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INTERFACE STANDARD

INTEROPERABILITY AND PERFORMANCE STANDARDS FOR THE DEFENSE INFORMATION SYSTEM

AMSC N/A

AREA TCSS/DCPS

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FOREWORD

1. Interoperability of Department of Defense (DOD) telecommunications systems, and of DOD with non-DOD telecommunications systems, has been and will continue to be a major consideration in developing and adopting standards for military use.

a. Military standards (MIL-STD) in the 188 series (MIL-STD-188-XXX) address specific telecommunications design parameters that have been proven to work, and are to be used in all new or major upgrades of inter- and intra-DOD systems and equipment, and to interface with commercial non-DOD systems and equipment, to ensure interoperability.

b. MIL-STDs in the 187 series (MIL-STD-187-XXX) address evolving telecommunications design parameters and concepts that are subject to change and that have not been adequately proven through the use of empirical test data. MIL-STD-187-XXX standards should be used as planning standards and guides until parameters are proven and included in approved federal, allied, MIL-STD-188-XXX, or DOD-adopted commercial standards.

c. MIL-STDs in the 2045 series (MIL-STD-2045-XXXXX) address DOD Communications Protocol Standards (DCPS). A DCPS may be either a base standard or a functional profile. MIL-STD-2045 standards will include enhancements to commercial standards or include new protocol standards that are entirely unique to DOD. The 2045 series also allows for a category of interim DOD standards. Interim standards are needed because of the usual disparity between immediate DOD needs and the amount of time required in the commercial world to adopt new standards.

2. Beneficial comments (recommendations, additions, deletions) and any pertinent data that may be of use in improving this MIL-STD should be addressed to:

Defense Information Systems Agency
Joint Interoperability and Engineering Organization
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by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this MIL-STD or by letter. For immediate concerns, questions can be resolved by calling (908) 532-7720, DSN 992-7720, or by fax (908) 289-8333.

3. MIL-STD-187-XXX standards provide uniform guidance for the design of the evolving and future Defense Information System (DIS) at the information-transfer level. Providing this guidance at the concept engineering stage will help minimize ineffective designs and costly interoperability problems at later stages of implementation, as well as ensure use of appropriate advances in technology. Planning standards are developed considering present and future plans for the DIS, commercial systems (national and international), and North Atlantic Treaty Organization (NATO) and other allied military systems. These standards are usually based on or make reference to American National Standards Institute (ANSI) standards, International Telecommunications Union-Telecommunication Standardization Sector (ITU-T) [formerly the International Telegraph and Telephone Consultative Committee (CCITT)] Recommendations, International Organization for Standardization (ISO) standards, NATO standardization agreements (STANAG), and other MIL-STDs, wherever applicable.

4. This MIL-STD contains the technical standards and design objectives necessary to allow strategic and tactical users to exchange all forms of information digitally, using the DIS. The standards contained herein are common to both tactical and strategic systems, unless otherwise specified. This MIL-STD addresses all interoperability elements specified in the DIS framework, except data-processing standards such as standard programming languages and data elements.

5. The standards in this MIL-STD are based on, or make reference to, corresponding parameters in other MIL-STDs, as well as ANSI standards, ITU-T (CCITT) Recommendations, ISO standards, and NATO STANAGs, wherever applicable. Users of this MIL-STD should be aware that there may be patent rights, copyright claims, or both, by companies or individuals on portions of the MIL-STD. Before incorporating this MIL-STD into systems or equipment, users are advised to contact the appropriate standards organization, such as ANSI, regarding claims or conditions that pertain to the use of an applicable commercial standard. Implementers of this MIL-STD are solely responsible for compensating companies or individuals entitled to any royalties.

6. This MIL-STD is approved and will be used appropriately by the Office of the Secretary of Defense, the military departments, the Chairman of the Joint Chiefs of Staff and the Joint Staff, the Unified and Specified Commands, DOD agencies, and DOD field activities.

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APPENDIXES

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1. SCOPE

1.1 Purpose. The purpose of this military standard (MIL-STD) is to provide a baseline for planning and designing the evolving Defense Information System Network (DISN), defined in 1.7.

1.2 Applicability. This MIL-STD is to be used in planning, designing, and developing new Defense Information System (DIS) communications systems, and in making major changes to existing systems. This MIL-STD does not necessarily apply to leased commercial facilities, but such facilities should be selected to be compatible with its requirements. This MIL-STD applies to digital communications systems only. MIL-STD-188-100 will continue to provide the standards for analog communications systems.

1.3 Objectives. This MIL-STD has five objectives:

a. To achieve interoperability between strategic and tactical digital networks for voice, data, facsimile, record traffic, and video services.

b. To provide performance standards for strategic and tactical system users.

c. To adopt specific subsets of commercial standards, where feasible, to achieve cost-effective interoperability, performance, and interfaces.

d. To provide a framework to change existing standards and prepare new standards.

e. To establish a reference source for use by all organizations involved in developing the DISN and procuring DISN-compatible hardware and software.

1.4 System standards and design objectives. When procurement, engineering, or design activities elect to incorporate this planning standard in their acquisition documents, the parameters and requirements specified in this MIL-STD shall be treated as mandatory system standards if the word *shall* is used. Nonmandatory parameters, requirements, and design objectives are indicated by the word *should* (design objectives, rather than standards, are used when there is a lack of measured and verified data or no consensus on the interpretation of the data). *Will* is used to express a declaration of purpose or intent. For a definition of *system standards* and *design objectives*, see Federal Standard (FED-STD)-1037.

1.5 Standards action areas. This MIL-STD addresses the interoperability, performance, and interface standards that should be met by future Department of Defense (DOD) information systems to provide a wide variety of end-to-end digital subscriber services in a single integrated network. These services include voice telephony, data transmission, facsimile, record traffic, and video teleconferencing (VTC). This MIL-STD addresses standardization in eight major areas:

a. Subscriber services

b. Interfaces, including protocols and voice algorithms

c. Circuit switching and packet switching

d. Transmission

e. Signaling

f. Information security

g. Network management and system control

h. End-to-end performance requirements

In accordance with MIL-STD-970, the standards are based on American National Standards Institute (ANSI) standards; International Telecommunications Union-Telecommunication Standardization Sector (ITU-T) Recommendations for the Integrated Services Digital Network (ISDN); the International Organization for Standardization (ISO) Open Systems Interconnection (OSI) reference model; and existing MIL-STD-188 and MIL-STD-2045 series standards. This MIL-STD references other existing standards (military, federal, commercial, and international). The intent is to avoid duplication of existing standards, ensure backward-interoperability, and provide for orderly transition to forward-looking standards for new systems.

1.6 <u>DIS framework</u>. The standards provided in this MIL-STD are based on the DIS framework (see section 4, Figure 1) described below:

a. The DIS concept provides for an evolutionary integration of existing and future DOD computer and telephone communications systems. The Services and Agencies adopted the DIS framework as a guide for developing this MIL-STD. The DIS framework provides efficient, end-to-end, integrated service for information sources, sinks, and processors. Integrated service provides for voice, message, data, graphics, and imagery information-transfer across a single network interface. By definition, the DIS framework includes all components necessary to achieve interoperability between DOD users.

b. The DIS framework consists of three major sections, demarcated by reference points A and B. Users may access the DIS through subscriber network elements, such as source, sink, or processor terminal equipment. These terminal equipment include telephones, facsimile machines, VTC, and other data terminal equipment (DTE). For the information source, sink, or processor elements to be interoperable, all seven layers of the ISO OSI reference model must be interoperable.

c. DTEs exchange information through information-transfer utilities, which are comprised of local-network elements, wide-network elements, and their respective interoperability reference points. The military Services provide fixed-plant, local-network elements to support strategic users and base operations. They also provide tactical local-network elements to support garrison operations and access to wide-network elements, as well as tactical local-network elements to support deployed combat forces. The Defense Information Systems Agency (DISA) provides wide-network elements to interconnect geographically separated local networks. The wide network includes the Defense Communications System (DCS) and public switched telephone networks (PSTN). Since the local- and wide-network elements and interoperability reference points in the information-transfer utilities represent the telecommunications portion of DIS, their functionality is limited to the lower three layers of the OSI reference model.

d. Advances in computer and telephone communications technology allow multiple services to be provided by a single network, as in ISDN. Wherever applicable, the DIS framework allows the adoption of ANSI standards for ISDN. Within the DIS framework, circuit-switched voice and data services are based on MIL-STDs for tactical systems and ISDN commercial standards for strategic systems.

1.7 <u>Defense Information Infrastructure (DII)/Defense Information System Network (DISN)</u>. The DII is defined as the worldwide aggregation of all mobile and fixed DOD information systems, including sensors, data entry devices, management and control facilities. The DII allows DOD to collect, produce, store, disseminate, display, and secure information. It consists of communications and all supporting resources, such as network management, control, and value-added services. The DII and DIS are the same, and include the information transport segment (DISN) as well as the information processing segment [such as Corporate Information Management (CIM) megacenters and user terminals] of the information infrastructure.

The DISN includes all telecommunications resources, as described in 4.1. It extends from the wide-area network to the information-transfer and transform functions of the end-user computing and terminal equipment. This equipment includes software and hardware required to interconnect user terminal equipment and software, as well as local-area networks, local-access switches, and radio terminals.

2. APPLICABLE DOCUMENTS*

2.1 Government documents

2.1.1 Standards. The following standards form a part of this MIL-STD to the extent specified herein. Unless otherwise specified, the issues of these standards are those listed in the current issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplements thereto.

FEDERAL

FED-STD-1002	Time and Frequency Reference Information in Telecommunication Systems
FED-STD-1016	Telecommunications: Analog to Digital Conversion of Radio Voice by 4,800 Bit/Second Code Excited Linear Prediction (CELP)
FED-STD-1037	Glossary of Telecommunication Terms
FED-STD-1045	Telecommunications: HF Radio Automatic Link Establishment
FED-STD-1046	Telecommunications: HF Radio Automatic Networking (Draft)
FED-STD-1047	Telecommunications: HF Radio Automatic Message Exchange (Draft)
FED-STD-1048	Telecommunications: HF Radio Automatic Networking to Multimedia (Draft)
FED-STD-1049	HF Radio Automatic Operation in Stressed Environment (Draft)
FED-STD-1055	Telecommunications: Interoperability Requirements for Meteor Burst Radio Communications Between Conventional Master and Remote Stations

* NOTE: Only applicable sections of the referenced documents are intended to be used.

FED-STD-1056	Telecommunications: Interoperability Requirements for

	the Encryption of Meteor Burst Radio Communications
FED-STD-1057	Telecommunications: Interoperability Requirements for Meteor Burst Radio Communications Between Networks by Master Stations
FIPS PUB 146	Government Open Systems Interconnection Profile (GOSIP)
FIPS PUB 178	Video Teleconferencing Services at 56 to 1,920 kb/s
FIPS PUB 179	Government Network Management Profile (GNMP)

MILITARY

MIL-STD-187-721	Planning and Guidance Standard for Automated Control Applique for HF Radio
MIL-STD-188-105	All-Digital Tactical-to-Strategic Gateway
MIL-STD-188-110	Interoperability and Performance Standards for Data Modems
MIL-STD-188-111	Interoperability and Performance Standards for Fiber Optic Communications Systems
MIL-STD-188-112	Subsystem Design and Engineering Standards for Common Long Haul/Tactical Cable and Wire Communications
MIL-STD-188-113	Interoperability and Performance Standards for Analog-to-Digital Conversion Techniques
MIL-STD-188-114	Electrical Characteristics of Digital Interface Circuits
MIL-STD-188-115	Interoperability and Performance Standards for Communications Timing and Synchronization Subsystems
MIL-STD-188-124	Grounding, Bonding and Shielding for Common Long Haul/Tactical

	Communication Systems Including Ground Based Communications-Electronics Facilities and Equipments
MIL-STD-188-136	EHF Medium Data Rate (MDR) Satellite Data Link Standards (SDLS): Uplinks and Downlinks (Draft)
MIL-STD-188-140	Equipment Technical Design Standards for Common Long Haul/Tactical Radio Communications in the Low Frequency Band and Lower Frequency Bands
MIL-STD-188-141	Interoperability and Performance Standards for Medium and High Frequency Radio Equipment
MIL-STD-188-145	Interoperability and Performance Standards for Digital LOS Microwave Radio Equipment
MIL-STD-188-146	Interoperability and Performance Standards for Satellite Communications
MIL-STD-188-148	Interoperability Standard for AJ Communications in the High Frequency (2-30 MHz) Band (U), SECRET
MIL-STD-188-161	Interoperability and Performance Standards for Digital Facsimile Equipment
MIL-STD-188-181	Interoperability Standard for Dedicated 5-kHz and 25-kHz UHF Satellite Communications Channels
MIL-STD-188-182	Interoperability Standard for 5-kHz UHF DAMA Terminal Waveform
MIL-STD-188-183	Interoperability Standard for 25-kHz UHF TDMA/DAMA Terminal Waveform
MIL-STD-188-184	Interoperability and Performance Standard for the Data Control Waveform

MIL-STD-188-185	UHF Satellite Communications TDMA/DAMA Controller
MIL-STD-188-190	Methods for Communications Systems Measurements
MIL-STD-188-194	Integrated Services Digital Network Profile
MIL-STD-188-196	NITFS, Bi-Level Image Compression (Draft)
MIL-STD-188-197	NITFS, Adaptive Recursive Interpolated Differential Pulse Code Modulation (ARIDPCM) (Draft)
MIL-STD-188-198	NITFS, Joint Photographic Experts Group (JPEG) Image Compression (Draft)
MIL-STD-188-200	System Design and Engineering Standards for Tactical Communications
MIL-STD-188-202	Interoperability and Performance Standards for Tactical Digital Transmission Groups (Coaxial Cable)
MIL-STD-188-203-1	Interoperability and Performance Standards for Tactical Digital Information Link (TADIL) A
MIL-STD-188-203-3	Subsystem Design and Engineering Standards for Tactical Digital Information Link (TADIL) C
MIL-STD-188-212	Subsystem Design and Engineering Standards for Tactical Digital Information Link (TADIL) B
MIL-STD-188-216	Interoperability Standards for Data Adapter Control Mode
MIL-STD-188-220	Interoperability Standard for Digital Message Transfer Device Subsystems
MIL-STD-188-242	Interoperability and Performance Standards for Tactical Single Channel Very High Frequency (VHF) Radio Equipment

MIL-STD-188-243	Interoperability and Performance Standards for Tactical Single Channel Ultra High Frequency (UHF) Radio Communications
MIL-STD-188-260	Design and Engineering Standards for Tactical Terminal Subsystems
MIL-STD-188-313	Subsystem Design and Engineering Standards and Equipment Technical Design Standards for Long Haul Communications Transversing Microwave (LOS) Radio and Tropospheric Scatter Radio
MIL-STD-188-331	Interoperability and Performance Standard for Video Teleconferencing
MIL-STD-210	Climatic Information to Determine Design and Test Requirements for Military Systems and Equipment
MIL-STD-449	Radio Frequency Spectrum Characteristics, Measurement of
MIL-STD-461	Electromagnetic Emission and Susceptibility Requirements for the Control of Electromagnetic Interference
MIL-STD-462	Electromagnetic Interference Characteristics, Measurement of
MIL-STD-470	Maintainability Program for Systems and Equipment
MIL-STD-471	Maintainability Verification/ Demonstration/Evaluation
MIL-STD-781	Reliability Testing for Engineering Development, Qualification, and Production
MIL-STD-785	Reliability Program for Systems and Equipment Development and Production

MIL-STD-810	Environmental Test Methods and Engineering Guidelines
MIL-STD-970	Standards and Specifications, Order of Preference for the Selection of
MIL-STD-1472	Human Engineering Design Criteria for Military Systems, Equipment and Facilities
MIL-STD-1582	EHF Low Data Rate (LDR) Satellite Data Link Standards (SDLS) Uplinks and Downlinks (SECRET)
MIL-STD-2045-13500	Information Technology - DOD Profiles - Internet Relay Profile for DOD Communications
MIL-STD-2045-13501	Information Technology - DOD Profiles - Internet Routing Between Autonomous Systems
MIL-STD-2045-14500-1	Information Technology - DOD Profiles TA21(D) Transport Profile Part 1: Reliable End System (ES) Transport for DOD Communications
MIL-STD-2045-14500-2	Information Technology - DOD Profiles TA21(D) Transport Profile Part - COTS Over CLNS Part 2: Balanced Point-to-Point Digital Data Circuit
MIL-STD-2045-14500-3	Information Technology - DOD Profiles TA21(D) Transport Profile - COTS Over CLNS Part 3: Subnetwork for an Unbalanced Link
MIL-STD-2045-14500-4	Information Technology - DOD Profiles TA21(D) Transport Profile Part 4: Local Area Networks (LANs), Using Token Bus
MIL-STD-2045-14500-5	Information Technology - DOD Profiles TA21(D) Transport Profile Part 5: Local Area Networks (LANs), Using Token Ring
MIL-STD-2045-14500-6	Information Technology - DOD Profiles TA21(D) Transport Profile

	Part 6: Integrated Services Digital Network (ISDN)
MIL-STD-2045-14502	Internet Transport Profiles
MIL-STD-2045-14502-01	Information Technology - DOD Profiles - Internet Transport Profile for DOD Communications - Part 1: Transport and Internet Services
MIL-STD-2045-14502-02	Information Technology - DOD Profiles - Internet Transport Profile for DOD Communications - Part 2: Point-to-Point Links
MIL-STD-2045-14502-03	Information Technology - DOD Profiles - Internet Transport Profile for DOD Communications - Part 3: Wide Area Network Access
MIL-STD-2045-14502-04	Information Technology - DOD Profiles - Internet Transport Profile for DOD Communications - Part 4: Local Area Network (LAN) Media Independent Requirements
MIL-STD-2045-14502-05	Information Technology - DOD Profiles - Internet Transport Profile for DOD Communications - Part 5: Carrier-Sense Multiple Access with Collision Detection (CSMA/CD) Local Area Network (LAN) Media Dependent Requirements
MIL-STD-2045-14502-06	Information Technology - DOD Profiles - Internet Transport Profile for DOD Communications - Part 6: Combat Net Radio (CNR)
MIL-STD-2045-14503	Information Technology - DOD Profiles - Internet Transport Service Supporting OSI Applications
MIL-STD-2045-17501-01	Information Technology - DOD Standardized Profiles AMH1n(D) Message Handling System (MHS) Common Messaging AMH1n Part 1: MHS Service Support

MIL-STD-2045-17501-02	Information Technology - DOD Standardized Profiles AMH1n(D) Message Handling System (MHS) Common Messaging AMH1n Part 2: Specification of ROSE, RTSE, ACSE, Presentation and Session Protocols for Use by DOD MHS
MIL-STD-2045-17501-03	Information Technology - DOD Standardized Profiles AMH1n(D) Message Handling System (MHS) Common Messaging AMH1n Part 3: Requirements for Message Transfer (P1)
MIL-STD-2045-17501-04	Information Technology - DOD Standardized Profiles AMH1n(D) Message Handling System (MHS) Common Messaging AMH1n Part 4: Messaging Requirements for MTS Access (P3)
MIL-STD-2045-17501-05	Information Technology - DOD Standardized Profiles AMH1n(D) Message Handling System (MHS) Common Messaging AMH1n Part 5: Messaging Requirements for MS Access (P7)
MIL-STD-2045-17502	Military Standard, Information Technology DOD Standardized Profiles AMH2n(D) Message Handling Systems (MHS) Military Messaging
MIL-STD-2045-17502-1	Information Technology - DOD Standardized Profile AMH2n(D) Message Handling System (MHS) Military Messaging (P772) Part 1: MM MHS Service Support
MIL-STD-2045-17502-2	Information Technology - DOD Standardized Profile AMH2n(D) Message Handling System (MHS) Military Messaging (P772) Part 2: AMH21(D) - MM Content
MIL-STD-2045-17502-3	Information Technology - DOD Standardized Profiles AMH2n(D) Message Handling System (MHS) Military Messaging (P772) Part 3:

	AMH22(D) MM Requirements for Message Transfer (P1)
MIL-STD-2045-17502-4	Information Technology - DOD Standardized Profiles AMH2n(D) Message Handling System (MHS) Military Messaging (P772) Part 4: AMH23(D) MM Requirements for MTS Access (P3)
MIL-STD-2045-17502-5	Information Technology - DOD Standardized Profiles AMH2n(D) Message Handling System (MHS) Military Messaging (P772) Part 5: MM Requirements for MS Access (P7)
MIL-STD-2045-17503	Internet Message Transport Profile
MIL-STD-2045-17503-01	Information Technology - DOD Standardized Profiles - Internet Message Transfer Profile for DOD Communications - Part 1: Simple Mail Transfer Protocol (SMTP)
MIL-STD-2045-17503-02	Information Technology - DOD Standardized Profiles - Internet Message Transfer Profile for DOD Communications - Part 2: Format of Text Messages
MIL-STD-2045-17504	Information Technology - DOD Standardized Profiles - Internet File Transfer Profile for DOD Communications
MIL-STD-2045-17505	Information Technology - DOD Standardized Profiles - Internet Domain Name Service (DNS) Profile for DOD Communications
MIL-STD-2045-17506	Information Technology - DOD Standardized Profile - Internet Remote Login Profile for DOD Communications
MIL-STD-2045-17507	Internet Network Management Profile
MIL-STD-2045-17507-01	Information Technology - DOD Standardized Profiles - Internet Network Management Profile for DOD

	Communications - Part 1: Simple Network Management Protocol (SNMP)
MIL-STD-2045-17507-02	Information Technology - DOD Standardized Profiles - Internet Network Management Profile for DOD Communications - Part 2: Management Information Base (MIB)
MIL-STD-2045-17507-03	Information Technology - DOD Standardized Profiles - Internet Network Management Profile for DOD Communications - Part 3: Structure and Identification of Management Information
MIL-STD-2045-17508	Information Transfer DOD Profiles AFT1n(D)-File Transfer, Access and Management (FTAM)
MIL-STD-2045-17508-01	Information Technology - DOD Standardized Profiles AFT1n(D) - File Transfer, Access and Management - Part 1: Specification of ACSE, Presentation and Session Protocols for use by FTAM
MIL-STD-2045-17508-02	Information Technology - DOD Standardized Profiles AFT1n(D) - File Transfer, Access and Management - Part 2: Definition of document types, constraint sets and syntaxes
MIL-STD-2045-17508-03	Information Technology - DOD Standardized Profiles AFT1n(D) - File Transfer, Access and Management - Part 3: AFT11 - Simple File Transfer Service (unstructured)
MIL-STD-2045-17508-04	Information Technology - DOD Standardized Profiles AFT1n(D) - File Transfer, Access and Management - Part 4: Positional File Transfer Service for Flat Files
MIL-STD-2045-17508-05	Information Technology - DOD Standardized Profiles AFT1n(D) -

	File Transfer, Access and Management - Part 5: Positional File Access Service for Flat Files
MIL-STD-2045-17508-06	Information Technology - DOD Standardized Profiles AFT1n(D) - File Transfer, Access and Management - Part 6: AFT3 - File Management Service
MIL-STD-2045-18500-01	Information Technology DOD Standardized Profiles AMHXn(D) - Message Handling Systems - Message Security Protocol - Part 1: MSP Service Support
MIL-STD-2045-18500-02	Information Technology DOD Standardized Profiles AMHXn(D) - Message Handling Systems - Message Security Protocol - Part 2: AMHx1(D) - MSP Content Protocol
MIL-STD-2045-18500-03	Information Technology DOD Standardized Profiles AMHXn(D) - Message Handling Systems - Message Security Protocol - Part 3: AMHx2(D) - MSP Requirements for Message Transfer (P1)
MIL-STD-2045-18500-04	Information Technology DOD Standardized Profiles AMHXn(D) - Message Handling Systems - Message Security Protocol - Part 4: AMHx3(D) - MSP Requirements for MTS Access (P3)
MIL-STD-2045-18500-05	Information Technology DOD Standardized Profiles AMHXn(D) - Message Handling Systems - Message Security Protocol - Part 5: AMHx4(D) - MSP Requirements for MS Access (P7)
MIL-STD-2045-38000	DOD Network Management for DOD Communications
MIL-STD-2045-44500	Tactical Communications Protocol 2 (TACO2) for the NITFS
MIL-STD-2045-48501	Common Security Label

2.1.2 Military specifications

MIL-H-46855	Human Engineering Requirements for Military Systems, Equipment and Facilities

2.1.3 Military handbooks

MIL-HDBK-232	RED/BLACK Engineering-Installation Guidelines
MIL-HDBK-235	Electromagnetic (Radiated) Environment Considerations for Design and Procurement of Electrical and Electronic Equipment, Subsystems and Systems
MIL-HDBK-237	Electromagnetic Compatibility Management Guide for Platforms, Systems and Equipments
MIL-HDBK-241	Design Guide for Electromagnetic Interference (EMI) Reduction in Power Supplies
MIL-HDBK-253	Guidance for the Design and Test of Systems Protected Against the Effects of Electromagnetic Energy
MIL-HDBK-419	Vol I, Grounding, Bonding and Shielding for Electronic Equipments and Facilities Basic Theory; and Vol II, Grounding Bonding, and Shielding for Electronic Equipments and Facilities Applications
MIL-HDBK-829A	Guidelines for Developing Data Communications Protocol Standards
MIL-HDBK-1350-1	Validation of Data Communications Protocol Standards for Military Applications
MIL-HDBK-1350-2	Data Communications Protocol Conformance and Interoperability Testing and Registration, Volume 2, Sept 1993 (Draft)
MIL-HDBK-1351	Network Management for DOD Communications

2.1.4 Other DOD publications

DCAC 370-175-13	Defense Switched Network (DSN) System Interface Criteria
DISN Architecture	Defense Information System Network (DISN) Architecture, DISN-AR-1000, 12 May 1993 (Draft)
DOD 5200.28-STD	Department of Defense Trusted Computer System Evaluation Criterion
TAFIM	Technical Architecture Framework for Information Management (TAFIM), Volume 7, Adopted Information Technology Standards (AITS), Version 2.0, 12 Nov 1994
Joint Pub 6-01.1	Tactical Digital Information Link (TADIL) Message Standards (CONFIDENTIAL)
Joint Pub 6-01.3	Technical Interface Design Plan for ATDL-1
Joint Pub 6-05	Manual for Employing Joint Tactical Communications Systems
JIEO Specification 9001	Joint Technical Interface Specification for VHF SINCGARS Waveform
JIEO Specification 9109	Technical Interface Specification: Joint Interoperability via Fiber Optic Cable
NACSEM 5201	TEMPEST Guidelines for Equipment/ System Design (U)
NSTISSAM TEMPEST/ 1-91	Compromising Emanations Laboratory Test Requirements, Electromagnetics (U)
PG/6 TCP 2000	Tri-Service Group on Communications and Electronics, Project Group 6 -- Post-2000
TT-A3-9012-0046	Digital Loop Signaling/Supervision Plan

TT-A3-9016-0056	Digital Common Channel Signaling/Supervision Plan

2.1.5 Standardization Agreements (STANAG)

STANAG 4175	Technical Characteristics of the Multi-Functional Information Distribution System (MIDS)
STANAG 4206	The NATO Multi-Channel Tactical Digital Gateway System Standards
STANAG 4207	The NATO Multi-Channel Tactical Digital Gateway Multiplex Group Framing Standards
STANAG 4208	The NATO Multi-Channel Tactical Digital Gateway Signalling Standards
STANAG 4209	The NATO Multi-Channel Tactical Digital Gateway Standards for Analogue-to-Digital Conversion of Speech Signals
STANAG 4210	The NATO Multi-Channel Tactical Digital Gateway Cable Link Standards
STANAG 4211	The NATO Multi-Channel Tactical Digital Gateway System Control Standards
STANAG 4212	The NATO Multi-Channel Tactical Digital Gateway Radio Relay Link Standards
STANAG 4213	The NATO Multi-Channel Tactical Digital Gateway Data Transmission Standards
STANAG 4214	International Routing and Directory for Tactical Communications Systems
STANAG 4249	The NATO Multi-Channel Tactical Digital Gateway -- Data Transmission Standards (Packet Switching Service)

STANAG 4251	NATO Reference Model for Open Systems Interconnection Layer 1 (Physical Layer) Service Definition
STANAG 4252	NATO Reference Model for Open Systems Interconnection Layer 2 (Data Link Layer) Service Definition
STANAG 4253	NATO Reference Model for Open Systems Interconnection Layer 3 (Network Layer) Service Definition
STANAG 4254	NATO Reference Model for Open Systems Interconnection -- Layer 4 (Transport Layer) Service Definition (Draft)
STANAG 4255	NATO Reference Model for Open Systems Interconnection -- Layer 5 (Session Layer) Service Definition (Draft)
STANAG 4256	NATO Reference Model for Open Systems Interconnection -- Layer 6 (Presentation Layer) Service Definition (Draft)
STANAG 4259	NATO Reference Model for Open Systems Interconnection Encoding Rules for ASN.1
STANAG 4261	NATO Reference Model for Open Systems Interconnection Layer 1 (Physical Layer) Protocol Specification
STANAG 4262	NATO Reference Model for Open Systems Interconnection Layer 2 (Data Link Layer) Protocol Specification; Annex D, Data Link Access Procedure Balanced (LAPB)
STANAG 4263	NATO Reference Model for Open Systems Interconnection Layer 3 (Network Layer) Protocol Specification, Annex D, X.75 Packet Level Protocol (STE-STE)
STANAG 4264	NATO Reference Model for Open Systems Interconnection -- Layer 4

	(Transport Layer) Protocol Specification (Draft)
STANAG 4265	NATO Reference Model for Open Systems Interconnection -- Layer 5 (Session Layer) Protocol Specification (Draft)
STANAG 4266	NATO Reference Model for Open Systems Interconnection -- Layer 6 (Presentation Layer) Protocol Specification (Draft)
STANAG 4290	The NATO Multi-Channel Tactical Digital Gateway Cable Link (Optical) Standards
STANAG 4372	Second-generation Anti-jam Tactical UHF Radio for NATO (SATURN)
STANAG 4406	Military Message Handling System
STANAG 5516	Tactical Data Exchange Link-16

2.1.6 <u>NIST publications</u>

NIST IR90-4250	Network Transport and Message Security Protocols
NIST Special Publication 500-183	National Institute of Standards and Technology (NIST) Special Publication 500-183, Stable Implementation Agreements for Open Systems Interconnection Protocols, Version 4, Edition 1

Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Commanding Officer, Naval Publications and Forms Center (ATTN: NPODS), 5901 Tabor Avenue, Philadelphia, PA 19120-5099.

Copies of Federal Information Processing Standards (FIPS) are available to DOD activities from the Commanding Officer, Naval Publications and Forms Center, 5901 Tabor Avenue, Philadelphia, PA 19120-5099. Others must request copies of FIPS from the National Technical Information Service (NTIS), 5285 Port Royal Road, Springfield, VA 22161-2171.

To obtain other DOD publications (see 2.1.4) not found in the DODISS, contact the Defense Information Systems Agency, Center for Standards, ATTN: TBBF, Fort Monmouth, NJ 07703-5613.

Copies of STANAGs, required by contractors in connection with specific acquisition functions, should be obtained from the contracting activity or as directed by the contracting officer.

NIST documents can be obtained from the National Technical Information Service (NTIS), 5285 Port Royal Road, Springfield, VA 22161-2171 or by calling 1-800-553-6847.

Requests for NACSEM 5201 and NSTISSAM TEMPEST/1-91 should be submitted to the National TEMPEST Information Center, Attention C941, National Security Agency, Fort George Meade, MD 20899.

2.2 Nongovernment documents

2.2.1 ITU-T (formerly known as CCITT) Recommendations. The ITU-T is part of the United Nations, a treaty organization. The United States Government participates in it through the Department of State, and although industry representatives may work on its committees, approval of standards (called Recommendations) is by governments.

