network Coordination Center
DoD	Department of Defense
DPA	Delegation of Procurement Authority
DPCM	Differential Pulse Code Modulation
DS0	65 Kbps single channel pulse code modulation rate
DSN	Defense Switched Network
DTE	Data Terminal Equipment
DVBX	Digital Video Branch Exchange
FAX	Facsimile
FIPS	Federal Information Processing Standards
FMET	Financial Management and Training

fps	frames per second
FTS	Federal Telecommunication System
GBVS	Global Business Video Service
GHz	Billions of hertz (Gigahertz), 1,000,000,000 hertz
GOB	Groups of Blocks
GSA	General Services Administration
GSA SOC A	General Services Administration Service Oversight Center for Network "A"
I/O	input/output
IMUX	Inverse Multiplexer
IRD	Integrated Receiver/Decoder
IRS	Internal Revenue Service
ISDN	Integrated Services Digital Network
ITU	International Telecommunications Union
ITU-TSS	International Telecommunications Union Standardization Sector
JPEG	Joint Photographic Experts Group
kbps	Thousands of bits (kilobits), 1,000 bits per second
KMAS	General Services Administration Authorization Branch
Mbps	Millions of bits (Megabits), 1,000,000 bits per second
MCU	Multi-point Control Unit
MHz	Millions of hertz (Megahertz), 1,000,000 hertz
MIL-STD	Military Standard
MPEG	Motion Picture Experts Group
MUX	Multiplexer
NAS	Naval Air Station
NCC	Network Coordination Center
NCTC	Naval Computer and Telecommunications Command
NIST	National Institutes of Standards and Technology

NSC	Naval Supply Center
NTC	Naval Training Command
NTSC	National Television Systems Committee
NTU	National Technological University
OSD	Office of the Secretary of Defense
PBX	Private Branch eXchange
PC	Personal Computer
PCM	Pulse Code Modulation
pixel	Picture element
PSS	Packet Switched Service
QCIF	Quarter Common Intermediate Format
RFP	Request For Proposal
SCI	Sensitive Compartmented Information
SDI	Strategic Defense Initiative
SDS	Switched Data Service
SDIS	Switched Digital Integrated Service
SDP	Service Delivery Points
SEN	Satellite Education Network
SHF	Super High Frequency (3,000 to 30,000 MHz)
SVS	Switched Voice Service
TDMA	Time Division Multiple Access
TNET	Army Video Teletraining Network
TRADOC	Army Training and Doctrine Command
USS	United States Ship
VASM	Voice Activated Switching Mode
VCR	Video Cassette Recorder
VSAT	Very Small Aperture Terminal
VTC	Video Teleconferencing
VTs	Video Transmission Service

VTT	Video Teletraining
VTel	Video Telecom
VTU	Video Teleconferencing Unit
1W/1W	One Way Video/One Way Audio
1W/2W	One Way Video/Two Way Audio
2W/2W	Two Way Video/ wo Way Audio

APPENDIX B.

DoD VTT NETWORK POINT OF CONTACT INFORMATION

Air Technology Network (ATN)
AFIT/LSE
Wright-Patterson AFB, OH 45433
Attn: Director for Distance Education

(513) 255-6863

Chief of Naval Education and Training (CNET)
CNET Educational School House Network (CESN)
Fleet Combat Training Center, Atlantic
Dam Neck, VA 23461-5200
Attn: CESN Project Manager

(804) 433-7795/7176

U.S. Army Video Teletraining Network (TNET)
U.S. Army Extension Training (AET)
Attn: ATIC-ETN
Building 1514 11th Street
Fort Eustis, VA 23604-5168

(804) 878-4725

DoD Satellite Education Network (SEN)
U.S. Army Training Support Center
Fort Lee, VA 23801-6052

(804) 765-4004

Defense Finance and Accounting Service (DFAS)
DFAS-HQ-SC
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