ITU-T E.163	Numbering Plan for the International Telephone Service
ITU-T E.164	Numbering Plan for the ISDN Era
ITU-T F.69	Plan for Telex Destination Codes
ITU-T F.811	Cell Relay Bearer Service Extended Stage 1 Service Description (Draft Supplement)
ITU-T G.703	Physical/Electrical Characteristics of Hierarchical Digital Interfaces
ITU-T G.704	Synchronous Frame Structures Used at Primary and Secondary Hierarchical Levels
ITU-T G.707	Synchronous Digital Hierarchy Bit Rates
ITU-T G.708	Network Node Interface for the Synchronous Digital Hierarchy
ITU-T G.709	Synchronous Multiplexing Structure
ITU-T G.721	32 kbps Adaptive Pulse Code Modulation

ITU-T G.811	Timing Requirements at the Outputs of Primary Reference Clocks Suitable for Plesiochronous Operation of International Digital Links
ITU-T H.320	Narrowband Visual Telephone Systems and Terminal Equipment
ITU-T I.121	Broadband Aspects of ISDN
ITU-T I.211	Broadband Integrated Services Digital Network (B-ISDN) Service Aspects
ITU-T I.252	Call Offering Supplementary Services
ITU-T I.254	Multiparty Supplementary Services
ITU-T I.321	Broadband Integrated Services Digital Network (B-ISDN) Protocol Reference Model and its Application
ITU-T I.361	Physical Layer Specification
ITU-T I.363	B-ISDN ATM Adaptation Layer (AAL) Specification
ITU-T I.432	B-ISDN User-Network Interface Physical Layer Specification
ITU-T I.460	Multiplexing, Rate Adaptation and Support of Existing Interfaces
ITU-T Q.704	Signalling Network Functions and Messages
ITU-T Q.774	Transaction Capabilities Procedure
ITU-T Q.920	ISDN User-Network Interface Data Link Layer -- General Aspects
ITU-T Q.921	ISDN User-Network Interface -- Data Link Layer Specification
ITU-T Q.922	ISDN-Data Link Layer Specification for Frame Mode Bearer Service

ITU-T Q.931	ISDN User-Network Interface Layer 3 Specification for Basic Call Control
ITU-T Q.933	Digital Subscriber Signalling System Number 1 (DSS 1) Signalling Specification for Frame Mode Basic Call Control (Draft)
ITU-T Q.2100	BISDN ATM Adaptation Layer for Signaling (Draft)
ITU-T Q.2110	Service Specific Connection Oriented Protocol (SSCOP) Specification (Draft)
ITU-T Q.2130	Service Specific Coordination Function (SSCF) for Signaling at the UNI (Draft)
ITU-T Q.2140	Service Specific Coordination Function (SSCF) for Signaling at the NNI (Draft)
ITU-T Q.2761 to Q.2764	BISDN NNI Network Signaling Requirements (Draft)
ITU-T Q.2931	BISDN UNI Layer 3 Access Call Control Requirements (Draft)
ITU-T V.35	Data Transmission at 48 Kilobits Per Second Using 60-108 kHz Group Band Circuits
ITU-T V.110	Support of Data Terminal Equipments (DTEs) with V-Series Type Interfaces by an Integrated Services Digital Network (ISDN)
ITU-T X.25	Interface Between Data Terminal Equipment (DTE) and Data Circuit-Terminating Equipment (DCE) for Terminals Operating in the Packet Mode and Connected to Public Data Networks by Dedicated Circuit
ITU-T X.31	Support of Packet Mode Terminal Equipment by an ISDN

ITU-T X.75	Packet-Switched Signalling System Between Public Networks Providing Data Transmission Services
ITU-T X.121	International Numbering Plan for Public Data Networks
ITU-T X.224	Transport Protocol Specification for Open Systems Interconnection for ITU-T Applications
ITU-T X.290	OSI Conformance Testing Methodology and Framework for Protocol Recommendations for ITU-T Applications
ITU-T X.400	Message Handling System and Service Overview
ITU-T X.410	Message Handling System: Remote Operations and Reliable Transfer Service (Red Book)
ITU-T X.435	Electronic Data Interchange (EDI) (Draft)
ITU-T X.500	The Directory -- Overview of Concepts, Models and Services

2.2.2 ANSI standards

ANSI T1.101	Synchronization Interface Standards for Digital Service
ANSI T1.105	Digital Hierarchy -- Optical Interface Rates and Formats Specifications
ANSI T1.106	Digital Hierarchy -- Optical Interface Specifications (Single Mode)
ANSI T1.107	Digital Hierarchy Format Specifications
ANSI T1.111	Signalling System Number 7 (SS7) -- Message Transfer Part (MTP)
ANSI T1.112	Signalling System Number 7 (SS7) -- Signalling Connection Control Part (SCCP)

ANSI T1.113	Signalling System Number 7 (SS7) -- Integrated Services Digital Network (ISDN) User Part
ANSI T1.114	Signalling System Number 7 (SS7) -- Transaction Capability Application Part (TCAP)
ANSI T1.408	ISDN Primary Rate -- Customer Installation Metallic Interfaces, Layer 1 Specification
ANSI T1.601	Integrated Services Digital Network (ISDN) -- Basic Access Interface for Use on Metallic Loops for Application on the Network Side of the NT (Layer 1 Specification)
ANSI T1.602	Integrated Services Digital Network (ISDN) -- Data-Link Layer Signalling Specification for Application at the User-Network Interface
ANSI T1.605	Integrated Services Digital Network (ISDN) -- Basic Access Interface for S and T Reference Points (Layer 1 Specification)
ANSI T1.606	Integrated Services Digital Network (ISDN) -- Architectural Framework and Service Description for Frame-Relaying Bearer Service
ANSI T1.607	Digital Subscriber Signalling System No. 1 -- Layer 3 Signalling Specification for Circuit Switched Bearer Service
ANSI T1.608	Digital Subscriber Signalling System No. 1 (DSS1) -- Signalling Specification for X.25 Packet Switched Bearer Service
ANSI T1.609	Interworking Between the ISDN User -- Network Interface Protocol and the Signalling System Number 7 ISDN User Part
ANSI T1.610	Digital Subscriber Signalling System No. 1 (DSS1) -- Generic

	Procedures for the Control of ISDN Supplementary Services
ANSI T1.613	Call Waiting Supplementary Service
ANSI T1.616	Call Holding Supplementary Service
ANSI T1.617	Integrated Services Digital Network (ISDN) -- Digital Subscriber Signaling System No. 1 (DSS1) -- Signaling Specification for Frame Relay Bearer Service
ANSI T1.618	Integrated Services Digital Network (ISDN) -- Core Aspects of Frame Protocol for Use with Frame Relay Bearer Service
ANSI T1.619	Integrated Services Digital Network (ISDN) -- Multi-Level Precedence and Preemption (MLPP) Service Capability
ANSI T1.621	Integrated Services Digital Network (ISDN) -- User-to-User Supplementary Service
ANSI T1.622	Integrated Services Digital Network (ISDN) -- Message Waiting Indicator Control and Notification Supplementary Service and Associate Switching and Signaling Specification
ANSI T1.625	Integrated Services Digital Network (ISDN) -- Calling Line Presentation and Restriction Supplementary Services
ANSI T1.629	BISDN -- ATM Adaptation Layer 3/4 Common Part Functions and Specifications
ANSI T1.630	BISDN -- ATM Adaption Layer for Constant Bit Rate Services Functionality and Specification
ANSI T1S1.2/91-408	Hotline Service Integrated Text
ANSI T1S1.1/92-188	Proposed Integrated Text for Line Hunting Service with Issue Section

ANSI T1S1.1/92-253	Call Completion to Busy Subscriber, Stage 1/2
ANSI T1S1.2/92-323	Call Completion to Busy Subscriber, DSS1, Stage 3 Description
ANSI T1S1.2/93-157	Preset Conference Calling Service, DSS1, Stage 3 Description
ANSI X3.4 1986	Code for Information Interchange
ANSI X3.16 1976	Character Structure and Character Parity Sense for Serial-by-bit data Communication in ASCII.
ANSI X3.25 1968	Character Structure and Character Parity Sense for Parallel-by-Bit Data Communication in ASCII.
ANSI X3.229	Fiber Distributed Data Interface (FDDI) Station Management
ANSI X3.257	FDDI Station Management to Common Services

2.2.3 ISO/IEC documents

TR 10000	Information Technology -- Framework and Taxonomy of International Standardized Profiles -- Part 1: Framework, Part 2: Taxonomy of Profiles, and Part 3: Principles and Taxonomy for Open Systems Environment Profiles (Draft)
ISO 3166	Codes for the Representation of Names of Countries
ISO 3309	Information Processing Systems -- Data Communication -- High-Level Data Link Control Procedures -- Frame Structure
ISO 4335	Information Processing Systems -- Data Communication -- High-Level Data Link Control Elements of Procedures
ISO 6523	Data Interchange -- Structure for the Identification of Organizations

ISO 7498	Information Processing Systems -- Open Systems Interconnection -- Basic Reference Model -- X-ref: ITU-T X.200
ISO 7809	Information Processing Systems -- Data Communication -- High-Level Data Link Control Procedures -- Consolidation of Classes of Procedures
ISO 8072	Information Processing Systems -- Open Systems Interconnection -- Transport Service Definition -- X-ref: ITU-T X.214
ISO 8073	Information Processing Systems -- Open Systems Interconnection -- Connection Oriented Transport Protocol Specification -- X-ref: ITU-T X.224
ISO 8208	Information Processing Systems -- Data Communications -- X.25 Packet Level Protocol for Data Terminal Equipment -- X-ref: ITU-T X.25
ISO 8326	Information Processing Systems -- Open Systems Interconnection -- Basic Connection Oriented Session Service Definition -- See: ITU-T X.215
ISO 8327	Information Processing Systems -- Open Systems Interconnection -- Basic Connection Oriented Session Protocol Specification -- See: ITU-T X.225
ISO 8348	Information Processing Systems -- Data Communications -- Network Service Definition -- X-ref: ITU-T X.213
ISO 8471	Data Communication -- High-Level Data Link Control Balanced Classes of Procedures -- Data-Link Layer Address Resolution/Negotiation in Switched Environments

ISO 8473	Information Processing Systems -- Data Communications -- Protocol for Providing the Connectionless-Mode Network Service
ISO 8571-1	Information Processing Systems -- Open Systems Interconnection -- File Transfer, Access and Management -- Part 1: General Introduction
ISO 8571-3	Information Processing Systems -- Open Systems Interconnection -- File Transfer, Access and Management -- Part 3: File Service Definition
ISO 8571-4	Information Processing Systems -- Open Systems Interconnection -- File Transfer, Access and Management -- Part 4: File Protocol Specification
ISO 8613-1	Information Processing -- Text and Office Systems -- Office Document Architecture (ODA) and Interchange Format -- Part 1: Introduction and General Principles -- X-ref: ITU-T T.411
ISO 8613-2	Information Processing -- Text and Office Systems -- Office Document Architecture (ODA) and Interchange Format -- Part 2: Document Structures -- X-ref: ITU-T T.412
ISO 8613-4	Information Processing -- Text and Office Systems -- Office Document Architecture (ODA) and Interchange Format -- Part 4: Document Profile -- X-ref: ITU-T T.414
ISO 8613-5	Information Processing -- Text and Office Systems -- Office Document Architecture (ODA) and Interchange Format -- Part 5: Office Document Interchange Format (ODIF) -- X-ref: ITU-T T.415
ISO 8613-6	Information Processing -- Text and Office Systems -- Office Document

	Architecture (ODA) and Interchange Format -- Part 6: Character Content Architectures -- X-ref: ITU-T T.416
ISO 8613-7	Information Processing -- Text and Office Systems -- Office Document Architecture (ODA) and Interchange Format -- Part 7: Raster Graphics Content Architectures -- X-ref: ITU-T T.417
ISO 8613-8	Information Processing -- Text and Office Systems -- Office Document Architecture (ODA) and Interchange Format -- Part 8: Geometric Graphics Content Architectures -- X-ref: ITU-T T.418
ISO 8649	Information Processing Systems -- Open Systems Interconnection -- Service Definition for the Association Control Service Element -- See: ITU-T X.217
ISO 8650	Information Processing Systems -- Open Systems Interconnection -- Protocol Specification for the Association Control Service Element -- See: ITU-T X.227
ISO 8802-2	Information Processing Systems -- Local Area Networks -- Part 2: Logical Link Control
ISO 8802-3	CSMA/CD Media Access Control
ISO 8802-4	Token Bus Media Access Control
ISO 8802-5	Token Ring Media Access Control
ISO 8822	Information Processing Systems -- Open Systems Interconnection -- Connection Oriented Presentation Service Definition -- See: ITU-T X.216
ISO 8823	Information Processing Systems -- Open Systems Interconnection -- Connection Oriented Presentation

	Protocol Specification -- See: ITU-T X.226
ISO 8824	Information Processing Systems -- Open Systems Interconnection -- Specification of Abstract Syntax Notation One (ASN.1) -- See: ITU-T X.208
ISO 8825	Information Processing Systems -- Open Systems Interconnection -- Specification of Basic Encoding Rules for Abstract Syntax Notation One (ASN.1) -- See: ITU-T X.209
ISO 8878	Information Processing Systems -- Data Communications -- Use of X.25 to Provide the OSI Connection-Mode Network Service -- See: ITU-T X.223
ISO 8879	Information Processing Systems -- Standard Generalized Markup Language (SGML)
ISO 8880	Information Processing System -- Open Systems Interconnection -- Protocol Combinations to Provide and Support the OSI Network Service
ISO 8885	Information Processing Systems -- Data Communication High-Level Data Link Control (HDLC) Procedures -- General Purpose XID Frame Information Field Content and Format
ISO 8886	Information Processing Systems -- Data Communication -- Data Link Service Definition for Open Systems Interconnection -- See: ITU-T X.212
ISO 9040	Information Processing Systems -- Open Systems Interconnection -- Virtual Terminal Service
ISO 9041	Information Processing Systems -- Open Systems Interconnection -- Virtual Terminal (VT) Protocol -- Basic Class

ISO 9069	Information Processing Systems -- SGML Support Facilities -- SGML Document Interchange Format
ISO 9070	Information Processing Systems -- SGML Support Facilities -- Registration Procedures for Public Text
ISO 9314-1	Information Processing Systems -- Fibre Distributed Data Interface (FDDI) -- Part 1: Physical Layer Protocol (PHY) -- See: ANSI X3.148
ISO 9314-2	Information Processing Systems -- Fibre Distributed Data Interface (FDDI) -- Part 2: Token Ring Media Access Control (MAC) -- See: ANSI X3.139
ISO 9314-3	Information Processing Systems -- Fibre Distributed Data Interface (FDDI) -- Part 3: Physical Layer Medium Dependent (PMD) Requirements -- See: ANSI X3.166
ISO 9542	Information Processing Systems -- Telecommunications and Information Exchange Between Systems -- End System to Intermediate System Routing Exchange Protocol for Use in Conjunction with the Protocol for Providing the Connectionless-Mode Network Service
ISO 9595	Information Technology -- Open Systems Interconnection -- Common Management Information Service Definition
ISO 9596-1	Information Technology -- Open Systems Interconnection -- Common Management Information Protocol -- Part 1: Specification
ISO 9646	Open Systems Interconnection -- Conformance Testing Methodology and Framework

ISO DIS 10589	Information Processing Systems -- Intermediate System to Intermediate System Routing Protocols
ISO XXXX	Remote Operations Service Element (ROSE) (Draft)
ISP 10607 (6 Parts)	Information Technology -- International Standardized Profile AFTnn -- File Transfer, Access, and Management (Draft)
ISP 10608 (Parts 1, 2, and 5)	Information Technology -- International Standardized Profile TAnnnn -- Connection-Mode Transport Service Over Connectionless-Mode Network Service (Draft)
ISP 10609 (9 Parts)	Information Technology -- International Standardized Profile TB, TC, TD and TE -- Connection-Mode Transport Service Over Connection-Mode Network Service (Draft)

2.2.4 <u>IEEE standards</u>

IEEE 802.1D	MAC Bridges
IEEE P802.1G/1D	Remote MAC Bridge
IEEE 802.6	Distributed Queue Dual Bus (DQDB) Subnetwork of a Metropolitan Area Network (MAN)

(NOTE: IEEE 802.3, 802.4, and 802.5 are referenced as ISO 8802-3, 8802-4, and 8802-5.)

2.2.5 <u>RFCs and IAB standards</u>

IAB STD-8	Telnet Protocol (IAB STD-8 consists of RFCs 854 and 855)

2.2.6 <u>Electronic Industries Association</u>

EIA 232	Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange

EIA 422	Electrical Characteristics of Balanced Voltage Digital Interface Circuits
EIA 423	Electrical Characteristics of Unbalanced Voltage Digital Interface Circuits

Copies of American National Standards Institute (ANSI) standards may be obtained from the American National Standards Institute, 1430 Broadway, New York, NY 10018.

Copies of International Telegraph and Telephone Consultative Committee (ITU-T) standards may be obtained from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161. [Note: The ITU-T has changed its name to the International Telecommunications Union - Telecommunication Standardization Sector (ITU-T)].

Copies of ISO standards may be obtained from the American National Standards Institute, 1430 Broadway, New York, NY 10018.

Copies of IEEE standards may be obtained from the Secretary, IEEE Standards Board, Institute of Electrical and Electronics Engineers, Inc., P.O. Box 1331, 445 Hoes Lane, Piscataway, NJ 08855-1331.

RFCs are available, free of charge via anonymous FTP or e-mail, from the DDN Network Information Center. The host is nic.ddn.mil and the directory is RFC, or via e-mail using the address: service @ nic.ddn.mil.

Copies of EIA standards may be obtained from ANSI or EIA, Electronic Industries Association, Engineering Department, 2001 Eye Street, Northwest Washington, D.C. 20006.

Draft copies of ANSI standards can be obtained from the Joint Interoperability and Engineering Organization (JIEO), ATTN: TBBB, Fort Monmouth, NJ 07703-5613.

2.3 Order of precedence. In the event of a conflict between this MIL-STD and the references cited herein, the text of this MIL-STD takes precedence. Nothing in this MIL-STD, however, supersedes applicable laws and regulations unless a specific exemption has been obtained. Whenever a DOD Standardized Profile (DSP) and the associated International Standardized Profile (ISP) are listed, the DSP takes precedence.

3. DEFINITIONS

3.1 Definitions of terms. Definitions of terms used in this MIL-STD shall be as specified in Federal Standard (FED-STD)-1037. Those definitions unique to information systems, and not defined in FED-STD-1037, are provided in this section.

Broadband terminal (BT): User equipment at the location where the user-to-network interface (UNI) terminates. The BT may be a single user equipment or it may act as an aggregator of other tributary devices.

Functional profiles: A profile is defined in TR 10000 as a "set of one or more base standards, and, where applicable, the identification of chosen classes, subsets, options, and parameters of those base standards, necessary for accomplishing a particular function." The term *profile*, as used in MIL-HDBK-829, has the same meaning, as does the term *functional profile*. Profile and functional profile are used interchangeably.

Generic flow control (GFC): A bit sequence in the asynchronous transfer mode (ATM) cell header that is intended to control traffic flow into the network, to support different quality-of-service (QOS). To date, the GFC has not been defined and remains an unused field. In the interim, the field shall be all zeros.

Local-network elements: Elements that make up a base information-transfer utility for strategic users or a tactical information-transfer utility for tactical users. They include such elements as circuit and packet switches, and transmission equipment. They may also include metropolitan-area networks (MAN).

Path overhead: Overhead assigned to and transported with the SONET payload. It provides for communications between the point of creation of a SONET payload and its point of disassembly.

Reference point A: The interface between subscriber-network elements and local-network elements.

Reference point B: The interface between local-network elements and wide-network elements.

Reference point B (NATO): The interface between U.S. network elements and NATO network elements.

Strategic user: A person, organization, or other entity (including a computer or computer system) not assigned as a tactical user.

Subscriber-network elements: Elements such as terminal equipment, end systems, intermediate systems, local-area networks, metropolitan-area networks, and radio networks normally considered to be provided by the subscriber.

Tactical user: A person, organization, or other entity (including a computer or computer system) in support of a joint task force who employs the services provided by a tactical telecommunications system, or by a tactical information-processing system, for transfer of information to others.

Telnet: The virtual terminal (VT) protocol in the Internet suite of protocols. Allows users of one host to login to a remote host and interact as normal terminal users of that host. The Telnet protocol is specified in IAB STD-8 (and for OSI networks in ISO 9040/9041).

Virtual Channel Indicator (VCI): Defines the explicit cell channel identification at the user-to-network interface (UNI) and network-to-node interface (NNI).

Virtual Path Indicator (VPI): Defines the explicit cell path identification at the UNI and NNI.

Wide-network elements: Elements, such as circuit switches, packet switches, and transmission equipment, that form the Defense Communications System (DCS) and public switched telephone networks (PSTN).

3.2 Acronyms and abbreviations used in this MIL-STD

AAL	ATM adaptation layer
ACK	acknowledgment
ACSE	association control service elements
A-D	analog-to-digital
ADP	automatic data processing
ADPCM	adaptive differential pulse-code modulation
AFI	authority and format identifier
AITS	Adopted Information Technology Standard
AJ	anti-jam
ALE	automatic link establishment
ANSI	American National Standards Institute
ARIDPCM	Adaptive Recursive Interpolated Differential PCM
ASCII	American Standard Code for Information Interchange
ASN.1	abstract syntax notation 1
ATDL-1	Army Tactical Data Link 1
ATM	asynchronous transfer mode
B-Channel	bearer channel
BCI	bit count integrity
BER	bit error ratio

B-ISDN	broadband-ISDN
BITE	built-in test equipment
BNZS	bipolar with N-zero substitution
bps	bit(s) per second
BPSK	binary phase-shift keying
BRI	basic rate interface
BT	broadband terminal
CBR	constant bit rate
CC	country code
CCIR	International Radio Consultation Committee
CCITT	International Telegraph and Telephone Consultative Committee (now referred to as ITU-T)
CELP	code-excited linear prediction
CIM	Corporate Information Management
CLIP	Calling Line Identification Presentation
CLIR	Calling Line Identification Restriction
CLNS	connectionless network service
CLP	cell loss priority
CMIP	Common Management Information Protocol
CMIS	Common Management Information Services
CNR	combat net radio
COMPUSEC	computer security
COMSEC	communications security
CONS	connection-oriented network service
CONUS	Continental United States
COTS	connection-oriented transport service (also, commercial off-the-shelf)
CPCS	common part convergence sublayer
CRBS	cell-relay bearer service
CRC	cyclic redundancy check
CS	convergence sublayer
CSMA/CD	carrier sense multiple access/collision detection
CSN	circuit-switched network
CVSD	continuously variable slope delta
C3I	command, control, communications, and intelligence
C4I	command, control, communications, computers, and intelligence
D	data
DAMA	demand-assignment multiple access
DBMS	database management system
D-Channel	16- or 64-kbps channel for signaling and data
dc	direct current
DCA	Defense Communications Agency (now DISA)
DCAC	DCA circular
DCC	data country code
DCC	Data Communications Channels

DCE	data circuit-terminating equipment
DCP	data communications protocol
DCPS	DOD Communications Protocol Standards
DCS	Defense Communications System
DDN	Defense Data Network
DEQPSK	differentially encoded quadrature phase-shift keying
DII	Defense Information Infrastructure
DIR	directory
DIS	Defense Information System; Draft International Standard
DISA	Defense Information Systems Agency (formerly DCA)
DISN	Defense Information System Network
DL	data link
DNS	Domain Name Service
DOD	Department of Defense
DODISS	Department of Defense Index of Specifications and Standards
DPI	data processing installation
DQDB	distributed queue dual-bus
DS	directory service
DSN	Defense Switched Network
DS1	Digital Interface Rate 1 (1.544 Mbps)
DS2	Digital Interface Rate 2 (6.312 Mbps)
DS3	Digital Interface Rate 3 (44.736 Mbps)
DSP	domain-specific part
DSP	DOD standardized profile
DSS1	Digital Subscriber Signaling System Number 1
DTE	data terminal equipment
DTH	down-the-hill
DTMF	dual-tone multifrequency
DU	data unit
ECCM	electronic counter-countermeasures
EDI	Electronic Data Interchange
EFS	error-free second
EHF	extremely high frequency
EIA	Electronic Industries Association
EMC	electromagnetic compatibility
EMI	electromagnetic interference
EMSEC	emission security
ES	end system
ESF	extended superframe
ETSI	European Telecommunications Standards Institute
EW	electronic warfare
FAX	facsimile
FDDI	Fiber Distributed Data Interface
FEC	forward error correction

FED-STD	federal standard
FIPS	Federal Information Processing Standard
FRM	frame relay mode
FSK	frequency-shift keying
FTAM	file transfer, access, and management
FTP	File Transfer Protocol
Gbps	gigabit(s) per second
GFC	generic flow control
GHz	gigahertz
GNMP	Government Network Management Profile
GOSIP	Government Open Systems Interconnection Profile
GSA	General Services Administration
GSM	Special Mobile Group
H-Channel	high-rate channel
H_0-Channel	384 kbps
H_{10}-Channel	1,472 kbps
HDB3	High-density bipolar with a maximum of 3 consecutive zeros
HDLC	high-level data link control
HDTV	high-definition television
HEC	header error check
HF	high frequency
HRC	hypothetical reference circuit
HRX	hypothetical reference connection
Hz	hertz
I	imagery
IAB	Internet Activities Board
IAP	international access prefix
ICD	international code designator
IDI	initial domain identifier
IDP	initial domain part
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IP	internet protocol
IPMS	interpersonal message service
IRAC	Interdepartment Radio Advisory Committee
IS	intermediate system
ISDN	Integrated Services Digital Network
ISO	International Organization for Standardization
ISP	International Standardized Profile
ITU	International Telecommunications Union
ITU-T	ITU-Telecommunication Standardization Sector (formerly CCITT)
IWG	interim working group

JCS	Joint Chiefs of Staff
JIEO	Joint Interoperability and Engineering Organization
JITC	Joint Interoperability Test Center
JPEG	Joint Photographic Experts Group
JTIDS	Joint Tactical Information Distribution System
kbps	kilobit(s) per second
kHz	kilohertz
km	kilometer(s)
LAN	local area network
LAP	link access procedure
LAPB	LAP balanced
LAPD	LAP on the D-channel
LDR	low data rate
LF	low frequency
LLC	logical link control
LME	layer management entity
LNE	local-network element
LOS	line-of-sight
LPC	linear predictive coding
MAC	media access control
MAN	metropolitan area network
MAU	medium attachment unit
Mbps	megabit(s) per second
MCEB	Military Communications-Electronics Board
MDR	medium data rate
MF	medium frequency
MHS	message-handling service
MHz	megahertz
MIB	management information base
MIDS	Multi-Functional Information Distribution System
MILDEP	military department
MIL-HDBK	military handbook
MIL-STD	military standard
MLPP	multi-level precedence and preemption
MM	military messaging
MMHS	Military Message-Handling System
MMS	Military Messaging Service
ms	millisecond(s)
MSP	message security protocol
MSR	message storage and retrieval
MTBF	mean time between failures
MTBPM	mean time between preventive maintenance
MTP	message transfer part
MTTR	mean time to repair
mW	milliwatt(s)

MWI	message waiting indicator
n	integer
NACK	nonacknowledgment
NACSEM	National COMSEC Engineering Memorandum
NACSIM	National COMSEC Information Memorandum
NATO	North Atlantic Treaty Organization
NCC	network control center
NDI	nondevelopmental item
NE	network element
NI	nationality identifier
N-ISDN	narrowband ISDN
NIST	National Institute of Standards and Technology
NITF	National Imagery Transmission Format
NITFS	NITF standard
NLSP	network-layer security protocol
NM	network management
NNI	network-node interface
NRI	net radio interface
NSA	National Security Agency
NT	network terminal
NTIS	National Technical Information Service
OC	optical carrier level
ODA	Office Document Architecture
ODIF	Office Document Interchange Format
OS	operating system
OSI	Open Systems Interconnection
OQPSK	offset quadrature phase-shift keying
PBX	private branch exchange
PCM	pulse-code modulation
PCS	personal communications system
PDN	public data network
PDU	protocol data unit
pFS	proposed Federal Standard
PG/6	Project Group 6
PHY	Physical Layer Protocol
PLCP	Packet Layer Convergence Protocol
PLP	packet level protocol
PLRS	Position Location Reporting System
PMD	Physical Layer Medium Dependent
POH	path overhead
ppm	part(s) per million
PRI	primary rate interface
PSK	phase-shift keying
PSN	packet-switched network
PSTN	public switched telephone network
PTI	payload type identifier
PTS	personal telecommunications service

QOS	quality-of-service
R	radio
RES	reserved
rf	radio frequency
RFC	request for comment
RM	reference model (OSI)
ROSE	remote operations service element
SAAL	AAL for signaling
SAR	segmentation and reassembly
SATCOM	satellite communications
SATURN	Second-generation Anti-jam Tactical UHF Radio for NATO
SCCP	signaling connection control part
SDH	synchronous digital hierarchy
SDLS	satellite data link standard
SDU	service data unit
SGML	Standard Generalized Markup Language
SHF	super high frequency
SINCGARS	Single-Channel Ground and Airborne Radio System
SMFA	system management functional area
SMT	station management
SMTP	Simple Network Management Protocol
SNE	subscriber network element
SNMP	Simple Network Management Protocol
SOH	synchronous optical hierarchy
SONET	synchronous optical network
SOQPSK	shaped offset quadrature phase-shift keying
SP	security protocol
SSAP	session service access point
SSCF	service-specific coordination function
SSCOP	service-specific connection-oriented protocol
SSCS	service-specific convergence sublayer
SS7	Signaling System Number 7
STANAG	standardization agreement
STE-STE	signaling terminal-to-signaling terminal
STM	synchronous transfer mode
STM-N	synchronous transport module - level N
STS	synchronous transport signal
TAC02	tactical communications protocol 2
TADIL	tactical digital information link
TAFIM	Technical Architecture Framework for Information Management
TBD	to be determined
TC	transport connect
TCAP	transaction capabilities application part
TCP	transmission control protocol
TDM	time-division multiplexing

TDMA	time-division multiple access
TE	terminal equipment
TEMPEST	compromising emanations
TIA	Telecommunications Industry Association
TLSP	transport-layer security protocol
TL1	transaction language 1
TP	transport protocol
TP0	Transport Protocol class 0
TP1	Transport Protocol class 1
TP2	Transport Protocol class 2
TP3	Transport Protocol class 3
TP4	Transport Protocol class 4
TPDU	transport protocol data-unit
TR	technical report
TRANSEC	transmission security
TRI-TAC	Tri-Service Tactical Communications
TSAP	transport service access point
TTY	teletypewriter
UHF	ultra high frequency
ULF	ultra low frequency
UMTS	Universal Mobile Telecommunications System
UNI	user-to-network interface
USAT	ultra-small aperture terminal
UTC	coordinated universal time
V	voice
VBR	variable bit rate
VCI	virtual channel indicator
VHF	very high frequency
VOX	voice-operated transmit
VPC	virtual path connection
VPI	virtual path indicator
VT	virtual terminal
VTC	video teleconferencing
WAN	wide area network
WARC	World Administrative Radio Conference
WG	working group
WNE	wide-network element
2B1Q	two binary, one quaternary

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4. GENERAL REQUIREMENTS

4.1 System requirements. The general system requirements in this section affect the design of subscriber-network elements (information sources, sinks, and subscriber-owned networks), local-network elements, and wide-network elements, as shown in Figure 1. The Defense Information System (DIS) is synonymous with the Defense Information Infrastructure (DII), except the DIS does not include the operations and support staff and facilities. Figure 2 [exhibit 1-2 in the Defense Information System Network (DISN) Architecture], depicts the DII/DISN relationship, including the transform/transfer functions and information use/creation functions that are part of the terminal/computing elements. All systems fielded to satisfy Department of Defense (DOD) requirements shall comply with applicable information technology standards in the DOD Technical Reference Model, which is Volume #7 of the *Technical Architecture Framework for Information Management (TAFIM)*. Use/creation functions are addressed in detail in the DOD Technical Reference Model, and the information-transfer portion is addressed by referencing this MIL-STD. The remainder of this MIL-STD applies to the DISN.

4.1.1 End-to-end digital service. All signals entering the local- and wide-network elements shall be digital and shall remain in a digital form until the signals exit the local network at reference point A. Analog-to-digital and digital-to-analog conversion, when required, shall occur in the terminal equipment or in a terminal adapter. The network elements shall preserve bit count integrity (BCI) through the aggregate of network elements for data service.

4.1.2 Signaling. The DISN shall provide for intranetwork, user-to-network, and user-to-user signaling, as described in 4.1.2.1 to 4.1.2.3.

4.1.2.1 Network-node signaling. Common-channel signaling shall be employed in local networks and wide networks. For tactical information-transfer systems, interswitch common-channel-signaling messages shall comply with TT-A3-9016-0056. For base information-transfer systems and wide networks, interswitch common-channel-signaling messages shall comply with American National Standards Institute (ANSI) standards for Signaling System Number 7 (SS7) T1.111, T1.112, and T1.113, as modified to provide the military enhancements described in MIL-STD-188-194, the mandatory appendix titled *DSN7 Common Channel Signaling*. For broadband networks, signaling messages shall comply with International Telecommunications Union - Telecommunication

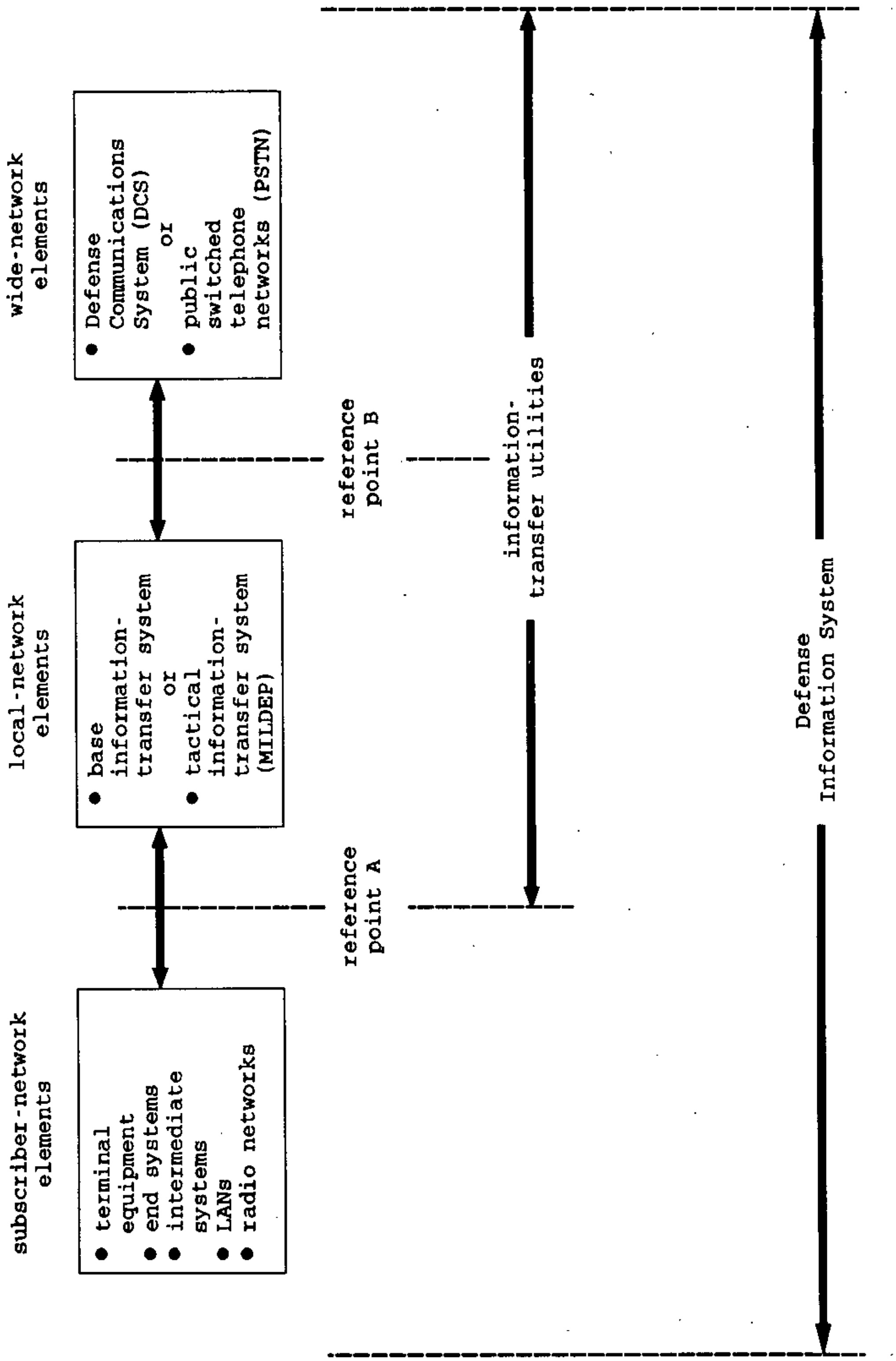


FIGURE 1. DIS framework.

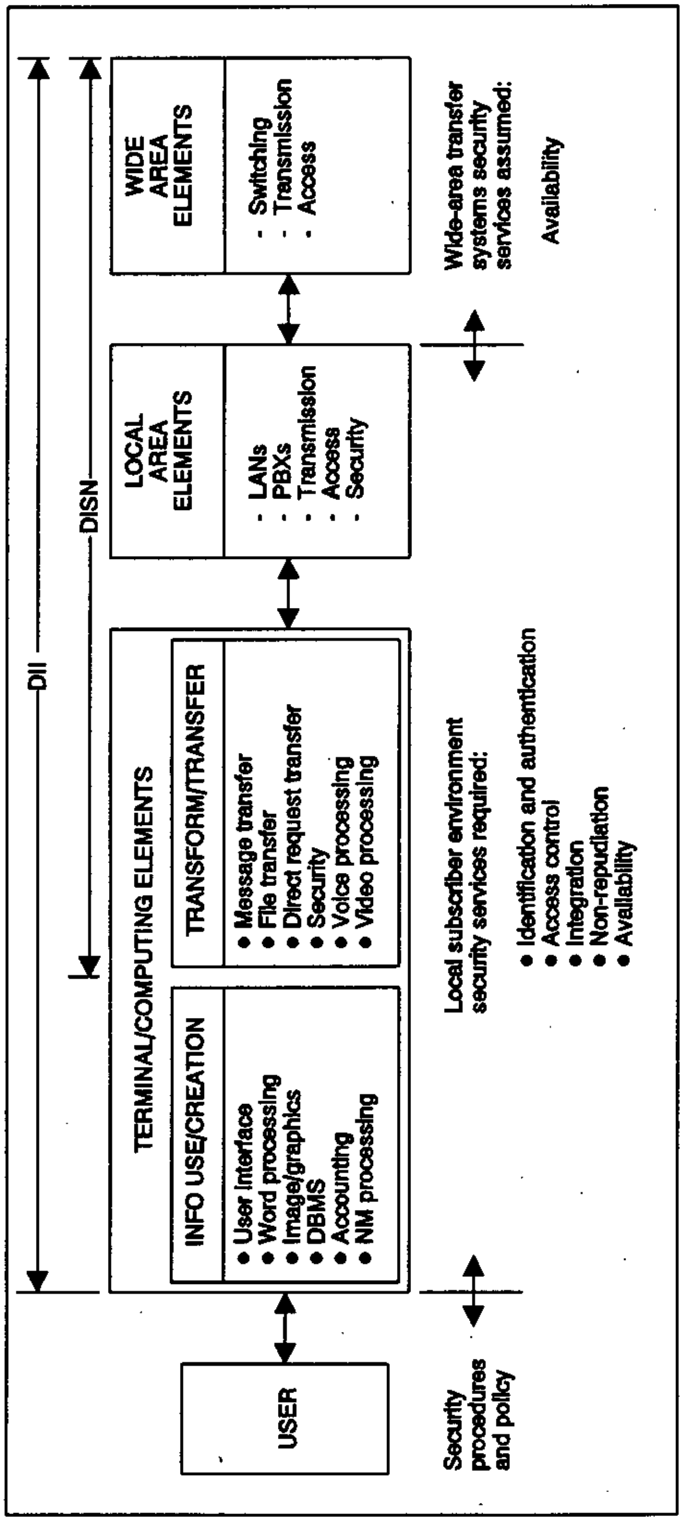


Figure 2. DISN relationship to DII.

Standardization Sector (ITU-T) Recommendations Q.2761 to Q.2764, and other applicable standards and implementation agreements as they become available.

4.1.2.2 User-to-network signaling

a. Common-channel signaling shall be employed at the user-to-network interface in base information-transfer systems. User-to-network signaling messages shall comply with the following ANSI standards:

(1) ANSI T1.602

(2) ANSI T1.607

(3) ANSI T1.608

(4) ANSI T1.610

b. In-band signaling shall be employed at the user-to-network interface in tactical information-transfer systems. User-to-network signaling messages shall comply with TT-A3-9012-0046.

c. For asynchronous transfer mode (ATM) networks, user-to-network signaling messages shall share the same transmission facility used to carry traffic. User-to-network signaling messages shall comply with ITU-T Recommendation Q.2931.

4.1.2.3 User-to-user signaling. User-to-user signaling is the control information exchanged between users' terminal equipment. This information shall be transmitted in the signaling and the information bearer channels, but shall be transparent to network elements. The user-to-user information element is used to establish end-to-end encrypted calls between tactical and strategic users, as defined in MIL-STD-188-105.

4.1.3 Internetwork and gateway functions. Reference point B shall include a wide-network gateway function to achieve interoperability between switched subscribers in tactical information-transfer systems and base information-transfer systems. The gateway function requires standards for layers 1 to 3 for tactical systems using 16-kbps channels (optionally 32-kbps) and strategic systems using 64-kbps channels. The gateway function shall include the capability to convert voice algorithms used in tactical information-transfer systems to 64-kbps pulse-code modulation (PCM) used in base information-transfer systems. The gateway function shall be able to accommodate additional conversion algorithms if needed in the future. The gateway function shall also include the signaling-message converter, defined in MIL-STD-188-105, to allow tactical-switched systems to internetwork with strategic-switched systems. The signaling messages shall be examined by the gateway function. If it is determined that a secure voice or data call is being established, the gateway function shall use rate adaptation at the interface, in accordance with 4.1.7. Gateways are a necessary solution for the interoperability of near-term tactical and strategic networks. Since end-to-end encryption is a long-term objective of this MIL-STD, the use of gateways that require reencryption should be minimized.

4.1.4 Subscriber services. Local-network elements shall provide telecommunications subscriber services for circuit-switched voice, circuit-switched data, and packet-switched data. Services supported include voice telephony, data transmission, facsimile, record traffic, video, and multimedia communications.

4.1.5 Voice digitization. The following voice digitization algorithms shall be used:

a. Base information-transfer systems shall use 64-kbps PCM (mu-law companding), as defined in MIL-STD-188-113, the section titled *Eight-bit pulse-code modulation (PCM)*.

b. Tactical information-transfer systems shall be able to interface either directly or via a switch, using 16-kbps continuously variable slope delta (CVSD) modulation, as defined in MIL-STD-188-113, the section titled *CVSD modulation*. Tactical systems employing 32-kbps digital loops shall double-sample 16-kbps CVSD signals to achieve joint interoperability.

c. Narrowband voice subscribers connected to the local network through high frequency (HF) radio, special electronic counter-countermeasures (ECCM) radios, or other narrow-bandwidth facilities shall use 2.4-kbps linear predictive coding (LPC), as defined in MIL-STD-188-113, the section titled *LPC*; or 4.8-kbps code excited linear prediction (CELP), as defined in FED-STD-1016.

d. Digital voice encoders employing 32-kbps adaptive differential pulse-code modulation (ADPCM) shall conform to ITU-T Recommendation G.721.

4.1.6 Voice services. The aggregate of tactical-network elements, wide-network elements, and base-level network elements shall provide the capability for both nonsecure and end-to-end encrypted voice calls between subscribers at a military base and subscribers in a tactical system. A discussion of nonsecure voice calls is described in 4.1.6.1; end-to-end encrypted voice calls are discussed in 4.1.6.2.

4.1.6.1 Nonsecure voice service. The Integrated Services Digital Network (ISDN) and tactical telephone terminals use different voice-encoding algorithms and different bit rates dictated by the bandwidth of the transmission equipment used in DOD networks. Base telephone terminals use 64-kbps PCM voice encoding. Tactical telephone terminals use 16-kbps CVSD (optionally 32-kbps CVSD) voice encoding. For nonsecure voice calls between subscribers at a military base and subscribers in a tactical network, transcoding will be done at the internetwork gateway to convert from 64-kbps PCM to 16-kbps CVSD (optionally 32-kbps CVSD), and from 16-kbps CVSD (optionally 32-kbps) to 64-kbps PCM, as described in MIL-STD-188-105, the two sections titled *Transcoding*.

4.1.6.1.1 Nonsecure voice service in tactical ATM networks. Nonsecure voice calls between tactical users could use 64-kbps PCM and ATM adaptation layer (AAL) Type 2 variable bit rates (VBR) (see 5.6.3.3.3) for access to and exit from ATM networks, to conserve bandwidth in tactical networks. This is an area for further study.

> NOTE: In ATM networks there is a delay associated with filling cells with bits from a voice encoder. The lower the voice encoding rate, the longer the delay. For example, at 64 kbps the delay is 6 ms. At 16 kbps the delay is 24 ms. Just as with satellite links, the delay of concern for conversation is the round-trip delay; thus CVSD-16 would introduce 48 ms of added round-trip delay. This is less than 10% of the round-trip delay experienced on a 1-hop satellite link.

One technique for alleviating delay is to partially fill cells. This will reduce the throughput; however, this may be an acceptable way to reduce delay for low-bit-rate voice, such as 2.4 or 4.8 kbps.

Another technique is to use VBR. Rather than dedicating a constant bit-rate (CBR), full-duplex, virtual circuit, this technique uses bandwidth only when a user is speaking. Since usually only one person speaks at a time, and there are many pauses, an average reduction by a factor of 2 to 3 in consumed bandwidth would be realized. This technique would realize a reduction in delay without the corresponding reciprocal increase in bandwidth. For example, 64-kbps PCM VBR with AAL Type 2 would require about 50% more bandwidth than CVSD-16 CBR, and would realize a reduction in delay by a factor of 4. AAL Type 2 may not work for end-to-end encrypted voice, where BCI is required.

In networks using 2-wire analog telephones, excess delay can cause echo problems. However, echo is not expected to be a problem in networks using digital telephones.

The issue of optimum voice-encoding techniques and choice of VBR/CBR for PCM-encoded voice in ATM networks is an area for further study.

4.1.6.2 End-to-end encrypted voice service. End-to-end encrypted voice service between tactical and strategic networks shall be available if the subscriber terminals contain a common voice-encoding algorithm and a common crypto algorithm, and are capable of mode negotiation. End-to-end encrypted voice calls shall be treated as a data service. BCI shall be preserved to maintain cryptographic synchronization between calling and called secure-voice terminals. End-to-end encrypted voice calls between base-level and tactical users may occur at any standard bit rate up to and including 16 kbps (optionally 32 kbps), as described in MIL-STD-188-105, the section titled *End-to-end encrypted telephone service*. The network elements shall allow switching from data-to-voice and voice-to-data to occur at the terminals.

NOTE: The 32-kbps CVSD option will work only for special cases in which calls do not transit subnetworks using 16-kbps channels.

4.1.6.2.1 Mode negotiation. New telephone terminals used in ISDN networks will be able to negotiate, during the call-establishment phase, to determine if a common voice-encoding mode exists. The new telephone terminal shall comply with MIL-STD-188-105, the section titled *New terminal*, and addressed by the National Security Agency (NSA) in their Secure Terminal Equipment Program. When used in ISDN networks, mode negotiation shall be accomplished using the user-to-user information element, as described in MIL-STD-188-105, the section titled *Call-establishment phase*.

4.1.6.2.2 Interoperable modes. New telephone terminals, as defined in MIL-STD-188-105, shall have at least two voice-encoding modes. One will be PCM, which will be used in ISDN networks, as defined in MIL-STD-188-194. Another will be CVSD-16, which will be used for end-to-end encrypted calls between tactical and strategic users. Other voice-encoding schemes may be 32-kbps ADPCM, 2.4-kbps LPC-10, and 4.8-kbps CELP.

4.1.6.2.3 End-to-end encrypted voice service in ATM networks. End-to-end encrypted voice service shall use AAL Type 1 CBR service (see 5.6.3.3.3) for access to and exit from ATM networks, to maintain BCI. The AAL Type 1 protocol may be implemented in either the telephone terminal or a terminal adapter. The terminal adapter may be located in the ATM switch.

4.1.7 Rate adaptation

a. Information sources, linked to a strategic-local network, that operate at rates of 600, 1200, 2400, 4800, 9600, 16000, 19200, or 32000 bps, shall be rate-adapted to a 64-kbps channel. The rate adaptation of bit rates up to 32 kbps shall use the multi-stage approach defined in ITU-T Recommendation V.110, the section titled *Adaptation of V-series data signaling rates to the intermediate rates*. With this approach, rates of 4.8 kbps and below are mapped to 8 kbps, 9.6 kbps is mapped to 16 kbps, and 19.2 kbps is mapped to 32 kbps. Rate adaptation of 8-, 16-, and 32-kbps signals shall be rate-adapted in accordance with the following procedure, as documented in ITU-T Recommendation I.460, the section titled *Rate adaptation of 8-, 16-, and 32-kbps streams*:

(1) The 8-kbps stream occupies bit position 1.

(2) The 16-kbps stream occupies bit positions 1 and 2.

(3) The 32-kbps stream occupies bit positions 1, 2, 3, and 4.

(4) All unused bit positions shall be set to "1."

(5) The order of bit transmission of the subrate stream shall be identical before and after rate adaptation.

b. Information sources, linked to a tactical network, that operate at rates of 75, 600, 1200, 2400, 4800, or 9600 bps, shall be rate-adapted to a 16-kbps channel, as described in MIL-STD-188-216, the section titled *Multisampling*.

4.1.8 Dedicated circuits. The DISN shall be able to provide dedicated circuits at 64-kbps, 384-kbps, and 1.544-Mbps rates. These circuits shall be provided by commercially leased lines or by multiplexing existing channels into dedicated through groups. The layer 1 interface shall conform to applicable portions of 5.1.1.1 for the 64-kbps rate, and 5.2.1.1 for both the 384-kbps and 1.544-Mbps rates.

4.1.9 Supplementary services. A network supplies supplementary services in addition to its basic services. The generic procedures applicable to the control of supplementary services at the user-to-network interface are defined in ANSI T1.610. A list of required (mandatory) and optional supplementary services is provided in MIL-STD-188-194, the section titled *Supplementary services*. The mandatory supplementary services, which are applicable to both fixed and deployed networks, are discussed in

4.1.9.1 to 4.1.9.3. The optional supplementary services are discussed in 4.1.9.4 to 4.1.9.14.

4.1.9.1 Multi-level precedence and preemption service. The multi-level precedence and preemption (MLPP) service provides a prioritized call-handling service. This service has two parts: precedence and preemption. Precedence involves assigning a priority level to a call. Preemption involves the seizing of resources, which are in use by a call of lower precedence, by a higher-level precedence call in the absence of idle resources. The MLPP service is a network provider's option applicable to a domain of the network, that is, all subscribers and the network and access resources that belong to the domain. Connections and resources belonging to calls from MLPP subscribers shall be marked with a precedence level and domain identifier and shall be preempted only by calls of a higher precedence from MLPP users in the same domain. Connections and resources belonging to calls from non-MLPP users and users from other MLPP domains shall not be preempted. The maximum precedence level of a subscriber will be set by the service provider, based on the subscriber's need. The subscriber may select a precedence level up to and including the maximum subscribed-to precedence level on a per-call basis. The MLPP service shall be mandatory in DOD networks (both fixed and deployed) and shall comply with ANSI T1.619. For calls to subscribers in existing deployed (tactical) networks that comply with Tri-Service Tactical Communications (TRI-TAC) specifications, the MLPP service shall comply with MIL-STD-188-105.

4.1.9.2 Preset Conference. The Preset Conference service allows the served user to quickly establish a conference call with a predetermined list of conferees stored in the network. All of the call attempts are done in parallel. This service is defined in ANSI Draft T1S1.2/93-157.

4.1.9.3 Hotline. The Hotline service allows a user to automatically initiate a call, act as a receiver for Hotline service calls, or do both. Three subscription options exist for the Hotline service: Protected Hotline Calling service, Unprotected Hotline Calling service, and Protected Hotline Receiving service. When subscribing to the Protected Hotline Calling service, the user shall initiate calls only to the predetermined called party. In addition, the Protected Hotline Calling service user will not receive calls from any third party and may receive calls only from the predetermined called party, if that predetermined called party is also a Hotline service user. When subscribing to the Unprotected Hotline Calling service, the user shall initiate calls only to the predetermined called party of the Hotline service call, who may or may not be another Hotline service user; however, the Hotline service user may receive calls from third parties in addition to calls from the called party of the Hotline service call. A protected Hotline Receiving service user may receive calls only from predetermined Hotline Calling service user(s); however, the user may initiate calls to other users. This service is defined in ANSI Draft T1S1.2/91-408.

4.1.9.4 Call Waiting. The Call-Waiting service permits a subscriber to be notified of an incoming call with an indication that no interface information channel is available. The subscriber then has the choice of accepting, rejecting, or ignoring the waiting call. This service is defined in ANSI T1.613.

4.1.9.5 Call Hold. The Call Hold service allows a user to interrupt communications on an existing call and then subsequently, if desired, reestablish communications. This service is defined in ANSI T1.616.

4.1.9.6 Call Forwarding. The Call Forwarding service allows a served user to have the network send to another number all incoming calls for the served user's number. This service is defined in ITU-T Recommendation I.252.

4.1.9.7 Call Transfer. The Call Transfer service allows a user to transfer an established call to a third party. This service is defined in ITU-T Recommendation I.252.1.

4.1.9.8 Conference Call. The Conference Call service allows a user to establish calls to multiple parties, one at a time, using normal call-handling procedures. The parties may also communicate among themselves. This service is defined in ITU-T Recommendation I.254.1.

4.1.9.9 User-to-User Signaling. The User-to-User Signaling service allows users to send and receive limited amounts of user-generated information to and from another user-network interface. This information is passed transparently (without changing contents) through the network. Users can transfer information during the establishment and clearing phases of calls. The information is transmitted in the user-user information element. The user-user information element is an optional element of the following Digital Subscriber Signaling System Number 1 (DSS1) types of messages: Alerting, Connect, Disconnect, Progress, Release, Release Complete, and Setup. This service is defined in ANSI T1.621.

4.1.9.10 Calling Line Identification Presentation. The Calling Line Identification Presentation (CLIP) service provides the called party with the calling line identification at call setup on all incoming calls. This service is defined in ANSI T1.625.

4.1.9.11 Calling Line Identification Restriction. The Calling Line Identification Restriction (CLIR) service notifies the network that the Calling Party Number is not allowed to be presented to the called party. This service is defined in ANSI T1.625.

4.1.9.12 Call Completion to a Busy Subscriber. The Call Completion to a Busy Subscriber service allows an authorized user, A, who encounters a busy destination, B, to be notified when the busy destination, B, becomes idle. The network reinitiates the call to destination B if user A desires. This service is defined in ANSI Drafts T1S1.1/92-253 and T1S1.1/92-323.

4.1.9.13 Message Waiting Indicator Control and Notification. The Message Waiting Indicator (MWI) Control and Notification service is provided by the network to a Message Storage and Retrieval (MSR) System provider. The MSR System may request the network to provide an indication to one of its client users that messages are waiting at the MSR System. This service is defined in ANSI T1.622.

4.1.9.14 Line Hunting. The Line Hunting service allows a served user to enable incoming calls to a specific ISDN number to cause a search for an available hunt group member to which calls can complete. This service may be made available on demand or by subscription. This service applies to both basic rate and primary rate interfaces. This service is defined in ANSI Draft T1S1.92-188.

4.1.10 Multimedia communications. Network access and signaling functions shall support multimedia services. Multimedia services provide the capability to manipulate and manage information consisting of text, graphics, images, video, and audio. These services can be used directly by mission area applications and by other support applications, as described in the *Technical Architecture Framework for Information Management* (TAFIM), Volume 7. Addition and deletion of types of information during an active multimedia session shall be supported.

4.1.11 Data Service. The aggregate of tactical-network elements, wide-network elements, and base-level network elements shall provide the capability for end-to-end data service such as interactive, video, and imagery data. The data service shall be supported by internet protocols; open system interconnection protocols; or any combination of both protocol over packet, frame, and cell switching, or router networks. The separation of traffic by classification shall be provided by (1) physical separation through network segmentation; (2) end-to-end encryption, wherein the keys associated with the encryption are protected as a minimum to the same level as the classification of the traffic that they handle; or (3) a combination of both. Authentication of nonsecure dial-up subscribers shall be provided by NSA- approved non-forgeable dynamic-token-based authentication technology. Authentication of secure dial-up subscribers and encryption of their traffic shall be provided through the use of NSA-approved secure terminal equipment (STE).

4.1.12 Internet. The Internet provides connectionless packet delivery services based on a set of network standards that specify the details of how computers communicate, as well as a set of conventions for interconnecting networks and routing traffic. Officially named the transmission control protocol/internet protocol(TCP/IP) suite and commonly referred to as TCP/IP, it is used to communicate across any set of interconnected networks. Although TCP/IP is based on conventional packet switching technology, it is independent of any particular vendor's hardware. The Internet allows computers to communicate by using a unit of data transmission, called *datagrams*. IP routers interconnect networks and pass packets from one to the other. Because IP addresses include the address for both a network and a host on that network, IP routers can route packets based on the destination network, not address the destination computer address. IP routers can exist at any place within the DII as either interior or exterior gateways. For the purpose of routing, a group of networks and gateways controlled by a single administrative authority is called an autonomous system, using interior gateway protocols. Gateways between autonomous systems use exterior gateway protocols. The IPs provide for acknowledgment between source and destination (end systems) instead of between successive routers and gateways along the path, even when the two end systems are not connected to a common physical network. In addition to basic connectionless-packet delivery service, the IP suite includes many common applications such as electronic mail, file transfer, and remote login. Existing IPS shall provide an interim solution. The objective solution will be presented in a future version of the Government Open Systems Interconnection Profile (GOSIP) based on the IP suite. The application software for both GOSIP and IP shall coexist in the end systems until such time that the IP applications are phased-out.

4.2 Information-transfer utility system parameters. The following ISDN system parameters listed in 4.2.1 through 4.2.4 shall apply to the information-transfer utilities portion of the DISN. These parameters are summarized here because of their impact on the design of information sources, sinks, and processors that exchange information through information-transfer utilities.

4.2.1 Information bearer channels. Base information-transfer systems shall be able to exchange multiple bearer channels over a single connection at reference point A. Below are four interface options:

a. Basic rate interface. The basic rate interface provides two 64-kbps bearer (B-) channels and one 16-kbps signaling data (D-) channel. B-channels can be used for voice or data. The D-channel is used for call control and low-speed packet data. The required method for multiplexing the 2B+D channels into a form suitable for transmission over a single twisted wire pair is provided in 5.1.1.1.

b. Primary rate interface. The primary rate interface provides a combination of 23B- (or 30B-) channels and one 64-kbps D-channel. The 23B+D (or 30B+D) channels will be used primarily to connect private branch exchanges (PBX) to central offices at reference point A. The primary rate interface will also be used at reference point B to interconnect local-network elements to wide-network elements. A D-channel may not be required for every primary rate interface; in this case, all 24 or 31 channels shall be available for use as B-channels.

c. High-rate channels. It shall be possible to treat multiple 64-kbps channels as a single high-rate (H) channel. Six B-channels can be treated as a single 384-kbps (H_0) channel. Twenty-three B-channels can be treated as a single 1472-kbps (H_{10}) channel. H_0 channels can be used in combination with B-channels on the same primary rate interface (PRI). Rules for time-slot assignments for high-rate signals are provided in 5.3.1.1j.

d. Broadband services interface. See 5.6.

4.2.2 Timing and synchronization

4.2.2.1 Reference point A. In general, information-source bit timing shall be slaved to the local network, as described in MIL-STD-188-115, the discussion of master-slave operation. Terminal equipment connected to network elements in the base information-transfer system shall comply with ANSI T1.601, the section titled *Baud Rate, Timing, and Synchronization*. Terminal equipment connected to network elements in the tactical information-transfer system shall comply with MIL-STD-188-115.

4.2.2.2 Reference point B. Local-network and wide-network elements that provide the reference point B interface shall provide stratum 1 clock accuracy, as defined in ANSI T1.101 and ITU-T Recommendation G.811, and buffering sufficient to maintain BCI for a minimum of 24 hours. Frame synchronization, as required to demultiplex time-division-multiplexed signals, shall be provided by use of the framing bits described in ANSI T1.408 and MIL-STD-188-202.

4.2.2.3 Coordinated Universal Time. Systems that require time and frequency reference information based on coordinated universal time (UTC) shall comply with FED-STD-1002.

4.2.3 System performance. System performance standards for base information-transfer systems and wide networks shall be based on the standards for 64-kbps channels, as given in 5.8. System performance standards for tactical information-transfer systems shall be based on 5.8.

4.2.4 Network management. The Simple Network Management Protocol (SNMP), as defined in RFC 1157, shall be used until it is superseded by the Common Management Information Protocol (CMIP)/Common Management Information Service (CMIS). The objective of DISN network management is to conform to the Government Network Management Profile (GNMP) (FIPS-PUB-179), and to support the establishment, reconfiguration, and maintenance of a stable signaling and user-network environment. To achieve this objective, network management entities within each segment of the DISN shall be based on an integrated management architecture and shall employ a set of common management protocols, as defined in MIL-HDBK-1351. DISN network management shall provide support for the following set of common management application functions:

a. Fault management

b. Configuration management

c. Account management

d. Performance management

e. Security management

Maximum use shall be made of automated management aids to ensure effective and responsive DISN network management. Section 5.7 defines specific DISN network management requirements.

4.3 Common requirements. DISN equipment will be used in a variety of applications and environments. Acquisition specifications should contain design requirements tailored to the expected application and environment; however, the nature of military operations also dictates some degree of flexibility. Extreme care must be taken to ensure that design requirements selected from applicable DOD documents are tailored to provide the necessary flexibility. The use of commercial off-the-shelf (COTS) equipment is encouraged when the acquisition authority determines that some or all of the common requirements listed in 4.3.1 to 4.3.13 do not apply.

4.3.1 Information security. The design of information systems shall allow the incorporation of communications security (COMSEC) and computer security (COMPUSEC) to protect information against unauthorized disclosure, transfer, modification, or destruction.

4.3.1.1 Communications security. Provisions for COMSEC shall include crypto security, transmission security (TRANSEC), emission security (EMSEC), and physical security.

4.3.1.1.1 Crypto security. Information systems shall provide internal or external crypto equipment. Digital interfaces to external crypto equipment shall be in accordance with MIL-STD-188-114.

4.3.1.1.2 Transmission security. HF radio anti-jam (AJ) systems shall comply with the TRANSEC algorithm provisions in MIL-STD-188-148. Very high frequency (VHF) radios shall comply with Joint Interoperability and Engineering Organization (JIEO) Specification 9001. Ultra high frequency (UHF) radios shall comply with Standardization Agreement (STANAG) 4372. Standards for satellite communications (SATCOM) AJ systems shall be based on existing UHF, super high frequency (SHF), and extremely high frequency (EHF) common-user DOD satellite systems.

4.3.1.1.3 Emission security. Compromising emanations shall be controlled within applicable TEMPEST criteria in the current edition of NSTISSAM TEMPEST/1-91.

NOTE: National COMSEC Engineering Memorandum (NACSEM) 5201 provides design guidance and MIL-HDBK-232 provides installation guidelines for compromising emanations.

4.3.1.1.4 Physical security. Systems shall have appropriate tamper-resistant design features and tamper-detection mechanisms.

4.3.1.2 Computer security. Computer systems shall comply with applicable provisions of DOD 5200.28-STD and the security standards identified in the TAFIM.

4.3.2 Electromagnetic compatibility. Systems and associated subsystems shall be designed to achieve intrasystem and intersystem electromagnetic compatibility (EMC). There shall be no emissions by any item of the subsystem or system beyond the tolerances established in MIL-STD-461. Techniques used to measure and determine EMC characteristics shall comply with the applicable requirements of MIL-STD-462. Equipment and subsystems should be designed in accordance with applicable EMC guidance in MIL-HDBK-235, MIL-HDBK-237, MIL-HDBK-241, and MIL-HDBK-253. The

EMC program must address both emissions and susceptibilities, not just emissions. Future specific electromagnetic emission requirements will require tailoring of MIL-STD-461 requirements to ensure compatibility.

NOTE: MIL-HDBK-237 provides guidance for implementing an EMC program, and MIL-HDBK-241 provides guidance for EMC enhancement (electromagnetic interference reduction) of equipment power supplies.

4.3.3 Electronic warfare vulnerability and electronic counter-countermeasures capabilities. Electronic warfare (EW) vulnerability analyses shall be performed on all radio subsystems, beginning with the concept formulation stage. Appropriate electronic counter-countermeasures (ECCM) capabilities shall be developed to protect these systems from the applicable EW threat.

4.3.3.1 Determining the electronic warfare technical threat. EW intelligence sources shall be used to provide an EW technical threat model during the concept formulation stage of system development. The EW technical threat model shall determine if 4.3.3.2 and 4.3.3.3 are required.

4.3.3.2 Analyzing electronic warfare vulnerability. Simulation techniques should be used to assess the effects of EW on radio links. Preliminary analyses of EW effects on candidate systems should be made to help eliminate unacceptable approaches. Subsequent analyses of emerging candidate techniques and equipment should be made at several stages of development. EW vulnerability analyses should be performed in accordance with applicable department or agency directives.

4.3.3.3 Developing electronic counter-countermeasures techniques. During each phase of system development and production, available ECCM technology should be reviewed for applicability to EW vulnerability. Where necessary, ECCM capability should be made integral to the system design. It should not be assumed that ECCM remedies can be applied at later stages of system development. EW and ECCM test requirements shall be stated in applicable system specifications. HF radio AJ systems shall comply with applicable provisions of MIL-STD-188-148. VHF radios shall comply with JIEO Specification 9001. UHF radios shall comply with STANAG 4372. Standards for SATCOM AJ systems shall be based on existing UHF, SHF, and EHF common-user DOD satellite systems.

4.3.4 Human engineering design. All information systems, subsystems, and facilities shall be designed in accordance with the applicable requirements of MIL-STD-1472 and MIL-H-46855, and in accordance with the Human Factor Interface Style Guide (Volume 8 of the TAFIM).

4.3.5 Reliability. All systems and subsystems shall be designed to meet quantitative reliability requirements. The reliability program shall be established in accordance with the applicable requirements of MIL-STD-785. Reliability acceptance tests shall be performed in accordance with the applicable requirements of MIL-STD-781.

4.3.6 Maintainability. All equipment, subsystems, and systems shall be designed to meet quantitative maintainability requirements. The maintainability program shall be established in accordance with the applicable requirements of MIL-STD-470. Maintainability acceptance tests shall be performed in accordance with the applicable requirements of MIL-STD-471.

4.3.7 Survivability. Survivability is the characteristic of equipment, subsystems, and systems to withstand or avoid such damage mechanisms as blast fragments, bullets, and explosive and incendiary devices, as well as the effects of such natural phenomena as lightning, without causing a malfunction. Survivability can be enhanced by such measures as adding armor plating, duplicating and separating critical components, and simplifying the design to reduce the number of critical components. The survivability of all systems and subsystems should be assessed by performing vulnerability reduction studies in accordance with applicable department or agency directives, regulations, and instructions.

4.3.8 Climatic conditions. All equipment shall be designed to meet the applicable climatic conditions specified in MIL-STD-210. The climatic condition and induced stress requirements for an equipment or an assemblage shall be consistent with the degree of exposure anticipated for intended field applications.

4.3.9 Environmental test methods. All systems and subsystems shall be designed to comply with the applicable environmental test methods specified in MIL-STD-810.

4.3.10 Electrical measurement and test methods. Electrical measurement and test methods for communications systems shall comply with MIL-STD-188-190.

4.3.11 Grounding, bonding, and shielding. Methods and practices for grounding, bonding, and shielding of ground-based telecommunications equipment and facilities, including buildings and structures supporting tactical and long-haul communications, shall comply with the applicable requirements of MIL-STD-188-124. MIL-HDBK-419 provides practical considerations for grounding, bonding, and shielding systems.

4.3.12 Radio regulations. The use of the frequency spectrum is regulated by international agreements embodied in radio regulations published by the General Secretariat of the International Telecommunications Union (ITU), Geneva, Switzerland, and modified periodically by a World Administrative Radio Conference (WARC). These radio regulations are further qualified at the national level through such Federal Government agencies as the Interdepartment Radio Advisory Committee (IRAC), and through such military agencies as the Joint Chiefs of Staff (JCS) and the Military Communications-Electronics Board (MCEB). Military frequency planning, including joint functional frequency allocation tables, is established as a joint action area under the MCEB. For subsystems and equipment design, the choice and performance of the equipment, as well as frequencies and emissions of any radio subsystem, shall satisfy the provisions of those radio regulations. Therefore, radio subsystem designers and users are required to have adequate familiarity with these regulations. Final approval of frequency bands, operating modes, and equipment characteristics within DOD rests with the MCEB.

4.3.13 Radio frequency spectrum characteristics. The spectral characteristics of all radio frequency (rf) transmitters, receivers, and antennas shall be measured in accordance with the applicable requirements of MIL-STD-449.

4.3.14 Conformance testing. ISO 9646 and ITU-T Recommendation X.290 shall be used for the conformance testing methodology and framework to ensure that conformance testing produces correct and consistent results. DOD Communications Protocol Standards (DCPS) conformance testing shall be in accordance with MIL-HDBK-1350-2. Acquisition agencies are cautioned that successful conformance testing of an equipment will not guarantee interoperability with all other equipment that also passed conformance testing. Conformance testing is not a substitute for interoperability testing.

4.3.15 Interoperability testing. Testing shall be performed to successfully demonstrate that systems successfully interoperate. DCPS interoperability testing shall be in accordance with MIL-HDBK-1350-2. The Joint Interoperability Test Center (JITC) is currently developing an interoperability testing guide. When this document, titled *Open Systems Environment Standards Conformance and Interoperability Testing Methodology*, is published, it will codify the processes for obtaining standards conformance and/or interoperability certification.

4.3.16 Validation. Validation of data communications protocols (DCP) shall be conducted in accordance with MIL-HDBK-1350-1.

4.4 Subsystem design considerations

4.4.1 Terminal subsystems. Digital interfaces between terminal subsystem equipment shall comply with MIL-STD-188-114 unless other standards apply.

4.4.1.1 Tactical terminal subsystems. Tactical terminal subsystems shall comply with the applicable requirements of MIL-STD-188-216 and MIL-STD-188-260.

4.4.1.2 Long-haul digital terminal subsystems. Long-haul digital terminal subsystems shall comply with the applicable requirements of ANSI standards X3.4, X3.16 and X3.25.

4.4.1.3 Facsimile subsystems. Tactical and long-haul facsimile subsystems shall comply with the applicable requirements of MIL-STD-188-161.

4.4.1.4 Tactical digital information links. Message formats and related information for tactical digital information links (TADIL) A, B, and C are published in Joint Pub 6-01.1. Technical characteristics for TADILs A and C are published in the MIL-STD-188-203 series and for TADIL B are published in MIL-STD-188-212.

4.4.1.4.1 TADIL A subsystems. Technical characteristics of TADIL A subsystems shall comply with applicable requirements of MIL-STD-188-203-1.

4.4.1.4.2 TADIL B subsystems. Technical characteristics of TADIL B subsystems shall comply with applicable requirements of MIL-STD-188-212.

4.4.1.4.3 TADIL C subsystems. Technical characteristics of TADIL C subsystems shall comply with applicable requirements of MIL-STD-188-203-3.

4.4.1.4.4 TADIL J subsystems. Technical characteristics of TADIL J subsystems shall comply with STANAGs 4175 and 5516.

4.4.1.4.5 ATDL-1 subsystems. Technical characteristics of Army Tactical Data Link 1 (ATDL-1) shall comply with Joint Pub 6-01.3.

4.4.2 Transmission subsystems. Transmission subsystems include fiber optic cables, metallic lines, and satellite and terrestrial radios.

4.4.2.1 Long-haul transmission subsystems. Long-haul transmission subsystems shall comply with the performance requirements given in 5.8.

4.4.2.2 Tactical transmission subsystems. Tactical transmission subsystems shall comply with the applicable requirements of MIL-STD-188-202.

4.4.2.3 Fiber optic communications subsystems. Long-haul fiber optic subsystems shall comply with the applicable requirements of MIL-STD-188-111. Tactical fiber optic subsystems shall comply with the applicable requirements of MIL-STD-188-111 and JIEO Specification 9109.

4.4.2.4 Metallic line transmission subsystems. Wire and cable transmission subsystems shall comply with the applicable requirements of MIL-STD-188-112.

4.4.2.5 Radio relay subsystems. The bands of the radio spectrum classified as VHF, UHF, and SHF are used by various types of radio relay subsystems.

4.4.2.5.1 Long-haul line-of-sight transmission subsystems. Long-haul line-of-sight (LOS) transmission subsystems shall comply with the applicable requirements of MIL-STD-188-313.

4.4.2.5.2 Satellite transmission subsystems. Satellite transmission subsystems shall comply with the applicable requirements of MIL-STD-188-146.

4.4.2.6 Radio subsystems operating in medium frequency and lower bands. Radio subsystems operating in the medium frequency (MF) band shall comply with the applicable requirements of MIL-STD-188-141. Radio subsystems operating in the low frequency (LF) and lower bands shall comply with the applicable requirements of MIL-STD-188-140.

4.4.2.7 High frequency radio subsystems. Radio subsystems using frequencies between 3 and 30 MHz shall comply with the applicable requirements of MIL-STD-188-141. AJ transmission systems operating in the HF band shall comply with the applicable requirements of MIL-STD-188-148 and MIL-STD-188-110. HF digital voice shall use LPC at 2.4 kbps, in accordance with MIL-STD-188-113. Automatic link establishment (ALE) of HF radio links shall be accomplished using the waveforms and procedures specified in Appendix A of MIL-STD-188-141, or in FED-STD-1045.

4.4.2.8 Very high frequency radio subsystems. Radio subsystems using frequencies between 30 and 300 MHz shall comply with the applicable requirements of MIL-STD-188-242.

4.4.2.9 Ultra high frequency radio subsystems. Radio subsystems using frequencies between 300 and 3000 MHz shall comply with the applicable requirements of MIL-STD-188-243.

4.4.2.10 Super high frequency radio subsystems. Radio subsystems using frequencies between 3 and 30 GHz shall comply with the applicable requirements of MIL-STD-188-145.

4.4.2.11 Extremely high frequency radio subsystems. Technical characteristics of EHF radio subsystems (30-300 GHz) are under consideration.

4.4.2.12 Single-channel-radio to switched-system interfaces. See 5.1.3.

4.5 Functional interface requirements. This section defines the scenario, network elements, and applications supported by this MIL-STD. This scenario and these applications determine which standards, options, and parameters are incorporated in this MIL-STD.

4.5.1 Scenario. The development of new systems is driven by the availability of new technology and funding for implementation. DOD procures nondevelopmental items (NDI) to meet military requirements at reduced costs. DOD will take advantage of rapid advances in commercial computer and communications technology, as well as emerging open standards, to meet future command, control, communications, and intelligence (C3I) requirements. Military-unique features must be introduced early in the commercial standards development cycle. Higher-performance processing systems and the provision of intelligent networks are new trends that will affect the DISN. These changes will accompany the introduction of ISDN for base and long-haul requirements, whereas the tactical system has evolved to an all-digital system based on TRI-TAC specifications. The tactical environment is expected to further evolve toward a hybrid TRI-TAC/commercial standard, as the Services upgrade their deployable systems. In the future, broadband-ISDN (B-ISDN) services will become part of the DISN. Broadband services will provide interactive and distributive services. Interactive services include bidirectional communications with real-time information transfer, such as conferencing, between users. Distributive services include broadcast services such as television or audio programs. The starting time of distributive services may or may not be controlled by the user. Tactical assets may have limited capability for broadband services, due to spectrum limitations. In the long term, the tactical architecture shall depend on ATM; thus, it will move away from channel limitations caused by the current synchronous transfer mode (STM).

4.5.2 Network elements. This MIL-STD identifies the standards necessary for information exchange between subscribers of common-user switched systems. Subscribers may be connected to the same network, or they may be connected to different but interconnected networks. Each network may consist of different elements, as illustrated in Figures 3 and 4. Figure 4 describes the DISN Goal Architecture. These network elements are described in 4.5.2.1 to 4.5.2.4. (See the DISN Architecture.)

4.5.2.1 Subscriber-network elements. Two types of subscriber-network elements exist: subscriber terminal equipment and subscriber networks. Subscriber terminal equipment, which can be manned or unmanned, includes telephones; teleprinters; facsimile machines; data terminals (such as host computers, workstations, personal computers, digital-message entry devices, sensors, and weapons systems); video terminals; or other information sources and sinks. Subscriber networks, through a common media, provide connectivity between a limited set of subscribers. These networks can provide selective addressing, but they do not switch or route traffic. Subscriber networks may be local area networks (LAN), as defined in International Organization for Standardization (ISO) 8802-3, 8802-4, and 8802-5; or radio networks such as combat radio networks. This MIL-STD does not apply to closed networks that do not interface with remote users via common-user systems. Subscriber terminal equipment and subscriber networks are illustrated in Figure 3. Terminal equipment (TE) is used to designate terminals in which information to be exchanged is voice or non-voice. End system (ES) and intermediate system (IS) equipment are used to designate data communications elements that comply with ISO and ITU-T (ITU-T) data communications standards. An end system represents a host for information-transfer applications. An intermediate system represents a relay or bridge used to transfer data between one subnetwork and another. R represents a radio terminal in a network of similar radios, for example, the Position Location Reporting System (PLRS), the Joint Tactical Information Distribution System (JTIDS), or combat net radio (CNR). For broadband systems, as illustrated by the DISN Goal Architecture of Figure 4, subscriber elements include sensors, multilevel secure voice/data/imagery workstations, high-definition studio video, data processing installations, and personal communications services (PCS). Not shown for deployed systems are the subscriber radio networks, as well as the LANs, which may be indigenous to the deployed platforms (aircraft, ships, trucks, and tanks). Subscriber terminal equipment and subscriber networks shall be directly connected to the local-network elements by cable (metallic or fiber) or by multi-role radio. The interface between subscriber-network elements and local-network elements is identified as reference point A.

4.5.2.2 Local-network elements. Local-network elements are the circuit switches, packet switches, and transmission equipment that constitute the common-user systems provided by the military Services. They provide switched service for base-level and tactical users. Local-network elements are illustrated in

Figure 3. The base-level circuit-switched networks (CSN) and packet-switched networks (PSN) are based on commercial standards for ISDN. Tactical CSNs and PSNs currently interface with TRI-TAC equipment; future upgrades to tactical systems should be based on commercial standards. Compatible terminal equipment shall be able to exchange information via switched networks comprised of local-network elements. The interface between subscriber-network elements and local-network elements shall comply with the standards described in 5.1. Tactical CSNs and PSNs within a theater of operations may be interconnected without going through the Defense Switched Network (DSN) or Defense Data Network (DDN). As illustrated by the DISN Goal Architecture of Figure 4, local-network elements include ATM adapters, as well as broadband and digital hierarchy transmission equipment, ATM LANs, and (not shown) distributed queue dual-bus (DQDB) subnetworks. The interface between local-network elements and wide-network elements is identified as reference point B. Broadband local-network elements are based on the commercial standards described in 5.6.

4.5.2.3 Wide-network elements. Wide-network elements are the circuit switches, packet switches, and transmission equipment provided by the Defense Communications System (DCS) and public switched telephone networks (PSTN). Wide-network elements are used to transfer information between remote local-network elements. The interface between local-network elements and wide-network elements shall comply with the standards described in 5.2. As illustrated by the DISN Goal Architecture of Figure 4, wide-network elements include ATM switches, broadband, and digital hierarchy transmission equipment. Broadband transmission bit-rates used in fixed networks will be based on the synchronous optical network (SONET) (see Table VII in 5.6.1.2.1). For deployed LOS radios, bit rates will be reduced to 1.544 Mbps (DS1) to match LOS bandwidth constraints. The interfaces between local-network elements and wide-network elements shall comply with the commercial standards described in 5.6.

4.5.2.4 NATO-network elements. North Atlantic Treaty Organization (NATO) network elements are the circuit switches, packet switches, and transmission equipment provided by NATO nations or those portions of the DCS that adhere to the technical standards of the host nation. Subscribers to U.S. common-user systems shall be able to exchange information with subscribers of other nations through reference point B (NATO), as illustrated in Figure 5. The interface between U.S. network elements and NATO network elements shall comply with the STANAGs and ITU-T standards described in 5.3. Future network elements shall comply with the Project Group (PG/6) *Tactical Communications Post-2000 Architecture*, which will lead to development of STANAGs in its final phase.

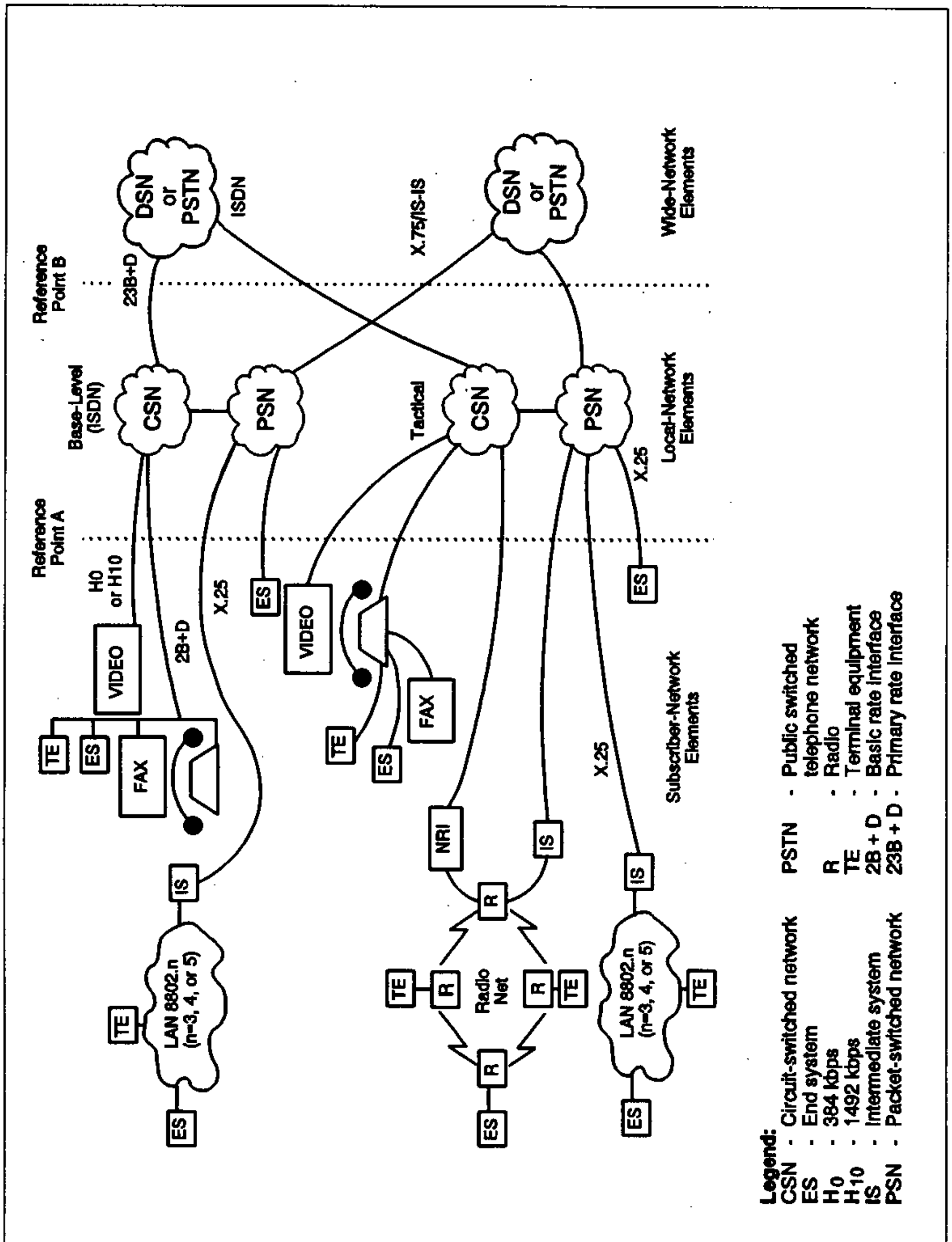


Figure 3. Typical DII network elements (ATM not shown).

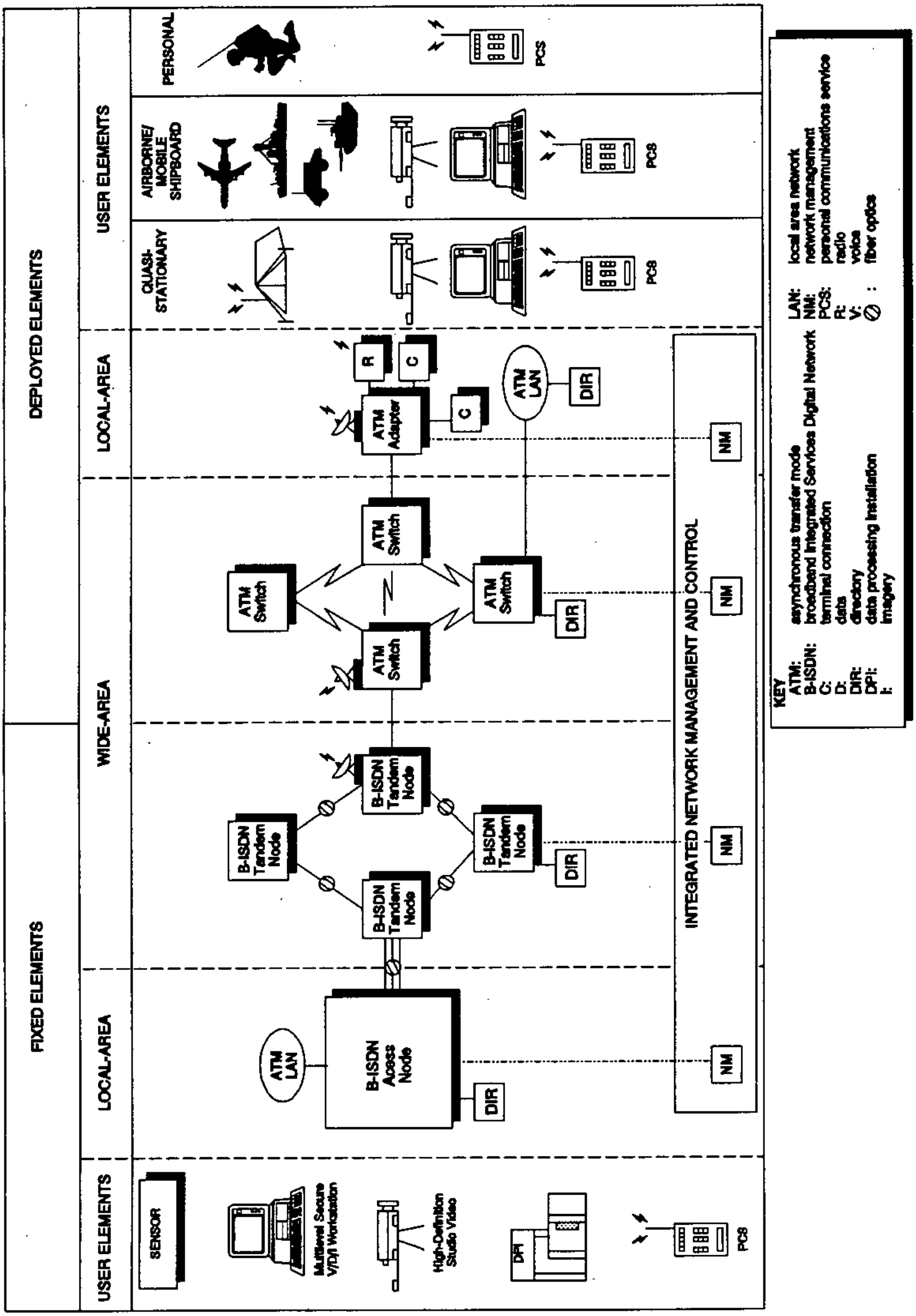
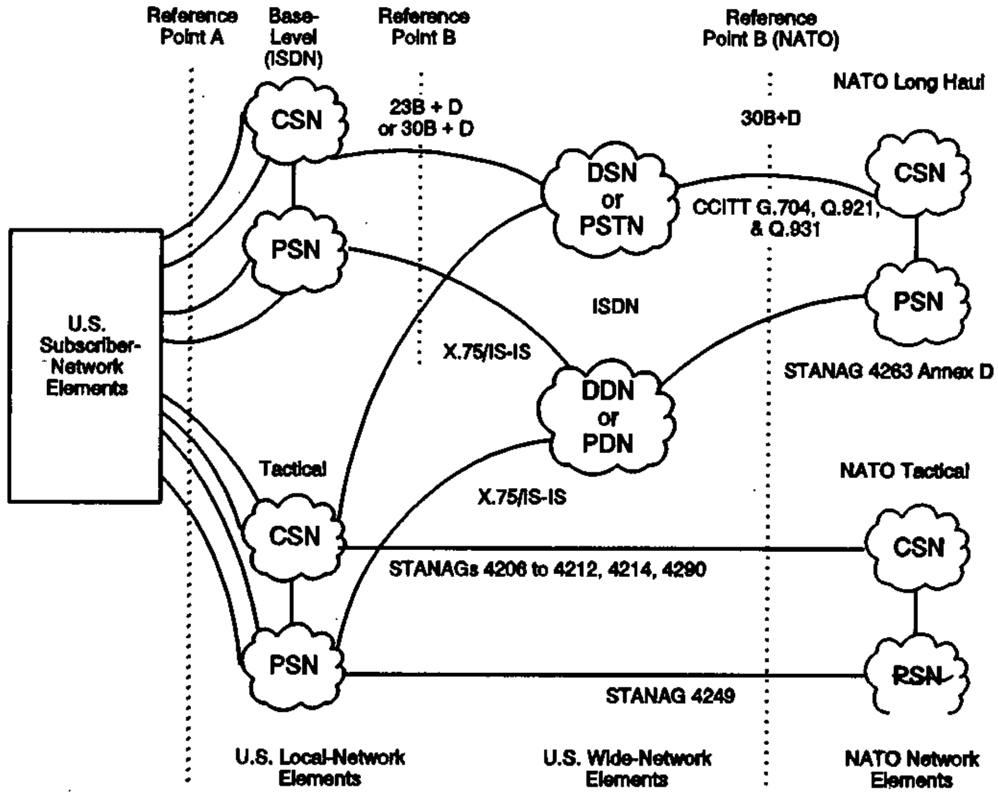


Figure 4. Key elements of the DISN Goal Architecture.



Legend:

CSN	- Circuit-switched network	PDN	- Packet data network
PSN	- Packet-switched network	ISDN	- Integrated Services Digital Network
PSTN	- Public switched telephone network	IS	- Intermediate system
23B + D	- Primary rate interface	STANAG	- Standardization agreement
30B + D	- European primary rate interface	NATO	- North Atlantic Treaty Organization
DDN	- Defense Data Network		

FIGURE 5. Typical DII interface with NATO network elements.

4.5.3 Military enhancements to commercial data communications protocols and standards. The intent of this MIL-STD is to adopt commercial standards for military use whenever it meets Government requirements. In some cases the commercial standards are not acceptable; thus, they require enhancements to satisfy the complete military requirement for a specific function or capability. These enhancements shall be found in the MIL-STD-2045 series. Eight military features have been identified in the data communications protocol area that are not adequately addressed by existing commercial data communications standards. These features are described in 4.5.3.1 through 4.5.3.8. Acquisition authorities should review the standards to ensure that these features are satisfactorily addressed and supplement their procurement documentation, as necessary.

4.5.3.1 Multihomed and mobile host systems. Multihoming is a mechanism for attaching an end system to two or more network access points so that a system setting up a call to the end system is not aware of the extra connectivity. In addition to enhancing survivability, this mechanism may be extended to "mobile hosts" such as aircraft, ships, and land vehicles during the move from one node to another.

4.5.3.2 Multi-endpoint connections (multi-addressing). To transmit data to a number of recipients (a common occurrence in signal handling), a user must establish a connection for each recipient and send a separate copy of the data across each connection. More efficient use is made of the communications resources (in particular, improved performance in terms of minimizing delay and conservation of bandwidth) if the sender has to transmit only one copy of the data. The network then takes care of routing, controlling, and distributing the data.

4.5.3.3 Internetworking. Mechanisms are required to facilitate the interconnection of various systems at the boundary point between subnetworks. Many of the interconnections would be engineered during interoperability testing.

4.5.3.4 Network and system management. Management functions are required that may be more sophisticated than those considered satisfactory for civilian networks: (a) management of broken networks, in which layers of protocols are inoperable; (b) fast responses to changes in network topology, which are essential to maintain important connections; and (c) counterattack management, to recognize and counter the effects of intelligent attack on and physical damage to the network.

4.5.3.5 Security. Protection measures are required (a) to prevent unauthorized access to the system and ensure the confidentiality of the information it carries, and (b) to preserve the integrity of the data and mitigate against denial of service.

4.5.3.6 Quality-of-service. The range of quality-of-service parameters required for military systems exceeds those currently permitted within civilian networks. The particular aim, to maximize network survivability, is to maintain an adequate quality-of-service to the users (or at least to users operating above a given priority level) in the face of a severely damaged or partitioned network. A military requirement exists for an ultimate delivery capability, whereby important communications are sustained, even at very low data rates.

4.5.3.7 Precedence and preemption. To minimize congestion, particularly in a damaged network where resources are at a premium, it is desirable to be able to allocate resources on the basis of priority levels assigned to the messages being routed through the congested area. A facility is therefore required to associate a priority level with a message. This requirement is needed for both connection-oriented and connectionless communications.

4.5.3.8 Real-time and tactical communications. Certain applications (often tactical in nature) require communications with specified time outs, which can be in the range of milliseconds to seconds. Accurate sequencing is essential. Real time may also include high demands on sequencing accuracy.

4.5.4 Enhancements for tactical environments. DOD requires use of commercial data communications protocol standards wherever possible. Most commercial data communications standards rely on "ACK/NACK" protocols for error detection and correction. This is fine for the error environment found in commercial and strategic communications networks. However, tactical communications environments are more severe than their commercial counterparts, and reliance on ACK/NACK protocols will likely result in extremely low throughput. In some cases channel quality can be improved by operational changes such as (a) increased transmitter power; (b) better antenna setting, alignment, or both; or (c) decreased transmission rate. Beyond these link engineering activities, forward error correction (FEC) codes should be used to reduce the link bit error ratio (BER). FEC techniques applied at the physical layer will provide a higher-quality service to the higher layers and yet maintain the higher-layer protocol necessary to be interoperable with strategic networks. For tactical systems working across the NATO digital interface, FEC should comply with Class 4, as defined in STANAG 4213. The appropriate standardized FEC techniques for other tactical interfaces need further study.

4.5.5 Functional profiles. To promote open digital systems, the commercial world has developed the 7-layer Open Systems Interconnection (OSI) Reference Model (RM), ISO 7498, with corresponding ISO and ITU-T standards. ANSI standards address the differences between North American and European implementations. The National Institute of Standards and Technology (NIST) developed the Government Open Systems Interconnection Profile (GOSIP), Federal Information Processing Standard (FIPS) PUB 146, which specifies a subset of existing standards approved for Government use. (FIPS-PUB-146-1 was used to develop this MIL-STD.) To define the end-system interface for data communications, the 7-layer OSI RM is divided into two profiles. The top 3 layers are designated the *application profile*, and the remaining lower 4 layers are designated the *transport profile*. The application and transport profiles are described in 5.4. The *relay profile* represents the interface between two different systems and consists of the lower 3 layers with a relay function that maps one system's network layer into the other system's network layer. Relay profiles occur at Reference points A and B and are described in 5.1 and 5.2, respectively.

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5. DETAILED REQUIREMENTS

5.1 Standards for reference point A. This section defines the standards applicable at the interface between the subscriber terminal equipment (or the subscriber's network equipment) and the local-network element (reference point A).

5.1.1 ISDN-terminal to base information-transfer system. The terminal equipment interfacing with the base information-transfer system shall comply with the existing ANSI standards and ITU-T Recommendations cited in 5.1.1.1 to 5.1.1.3.3, and shall conform to FIPS-PUB-146 for ISDN basic rate access at the user-to-network interface. This interface applies to both circuit-switched and packet-switched service.

5.1.1.1 Layer 1 (the physical layer). Layer 1 provides the mechanical, electrical, functional, and procedural characteristics to activate, maintain, and deactivate a physical circuit. Layer 1 allows for the transparent transmission of bits between the terminal equipment and local-network elements. The interface between the terminal equipment and local-network elements shall comply with ANSI T1.601. This interface shall support up to 2 full-duplex, 64-kbps information bearer channels; 1 full-duplex, 16-kbps signaling channel; and 1 full-duplex, 16-kbps overhead channel over a single twisted pair of telephone wires.

5.1.1.1.1 Physical characteristics. The wiring polarity and connector shall comply with ANSI T1.601, the section titled *Physical Characteristics*.

5.1.1.1.2 Transmission method. The line code used on the twisted pair of telephone wires shall be 2B1Q (2 binary, 1 quaternary), as defined in ANSI T1.601, the section titled *Transmission Method*.

5.1.1.1.3 Functional characteristics. The modulation rate of the 2B1Q signal shall be 80 kilobaud. The timing signal for the subscriber's terminal equipment shall be slaved to the signal received from the local-network element. The two 64-kbps bearer channels, the 16-kbps signaling channel, and the 16-kbps overhead channel shall be multiplexed in accordance with the frame structure defined in ANSI T1.601, the section titled *Functional Characteristics*.

5.1.1.1.4 Electrical characteristics. The subscriber's terminal equipment shall comply with the impedance and return loss, longitudinal output voltage, longitudinal balance, jitter, and dc characteristics defined in ANSI T1.601, the section titled *Electrical Characteristics*.

5.1.1.2 Layer 2 (the data link layer). Layer 2 defines the procedures required to establish, maintain, and disconnect the data link between the subscriber's terminal equipment and the network.

5.1.1.2.1 Signaling channel (the D-channel). The link access procedure on the D-channel shall comply with ANSI T1.602. T1.602 contains the complete text of ITU-T Recommendations Q.920 and Q.921, which specify the frame structure, the procedure elements, the field formats, and the link access procedures (LAP) for the D-channel (LAPD). Out-of-band signaling procedures (D-channel) shall be used to negotiate a packet-switched or circuit-switched connection for each information bearer channel.

5.1.1.2.2 Signaling in the bearer channel. Packet-switched calls shall be connected to the local packet handler. Remaining signaling information, including the called user address, shall be provided in the bearer channel and shall comply with the link access procedures balanced (LAPB), as defined in sections 2.2, 2.3, and 2.4 of ITU-T Recommendation X.25 for basic (modulo 8) operation. Connections for circuit-switched calls shall be completed based on D-channel signaling only. At the user-to-network interface, layer 2 does not apply to information bearer channels, for circuit-switched calls.

5.1.1.3 Layer 3 (the network layer). Layer 3 protocols provide the information required to route calls through the local- and wide-network elements to the destination-terminal equipment. Three types of signaling messages shall be used to control circuit-switched and packet-switched connections: call establishment, call clearing, and miscellaneous messages. A list of the messages in each category is provided in Tables I and II.

TABLE I. Messages for circuit-switched connection control.

CALL ESTABLISHMENT	CALL CLEARING	MISCELLANEOUS
Alerting	Disconnect	Information
Call Proceeding	Release	Notify
Connect	Release Complete	Status
Connect Acknowledge	Restart	Status Inquiry
Progress	Restart Acknowledge	
Set-up		
Set-up Acknowledge		

TABLE II. Messages for packet-switched connection control.

CALL ESTABLISHMENT	CALL CLEARING	MISCELLANEOUS
Alerting	Disconnect	Status
Call Proceeding	Release	Status Inquiry
Connect	Release Complete	
Connect Acknowledge	Restart	
Progress	Restart Acknowledge	
Set-up		

5.1.1.3.1 Circuit-switched connections. The definition, message format, and information element coding for messages used to control circuit-switched connections shall be as defined in ANSI T1.607 and 5.1.1.3.2. ANSI T1.607 is aligned with ITU-T Recommendation Q.931. It specifies the messages and procedures used for control of circuit-switched connections at user-to-network interfaces. The messages are exchanged over the D-channel and apply to both basic-rate and primary-rate interfaces.

5.1.1.3.2 DSN features. The circuit-switched call control procedures described in ANSI T1.607 shall be used in the control of supplementary procedures, as specified in ANSI T1.610, except where modified to provide for DSN features. The following DSN features shall be implemented in accordance with MIL-STD-188-194, the mandatory Appendix titled *DSN No. 7 Common Channel Signaling*:

a. Multi-level precedence and preemption (MLPP)

b. Off-hook (or hot-line) service

c. Preset conference calling

d. Community-of-interest service

5.1.1.3.3 Packet-switched connections. The definition, message format, and information element coding for messages used to control packet-switched connections are defined in ANSI T1.608. ANSI T1.608 specifies the messages and procedures used for control of packet-switched connections at user-to-network interfaces. The procedures in T1.608 shall be used for the following two cases:

Case A: Circuit-switched access to packet-switched public data network. Layer 3 signaling between the subscriber's terminal equipment and the public data network (PDN) shall comply with the packet level protocol defined in section 3 of ITU-T Recommendation X.25. Only the B-channel is used after the circuit-switched connection to the PDN is completed. Signaling for the circuit-switched portion of the call shall be accomplished using the D-channel.

Case B: Packet-switched access to an ISDN virtual circuit service (B- and D-channels). Layer 3 signaling between the subscriber and the ISDN packet handler shall comply with the packet layer protocol defined in section 3 of ITU-T Recommendation X.25. The connection between the subscriber's terminal equipment and the packet handler may be a full period connection or may be obtained using D-channel signaling, as defined in ANSI T1.608. In this case, the information bearer channel may be either a B- or D-channel.

A list of the ANSI T1.608 messages applicable to D-channel signaling is provided in Table I for Case A and Table II for Case B.

5.1.2 Terminal-equipment to tactical-network interface. The terminal equipment interface for tactical users shall comply with the existing MIL-STD-188 series standards and ITU-T Recommendations cited in 5.1.2.1 and 5.1.2.2.

5.1.2.1 Tactical circuit-switched connections. The terminal equipment interface for tactical circuit-switched users shall comply with 5.1.2.1.1 to 5.1.2.1.3.

5.1.2.1.1 Layer 1 (the physical layer). Loops between tactical terminal equipment and tactical local-network elements shall operate on a full-duplex, 4-wire basis with a transmit pair and a receive pair. Common battery may be provided between the pairs by a local-network element. The loop shall operate at a 16-kbps information rate in each direction, using conditioned diphase, as defined in MIL-STD-188-200. The signal amplitude shall be 3 V, plus or minus 10 percent, with a source impedance of 125 ohms, resistive.

5.1.2.1.2 Layer 2 (the data link layer). Tactical loop signaling shall be in-band, using 8-bit cyclically permutable codewords. The codewords shall be repeated continuously until acknowledged or timed-out, in accordance with TT-A3-9012-0046, the sections titled *Signaling codewords and Signaling timeout*. The idle state, for the signaling channel, shall consist of alternating ones and zeros.

5.1.2.1.3 Layer 3 (the network layer). Tactical loop signaling shall be in accordance with TT-A3-9012-0046, the section titled *Signaling and cryptophases*. Certain codewords shall be used to represent more than one signaling statement. The ambiguity shall be resolved by considering the context of the signaling sequence involving use of the codewords.

5.1.2.2 Tactical packet-switched connections. As illustrated in Figure 3, a host computer or end system (ES) may be connected to a tactical packet switch in three ways:

a. By direct cable connection to a packet switch.

b. By connection to a LAN through an intermediate system (IS) to a packet switch (the IS may be located with the LAN or with the packet switch).

c. By connection through a circuit switch to a packet switch (in this case, the host computer or ES must first call up the local packet switch).

5.1.2.2.1 Layer 1. The interface, at reference point A, shall comply with MIL-STD-188-114 for 5.1.2.2 a and b. It shall comply with 5.1.2.1.1 for 5.1.2.2c.

5.1.2.2.2 Layer 2. The protocol used to access the packet switch shall comply with LAPB basic (modulo 8) operation, as defined in sections 2.2, 2.3, and 2.4 of ITU-T Recommendation X.25.

5.1.2.2.3 Layer 3. Network signaling to the packet switch shall comply with the packet layer protocols defined in section 3 of ITU-T Recommendation X.25.

5.1.3 Net-radio-terminal to tactical-network interface. Tactical network elements shall provide circuit-switched and packet-switched service to and from radio networks. Interoperability between the radio network and local-network elements shall be achieved by providing a net radio interface (NRI) for circuit-switched voice and data calls, or an IS function for packet-switched data communications.

5.1.3.1 Circuit-switched connections. Tactical circuit-switched network interfaces to net radio terminals shall use the same loop signaling protocols as described in 5.1.2.1, with the addition of a means to control the NRI gateway's push-to-talk function. These means may be manual (whereby a local operator monitors both sides of the interface), or automatic. Automatic operation may be achieved by voice-operated transmit (VOX), digitized push-to-talk control tone bursts (1231 Hz, transmit on; 1455 Hz, transmit off), dual-tone multifrequency (DTMF) digits (1 transmit on, 3 transmit off), or digital start-of-transmission/end-of-transmission codewords.

5.1.3.2 Packet-switched data. Tactical packet-switched network interfaces to and from net radio terminals shall use the same protocols described in 5.1.2.2. The IS function may be an integral part of the radio terminal located at the network gateway.

5.2 Standards for reference point B. This section defines the standards applicable at the interface between local-network elements and wide-network elements.

5.2.1 ISDN base-level interface to reference point B. Base information-transfer systems shall comply with 5.2.1.1 to 5.2.1.3 at reference point B.

5.2.1.1 Layer 1. The signal at the wide-network interface shall comply with the following parameters, as specified in ANSI T1.408, for the primary rate interface (PRI):

a.	Line code	Bipolar with 8-zero substitution (B8ZS) and 50% duty cycle.
b.	B8ZS	Eight consecutive zeros shall be replaced with 000+-0-+ if the preceding pulse was positive and with 000-+0+- if the preceding pulse was negative.
c.	Bit rate	1.544 Mbps.
d.	Number of channels	24 (Normally 23 channels are used as information-bearer channels and 1 channel is reserved for common-channel signaling.)
e.	Frame format	193-bit frame (see Figure 6).
f.	Frame repetition rate	8000 frames per second.

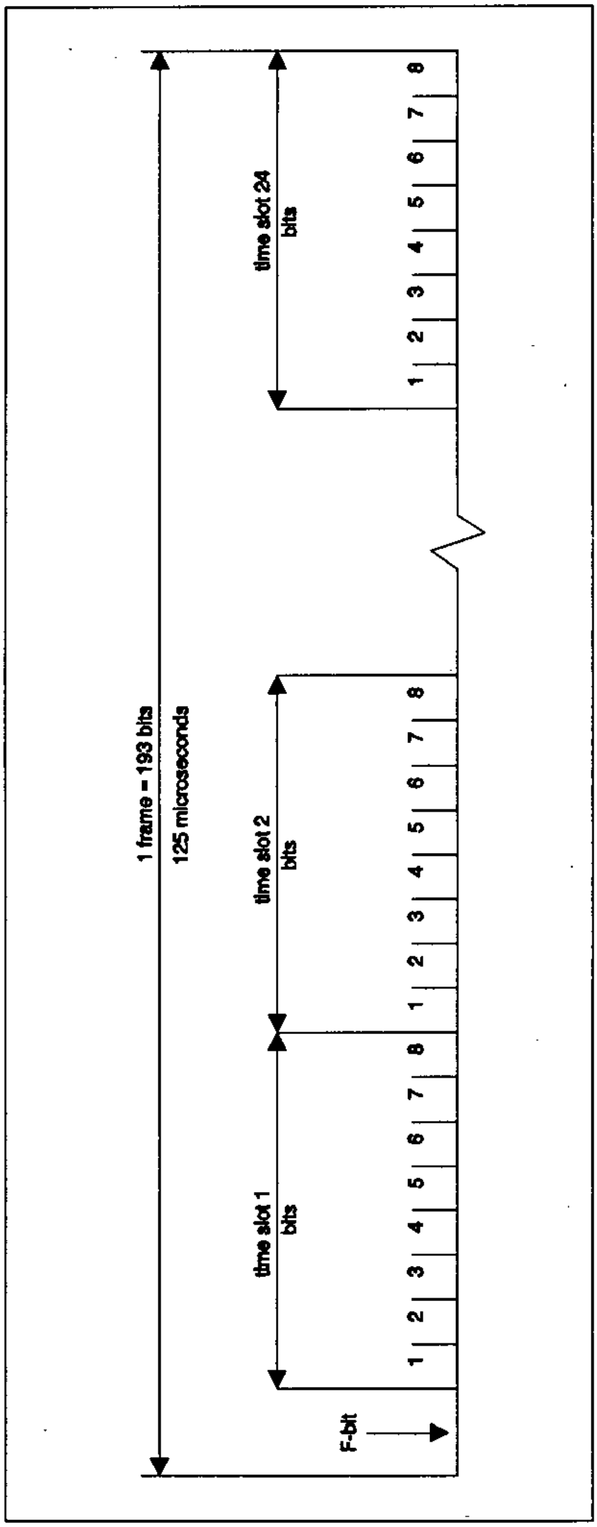


FIGURE 6. Frame format for a 1.544-Mbps signal.

g.	F-bit signal bit rate and allocation	2000 bps of the 8000-bps F-bit signal shall be used for the frame alignment signal (FAS). To convey fault status and maintenance information, 4000 bps shall be available for use as a data link (data orderwire). Using the CRC-6 cyclic redundancy check as defined in ANSI T1.408, 2000 bps shall be available for performance monitoring.
h.	F-bit signal format	See Table III.
i.	High rate signals	H_0=384 kbps; H_{10}=1472 kbps; H_{11}=1536 kbps. (H_{10} and H_{11} are optional services.)
j.	Time-slot assignment	Time slot 24 shall be used to transfer common-channel signaling information (D-channel), when it is present. A channel shall occupy an integer number of time slots and the same time-slot positions in every frame. A B-channel may be assigned any time slot in the frame; an H_0-channel shall be assigned any six slots in the frame, in numerical order (not necessarily consecutive); and an H_{10} channel shall be assigned time slots 1 to 23. The assignment may vary on a call-by-call basis.
k.	Signaling data link	The signaling data link bit rate shall be 56 kbps, evolving to 64 kbps. Fifty-six kbps signals shall occupy bit positions 1, 2, 3, . . ., 7 of the 64-kbps D-channel. The unused bit position shall be set to "1." The signaling data link shall be a bidirectional transmission path for common-channel

TABLE III. F-bit signal format.

FRAME NUMBER	F-BITS			
	BIT NUMBER	FAS	DL	CRC
1	1		m	
2	194			C1
3	387		m	
4	580	0		
5	773		m	
6	966			C2
7	1159		m	
8	1352	0		
9	1545		m	
10	1738			C3
11	1931		m	
12	2124	1		
13	2317		m	
14	2510			C4
15	2703		m	
16	2896	0		
17	3089		m	
18	3282			C5
19	3475		m	
20	3668	1		
21	3861		m	
22	4054			C6
23	4247		m	
24	4440	1		

FAS = framing alignment signal
DL = 4-kbps data link
CRC = CRC-6 cyclic redundancy check
m = data bit in maintenance channel

signaling, comprising two "data channels" operating together in opposite directions at the same data rate. The signaling data link constitutes the lowest functional level (layer 1) in the SS7 functional hierarchy. SS7 shall be capable of operating over both terrestrial and satellite transmission links. The operational signaling data link shall be exclusively dedicated to the use of a SS7 signaling link between two signaling points in SS7.

5.2.2 Tactical-network interface to reference point B. Tactical local network elements are likely to change in the long-range future to reflect commercial 64-kbps ISDN architectures for fixed applications and 4.8-kbps architectures for mobile applications. Future tactical interfaces are likely to reflect these commercial standards when they are in place. The near-term standards for tactical local-network elements shall comply with MIL-STD-188-105, the section titled *Tactical network interface to reference point B*.

5.2.3 Wide-network interface to reference point B. This interface is the same as the ISDN base-level interface (see 5.2.1).

5.2.4 Gateway functions. The tactical, ISDN base-level, and wide networks shall provide end-user to end-user service. The gateway function at reference point B shall provide signal conversion, as described in MIL-STD-188-105, to obtain interoperability between strategic and tactical users.

5.2.4.1 Circuit-switch-signaling message conversion. Interoperability between tactical circuit switches and ISDN circuit switches shall be accomplished through appropriate transformation of signaling messages at the gateway function located at reference point B. The gateway function shall translate out-of-band signaling messages between the tactical circuit-switched network and ISDN switched networks for calls initiated in either direction, in accordance with MIL-STD-188-105.

5.2.4.2 Packet switching. Tactical packet switches and ISDN packet switches shall comply with ITU-T Recommendation X.75 for connection mode service. They shall provide interoperability between host computers connected to tactical packet-switched networks and host computers connected to ISDN packet-switched networks. All switches requiring connectionless mode of service will comply with ISO DIS 10589 for IS-IS routing information exchange protocols.

5.2.4.3 Voice telephony. Tactical telephone subscribers shall be interoperable with ISDN telephone subscribers. Normally, this shall be accomplished by conversion between the tactical voice algorithm and the ISDN voice algorithm. See 4.1.5 for a description of ISDN and tactical voice algorithms. The gateway function shall provide the capability to achieve end-to-end secure voice calls by providing a transparent, bit-rate-adapted connection between compatible digital voice terminals, as described in 4.1.6, 4.1.7, and MIL-STD-188-105.

5.2.4.4 Circuit-switched data. The gateway function shall provide for the transfer of circuit-switched data between tactical users and ISDN users. The gateway function shall provide bit-rate adaptation for ISDN B-channels in the manner described in 4.1.7, for standard bit rates up to 16 kbps.

5.3 Standards for reference point B (NATO). This MIL-STD defines the standards applicable to the interface between U.S. network elements and NATO network elements.

5.3.1 U.S.-wide-network to NATO interface. The interface between U.S. strategic and NATO strategic circuit-switched networks shall comply with 5.3.1.1 to 5.3.1.3. The interface between U.S. strategic and NATO strategic packet-switched networks shall comply with STANAG 4263, Annex D (for layer 3), and STANAG 4262, Annex D (for layer 2).

5.3.1.1 Layer 1. The signal at reference point B (NATO) shall comply with the following parameters, as specified in ITU-T Recommendation G.704.

a.	Line code	HDB3.
b.	BNZS	B4ZS, in accordance with ITU-T Recommendation G.703, the annex titled *Definition of Codes*.
c.	Bit rate	2.048 Mbps.
d.	Number of channels	32, numbered from 0 to 31. (Normally, 30 channels are used as information-bearer channels, 1 channel is reserved for frame alignment, and 1 channel is reserved for common-channel signaling.)
e.	Frame length	256 bits, numbered 1 to 256.

f.	Frame repetition rate	8000 frames per second.
g.	Frame alignment signal	0011011. The frame alignment signal shall occupy positions 2 to 8 in time slot 0 of every other frame. Bit 2 of time slot 0, in frames not containing the frame alignment signal, shall be fixed at logical one. (See Figure 7.)

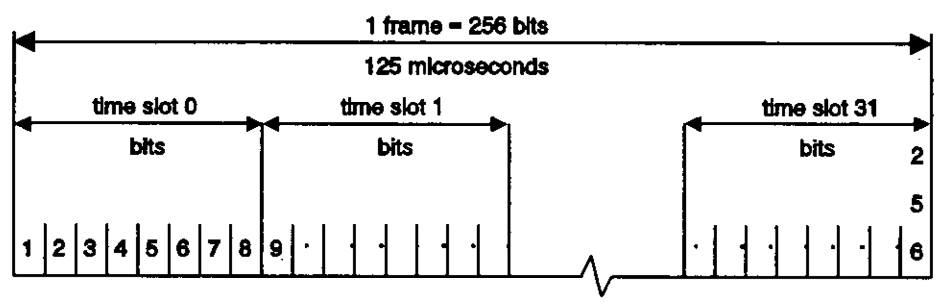


FIGURE 7. Frame format for a 2.048-Mbps signal.

h.	Frame alignment signal format	See Table IV.
i.	High-rate signals signals	H_0 = 384 kbps.
j.	Time-slot assignment	Time slot 16 shall be used to transfer common-channel signaling information (D-channel), when it is present. Time slots 1 to 15 and 17 to 31 are available for allocation to other channels (B or H_0). An H_0-channel may be assigned any 6 time slots in the frame, in numerical order (not necessarily consecutive).

TABLE IV. Allocation of frame bits 1 to 8.

Alternate frames \ Bit number	1	2	3	4	5	6	7	8
Frame containing the frame alignment signal	Si	0	0	1	1	0	1	1
	Note 1	Frame alignment signal						
Frame not containing the frame alignment signal	Si	1	A	Sa4	Sa5	Sa6	Sa7	Sa8
	Note 1	Note 2	Note 3	Note 4				

NOTES:

1. Si is the bit reserved for international use. If not used, this bit should be fixed at 1 on digital paths crossing an international border.
2. This bit is fixed at 1 to assist in avoiding simulation of the frame alignment signal.
3. A is the remote alarm indication. In undisturbed operation, it is set to 0; in alarm condition, it is set to 1.
4. Sa4 to Sa8 are spare bits.

k. Signaling data link — The signaling data link bit rate shall be 56 kbps, evolving to 64 kbps. Fifty-six-kbps signals shall occupy bit positions 1, 2, 3, ..., 7 of the 64-kbps D-channel. The unused bit position shall be set to "1." The signaling data link shall be a bidirectional transmission path for common-channel signaling, comprising two "data channels" operating together in opposite directions at the same data rate. The signaling data link constitutes the lowest functional level (layer 1) in the SS7 functional hierarchy. SS7 shall be capable of operating over both terrestrial and satellite transmission links. The operational signaling data link shall be exclusively dedicated to the use of a SS7 signaling link between two signaling points in SS7.

5.3.1.2 Layer 2. The data link layer shall provide for reliable transfer of common-channel signaling information across the physical channel. This shall include error control, message sequencing, and message delimitation. Data link signaling functions and procedures shall comply with ANSI T1.111, the section titled *Signaling data link*. The data link layer shall also be responsible for initializing the link and logically disconnecting secondary stations. The standard routing label for international signaling shall comply with ITU-T Recommendation Q.704, the section titled *Routing label*. The routing label for international calls shall consist of 14 bits for the destination point code, 14 bits for the originating point code, and 4 bits for the link selection code.

5.3.1.3 Layer 3. The network layer shall comply with the following requirements:

a. Layer 3 protocols shall comply with ANSI standards T1.111 (sections 4 and 5), T1.112, T1.113, and T1.114.

b. The interworking relationship between the D-channel signal at the user-to-network interface and the ISDN-User Part, as defined in ANSI T1.113, shall comply with ANSI T1.609.

The ANSI standards in section 4 of T1.114 include some minor variations from the international standards. ITU-T Recommendation Q.774 shall take precedence over the national standard when signaling messages are exchanged over international gateways.

5.3.2 U.S.-tactical to NATO-tactical interface. The interface between U.S.-tactical and NATO-tactical circuit-switched networks shall comply with STANAGs 4206 to 4212, 4214, and 4290. The interface between U.S.-tactical and NATO-tactical packet-switched networks shall comply with STANAG 4249.

5.3.3 Transmission Control Protocol (TCP)/ISO gateway. The U.S. anticipates that ESs and networks will use data communications protocols based on the MIL-STD-2045 series for a period of time after the ISO transport protocol is implemented in NATO. For this reason, a TCP-to-ISO protocol conversion capability shall be included at reference point B (NATO). This will allow the U.S. to comply with STANAG 4264 during the transition period in which both TCP and ISO transport protocols are used. This approach has been described and published, and is provided in mandatory Appendix A. The TCP/ISO gateway approach shall be an interim measure until ESs achieve ISO compatibility, as described in 5.4.2.

NOTE: NIST is considering the inclusion of TCP/IP-compliant products in GOSIP, Version 3.

5.4 Functional profiles. The functional profiles described in 5.4.1 and 5.4.2 apply to host computers (ESs) that may be connected directly to a local-network element (reference point A) or to a gateway (IS) which is then connected to a common-user network via reference point A. Data communications between ESs may cross-reference points A, B, and B (NATO). Data communications, which cross reference point B (NATO), between a U.S. ES and a NATO nation ES shall comply with all STANAGs applicable to layers 4 through 7 of the OSI RM. STANAG numbers are given in 5.4.1 and 5.4.2. The corresponding International Standardized Profile (ISP) classifications are provided. ISO/IEC TR 10000 governs the preparation of ISPs and MIL-HDBK-829A governs the preparation of Defense Standardized Profiles (DSPs).

5.4.1 Application profiles. ISO-based DOD application profiles use protocol standards from ISO RM layers 5-7, as called out in GOSIP, to accomplish end-to-end syntax control and application-to-application information exchanges. The actual transfer and control of data, i.e., the bit stream and its management, is accomplished in ISO RM layers 1-4. The internal suite of protocols is based on a 5-layer protocol start. DOD application protocols, for the Internet suite of protocols, are defined in layer 5 with the actual transfer of data being accomplished in layers 1-4. Sections 5.4.1.1 through 5.4.1.4 provide the application profiles for file transfer, access, and management (FTAM); for the message handling system (MHS); for directory service (DS); and for virtual terminals (VT). These functional profiles are used to ensure interoperability between DOD computers. Part 5 of NIST Special Publication 500-183 provides stable implementation agreements for protocols associated with the upper layers (4-7).

5.4.1.1 File transfer, access, and management. The FTAM application shall provide the capability to address, access, and manage the movement of information files among users. *File transfer* is the movement of a complete file between ESs. *File access* is the reading, writing, or deleting of selected parts of a file residing on one ES by a user located at a remote ES. *File management* is the remote reading and altering of attributes that define a file. The DSPs for FTAM are specified in MIL-STD-2045-17508, parts 1 through 6. These profiles are based on ISO ISP 10607 parts 1-6. Both profiles define two categories of file transfer: limited-purpose systems and full-purpose systems.

5.4.1.1.1 Limited-purpose system. A limited-purpose system shall implement, as a minimum, the following profiles:

DSP	ISP	DESCRIPTION
MIL-STD-2045-17508-3	AFT 11	Simple File Transfer -- This profile shall enable users to read or write a complete file with unstructured text or a binary set.
MIL-STD-2045-17508-6	AFT 3	Management -- This profile shall enable ES users to manage files within the Virtual Filestore residing remotely.

5.4.1.1.2 Full-purpose system. A full-purpose system shall implement, as a minimum, the following profiles:

DSP	ISP	DESCRIPTION
(DSP not required at this time. Civil standard is sufficient.)	AFT 12	Positional File Transfer -- This profile shall enable users to read or write a single file access data unit or a complete file with sequential text, in addition to the capability provided by the AFT 11 profile. This profile shall be compatible with the Simple File Transfer (MIL-STD-2045-17508/AFT 11) for transfer of unstructured files.
(DSP not required at this time. Civil standard is sufficient.)	AFT 22	Positional File Access -- This profile shall enable users to access files with unstructured text, sequential text, and an unstructured binary set.
MIL-STD-2045-17508-6	AFT 3	Management -- This profile shall enable ES users to manage files within the Virtual Filestore residing remotely.

5.4.1.1.3 Application layer. The FTAM functional profiles shall be supported at the application layer by the following base standards:

ISO 8613 *Office Document Architecture (ODA)*

ISO 8571 *FTAM*

ISO 8650 *Association Control Service Elements (ACSE)*

ISO 8879, 9069, and 9070 *Standard Generalized Markup Language (SGML)*

ISO 8632 *Computer Graphics Metafile*

5.4.1.1.3.1 Office Document Architecture. ISO 8613 (Parts 1, 2, and 4 to 8) specifies rules for describing the logical and layout structures of documents. It also specifies the rules for character, raster, and geometric content of documents so that complex documents can be interchanged. Since the functional profiles addressed are limited to files with unstructured text, sequential text, and an unstructured binary set, no further discussion is provided for the Office Document Architecture (ODA) at this time.

5.4.1.1.3.2 FTAM service elements. The services offered are specified in MIL-STD-2045-17508 and defined in ISO 8571. MIL-STD-2045-17508, *Information Technology DOD Standardized Profiles AFTn(D) File Transfer, Access, and Management (FTAM)*, is a series of profiles that defines the specific DOD FTAM requirements and options. In addition, the MIL-STD-2045-17508 series defines which service elements are mandatory versus optional in an effort to ensure interoperability. If an interim solution is required, the Internet File Transfer Protocol (FTP) shall be used as defined in MIL-STD-2045-17504.

5.4.1.1.3.3 Association control service elements. The FTAM shall use ACSEs that are required by all application standards but that do not depend on the specific nature of the standardized application. The ACSE elements of service are specified in MIL-STD-2045-17508-1 and defined in ISO 8649 and ISO 8650. The services in the association category shall include the following: application association establish, application association release (orderly release), and application association abort (disorderly release).

5.4.1.1.3.4 Standard Generalized Markup Language (SGML). ISO 8879 specifies an abstract syntax that expresses the description of a document's structure and other attributes, as well as other information that makes the markup interpretable. ISO 9069 provides the document interchange format and ISO 9070 provides the registration procedures for public text to be used in SGML support facilities.

5.4.1.1.4 Presentation layer. This layer is associated with Presentation Layer issues being conducted over a Session Layer connection, and is specified in MIL-STD-2045-17508-1 and defined in ISO 8823. STANAG 4256 contains a provision to satisfy NATO military requirements for OSI RM presentation layer service, and STANAG 4266 discusses the provision for the basic NATO military features for the presentation layer protocol. With the interconnection of heterogeneous systems, it is assumed that the service coding is not necessarily the same at both systems.

5.4.1.1.4.1 Abstract syntax. The FTAM presentation entities shall exchange abstract syntax in a precise representational form understood by peer entities for the following abstract syntaxes:

a. ISO FTAM unstructured text (FTAM-1)

b. ISO FTAM sequential text (FTAM-2)

c. ISO FTAM unstructured binary set (FTAM-3)

The abstract syntax is formally defined in ISO 8824, Abstract Syntax Notation 1 (ASN.1), without reference to the use of any encoding technique. The transfer syntax defines the order in which the bytes shall be physically transmitted to include information encryption requirements, compression of recurrent information, or both. Transfer syntax is derived by applying the basic encoding rules for ASN.1 to the abstract syntax defined in ISO 8825 and STANAG 4259. A pairing of abstract and transfer syntax, known as presentation context, shall be successfully negotiated between peer presentation entities. The list of negotiated presentation contexts is known as the *defined context set*.

5.4.1.1.4.2 Presentation services. Presentation Layer services are specified in MIL-STD-2045-17508-1 and defined in ISO 8822. STANAG 4266 contains provisions to satisfy NATO's military requirement for the OSI RM presentation layer.

5.4.1.1.5 Session layer. The Session Layer protocol and services are specified in MIL-STD-2045-17508-1. The Session Layer protocol is defined in ISO 8327, and session service elements are defined in ISO 8326. STANAG 4255 contains a provision to satisfy NATO military requirements for OSI RM session layer service, and STANAG 4265 discusses the provision for the basic NATO military features for the session layer protocols. This layer, defined in ISO 8327, is associated with data transfer, control, and management services over a session connection. The intelligence behind the control of session services lies with peer application processes. These processes shall access the session services by use of mirrored services provided through the presentation layer. For the FTAM to function over a session connection, the following functional units shall be available at this layer: kernel, resynchronization, and minor synchronization.

5.4.1.1.5.1 Kernel. The kernel functional unit supports the basic session services of connection establishment, normal data transfer, and connection release.

5.4.1.1.5.2 Resynchronization. The resynchronization function shall be used when a session user determines the information exchange is unreliable and requests that information transfer restarts at a mutually agreed point: synchronization point serial number. This service originated at the application layer (F-CANCEL) and mirrored through the presentation layer (P-RESYNCHRONIZE). On issuing this request, the application processor shall not invoke any further session service, other than a disorderly termination (F-ABORT), until such time as the confirmation has been received.

5.4.1.1.5.3 Minor synchronization. Minor synchronization points are used to establish commonly understood points in the information exchange within a dialog unit. The FTAM check point service shall be used to provide either the recovery or restart function. The F-CHECK service element shall provide a facility for FTAM to insert check points into the flow of data. The presentation layer mirrors this service element (P-MINOR-SYNC) and becomes S-MINOR-SYNC at the session layer.

5.4.1.2 Message-Handling System (MHS). The MHS application profile addresses store-and-forward electronic messaging between network users. The MHS is defined in MIL-STD-2045-17501, parts 1-6, and is based on ITU-T recommendation X.400 (1988). Message Handling Systems (MHS) requiring security services must comply with the MIL-STD-2045-18500 series. New message-handling systems requiring security services must comply with the MIL-STD-2045-18500 series. If an interim solution is required, the Internet Message Transport Profile shall be used, as defined in the MIL-STD-2045-17503 series.

5.4.1.2.1 Military Messaging Service (MMS). The MMS is specified in MIL-STD-2045-17502. MMS is similar to the Interpersonal Message Service (IPMS) defined in civilian standards but includes extensions for services required in the military environment. The vendor shall provide an MMS implementation in accordance with MIL-STD-2045-17502, parts 1-6. The content type used for MMS is P772 (IPMs uses P22).

5.4.1.2.2 Electronic Data Interchange (EDI) service. EDI service shall comply with ITU-T Recommendation X.435 and applicable portions of NIST Special Publication 500-183 (*Stable Implementation Agreements*).

5.4.1.3 Directory services (DS). DS is specified in ITU-T Recommendation X.500 (*Blue Book*, 1988). FIPS-PUB-146, Version 3, is expected to address X.500. Part 11 of NIST Special Publication 500-183 provides stable implementation agreements for DS protocols. The ISP for DS will comply with the profile classification ADIn, as indicated below:

ADIn	**APPLICABLE STANDARDS**
Layer 7	ITU-T Recommendation X.500 ISO 8650 Association Control Service Element (5.4.1.1.4.3)
Layer 6	ISO 8823 Connection-oriented Presentation Protocol (5.4.1.1.5)
Layer 5	ISO 8327 Connection-oriented Session Protocol (5.4.1.1.6)

If an interim solution is required, the Internet Domain Name Service Profile shall be used, as defined in MIL-STD-2045-17505.

5.4.1.4 Virtual terminal (VT). VT application profiles allow terminals and hosts on different networks to communicate without the hosts having knowledge of specific terminal characteristics. Part 14 of NIST Special Publication 500-183 provides stable implementation agreements of VT protocols. Two categories are defined:

5.4.1.4.1 Simple system. A teletype (TTY)-compatible device that uses a simple line or character at a time and controls characters from the American Standard Code for Information Interchange (ASCII) character set. A simple system supporting the Telnet protocol requires the asynchronous mode (a-mode) of operation, as indicated below:

ISP	DESCRIPTION
AVT12	Mode A; TELNET -- FIPS-PUB-146 Version 3
AVT13	Mode A; Line Scroll -- FIPS-PUB-146 Version 3
AVT14	Mode A; Paged -- FIPS-PUB-146 Version 3

5.4.1.4.2 Forms capable system. Supports forms-based applications with local entry and validation of data by the terminal system. Some of the functions supported are cursor movement, erase screen, and field protection. The forms profile requires the synchronous mode (S-mode) of operation and specifies simple delivery control. A forms-capable system shall support the forms profile specified in section 14.8.3 of the Workshop Agreements. The corresponding Workshop Agreements with FIPS-PUB-146, Version 2, limits the forms-capable system to the A-mode. The S-mode should be addressed when the FIPS-PUB-146, Version 3, is released. The applicable standards are shown below:

AVT2n	APPLICABLE STANDARDS
Layer 7	ISO 9040, VT ISO 8650, Association Control Service Element (ACSE) (5.4.1.1.4.3) ISO XXXX, Remote Operations Service Element (ROSE)
Layer 6	ISO 8823, Connection-oriented Presentation Protocol (5.4.1.1.5)
Layer 5	ISO 8327, Connection-oriented Session Protocol (5.4.1.1.6)

If an interim solution is required, the Internet Remote Login Profile shall be used, as defined in MIL-STD-2045-17506.

5.4.2 Transport profiles. Transport profiles identify the use of base standards for OSI RM layers 1 through 4 to provide information transfer between transport entities. The transport profiles are limited to providing connection-oriented transport service (COTS) (see 5.4.2.1). COTS may be supported by either a connectionless network (see 5.4.2.2.2) or a connection-oriented network (see 5.4.2.2.3). To meet the evolutionary requirement for existing DOD network protocols, ESs shall emulate the transport service described in 5.4.2.1.1, using the end-to-end service of the internet protocol suite. The approach taken shall be based on MIL-STD-2045-14503 to treat the TCP (which is a connection-oriented, stream-based, transport protocol) as though it were actually offering a connection-oriented network service. This approach shall use TP0 over TCP/IP and shall be used only in the interim until GOSIP is fully implemented. New systems requiring transmission of large files over CLNS digital subnetworks shall comply with the MIL-STD-2045-14500 series.

5.4.2.1 Connection-oriented transport service. COTS implies that although the internal operation of a network is based on packets, to the end user the network is indistinguishable from a full-period, end-to-end system. The packetized operation is essentially invisible to the user, with data coming out of the network in exactly the same sequence it went into the network.

5.4.2.1.1 Transport service. The transport service, as defined in ISO 8072, shall move data reliably from one ES to another. STANAG 4254 contains provisions to satisfy NATO military requirements for transport layer service. IF a interim solution is required, the Internet Transport Profile shall be used, as defined in the MIL-STD-2045-14502 series. The transport service is in one of three phases at any one time: transport connect (TC) establishment, data transfer, and transport connection release.

5.4.2.1.2 Transport protocols. Based on the available network service, five different COTS protocols exist. These are termed Transport Protocol (TP) Classes 0 through 4 (TP0-TP4). For GOSIP ESs, COTS, as provided by TP4, is mandatory, except when the ES is also connected to public messaging domains conforming to ITU-T Recommendation X.410 (*Red Book*). Then it must be capable of using TP0 when acting as a messaging relay between the two domains. A detailed description of the structure and encoding of these transport protocol data units (TPDU) can be found in ITU-T Recommendation X.224, the section titled *Structure and Encoding of TPDUs*, or ISO 8073. STANAG 4264 discusses the provision for the basic NATO military features for the transport layer protocol. Part 4 of NIST Special Publication 500-183 provides stable implementation agreements for TPDUs. All unknown parameters in a TPDU shall be ignored. Known parameters with valid lengths but with invalid values shall be handled as follows:

5.4.2.1.3 Security protocol. MSP provides MM MHS writer-to-reader security services. The writer may select encryption, electronic signature, and nonrepudiation services. End-to-end security is currently provided by external COMSEC devices until NLSP and TLSP have evolved. MSP defines for an X.400 message a new message content type that includes a security heading and the original content type. MSP does satisfy the requirements for classified messages and is currently intended to be used with

GENSER unclassified messages. It is independent of the message content being protected. MSP provides security services for X.400-based electronic messaging, but may also be used as a secure message encapsulation facility with other message environments. MIL-STD-2045-48501 is a DCPS that provides the format for the common security label used to exchange security attributes.

5.4.2.2 Supporting networks. COTS shall be supported by either a connectionless network that provides Connectionless Network Service (CLNS) or a connection-oriented network (see 5.4.2.2.3) that provides Connection-Oriented Network Service (CONS). COTS shall have a common network addressing structure (see 5.4.2.2.1).

5.4.2.2.1 Network addressing. The second addendum to the network service, ISO 8348, defines network layer addressing. To maintain the transparent goals of the OSI RM, a network address makes no implications about the physical location of a node, nor does a network address contain explicit routing information. The OSI strategy is to use a hierarchically structured address. At the top level, an address shall be divided into two parts: an initial domain part (IDP) assigned by the ISO/IEC, and a domain specific part (DSP). The IDP is further subdivided into two parts: the authority and format identifier (AFI) and the initial domain identifier (IDI). Table V provides the AFI values assigned by ISO/IEC as a function of the IDI format. The AFI values are a function of the DSP syntax indicating either decimal or binary. The maximum IDP length in digits is also provided.

TABLE V. AFI values.

IDI FORMAT	AFI VALUE DSP SYNTAX		IDP MAXIMUM LENGTH
	DECIMAL	BINARY	
ITU-T X.121	36, 52	37, 53	16
ISO 3166 DCC	38	39	5
ITU-T F.69	40, 54	41, 55	10
ITU-T E.163	42, 56	43, 57	14
ITU-T E.164	44, 58	45, 59	17
ISO 6523 ICD	46	47	6
NON-ALIGNED	48	49	2

The ISO/IEC assigned the international code designator (ICD) to NIST and the data country code (DCC) to ANSI. The System and Network Architecture Division at NIST determines how Government agency-specific identifications are assigned and registered at the national level. NIST has delegated the management responsibility to the Telecommunications Customer Service Division within the General Services Administration (GSA). Currently, the GSA is defining the registration procedures as well as usage guidelines. The AFI value of decimal 47 specifies that the IDI part is interpreted as a 4-decimal-digit ICD and that the DSP has a binary abstract syntax. The IDI, set to 5 for the entire Government's use (including DOD and the DSP address structure), is defined in FIPS-PUB-146-1, section 5.1.1. NIST applied for and obtained an ICD equal to 6 for DOD use. The DSP is undefined.

5.4.2.2.2 Connectionless network. A connectionless network is one in which there is no requirement to establish a connection between users. Since no connection exists between users, the network address shall be included explicitly with every transfer request. Wide-area networks (WAN), such as the Defense Data Network (DDN), use internetwork protocols (see 5.4.2) to provide connectionless network service. Most of the commercially available connectionless networks are configured within a localized geographical area known as a LAN. These LANs are often capable of transmitting data at very high rates, up to 10 Mbps. This is made possible because the physical medium is installed between systems located in close proximity. The ISPs for COTS over CLNS are in ISO ISP 10608 (Parts 1, 2, and 5). GOSIP, Version 2, mandates that connectionless network service be provided to Government users.

5.4.2.2.2.1 Network service. Connectionless network services are defined in Addendum 1 to the Network Service Definition Standard, ISO 8348.

5.4.2.2.2.2 Network protocols. Protocol combinations to provide connectionless network service are defined in ISO 8880, Appendix 3. To offer connectionless network service, ISO 8880, Appendix 3, identifies the protocols used to implement the connectionless network protocols found in ISO 8473. ISO 8473, Addendum 3, specifies the provisions of the underlying service over a subnetwork that provides the OSI data link service. Part 3 of NIST Special Publication 500-183 provides stable implementation agreements for network protocols. When an end system is connected to a local-area or point-to-point subnetwork, the ES to IS dynamic routing protocol, as defined in ISO 9542, shall be used. This protocol is limited to addressing the routing between ESs and ISs on the same or directly connected subnetworks. IS-to-IS dynamic routing protocols shall comply with ISO DIS 10589 after approval. As an interim solution, the Internet Relay Profiles defined in MIL-STD-2045-13500 and MIL-STD-2045-13501 shall be used. Implementation of the security option shall require the assignment of new parameter values to the Reason for Discard parameter in the error reporting, as defined in FIPS-PUB-146-1. The NIST IR90-4250 SP3 (submitted to

ANSI for adoption) shall be used to define the security option at the network layer. This standard shall be implemented in intermediate gateway systems, as well as ESs. The security protocol encapsulates the TPDU, but first adds network addresses to the protocol header for network routing, adds an integrated code if integrity is required, encrypts the entire TPDU if required, and then puts the result in a secure encapsulation of the TPDU.

5.4.2.2.2.3 Link service. The link service provided over a LAN shall be a Type-1 connectionless network service. The link layer of the OSI RM shall be divided into two sublayers. The logical link control (LLC) shall establish, maintain, and terminate the logical link between devices, and the media access control (MAC) shall regulate access to the medium. Part 2 of NIST Special Publication 500-183 provides stable implementation agreements for protocols related to subnetworks.

5.4.2.2.2.3.1 Logical link control. For LANs, the LLC shall comply with ISO 8802-2 to provide a connectionless subnetwork service to support connectionless network protocols. The LLC shall be used to maintain the logical link between devices. The LLC generates command packets (or frames) called protocol data units, and interprets them. The unacknowledged connectionless service shall allow the network entities to exchange link service data units without a data-link level connection. The data transfer can be point-to-point, multicast, or broadcast.

5.4.2.2.2.3.2 Media access control. The MAC in LANs handles the methods for allowing a particular node to transmit on the data transmission channel available to it. A LAN can be configured as either a bus or a ring topology. Furthermore, two primary methods are used to control access: carrier sense multiple access/collision detection (CSMA/CD) and token passing. The IEEE 802 Committee on LAN and the ISO community have followed with corresponding ISO 8802 series standards that address media control and physical layers. The ISO 8802-3 standard addresses CSMA/CD, ISO 8802-4 addresses token-passing buses, ISO 8802-5 addresses token-passing ring, and ISO 9314 addresses FDDI.

5.4.2.2.3 Connection-oriented network. A connection-oriented network is based on the ability to reserve a path through a network for the duration of the network connection. Based on FIPS-PUB-146-1, an end-system shall be directly connected to a connection-oriented network only when the network is a ITU-T Recommendation X.25 wide-area network or an ISDN wide-area network. The ISPs for COTS over CONS are in ISO ISP 10609 (9 parts).

5.4.2.2.3.1 Network service. The network service for a connection network is defined in ISO 8348. STANAG 4253 contains provisions to satisfy NATO's military requirements for OSI RM network layer service. The network service is in one of three phases at any one time: connection establishment, data transfer, and connection release.

5.4.2.2.3.2 Network protocols. Protocol combinations to provide connection network service shall be as defined in ISO 8880, Appendix 2. To offer the connection network service, ISO 8880, Appendix 2, identifies the protocols used to realize the ITU-T Recommendation X.25 packet-level protocol (PLP) over the subnetwork. ISO 8878 defines the use of ITU-T Recommendation X.25 PLP to provide the OSI connection network service. ISO 8208 defines the packet format and control procedures for the exchange of packets that contain control information and user data at data terminal equipment. ISO 8208, Addendum 2, defines the dial-up access to a packet-switched public data network through a public switched telephone network (PSTN), an integrated-services digital network, or a circuit-switched public data network. ITU-T Recommendation Q.931 defines additional signaling requirements during set-up of an incoming call when D-channel access is required on the ISDN. Part 3 of NIST Special Publication 500-183 provides stable implementation agreements for network protocols. STANAG 4263 contains the military features required for NATO's network layer protocols.

5.4.2.2.3.3 Data link service. Data link service for a connection network is defined in ISO 8886. STANAG 4252 contains provisions to satisfy NATO's military requirements for OSI RM data-link layer service. The data link service is in one of three phases at any one time: connection establishment, data transfer, and connection release.

5.4.2.2.3.4 Data link protocols. End systems that are directly connected or use dial-up access to the packet-switched public network shall use the LAPB protocol, except for connection to the ISDN D-channel. For access via the ISDN D-channel, the LAPD protocol shall be used as defined in ITU-T Recommendation Q.921. The LAPD protocol is a fully standard implementation of the ISO High-level Data Link Control (HDLC) protocol and can be found in the following documents: ISO 7809, ISO 4335, ISO 3309, ISO 8471, and ISO 8885. Part 2 of NIST Special Publication 500-183 provides stable implementation for protocols related to subnetworks. STANAG 4262 contains the military features required for NATO's data-link layer protocols.

5.4.2.2.3.5 Physical layer. FIPS-PUB-146-1 does not mandate any specific physical interface except for ISDN. For non-ISDN application, or for the R interface of ISDN applications using terminal adapters, MIL-STD-188-114 shall be used for the physical layer interface. MIL-STD-188-114 is based on EIA 422 and 423 and is interoperable with EIA 232 (formerly RS-232), and the ITU-T Recommendation V.35 digital interface referenced in GOSIP FIPS-PUB-146. For ISDN, FIPS-PUB-146, Version 2, mandates that for the basic rate interface (BRI) at the S and T reference points, ANSI T1.605-1988 shall be used. STANAG 4251 contains provisions to satisfy NATO's military requirements for OSI RM physical layer service, and STANAG 4261 contains the military features for NATO's physical layer protocols.

5.5 Subscriber-network elements. General requirements for subscriber-network elements are listed in 4.5.2.1. The implementation of narrowband ISDN and in the future broadband ISDN (B-ISDN) requires a substantial investment in the upgrade of the DISN. To take advantage of DISN features requires that direct digital capabilities be provided to all subscriber-network elements. These subscriber elements are discussed on the basis of their access requirements: direct, mobile, universal, and indirect.

5.5.1 Direct access. Direct access may be provided by copper wire, coaxial cable, or fiber optic cable. The access method depends on the bandwidth to be supported. This entails developing all-digital subscriber-terminal equipment with direct access that can provide voice, high-speed data communications; facsimile (text and graphics); still and motion video communications; as well as high-resolution television broadcast.

5.5.1.1 Voice. All voice end terminals shall provide voice digitization. Strategic user terminals shall use 64-kbps PCM or 32-kbps ADPCM. Tactical user terminals shall have the capability to interface, either directly or via a switch, using 16-kbps (optionally 32-kbps) CVSD analog-to-digital (A-D) conversion, as defined in MIL-STD-188-113. Voice terminals employing CELP shall be capable of providing 4.8-kbps CELP A-D conversion, as defined in FED-STD 1016. The voice digitization algorithm shall be negotiated during the call establishment phase, and the 4.8-kbps CELP shall be the preferred mode. Military satellite (in the anti-jam mode) and HF radio applications shall use 2.4-kbps LPC.

5.5.1.2 Data. All end terminals that provide data communications shall be capable of supporting all application profiles, as defined in 5.4.1.

5.5.1.3 Facsimile. All end terminals that provide text and graphics in the form of facsimile shall conform to MIL-STD-188-161.

5.5.1.4 Video Teleconferencing. All end terminals that provide video teleconferencing service shall comply with MIL-STD-188-331.

5.5.1.5 High-definition television. High-definition television (HDTV) standards are under development for end terminals that provide the HDTV function.

5.5.2 Mobile access. Due to rapid advances in signal processing and integrated circuit technology, digital radio has become viable technology for implementing wireless subscriber loop service in remote rural areas; for providing wireless private branch exchange (PBX) service; for cellular digital mobile radio service; for digital mobile satellite service; and for tactical digital radio network service. All subscriber network elements requiring mobile access shall have a default voice algorithm of 4.8-kbps CELP, and the gateway function at reference point A shall allow for data traffic with bit count integrity (BCI) to support both secure voice and data. Standards for mobile access are under development. NSA has been leading the Government effort to create standards within industry that support interoperable voice and data communications via mobile subscriber interfaces.

5.5.2.1 Wireless subscriber loop service. Standards for remote wireless subscriber loop service are under development.

5.5.2.2 Wireless PBX service. New low-power, short-range digital radio (average transmitter power in the order of 10 mW) technologies are being developed. The use of digital multiplexing with demand assignment multiple access (DAMA) of digital radio links could service multiple user terminals. Time-division multiple access (TDMA) standards for cellular digital mobile radio service (see 5.5.2.3) may also be viable for multiple user indoor application.

5.5.2.3 Cellular digital mobile radio service. Standards are being developed for next-generation digital cellular mobile radio systems. [The Special Mobile Group (GSM) of the European Telecommunications Standards Institute (ETSI) is standardizing a pan-European TDMA mobile radio technology. The Telecommunications Industry Association (TIA) and Cellular TIA (CITA) are standardizing an entirely different technology for North America. It is expected that these two efforts will converge to enhance interoperability.]

5.5.2.4 Digital mobile satellite service. Digital mobile satellite service will be based on Ultra Small Aperture Terminal (USAT) technology with a 10- to 12-inch antenna diameter. USAT requires very complex hybrid spread-spectrum modulation and access techniques to limit interference. The information rate is limited to 2.4 kbps, ruling out the use of the default 4.8-kbps CELP voice algorithm for this service. Standards will be developed for end terminals requiring service over digital mobile satellite links.

5.5.2.5 Tactical digital radio network service. Standards for HF radio subsystems are listed in 4.4.2.7. Standards for HF radio subscriber networks are under development. Planning standards for HF will be contained in MIL-STD-187-721. HF radio automatic link establishment (ALE) shall comply with FED-STD-1045. Standards for automatic HF radio networking will be contained in FED-STD-1046. Standards for HF store-and-forward service will be contained in FED-STD-1047. Standards for automatic HF networking to multiple transmission media will be contained in FED-STD-1048. Standards for HF radio automatic operation in stressed environments will be contained in FED-STD-1049.

5.5.3 Universal access. Universal access will allow subscribers to initiate and receive calls through the DISN, irrespective of their geographical location. Two basic concepts related to universal access are emerging: the mobile communications facility offered by the Universal Mobile Telecommunications System (UMTS), and the personal communications facility offered by the Personal Telecommunications Service (PTS). Standards for universal access are under development.

5.5.3.1 Universal Mobile Telecommunications System (UMTS). The UMTS shall provide mobile communications, not only by keeping track of the location of the mobile subscriber (by storing information about their current location), but also by maintaining ongoing calls and connection, despite their movement.

5.5.3.2 Personal Telecommunications Service (PTS). The PTS shall be provided across multiple networks and allows network-independent user identification. From a network point of view, the PTS may be based on either wired or wireless interface.

5.5.4 Indirect access. End terminals can be configured on a LAN or a group of LANs joined by bridges to form an extended LAN.

5.5.4.1 Local area network. End terminals configured to a LAN at the network layer shall use connectionless network protocols, as defined in ISO 8473; at the link layer, end terminals shall use logical link control type-1, as defined in ISO 8802-2. End terminals at the MAC level that require carrier sense multiple access (CSMA) shall conform to ISO 8802-3. End terminals at the MAC level that require token passing bus access shall conform to ISO 8802-4. End terminals at the MAC level that require token-passing ring access shall conform to ISO 8802-5. End terminals at the MAC level that require FDDI access shall conform to ISO 9314. ANSI Draft standards, X3T9/92-067 address station management for FDDI. FDDI LANs provide broadband service to end users. This service may be extended via broadband networks (see 5.6). The IEEE has developed an IEEE Standard 802.6, *Distributed Queue Dual Bus (DQDB) Subnet of a Metropolitan Area Network (MAN)*, which will eventually be adapted as an ISO 8802-6 standard. End terminals at the MAC level that require broadband service (see 5.6) via MAN shall conform to ISO 8802-6. Wireless LANs are a subject for further study.

5.5.4.2 Bridges. A bridge connects data links to forward packets between local networks. A bridge operates at the logical link or MAC layer (level 2 of the ISO RM), independent of higher-level protocols. A bridge architecture can be based on either a transparent spanning tree or on source routing.

5.5.4.2.1 Transparent-spanning-tree bridge. A transparent-spanning-tree bridge shall modify its address table dynamically for each packet it receives. If a station address is unknown, the bridge shall flood all links other than the link over which the packet was received. A transparent-spanning-tree bridge can function as either a local or remote MAC bridge. A local MAC bridge directly connected to LANs shall conform to IEEE 802.1D. A remote MAC bridge directly attached to one or more LANs, and also to an unspecified interconnection medium, will conform to draft standard IEEE P802.1G/1D. The MAC frame is encapsulated within the appropriate interconnecting medium for transmission across the network to a peer remote bridge.

5.5.4.2.2 Source-routing bridge. In a source-routing bridge the route shall be determined by the source station for each frame sent through one or more bridges to the destination station. The routing information is contained within each frame and used by each bridge it transitions over. Source-routing information shall be acquired by the originating station, by broadcasting a request that is updated by each bridge it transitions over. Multiple copies received by the destination station are sent back to the originating station, and the information is used to select the preferred path. A source-routing bridge shall conform to ISO 8802-5.

5.6 Broadband service support. Broadband service support within the DISN shall comply with network interface transport rates, formats, and architectures associated with digital hierarchies defined in ANSI T1.105, ITU-T Recommendations G.707 and I.121, and IEEE 802.6.

5.6.1 Transport digital hierarchy. In support of broadband services, two primary digital hierarchy standards are applicable: ANSI T1.105 and ITU-T Recommendation G.707. Within CONUS, the ANSI T1.105 Digital Hierarchy Optical Interface Rates and Formats Specification, commonly referred to as SONET, defines the layer 1 Synchronous Optical Hierarchy (SOH). ITU-T Recommendations G.707 through G.709 define the layer 1 Synchronous Digital Hierarchy (SDH) for international use. Where common rates and formats exist, the SONET standard is functionally and structurally equivalent to ITU-T Recommendation G.707.

5.6.1.1 Synchronous Optical Network. The primary objective of SONET is the definition of a SOH with sufficient flexibility to support transmission rates and formatted signals. Any signal transmitted using ANSI T1.105 shall employ ANSI T1.106 to provide opto-electrical conversion.

5.6.1.1.1 Rates. Where necessary, support of various low transmission rates across a high-rate connection shall be accomplished through the employment of synchronous multiplexing. Multiplexing results in a family of standard rates and formats, which are multiples of the basic 51.84-Mbps Synchronous Transport

Signal Level 1 (STS-1) rate. To support broadband services, basic rate signals shall be time-division multiplexed to build higher transmission rates. SONET shall support sub-STS-1 rate signals by multiplexing these lower rate signals in accordance with ANSI T1.105. SONET rates applicable to the DISN are listed in Table VI.

TABLE VI. SONET rates (Mbps).

STS-1	51.840
STS-3	155.520
STS-12	622.080
STS-24	1244.160
STS-48	2488.320

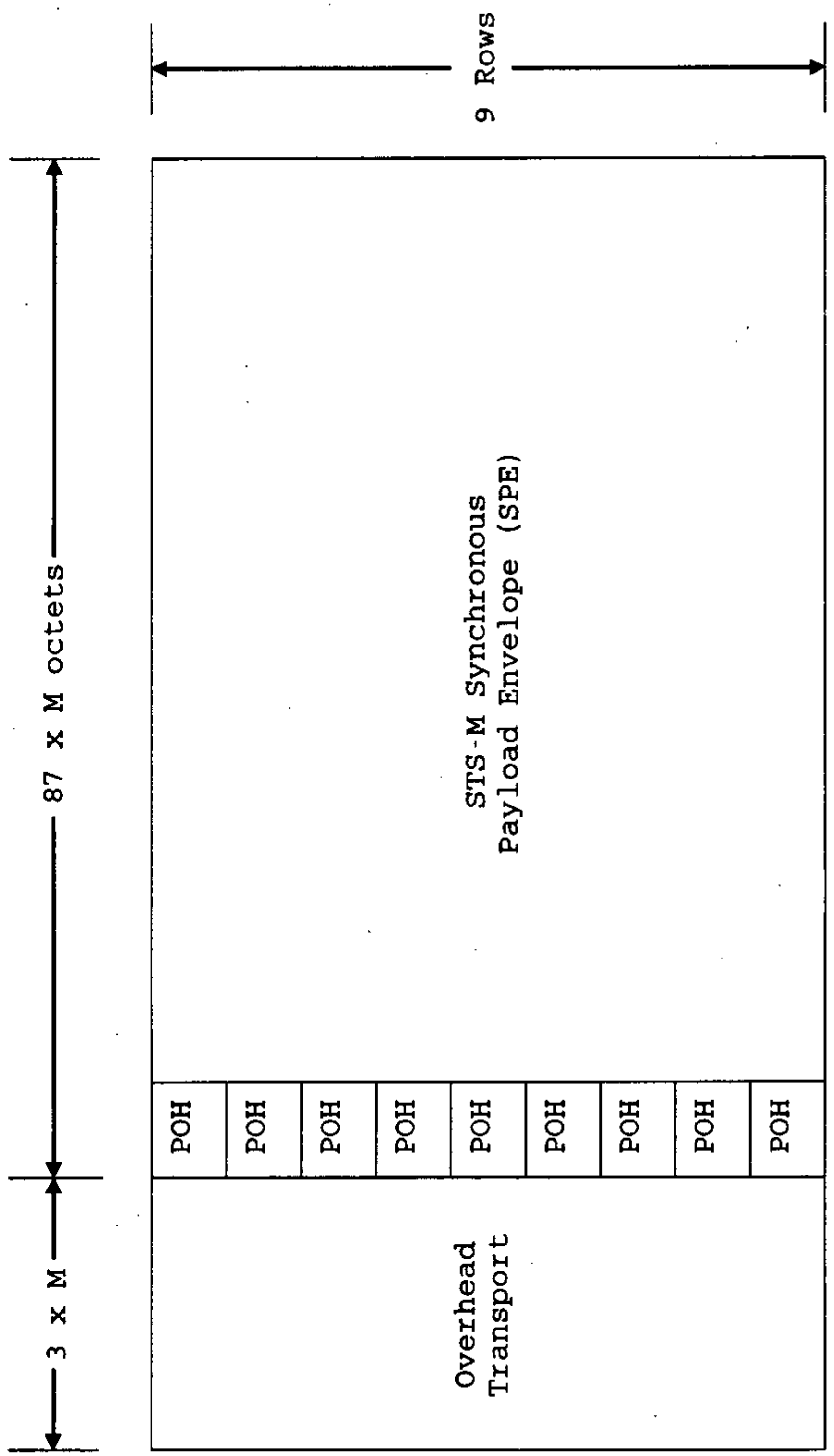
NOTE:

STS-M = Synchronous Transport Signal Level M
OC-M = Optical Carrier Level-M, the optical equivalent to STS-M

5.6.1.1.2 Frame format. Figure 8 depicts the STS-M frame structure. For M=3, each of 9 rows of the STS-M frame consists of 9 octets of transport overhead, 1 octet of path overhead, and 260 octets of user traffic payload.

5.6.1.1.3 Services. The SONET standard can support a variety of connection-oriented and connectionless transport data services. (The services that SONET supports include DS3 telecommunications signals; video; or low-rate telephone services, such as DS1, DS1C, or DS2 signals). The following SONET concatenated rates shall be supported: STS-3C, STS-12C, and STS-24C.

5.6.1.1.3.1 Management. The SONET standard incorporates embedded operations channels within its overhead field. These are referred to as the Line, Section, and Path Data Communications Channels (DCC). These embedded channels shall be used to provide communications capacity to support DISN integrated network management. To facilitate the reliable transport of management traffic, the DCC shall be multiplexed into the STS-M frame to support link integrity. In addition, the DCC will use a standardized OSI data communications profile to promote interoperability between SONET network elements. The purpose of this profile is to support the interoperation of management systems using either Transaction Language 1 (TL1) or Common Management Information Protocol (CMIP) for managed object communications. See Table VIa for the appropriate profiles.



Legend:
POH - Path overhead

FIGURE 8. SONET STS-M frame format.

TABLE VIa. Profile for TL1/CMIP over the DCC

Application	CMIP (ISO 9595/9596-1) TL1 FTAM (ISO 8571) ROSE (X.219/.229), ACSE (X.217/X.227)
Presentation	ISO 8823
Session	ISO 8327
Transport	TP4 (ISO 8073)
Network	CLNP (ISO 8473) ES-IS (ISO 9542) IS-IS (ISO 10589)
Data Link	LAP-D (Q.921)
Physical	Data Communications Channel (ANSI T1.105)

5.6.1.1.4 Interworking support. SONET shall provide a layer 1 transport service for interworking between DISN network elements.

5.6.1.2 Synchronous Digital Hierarchy

5.6.1.2.1 Rates. The SDH supports broadband services as a layer 1 capability. Table VII shows the applicable SDH rates. The basic SDH rate of 155.520 Mbps is designated STM-1. Other rates are derived by multiplexing the basic rate in accordance with ITU-T Recommendations G.708 and G.709.

TABLE VII. ITU-T Recommendation G.707 rates (Mbps).

STM-1	155.520
STM-4	622.080
STM-8	1244.160*
STM-16	2488.320*

NOTES:

* = This rate is under study by the ITU-T.
STM-N = Synchronous Transport Module-Level N

In accordance with ITU-T Recommendation G.709, provisions shall be made to support sub-STM-1 rates.

5.6.1.2.2 Frame format. Figure 9 illustrates the STM-N frame format. For N=1, the STM-1 frame shall consist of 93 octets of

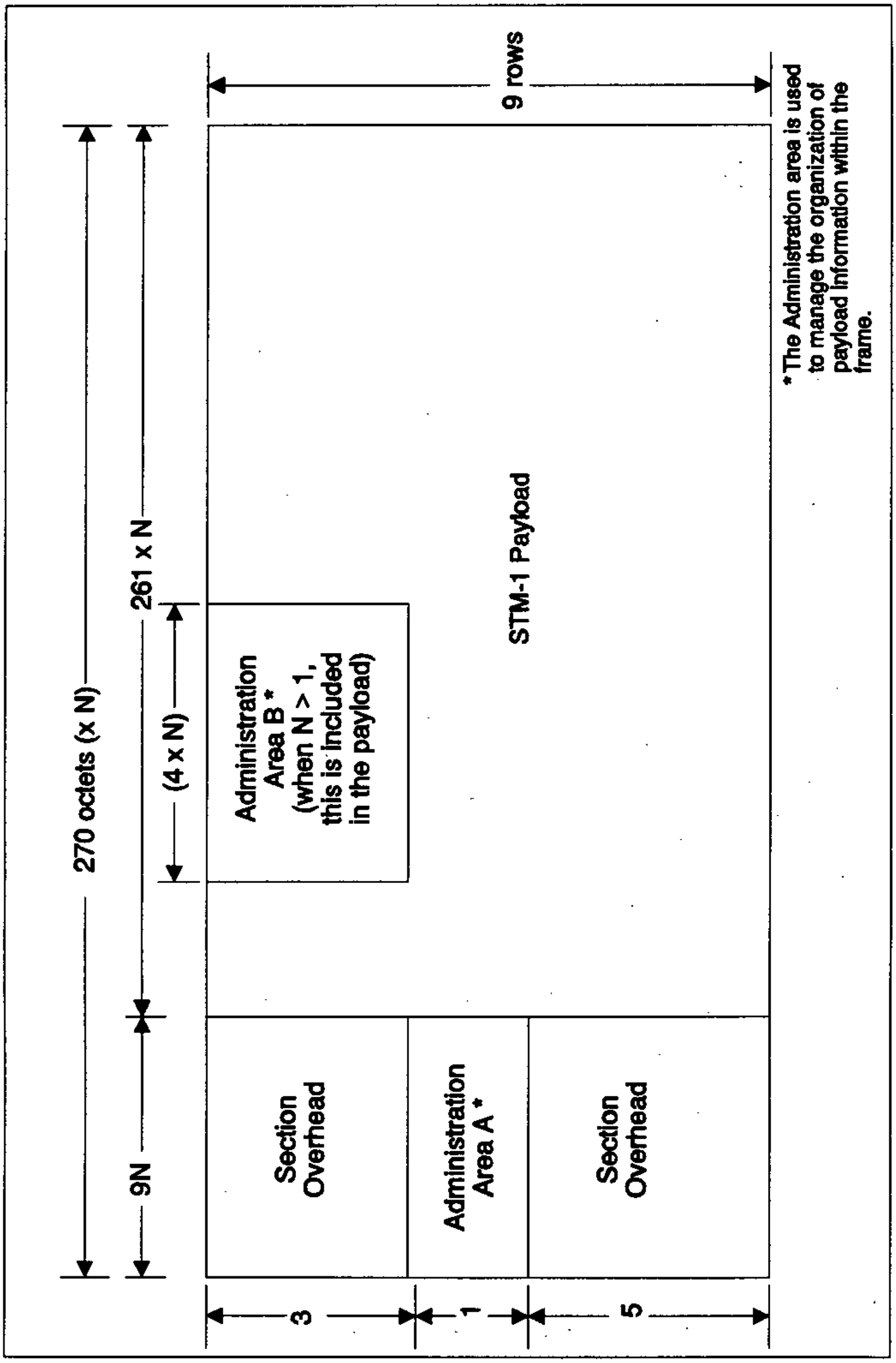


FIGURE 9. CCITT STM-N frame format.

overhead and 2337 octets of payload. An STM-N (where N>1) consists of 81 x N octets of overhead and 2349 x N octets of payload.

5.6.1.2.3 Services. The SDH shall support all services defined in 5.6.1.1.3.

5.6.1.2.4 Management. Network management services shall be supported via an embedded service channel within the SDH overhead structure. The SDH service channels shall support DISN network management objectives, as specified in 5.7.

5.6.2 Metropolitan area networks. The DISN shall support IEEE 802.6 DQDB subnetworks. To support broadband services across large areas, multiple DQDB subnetworks may be interconnected to form MANs. MANs may be suitably interconnected to form wide-area networks (WAN). By definition, MANs are subscriber-network elements within the DISN.

The primary objective of MANs shall be to establish a transparent and reliable (low delay and no loss of user throughput capacity) mechanism for interconnecting LANs. A transparent MAN environment is one in which two or more interconnected LANs appear as a single, logical LAN to their respective users.

5.6.2.1 Services. The DQDB subnetwork is a distributed multi-access network that supports integrated communications services. Specifically, the DQDB supports connectionless data transfer, connection-oriented data transfer, and isochronous communications (such as voice). In support of connectionless services, Appendix B of IEEE 802.6 provides information on a mechanism for controlling bus communications between nodes. Currently, DQDB/MAN-related services are planned as a public offering within the continental United States (CONUS). Outside CONUS, the DQDB/MAN architecture and its services will be supported as a private subscriber network element.

Connectionless packet service shall support variable-length packet service. The connection-oriented data service shall support a virtual channel between any pair of data service users. The MAN reference model used to support these services is depicted in Figure 10.

5.6.2.2 Rates. The MAN will support IEEE 802.6 DQDB/MAN high-speed transport of information across interconnected IEEE 802.6 DQDB subnetworks within the DISN. Transport of information will be achieved through the use of a 53-octet cell-based format. (The cell length is equivalent to that of an ATM cell.) A DQDB/MAN located outside CONUS shall be interconnected via a SONET/ITU-T Recommendation G.707 rate interface.

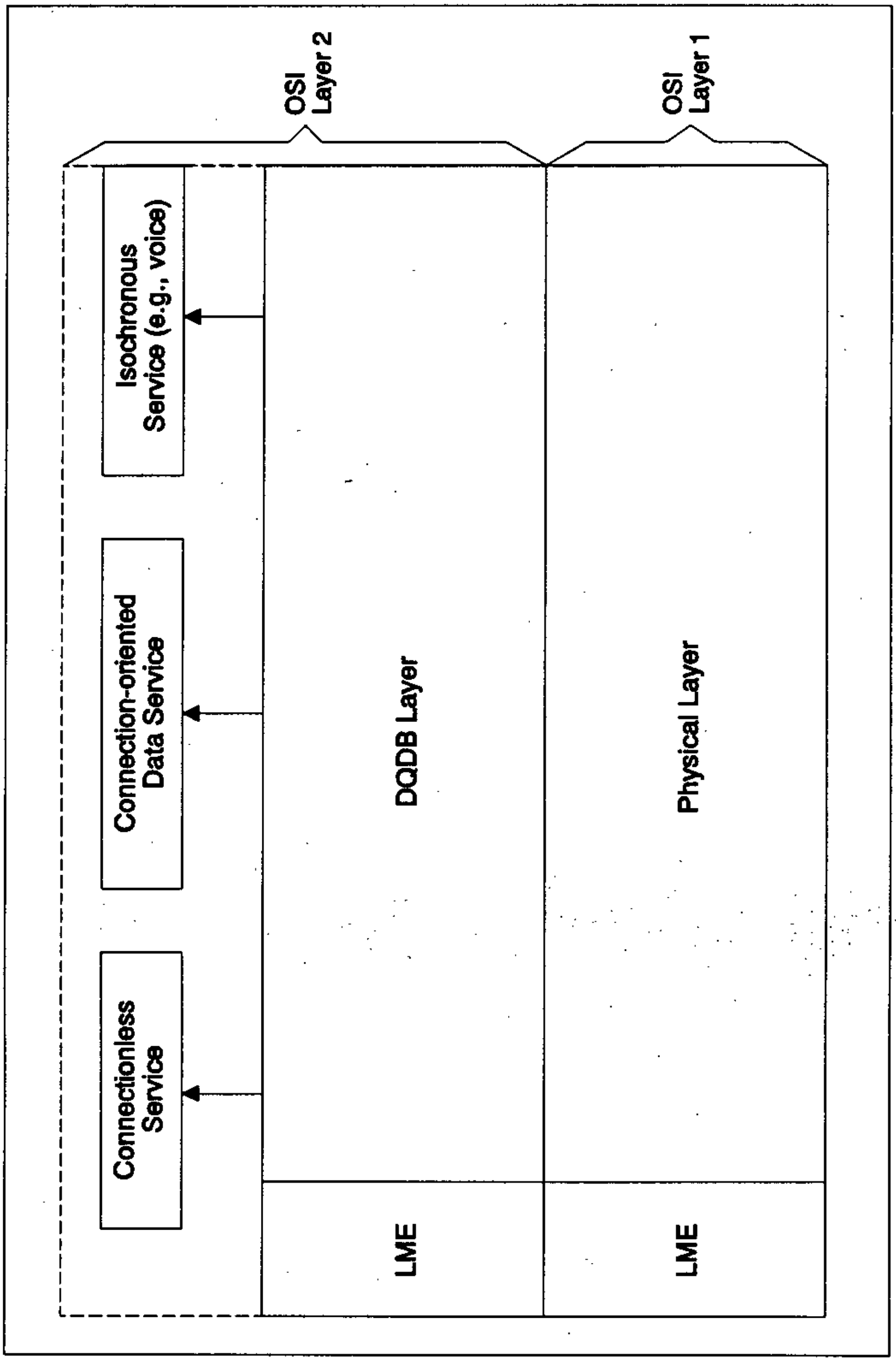


FIGURE 10. IEEE 802.6 layer reference model.

The rates supported are as defined in ITU-T Recommendation G.703 (at 34.368 and 139.264 Mbps) and ITU-T Recommendation G.707 (at 155.520 Mbps). Lower-rate interfaces shall be supported via multiplexing, in accordance with ITU-T Recommendation G.709.

5.6.2.3 Architecture. Multiple DQDB subnetworks may be interconnected to form MANs via mediation devices (bridge, router, or gateway). MANs may be viewed as a public or private (that is, DOD) backbone network. Figure 11 shows a notional interconnection of public and private MAN networks.

5.6.2.3.1 DQDB subnetwork architecture. A DQDB subnetwork uses a pair of unidirectional buses (a dual bus pair), referred to as Bus A and Bus B. Bus A and Bus B are independent from the point-of-view of data flow. That is, information on the buses flows independently in opposite directions.

A DQDB subnetwork shall support either an open dual-bus or a looped dual-bus. In the open dual-bus topology, the head of Bus A and the head of Bus B are logically separate. In the looped-bus topology, the head of Bus A and the head of Bus B are collocated.

Within the DQDB subnetwork, adjacent nodes shall be physically interconnected by two separate transmission links. The transmission link shall carry management and user traffic. Eight levels of priority are supported by the DQDB standard. These levels of priority are shared between network and user traffic.

5.6.2.4 DQDB/MAN interworking. In support of broadband interworking within the DISN, the DQDB/MAN architecture and protocols shall be used to support any combination of LAN and ISDN connectivity (for example, LAN-LAN, LAN-ISDN-LAN).

To simplify LAN/MAN interworking, the IEEE 802.6 subnetwork has been designed to be compatible with other LANs at OSI layer 2. Figure 11 depicts a typical scenario in which DQDB/subnetworks are interworking with a variety of other LANs, public and private networks, and ESs (hosts and terminal equipment). Interworking of DQDB subnetworks with ATM networks is simplified by the common use of a fixed-size 53-octet cell and the similarity of their 5-octet headers.

5.6.2.5 Protocol. The DQDB shall employ management, signaling, and traffic protocols to control and monitor access and use of its resources.

5.6.2.5.1 Signaling. Signaling associated with IEEE 802.6 services is not specified within the standard. Existing signaling protocols (such as ITU-T Recommendation Q.931 or ITU-T Recommendation Q.2931) shall be employed. The signaling shall provide for interworking across public networks.

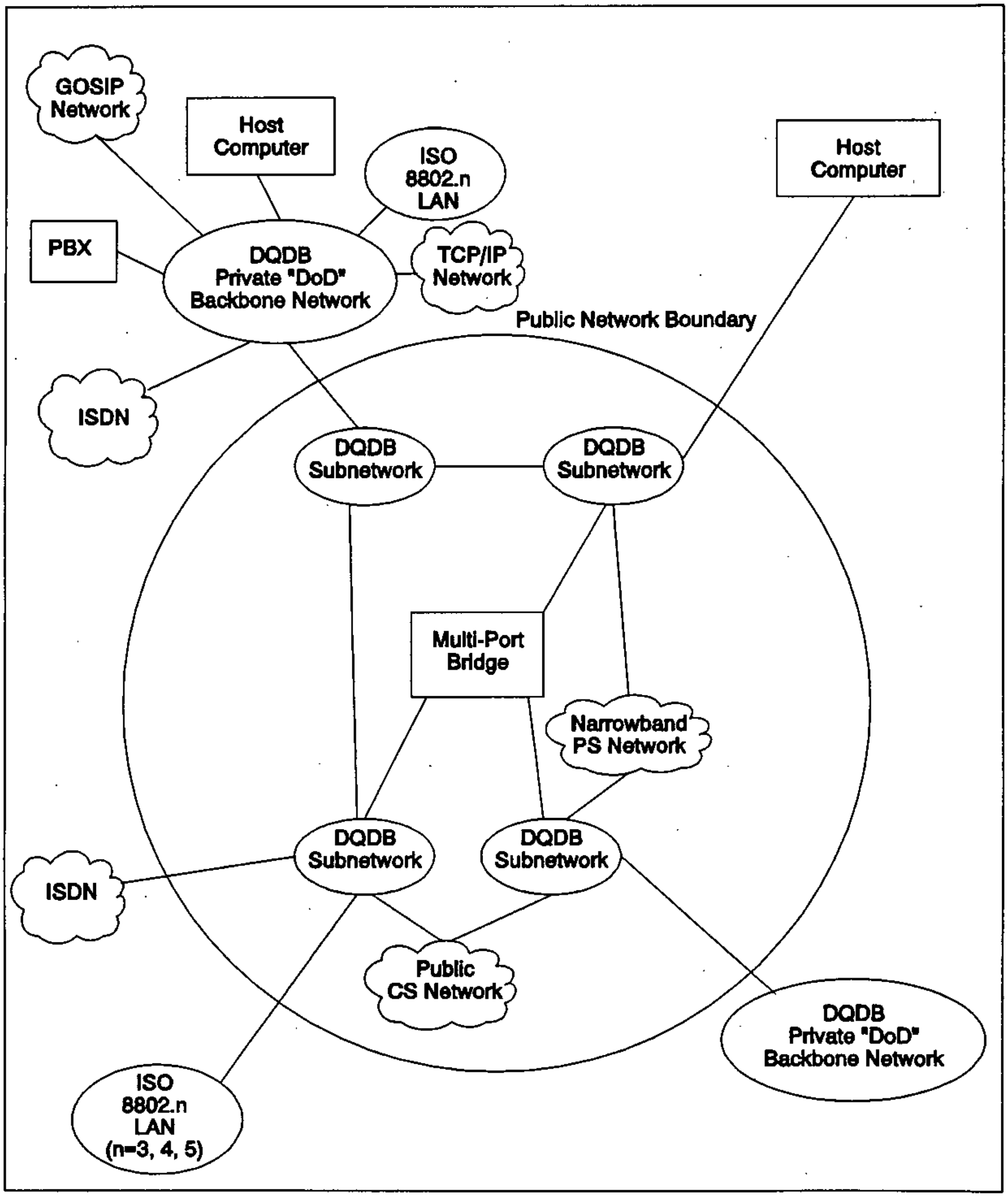


FIGURE 11. Notional internetworking network architecture.

5.6.2.5.2 Management. To support integrated DISN network management, the DQDB/MAN shall provide for local and remote management and control of its resources.

5.6.2.5.2.1 Local node management. Local management is not subject to the OSI management definition, since all information flow is local to the node's management process. However, when MANs are interconnected via a DISN local- or wide-area network element, the local management shall conform to the management concept defined in 5.7.

5.6.2.5.2.2 Remote management via network/system management. A node's physical and data-link layer objects are monitored, controlled, and coordinated via DISN network management through the DQDB-layer management interface. System management application functions shall provide for monitoring, control, and coordination of managed objects through interaction with the DQDB-layer management interface.

5.6.2.5.2.3 Remote management via DQDB layer management. Remote management shall provide for remote monitoring, control, and coordination of managed objects within a local node.

5.6.2.6 ATM LAN. Based on technology advancements, an ATM LAN is an alternative to a DQDB subnet. ATM switches can be configured to form a MAN for interconnection of LANs and direct connection of user end devices. Standards specifying use of ATM are identified in 5.6.3.

5.6.3 Asynchronous transfer mode. The ATM, which shall be used to provide broadband services, is a connection-oriented technique that can be used for supporting both connectionless and connection-oriented services. Signaling and user information are carried on separate virtual channels. The ATM shall comply with ITU-T Recommendations I.321, I.361, I.363, and I.432.

5.6.3.1 ATM services. Based on commercially available standards, ATM shall support a variety of user services, including voice, video, data, and signaling information. Service parameters shall be negotiable call-by-call, subject to network management constraints and limitations on parameter ranges.

5.6.3.1.1 Voice. For end-to-end encrypted voice calls, and for nonsecure voice calls between deployed and fixed subscribers, continuous bit rate (CBR) shall be used. For nonsecure voice calls in the deployed network, variable bit rate (VBR) shall be used to conserve bandwidth by deleting idle periods. (VBR for voice is a unique military requirement to conserve bandwidth in deployed ATM networks.

5.6.3.1.2 Video. CBR shall be used for high-quality video. VBR may be used for compressed video.

5.6.3.1.3 Data. VBR shall be used for data transmission.

5.6.3.1.4 Signaling. VBR shall be used for transmission of signaling messages.

5.6.3.2 ATM cell attributes. ATM cell format and transfer rates shall comply with 5.6.3.2.1 and 5.6.3.2.2.

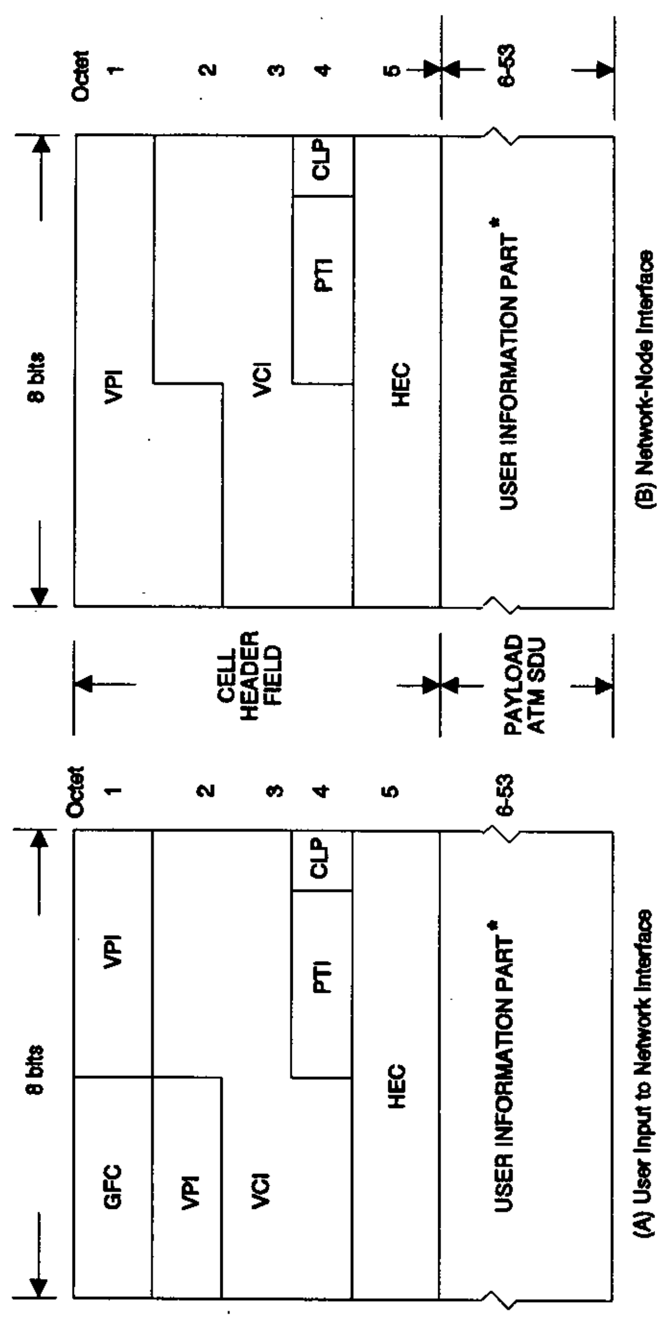
5.6.3.2.1 Cell format. The ATM shall be based on the cell structure shown in Figure 12. Cells are of fixed size, 53 octets, consisting of a 5-octet header field and a 48-octet information field. Any control information pertaining to the user application is carried in the user information field.

The cell header shall conform to ITU-T Recommendation I.361. It is the same at the UNI and NNI, except for the first four bits. These shall be used for generic flow control (GFC) at the UNI, and as an extension of the virtual path indicator (VPI) field at the NNI. UNI refers to the interface at both reference points A and B. NNI refers to the interface between nodes of a network. The GFC field shall be set to "0000".

5.6.3.2.2 Cell transfer rate. ATM shall support CBR and VBR connections. Anticipated operational rates are 155.52 Mbps (SONET STS-3 and ITU-T STM-1) and 622.08 Mbps (SONET STS-12 and ITU-T STM-4). The ATM shall not inhibit operation with other digital hierarchies.

5.6.3.2.3 Cell loss priority. The purpose of the cell loss priority (CLP) field is to indicate relative priority of cells within a single-user information stream. For example, a video stream can be divided into cells of two priorities; the higher priority for the cells that paint the outline of the picture, the lower priority for the cells that fill in the areas within the outline. The lower loss priority cells may be discarded during periods of congestion. Delivery of higher loss priority cells is not guaranteed; however, other measures shall be used to avoid discarding higher-loss priority cells. For example, ATM switches could monitor the cell discard rate. When the rate exceeds a predetermined dynamic threshold, call(s) could be preempted in accordance with 4.1.9.1. The use of the CLP field is an area for further study.

5.6.3.3 ATM reference model. Figure 13 depicts the ATM layered protocol reference model (ATM-RM). The two specific layers related to the ATM functions are the ATM layer, which is common to all services and provides cell transfer capabilities, and the ATM adaptation layer (AAL), which is service-dependent. The ATM layer uses cell header information to transfer the cell payload field through the ATM network. AAL layer functions depend on the service provided to the user and operate only on information contained in the payload field.



LEGEND:

AAL ATM Adaptation Layer
ATM asynchronous transfer mode
CLP cell loss priority (1 bit)
GFC generic flow control (4 bits) **
HEC header error check (8 bits)
PTI payload type identifier (3 bits)
SDU service data unit
VCI virtual channel indicator (12-16 UNI, 16 NNI) **
VPI virtual path indicator (8-12 bits) **

* The User Information part includes 0 to 4 octets used by the AAL. The number of octets and location depend on the AAL type.

** See 3.1 for definitions

FIGURE 12. ATM cell structure.

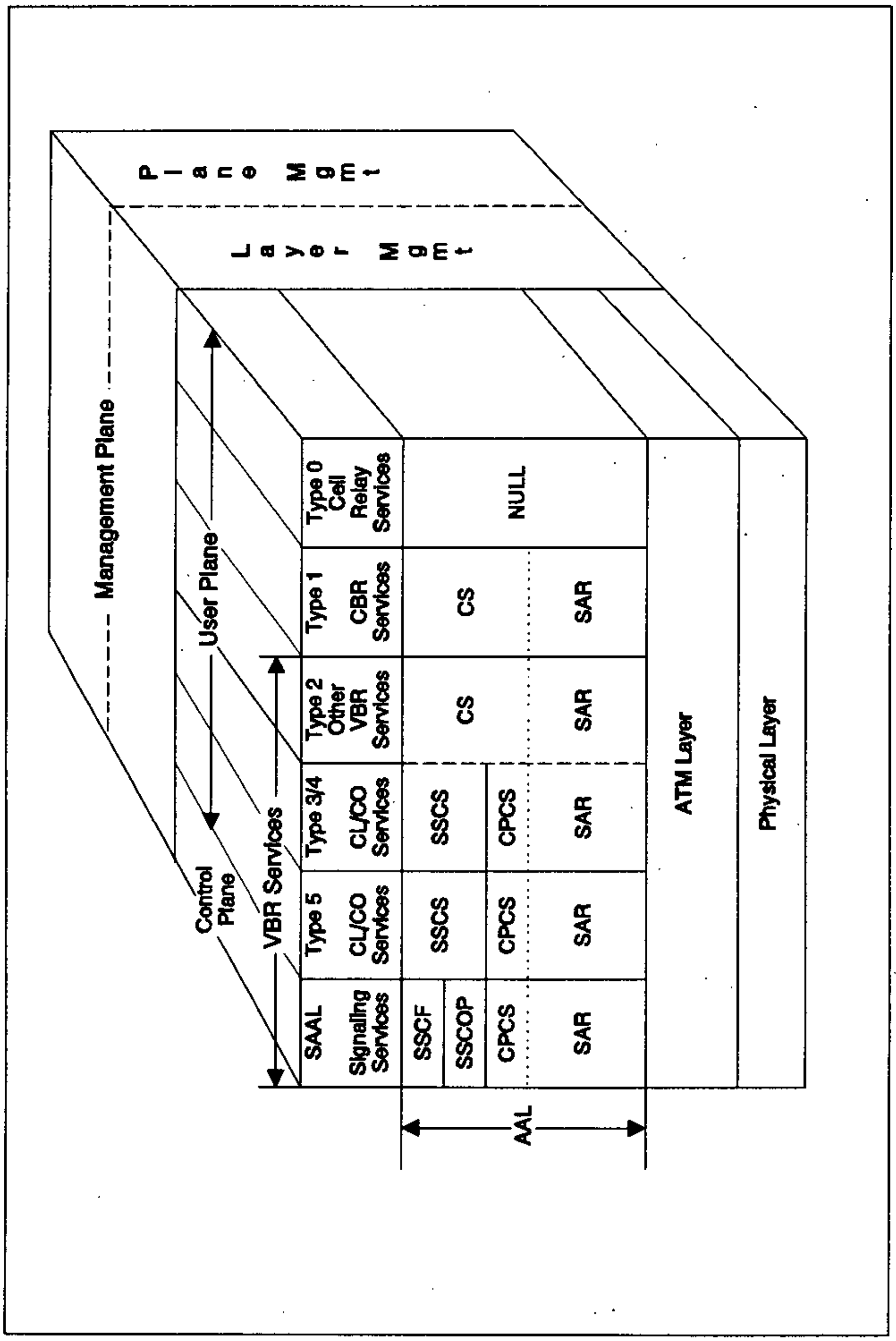


FIGURE 13. ATM protocol reference model.

5.6.3.3.1 Physical layer. The physical layer provides transmission services to the ATM layer. It shall provide transmission adaption to the ATM cell and media-dependent service for the specific transmission media, such as SONET (see ITU-T Recommendation I.432).

5.6.3.3.2 ATM layer. The ATM layer provides connection-oriented network service to the layers above. After a virtual connection has been established (see 5.6.3.5), the ATM layer transfers cells in accordance with their virtual path indicators (VPI) and their virtual channel indicators (VCI), in accordance with ITU-T Recommendation I.361.

5.6.3.3.3 ATM adaptation layer. The AAL performs the necessary functions to adapt the services provided by the ATM layer to the services required by different Service users. The AAL supports higher-layer functions of the user and control planes, and shall support connections between ATM and non-ATM users. It shall support both CBR and VBR services. The AAL consists of two main sublayers: the segmentation and reassembly (SAR) sublayer and the convergence sublayer (CS). The SAR sublayer is common to all VBR services, and handles the segmentation and reassembly of data units so they can be mapped into the fixed-length payloads of the ATM cells. The CS provides the specific service-related functions of the AAL and may be divided into two sublayers, the common-part convergence sublayer (CPCS) and the service-specific convergence sublayer (SSCS). VBR services include connection-oriented and connectionless data services for a range of applications from bursty data to variable bit rate video. VBR services also include signaling. CBR services include voice and video. Adaptation layer protocols, AAL Types 0-5 for user services and Type SAAL for signaling, are described below (see Figure 13). The choice of Type 3/4 or Type 5 for use in the tactical environment is for further study.

AAL Type 0. AAL Type 0 refers to the case when interconnection is at the ATM cell level. This is the case in which cell relay bearer service (CRBS) is used to connect the ATM network to a broadband terminal (BT), that is, at the UNI (see 5.6.4). The BT is an end device that may be acting as an aggregator of other tributary devices present at the location where the UNI terminates. (See supplement to ITU-T Recommendation F.811.)

AAL Type 1. AAL Type 1 supports continuous bit rate applications in which a timing relationship is required to exist between source and destination, such as voice or video, and shall comply with ANSI T1.630. BCI shall be ensured.

AAL Type 2. AAL Type 2 supports variable bit rate applications in which a timing relationship is required to exist between source and destination, such as compressed video.

AAL Type 3/4. AAL Type 3/4 supports both CLNS and CONS data transfer. It provides for the transparent and sequential transfer of protocol data units (PDU) between corresponding upper-layer entities with an agreed QOS. The transfer may provide either assured or non-assured data transfer, as requested by the user. Each cell carries 44 payload octets, with a 2-octet header and a 2-octet trailer. The header and trailer provide protection against misordering of cells, and a 10-bit CRC for error detection, in accordance with ANSI T1.629 for the CPCS. For assured service, LAPD shall be used in the SSCS. Optional error discard allows corrupted PDUs to be delivered to the user. For non-assured service, the SSCS is null. Type 3/4 may be used over a shared media such as a DQDB subnet.

AAL Type 5. AAL Type 5 supports services identical to Type 3/4, but provides a 48-octet payload. No error detection is provided in the cell. There is also no mis-sequencing protection at the cell level; therefore, it can be used only for point-to-point service and cannot be used over shared media. A 32-bit CRC for error detection is provided at the CPCS, in accordance with ITU-T Recommendation I.363. For assured service, the SSCS shall provide sequencing and retransmission of erroneous CPCS PDUs. Optional error discard allows corrupted protocol data units to be delivered to the user. For non-assured service, the SSCS is null.

AAL Type SAAL. Type SAAL conveys signaling information between layer 3 entities across the UNI and NNI. The SSCS is divided into two sublayers: the service-specific coordination function (SSCF) and the service-specific connection-oriented protocol (SSCOP). The SSCF maps the services of SSCOP to the needs of the layer 3 protocol, in accordance with ITU-T Recommendation Q.2130 for the UNI, and Q.2140 for the NNI. The SSCOP provides assured data delivery for the signaling PDUs, in accordance with ITU-T Recommendation Q.2110, which does not specify a reliable link protocol. For deployed systems, LAPD shall be used. The SSCOP shall use the services of the SAR and CPCS from Type 5 for fixed systems. For deployed systems, the choice of Type 3/4 or Type 5 is for further study.

5.6.3.4 ATM interworking. ATM connections shall support ISDN user and signaling services. ATM networks shall support interworking with other ATM networks and non-ATM networks. Between ATM networks, interconnection may be at the cell level. When interworking with non-ATM networks, interconnection will be via an ATM adapter. Interconnection with N-ISDN networks will also require an ATM adapter. The adapter may be implemented via an external ATM device, or in the ATM switch.

5.6.3.5 ATM signaling. Signaling at the UNI shall be based on the ITU-T Recommendation Q.2931 protocol, which is derived from ITU-T Recommendation Q.931 and ITU-T Recommendation Q.933. The signaling function shall support point-to-point and point-to-multipoint network connections. The signaling shall use the SAAL protocol. A service-specific connection-oriented protocol (SSCOP), a sublayer of the SAAL protocol, will provide reliable delivery of signaling messages. SAAL shall be the link layer protocol for use across international interfaces for B-ISDN signaling. Signaling at the NNI shall be based on the ITU-T Recommendation Q.2761 to Q.2764. ATM signaling shall support CBR services, and both connection-oriented and connectionless VBR services. ATM signaling shall permit connection of users on B-ISDN to connect to users on N-ISDN. ATM signaling shall also permit users on different N-ISDNs to interconnect via B-ISDN.

5.6.3.6 ATM service support. ATM shall provide a variety of transport services, such as cell relay, frame relay, switched multi-megabit data, and connectionless broadband data. These services (except cell relay) may be provided on top of AAL Type 3/4 or Type 5. ATM shall also support connection to N-ISDN services at the UNI.

5.6.3.7 ATM on DS1. The ATM shall also support mapping of ATM cells into the DS1 signal for the 1.544-Mbps interface. The DS1 interface shall use the Extended Super Frame (ESF) format with the multiframe structure defined in ANSI T1.107. ATM cells shall be mapped into the 192-bit payload field of the DS1 frame so that the octet structure of the ATM cells is aligned with the octet structure of the DS1 frame.

5.6.3.8 ATM on E1. The ATM shall also support mapping of ATM cells into the E1 signal for the 2.048-Mbps interface. The E1 interface shall use the basic frame structure shown in Figure 7 and defined in ITU-T Recommendation G.704. ATM cells shall be mapped into timeslots 1 through 31 of the E1 frame so that the octet structure of the ATM cells is aligned with the octet structure of the E1 frame. Timeslot 0 is reserved for frame alignment signals.

5.6.3.9 ATM on DS3. The ATM shall also support mapping of ATM cells into DS3 signals for the 44.736 Mbps interface. The mapping of the ATM cells shall comply with the ATM Physical Layer Convergence Protocol (PLCP) specified in the ATM User-Network Interface Specification, the section titled *DS3 Physical Layer Interface*. The bit rate available for transport of ATM cells in the DS3 PLCP-based format shall be nominally 40.70 Mbps.

5.6.3.10 Application of ATM in tactical systems. The ATM concept is an integrating concept in that it enables all types of information, from voice to data to video, to be handled by common transmission and switching facilities. DOD's high level of interest in ATM for tactical systems is driven by the desire for seamless integration of fixed and deployed resources. Commercial standards for ATM are based on the availability of highly reliable (BER = 10^{-11}), high bandwidth (50 Mbps to Gbps) transmission facilities (fiber, cable, SONET). However, tactical channels may be characterized as low bandwidth and unreliable. These include radio links in the low Mbps range (DS1) with BERs of 10^{-5} or worse. Tactical radio links at VHF and HF have even less bandwidth and worse BERs. In traditional packet-switched networks, data links are made reliable by means of error detection and retransmission at each node in the network. In ATM networks, retransmission is not done at each node; it is done only end-to-end across the network, or end-to-end between user end devices. The connections through deployed ATM networks are likely to traverse multiple radio links. The end-to-end error probability will approach the sum of the individual link error probabilities, causing excessive retransmission and severe reduction of throughput when deployed radios are used. For this reason FEC shall be provided in deployed radio links to reduce the number of retransmissions. Selection of a standard FEC for deployed ATM networks is an item for further study.

5.6.4 Cell-relay bearer service (CRBS). The DISN will support CRBS to provide a variety of access rates, as addressed in ITU-T Recommendation I.211. CRBS provides a connection-oriented, sequence-preserving, cell transfer service between two or more BTs, in accordance with the ATM UNI Specification.

5.6.4.1 Services. CRBS is defined at the UNI for a single BT. Multiple on-demand virtual connections can be provided to one or more BTs via an ATM network. CRBS is defined to operate between ATM layer entities (ITU-T Recommendation I.321) in BTs, providing for transparent transfer of ATM cells. Services provided shall be the same as provided by ATM (see 5.6.3.1).

5.6.4.2 Rates. CRBS supports a variety of access rates, including DS0 (64 kbps), *n* x 64 kbps for even values of *n* up to 672, DS1, DS2, DS3, STS-1, STS-3c, and STS-12c (See ITU-T Recommendation F.811). The physical access channel can be T3 or SONET-based.

5.6.4.3 Format. Cells are 53 octets long and shall conform to ITU-T Recommendation I.361.

5.6.4.4 Management. Service management capabilities exist at two levels: layer management and management plane. Layer (specifically, ATM layer) management capabilities handle issues such as loopback, performance monitoring, and alarm surveillance. Management plane capabilities handle service aspects, such as changing subscription parameters, obtaining billing information, and reconfiguring VPs/VCs.

5.6.4.5 Interworking. Interworking is supported for the entire range of ATM services. However, CRBS is a pure cell-relay transport capability; thus, for some services, it may be necessary for the BT or the ES to provide AAL capabilities.

5.6.4.6 Signaling: User-network signaling is done on a VCI allocated to the signaling function. The call/bearer control protocol is contained in ITU-T Recommendation Q.2931. The AAL in support of UNI signaling for CRBS shall comply with Q.2110 and Q.2130.

5.6.5 Frame relay mode. The DISN shall support the frame relay mode (FRM). Support of FRM within the DISN shall conform to the ISDN FRM bearer service definition and architectural framework defined in ANSI T1.606. The ANSI FRM definition is closely aligned with ITU-T Recommendation Q.922.

5.6.5.1 Services. Although the ANSI FRM is, by definition, an ISDN packet mode bearer service, the FRM service definition does not inhibit its use with any suitable low-bit-error-rate service.

The FRM shall be capable of supporting a variety of connection-oriented and connectionless transport data services. These services shall support the following DISN service access definitions:

a. Circuit-switched access to the DISN network element's remote frame handler (FRM-Case A). The B- and H-channels may be used to send FRM data with this access method.

b. Virtual access via the DISN network element's local ISDN connection (FRM-Case B). The B-, H-, and D-channels may be used to send FRM data with this access method.

It shall be possible to establish access connections on demand and permanently, in accordance with ANSI T1.617. Multiplexing of multiple subscriber data streams onto a single connection, unlike ITU-T Recommendation X.25, shall be performed at the link layer.

5.6.5.2 Rates. The FRM shall have the capability of using the strategic-local network B-, H-, and D-channels and tactical-local network bit rates from 16 kbps to 2.048 Mbps. When using the basic rate ISDN interface, the FRM shall operate at the 64-kbps rate. The FRM use of the D-channel shall be at either the basic (16-kbps) or the primary (64-kbps) rates. The D-channel rates are applicable only for the FRM-Case B.

5.6.5.3 Format. The FRM frame format shall be as depicted in Figure 14 and defined in ANSI T1.618. The fields identified in the figure are described as follows:

Bits

8	7	6	5	4	3	2	1	Octet
0	1	1	1	1	1	1	0	1
Address Field (High-order octet)								2
(Low-order octet) (optional)								3
Frame Relay Information Field								4 to (n-3)
Frame Check Sequence Field (First octet)								n-2
(Second octet)								n-1
Flag Field								n
0	1	1	1	1	1	1	0	

FIGURE 14. Frame format for frame relay mode.

Flag:	Each frame contains a beginning and closing high-level data link control (HDLC) flag. The flags are used to indicate the beginning and end of a negotiated packet of user information.
Address:	The address field is used to support routing and network status (such as congestion) control information.
Control:	The FRM does not employ the HDLC control field.
Information:	The information field shall support the transport of a defined amount of user information. The default information field size is 262 octets (chosen to be compatible with LAPD on the D-channel). The minimum frame relay information field size is 1 octet. The support by networks of a negotiated maximum value of at least 1600 octets is recommended for applications such as LAN interconnect, to minimize the need for segmentation and reassembly (SAR) by the user equipment.
Frame check sequence:	The frame check sequence (FCS) is used to provide error checking. The FCS is defined to be a 16-bit sequence.

5.6.5.4 Management. The FRM provides no intrinsic network management capability. Thus, the FRM shall be managed as a layer 1 and layer 2 service, in accordance with relevant portions of 5.7.

5.6.5.5 Interworking. The FRM shall support interworking between tactical-local network and strategic-local networks. Interworking via the FRM shall support LAN-to-LAN and terminal-to-terminal interconnections. FRM may also take advantage of broadband transport services to traverse non-FRM network segments.

5.7 DISN network management. The DISN network management system shall comply with FIPS-PUB-179 for all but unique military features. The implementation of the unique military features shall comply with MIL-STD-2045-38000 and the companion MIL-HDBK-1351. The DISN network management features are described below.

5.7.1 Management communications. The DISN network management communications protocol and services, which provide the management information transfer mechanism, shall comply with

FIPS-PUB-179, the sections titled *Common Management Information Protocol (CMIP)* and *Common Management Information Services (CMIS)*. If an interim solution is required, the Simple Network Management Profile (SNMP) shall be used, as defined in MIL-STD-2045-17507. A complete coverage of CMIP and CMIS can be found in ISO 9596-1 and ISO 9595, respectively.

5.7.2 Military-unique features. MIL-STD-2045-38000 builds upon FIPS-PUB-179 by describing common military architectures and requirements, manageable computer and communications resources, and associated NM system solutions unique from the GNMP. The military-unique features are described in 5.7.2.1 to 5.7.2.5.

5.7.2.1 NM architecture. The DISN shall be partitioned into a number of management domains called NM system domains. Allocations are typically based on organization or geography. Management authority shall be assigned to a single network control center (NCC) within each NM system domain. NCCs shall be responsible for interfacing with other NM system domains (see Figure 15) as well as providing top-level management within their own NM system domain (see Figure 16), in accordance with MIL-HDBK-1351, the section titled *NM architecture*.

5.7.2.2 NM system characteristics. Human engineering (ergonomics), automated analysis tools, and administrative activities shall comply with MIL-HDBK-1351, the section titled *NM system characteristics*.

5.7.2.3 Systems management functional areas. The DISN NM system shall provide the following five systems management functional areas (SMFA), in accordance with MIL-HDBK-1351, the section titled *Systems management functional areas*:

a. Fault management. NM systems shall detect faults, isolate the causes, and correct the abnormal operation or fault situation of network components.

b. Configuration management. Dynamic configuration of networks shall provide tactical communications; interbase communications; and interconnection with external networks through bridges, gateways, and routers.

c. Account management. Details regarding use of the network shall be collected, recorded, and archived for the appropriate distribution of costs.

d. Performance management. Performance management functions shall provide the network manager with the ability to measure the quality and effectiveness of network communications and network components.

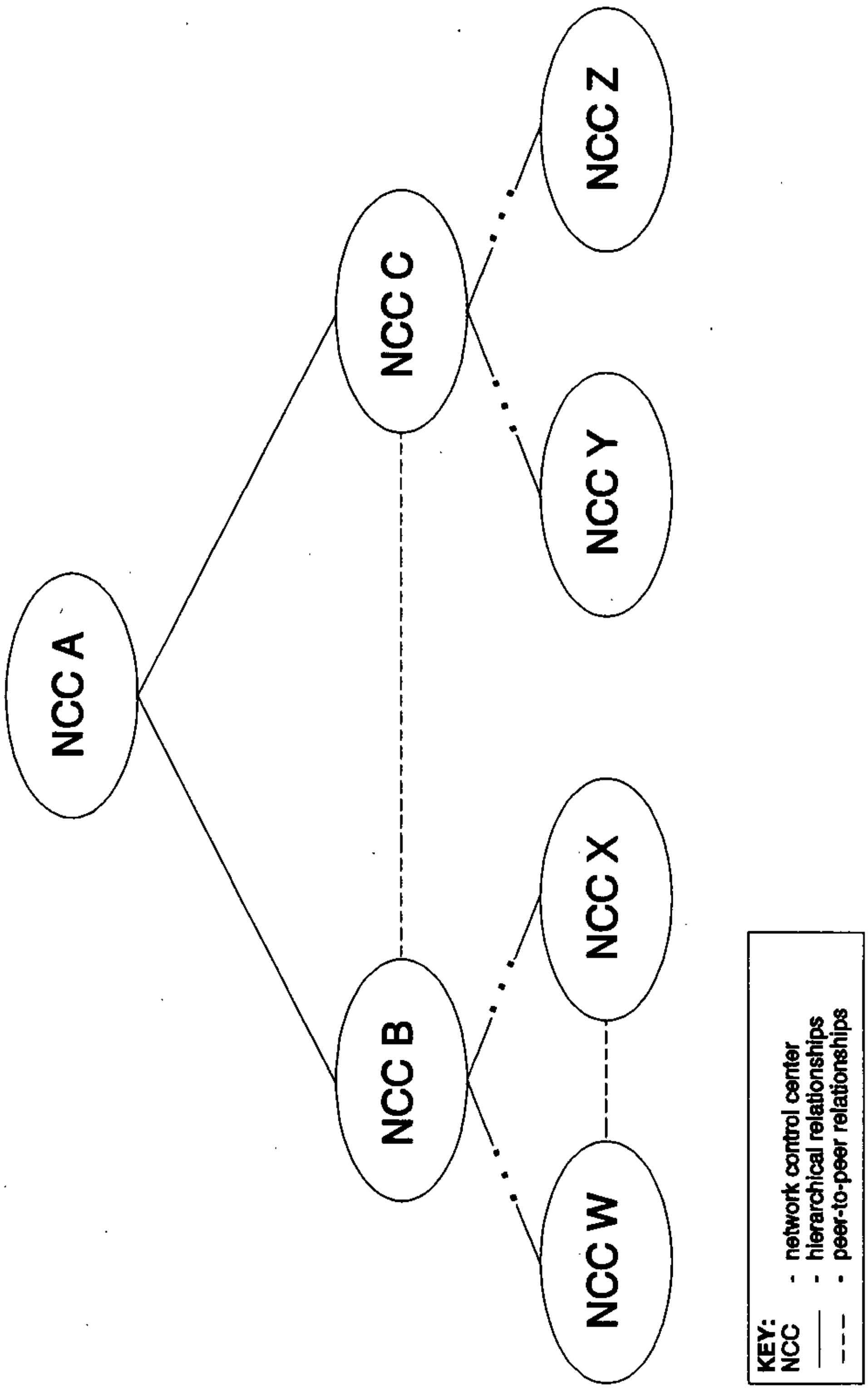


Figure 15. Hierarchical structure (manager-of-managers method).

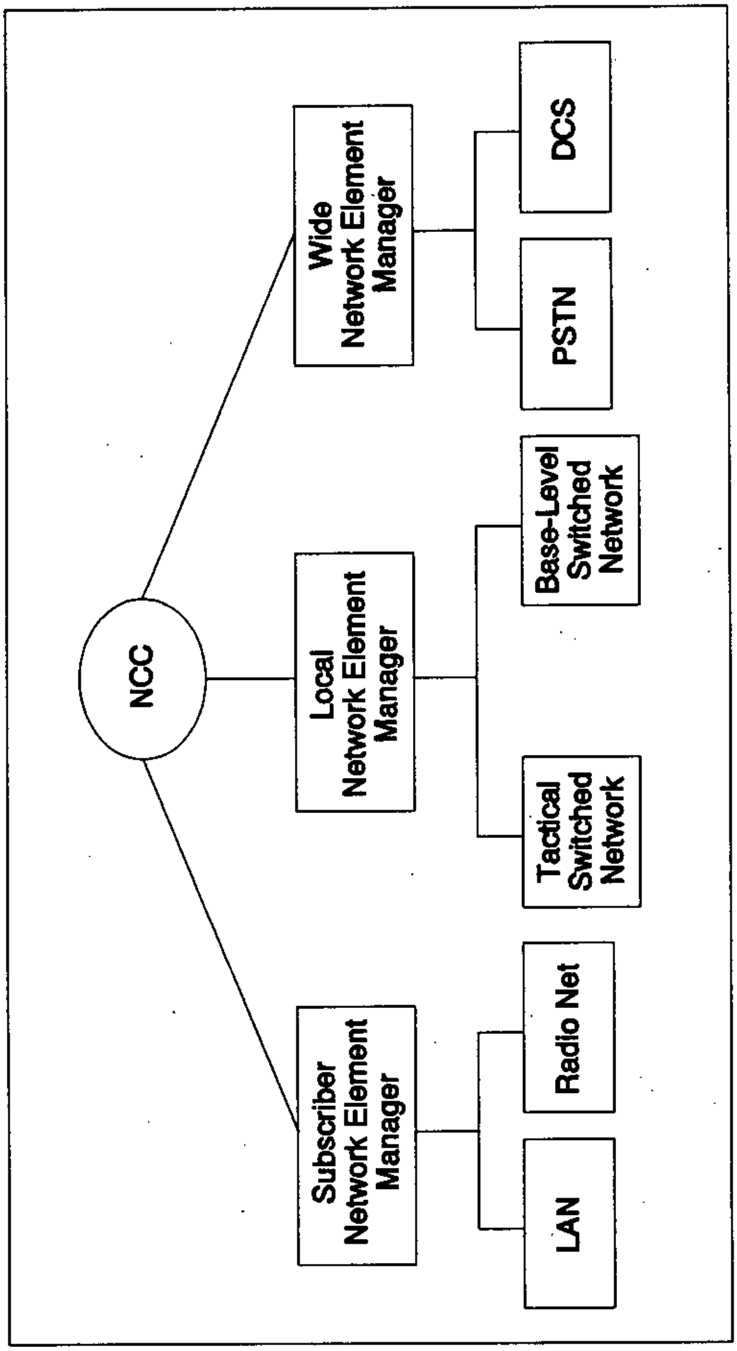


FIGURE 16. Typical intrabase, distributed, hierarchical network management architecture.

e. Security management. The network security manager shall be able to grant or restrict access to the entire network or selected critical parts of the network, such as the NM information base.

5.7.2.4 NM security. Security of the NM systems and information, and management of the security mechanisms that protect user traffic, shall be in accordance with MIL-HDBK-1351, the section titled *NM security*.

5.7.2.5 Military requirements for tactical systems. Tactical NM systems shall provide additional capabilities (such as conservation of bandwidth, precedence, mobility, and survivability), as defined in MIL-HDBK-1351, the section titled *Military requirements for tactical systems*.

5.8 Performance standards. Terminal-to-terminal performance standards, applied to hypothetical reference circuits (HRC), are included in this MIL-STD to provide system designers and planners with a consistent basis for establishing system parameters.

5.8.1 Hypothetical reference circuits. An HRC has a specified configuration and length. It is based on such factors as communications requirements, user satisfaction, equipment performance, installation and operation procedures, and experience. Reference circuit configurations, such as the number of links, trunks, and nodes in tandem with associated transmission equipment, are chosen so that each configuration can be considered representative of a typical network or subsystem operational circuit. The nominal length of a reference circuit normally represents the probable maximum distance over which communications are required in the network or subsystem under consideration.

An HRC is used (a) as a reference for the performance of planned or operational circuits; (b) as guidance for planning and engineering circuits and networks; (c) as a means of prorating and allocating transmission parameters to different portions of a circuit and associated equipment; and (d) as a basis to derive interface, subsystem, and equipment standards.

Normally, in an operational communications system, various circuits with different lengths and parameters from the HRCs are employed. It is not practical to standardize the performance of every link or circuit that may have to be engineered and installed. The purpose of standardizing performance end-to-end (and defining HRCs) is to ensure that actual links, trunks, and circuits will perform satisfactorily as parts of an overall subsystem or system.

Designers and circuit engineers are expected to make their own assumptions and decide on such factors as length of radio links; channel perturbations, such as noise and jitter; number of

PCM, ADPCM, and CVSD tandem links; number of A/D conversions; and delay characteristics to optimize circuit performance.

5.8.2 Hypothetical reference connections. The HRCs described in 5.8.2.1 and 5.8.2.2 can also be viewed as hypothetical reference connections (HRX) for circuit-switched calls or packet-switched calls. End-to-end performance parameters given in 5.8.2.2 and 5.8.3 apply only to circuit-switched calls. End-to-end performance parameters for packet-switched calls are a subject for further study.

5.8.2.1 Wide-network segments. The segments that constitute each HRC are summarized in Table VIII.

TABLE VIII. Reference segments for wide-network segments.

REFERENCE SEGMENT	DESCRIPTION
Tail	Same as 320-km terrestrial segment
320-km terrestrial segment	Eight line-of-sight (LOS) radio repeater links
Satellite or transoceanic submarine cable	One satellite link with a 40-km LOS radio link at one end, and a metallic or fiber optic cable connection at the other end

5.8.2.2 Error-free-second ratio allocation. The error-free-second (EFS) ratio allocation for each segment and the resulting performance for each HRC is provided in Table IX.

TABLE IX. Error-free-second ratio allocation.

SEGMENT	PER SEGMENT	HRC		
		GLOBAL	OVERSEAS	INTRA-CONTINENTAL
Tail	0.9996	---	---	---
320-km terrestrial segment	0.9995	---	---	---
Satellite or transoceanic cable	0.9997	0.9936 ---	N/A ---	0.9968 ---
HRC	---	0.9916	0.9936	0.9949

5.8.3 Wide networks. Three HRCs for wide networks exist. They are illustrated in Figure 17. The parameter selected to characterize error performance in wide networks shall be the EFS ratio for a 64-kbps channel. The terminal-equipment to terminal-equipment performance requirement for the EFS ratio is 0.99 for a circuit traversing each HRC, as shown in Figure 17.

5.8.4 Tactical networks. Three HRCs exist for U.S. tactical circuits:

a. The first HRC, shown in Figure 18, consists of six internodal line-of-sight (LOS) radio links in tandem. Each internodal LOS radio has a maximum planning distance of 50 km with an 8-km down-the-hill (DTH) millimeter wave or cable link on each end.

b. The second HRC, shown in Figure 19, consists of one internodal troposcatter link covering a transmission distance of 200 km in tandem with 2 internodal LOS radio links of 50 km each. Each troposcatter and LOS radio link has an 8-km DTH millimeter wave radio or cable link on each end.

c. The third HRC, shown in Figure 20, consists of 2 tactical subnetworks interconnected by wide network elements, as provided by the DCS or public switched telephone networks (PSTN). In this case the information transmits up to 12 LOS radio links and 24 DTH links.

The contribution to the overall circuit error ratio allocated to tactical network elements is provided in Table X.

TABLE X. Operational bit error ratios for HRCs that use tactical-network elements.

TYPE OF SECTION	CONTRIBUTION PER CIRCUIT	
	BIT ERROR RATIO (BER)	% OF ANY MINUTE
LOS radio	1×10^{-4}	99.0
Tropo radio	4×10^{-4}	99.0
DTH radio	1×10^{-5}	99.0
DTH coaxial cable	1×10^{-6}	99.9
DTH fiber optic cable	1×10^{-8}	99.9

NOTE: The operational error rates are transmission errors and do not include effects of error correction or encryption devices.

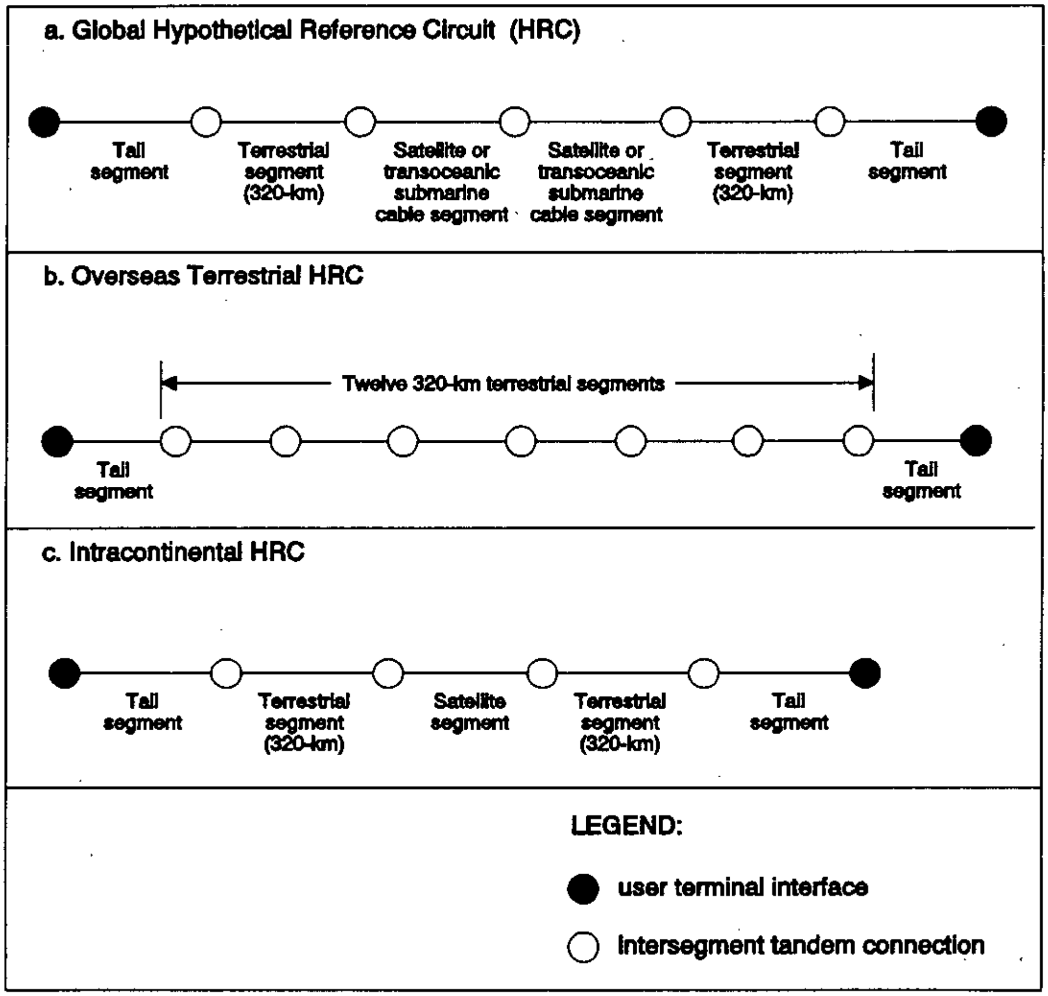


FIGURE 17. HRCs for wide networks.

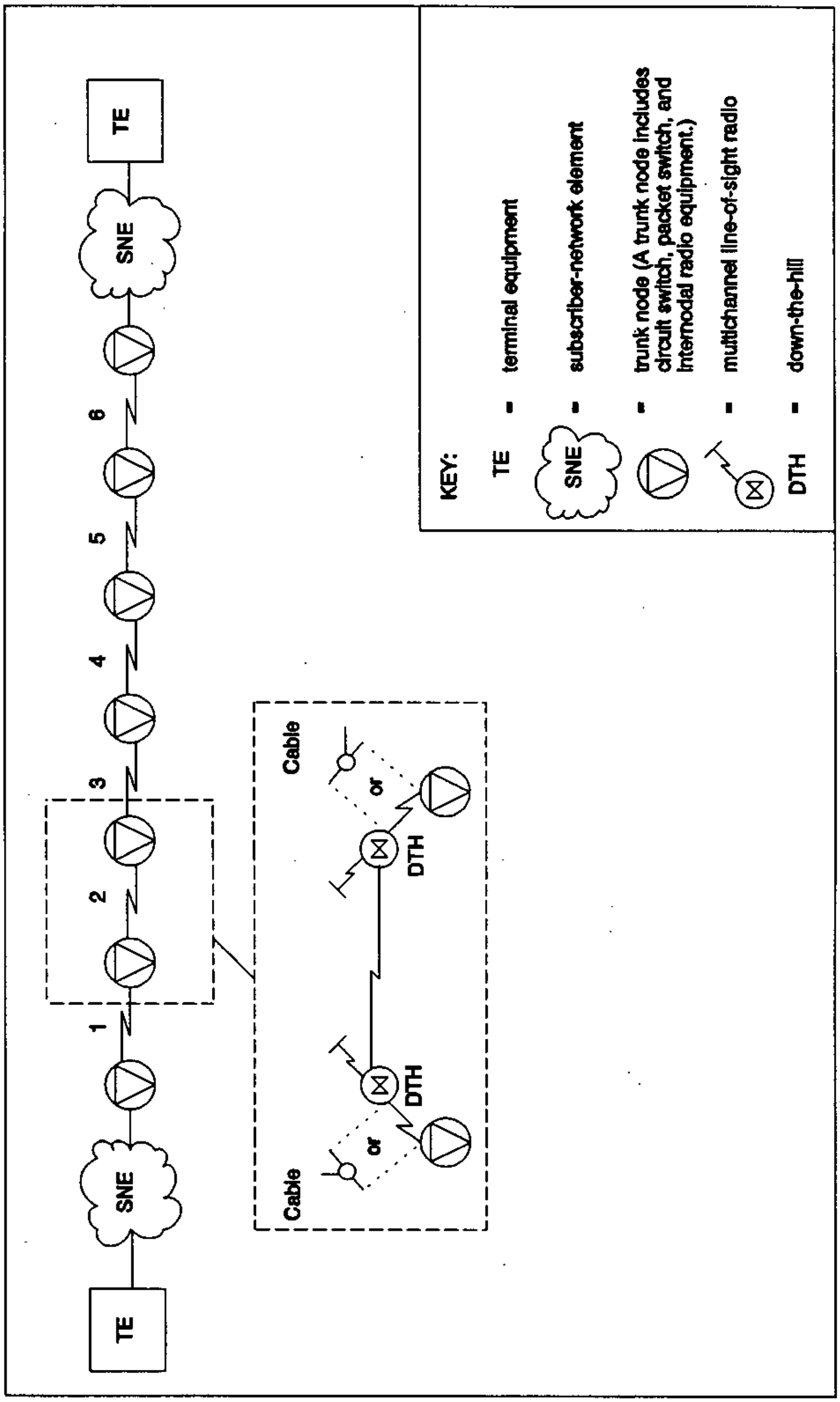


FIGURE 18. HRC for tactical networks based on LOS radio links.

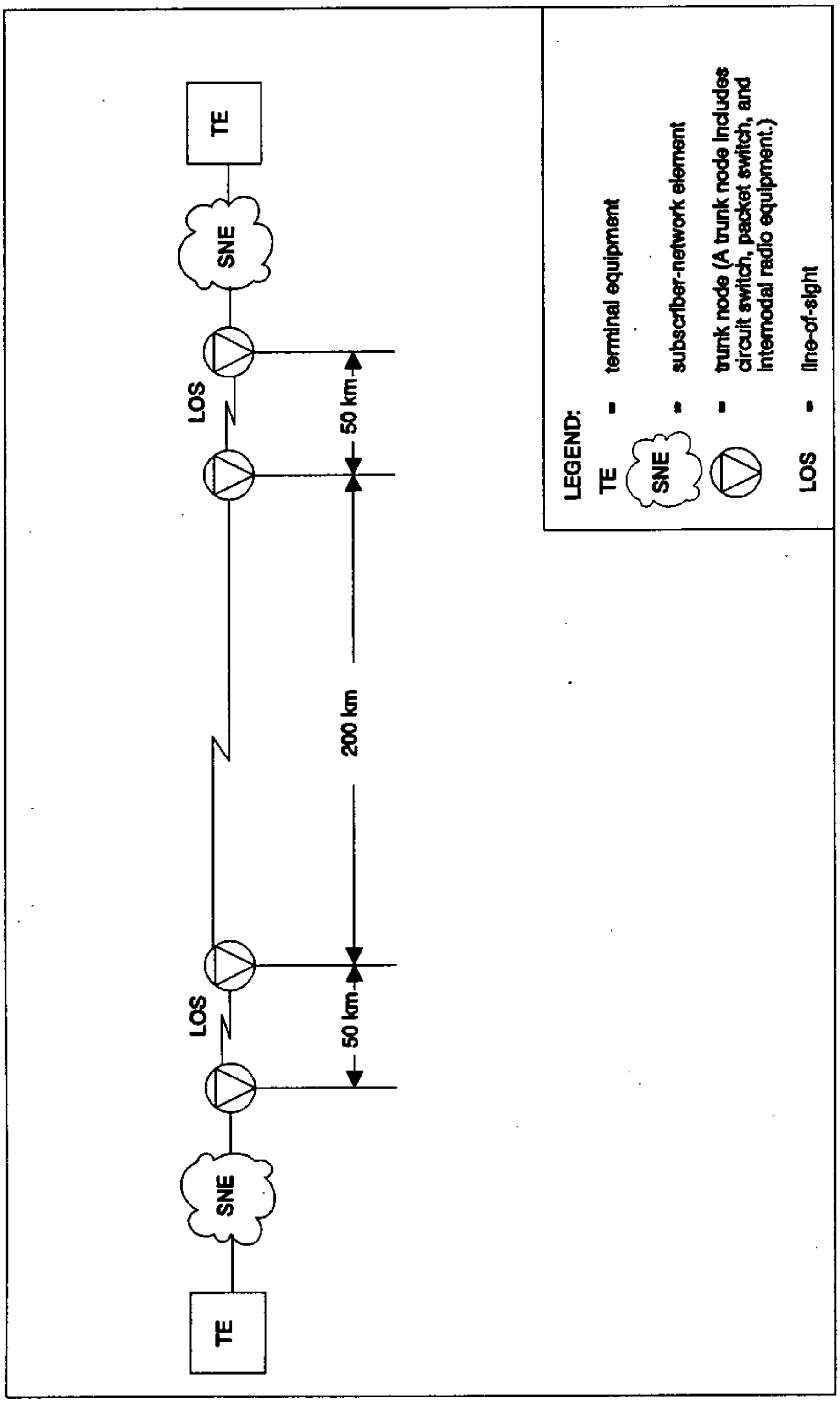


FIGURE 19. HRC for tactical networks based on LOS and tropo radio links.

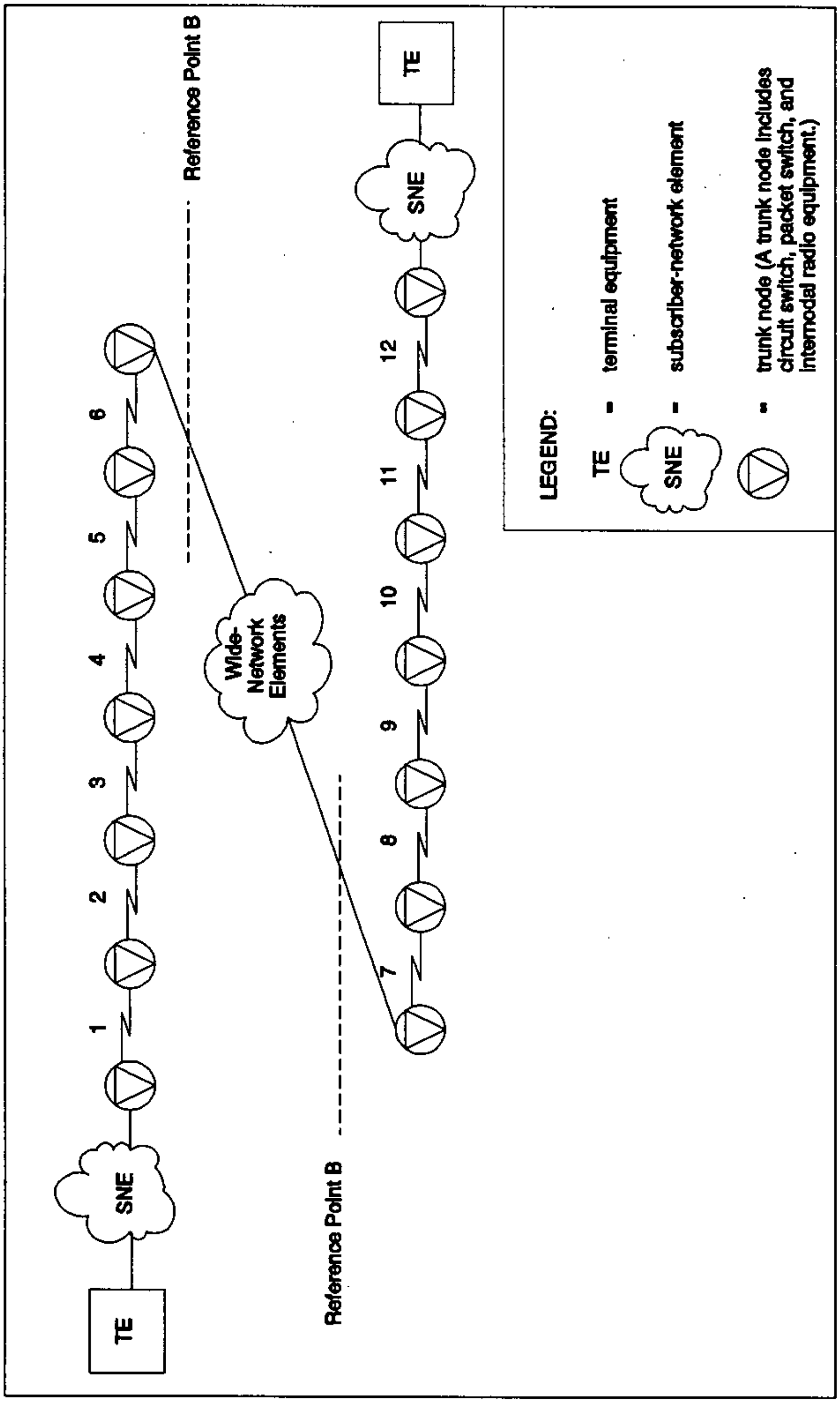


FIGURE 20. HRC for tactical networks interconnected by wide-network elements.

5.8.5 Subscriber networks. Subscriber terminal equipment is connected to the local base-level or tactical network via subscriber network elements. Four HRCs applicable to subscriber networks exist. The first two are applicable to both strategic and tactical users. The third and fourth are applicable to tactical users only.

a. A direct metallic cable connection between the subscriber's terminal equipment and the local circuit or packet switch. The cable may be up to 4 km long.

b. A LAN complying with LAN standards ISO 8802-3, 8802-4, or 8802-5.

c. A radio network made of combat net radios.

d. A mobile subscriber radio terminal (MSRT).

The contributions to the overall circuit bit error ratio (BER) allocated to subscriber network elements is provided in Table XI.

5.9 Numbering plans. A standard numbering plan format shall be employed on all trunks that cross reference-point B. This includes all joint and international circuit- and packet-switched trunks.

TABLE XI. Operational error rates for HRCs that use subscriber-network elements.

TYPE OF SECTION	CONTRIBUTION PER CIRCUIT	
	BIT ERROR RATIO (BER)	% OF ANY MINUTE
Metallic cable connection	1×10^{-6}	99.9
Local area network	TBD	TBD
Radio network	4×10^{-3}	95.0
Mobile subscriber radio terminal	TBD	TBD
DTH fiber optic cable	1×10^{-8}	99.9

5.9.1 Circuit-switched trunks. Telephone numbers, as they appear on joint circuit-switched trunk interfaces, shall consist of a 3-digit area code and a 7-digit subscriber number unique to each area code. Telephone numbers for international calls shall consist of an international access prefix (IAP), in addition to the area code and the subscriber number.

5.9.1.1 International access prefix. The IAP for calls between U.S. tactical users and NATO tactical users, reference point B (NATO), shall comply with STANAG 4214 and its description of the nationality identifier (NI). The NI is of the form 9CC, where CC is a 2-digit country code. The IAP for calls between U.S. strategic users and other nations' strategic users shall comply with ITU-T Recommendations E.163 and E.164.

5.9.1.2 Area codes. The area codes for calls between U.S. tactical users and NATO tactical users shall comply with STANAG 4214 and shall be of the form NCC, where N = 0, 1, ..., 8 and CC is the 2-digit country code. Area codes for calls between U.S. joint tactical networks shall comply with the Joint Pub 6-05.2 chapter titled *Numbering Systems and Plans and Routing*. Area codes for base-level and wide-network elements shall comply with DCAC 370-175-13, the section titled *DSN Worldwide Numbering and Dialing Plan*.

5.9.1.3 Subscriber telephone numbers. The standard telephone number, as it appears at joint and combined trunk interfaces, shall have 7 digits. The 7 digits consist of 2 subcomponents: a 3- or 4-digit switch code, and a 4- or 3-digit subscriber number. Systems that employ deducible directories, automatic subscriber affiliation, and flood-search routing shall use all 7 digits as the unique subscriber number.

5.9.2 Packet-switched trunks. The address of the called terminal shall be provided in the call request packet, in accordance with ITU-T Recommendation X.31. As an objective, DOD will evolve toward an integrated addressing plan applicable to both circuit-switched and packet-switched trunking. In the interim, packet-switched network elements shall comply with standards adopted for use by DDN.

5.9.3 Digit capacity for international systems. The number length for international calls may be increased to accommodate future network requirements (see ITU-T Recommendation E.163, the section titled *Digit capacity of international registers*, and E.164, the section titled *Number length*). The digit capacity of registers required to process international calls should provide a minimum capacity of 15 digits. This digit capacity does not include all digits dialed by telephone subscribers, such as access and priority digits.

5.9.4 Subaddressing (network address extension). The 7-digit subscriber number shall identify connections at reference point A. Additional subaddressing required to identify subscriber-to-network terminations or service access points shall be transparent to the local- and wide-network elements. For base-level subscribers, up to 40 digits may follow the subscriber number, as illustrated in ITU-T Recommendation E.164, the section titled *Address information*. Subaddressing for tactical users is a subject for further study.

5.10 National Imagery Transmission Format Standard. The National Imagery Transmission Format (NITF) Standard (NITFS) defines the standard formats for digital imagery and imagery-related products that are to be exchanged between members of the Intelligence Community, DOD, and other departments and agencies of the United States Government. The NITFS includes supporting standards for imagery, image compression, other imagery related requirements, and the Tactical Communications 2 (TACO2) protocol. The document structure for current and anticipated NITFS documentation is described in MIL-HDBK-1300). DOD has developed imagery related standards for the NITFS suite: MIL-STD-2500, MIL-STD-2301, MIL-STD-188-196, MIL-STD-188-197, and MIL-STD-188-198. The NITFS suite includes MIL-STD-2045-44500, which defines a standard format for transmitting digital imagery information over tactical communications circuits.

5.10.1 MIL-STD-2500. The National Imagery Transmission Format (NITF) for the National Imagery Transmission Standards (NITFS) provides a detailed description of the overall structure of the file format, as well as specification of the valid data content and format for all fields defined within a NITF file.

5.10.2 MIL-STD-2301. The Computer Graphics Metafile (CGM) Implementation Standard defines the subset of CGM commands applicable for graphic annotation of imagery within the NITFS.

5.10.3 MIL-STD-188-196. The Bi-Level Compression Standard defines the compression algorithm used for encoding bi-level image and overlay information used for transmission of on-bit-per-pixel imagery.

5.10.4 MIL-STD-188-197. The Adaptive Recursive Interpolated Differential Pulse-Code Modulation (ARIDPCM) Standard defines a compression for 8- and 11-bit gray-scale imagery used in conjunction with NITF version 1.1.

5.10.5 MIL-STD-188-198. The Joint Photographic Experts Group (JPEG) Standard defines compression of 8- and 12-bit gray-scale and 24-bit color image data used in conjunction with NITF version 2.0.

5.10.6 MIL-STD-2045-44500. Tactical Communications Protocol 2 (TACO2) defines a communications protocol and error correction methods used to exchange NITFS messages across a wide variety of tactical communications circuits.

5.11 Satellite communications. The standards for satellite communications (SATCOM) can be categorized in accordance with the frequency band of operation, that is, UHF, SHF, and EHF. Joint efforts between NASA and DOD are ongoing to develop upper-layer communications protocols for use in the space environment.

5.11.1 UHF SATCOM standards. The standards for UHF SATCOM are described in 5.11.1.1 to 5.11.1.5.

5.11.1.1 MIL-STD-188-181. The parameters defined in MIL-STD-188-181 provide for the interoperability and performance of UHF SATCOM terminals that use nonprocessed 5-kHz (narrowband) and 25-kHz (wideband) channels. The waveform is for use in the dedicated/phase-shift keying (PSK) mode for narrowband channels and the dedicated/frequency-shift keying (FSK)/PSK mode for wideband channels.

5.11.1.2 MIL-STD-188-182. The parameters defined in MIL-STD-188-182 provide for the dynamic sharing of one or more nonprocessed narrowband UHF SATCOM channels in the dedicated/shaped offset quadrature phase-shift keying (SOQPSK) or demand assignment multiple access (DAMA)/SOQPSK mode, among numerous users.

5.11.1.3 MIL-STD-188-183. The parameters defined in MIL-STD-188-183 provide for the dynamic sharing of a nonprocessed wideband UHF SATCOM channel in either the TDMA/binary phase-shift keying (BPSK)/differentially encoded quadrature phase-shift keying (DEQPSK) or DAMA/BPSK/DEQPSK mode, among numerous users.

5.11.1.4 MIL-STD-188-184. The parameters defined in MIL-STD-188-184 provide for data compression and adaptive error-correction processing of user data.

5.11.1.5 MIL-STD-188-185. The parameters defined in MIL-STD-188-185 provide for dynamic management and control of UHF SATCOM dedicated and DAMA operation over nonprocessed channels.

5.11.2 SHF SATCOM standards. MIL-STD-188-1XX will define the parameters for BPSK and offset quadrature phase-shift keying (OQPSK) operations of modems that will interface with SHF SATCOM earth terminals operating in the C-Band, X-Band, and Ku-Band.

5.11.3 EHF SATCOM standards. The standards for EHF SATCOM are described in 5.11.3.1 and 5.11.3.2.

5.11.3.1 MIL-STD-1582. MIL-STD-1582 defines a common waveform for low-data-rate (75 to 2400 bps) EHF satellite data links.

5.11.3.2 MIL-STD-188-136. MIL-STD-188-136 will define a common waveform for medium-data-rate (up to 1.544 Mbps) EHF satellite data links.

5.11.4 MIL-STD-2045-14500. MIL-STD-2045-14500 will define the upper-layer satellite communications protocols for use in the space environment. This involves space-to-ground and space-to-space link. The protocols are being developed in these areas: file transfer, transpack security, and networking. The series of MIL-STD-2045-10500 will address unique constraints of the space environment such as effects of limited bandwidth; limited processing and memory capability; dynamically changing network parameters; and high BER.

5.12 Meteor burst communications. Meteor burst radio communications relies on the billions of meteors that enter the earth's atmosphere daily, that are vaporized by atmospheric friction, and that produce ionized trails. A high percentage of these trails lasts less than one-half second, although some trails last up to several seconds. Trail occurrence and duration are random events. Three proposed Federal Standards (FED-STD) are intended for use by systems that use meteor burst communications: FED-STD-1055, FED-STD-1056, and FED-STD-1057.

5.12.1 FED-STD-1055. Half-duplex operation between conventional master and conventional remote meteor burst communications stations shall comply with the interoperability parameters provided in FED-STD-1055. Major interoperability parameters are listed below.

a.	Frequency range:	40 to 50 MHz (minimum)
b.	Frequency accuracy:	3 ppm for master stations 5 ppm for remote stations
c.	Modulation:	Differentially-encoded BPSK Binary 0 = 0° phase change Binary 1 = 180° phase change
d.	Data rates:	4 and 8 kbps ± .01%
e.	Error control:	16-bit CRC check sum, code generator polynomial $g(x) = x^{16} + x^{15} + x^2 + 1$
f.	Link-level operation:	See FED-STD-1055, the sections titled *Link Level Operation for Bi-directional Communications* and *Broadcast Link Level Operation*

5.12.2 FED-STD-1056. The method used for encrypting the text of messages between meteor burst communications stations shall comply with FED-STD-1056. (NOTE: FED-STD-1056 does not restrict the use of other encryption devices capable of providing cryptographic compatibility with FED-STD-1055 and FED-STD-1057, such as the KG-84.)

5.12.3 FED-STD-1057. Full-duplex operation between conventional master stations in different meteor burst communications networks shall comply with the interoperability parameters provided in

FED-STD-1057. Major interoperability parameters are listed below.

a.	Frequency range:	40 to 50 MHz (minimum)
b.	Frequency accuracy:	3 ppm
c.	Modulation:	Differentially-encoded BPSK Binary 0 = 0° phase change Binary 1 = 180° phase change
d.	Data rates:	8 kbps ± .01%
e.	Error control:	16-bit CRC check sum, code generator polynomial $g(x) = x^{16} + x^{15} + x^2 + 1$
f.	Link-level operation:	See FED-STD-1057, the section titled *Link Level Operation*

5.13 <u>Digital message transfer devices</u>. A digital message transfer device (DMTD) is a portable data terminal device with limited message generation and processing capability. DMTDs are used for remote access to automated C4I systems and to other DMTDs. The environment encompasses point-to-point, point-to-multipoint, and broadcast transfer of information over data communications links. New DMTDs shall comply with the communications protocols, parameters, and procedures defined in MIL-STD-188-220. MIL-STD-188-220 applies to the design and development of new equipment and systems, and to the retrofit of existing equipment and systems.

6. NOTES

6.1 Key-word listing. The following key words, phrases, and acronyms apply to MIL-STD-187-700:

- asynchronous transfer mode
- broadband ISDN
- circuit-switched networks
- Data Communications Protocol Standards
- Defense Data Network
- distributed queue dual-bus
- Digital Subscriber Signaling System Number 1
- DOD Standardized Profiles
- Fiber Distributed Data Interface
- GOSIP
- hypothetical reference circuit
- Internet
- ISDN
- local-area network
- metropolitan-area network
- multi-level precedence and preemption
- Military Message-Handling System
- Military Messaging System
- networking
- network management
- packet-switched network
- personal telecommunications service
- Synchronous Optical Hierarchy
- Synchronous Optical Network
- Signaling System Number 7
- tactical-to-strategic interface
- wide-area network

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DISA - DC

OASD - IR

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DLA - DH

ECAC

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(Project SLHC-7001)

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