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MILITARY HANDBOOK

NATIONAL IMAGERY TRANSMISSION FORMAT STANDARD (NITFS)

AMSC N/A

AREA INST

DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.

FOREWORD

1. The National Imagery Transmission Format Standard (NITFS) is the standard for formatting digital imagery and imagery-related products and exchanging them among members of the Intelligence Community (IC) as defined by Executive Order 12333, the Department of Defense (DOD), and other departments and agencies of the United States Government as governed by Memoranda of Agreement (MOA) with those departments and agencies.

2. The National Imagery Transmission Format Standard Technical Board (NTB) developed this standard based upon currently available technical information.

3. The DOD and members of the Intelligence Community are committed to interoperability of systems used for formatting, transmitting, receiving, and processing imagery and imagery-related information. This handbook describes the National Imagery Transmission Format (NITF) file format and establishes its application within the NITFS.

4. Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to Defense Information Systems Agency (DISA), Joint Interoperability and Engineering Organization (JIEO), Center for Standards (CFS), Attn: TBCE, Parkridge III, 10701 Parkridge Blvd., Reston, VA 22091-4398 by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

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1. SCOPE

1.1 Purpose. This document describes the NITFS and its image and communications processing components. It provides general information regarding NITFS. The component documentation which contain the specific set of mandatory standards for the NITFS suite, is as follows:

a. MIL-STD-2500A, National Imagery Transmission Format (NITF) for the National Imagery Transmission Format Standard (NITFS).

b. MIL-STD-2301, Computer Graphics Metafile (CGM) for the National Imagery Transmission Format Standard (NITFS).

c. MIL-STD-188-196, Bi-Level Image Compression for the National Imagery Transmission Format Standard (NITFS).

d. MIL-STD-188-197A, Adaptive Recursive Interpolated Differential Pulse Code Modulation (ARIDPCM) Image Compression for the National Imagery Transmission Format Standard (NITFS).

e. MIL-STD-188-198A, Joint Photographic Experts Group (JPEG) Image Compression for the National Imagery Transmission Format Standard (NITFS).

f. MIL-STD-2045-44500, Tactical Communications Protocol 2 (TACO2) for the National Imagery Transmission Format Standard (NITFS).

g. MIL-STD-188-199, Vector Quantization Decompression for the National Imagery Transmission Format Standard (NITFS) .

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issue of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation.

STANDARDS

FEDERAL

FED-STD-1037B	-	Telecommunications: Glossary of Telecommunications Terms.

FEDERAL INFORMATION PROCESSING STANDARDS (FIPS)

FIPS PUB 128	-	Computer Graphics Metafile (CGM) [adaptation of American National Standards Institute/International Organization for Standardization (ANSI/ISO) 8632:1992].

MILITARY

MIL-STD-188-161	-	Common Long Haul and Tactical Digital Facsimile Equipment.
MIL-STD-188-199	-	Vector Quantization Decompression for the National Imagery Transmission Format Standard (NITFS).
MIL-STD-2301	-	Computer Graphics Metafile for the National Imagery Transmission Format Standard (NITFS).
MIL-STD-2045-44500	-	Tactical Communications Protocol 2 (TACO2) for the National Imagery Transmission Format Standard (NITFS).
MIL-STD-188-196	-	Bi-Level Image Compression for the National Imagery Transmission Format Standard (NITFS).

MIL-STD-188-197A	-	Adaptive Recursive Interpolated Differential Pulse Code Modulation (ARIDPCM) Image Compression for the National Imagery Transmission Format Standard (NITFS).
MIL-STD-188-198A	-	Joint Photographic Experts Group (JPEG) Image Compression for the National Imagery Transmission Format Standard (NITFS).
MIL-STD-2500A	-	National Imagery Transmission Format (NITF) (Version 2.0) for the National Imagery Transmission Format Standard (NITFS).

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Standardization Documents Order Desk, 700 Robbins Avenue, Building #4, Section D, Philadelphia, PA 19111-5094.)

(Copies of Federal Information Processing Standards (FIPS) are available to Department of Defense activities from the Standardization Documents Order Desk, 700 Robbins Avenue, Building #4, Section D, Philadelphia, PA 19111-5094. Others must request copies of FIPS from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161-2171.)

2.1.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified. Unless otherwise specified, the issues are those cited in the solicitation.

DISA/JIEO Circular 9008	-	NITFS Certification Test and Evaluation Plan.
DISA/JIEO SPEC 9137	-	NITF Standard TACO2 Protocol to KY-57/58 Cryptographic Device Technical Interface Specification (TIS).
DISA/JIEO SPEC 9138	-	NITF Standard TACO2 Protocol to KG-84-A/C Cryptographic Device Technical Interface Specification (TIS).
DISA/JIEO SPEC 9139	-	NITF Standard TACO2 Protocol to KY-68 Cryptographic Device Technical Interface Specification (TIS).
DISA/JIEO SPEC 9140	-	NITF Standard TACO2 Protocol to STU-III Cryptographic Device Technical Interface Specification (TIS).

NITF Version 1.1	-	National Imagery Transmission Format (NITF) Version 1.1.

(Copies of DISA/JIEO Circular 9008 may be obtained from DISA/JITC ATTN: GADB Bldg. 57305, Fort Huachuca, AZ 85613-7020. Copies of DISA/JIEO Specifications may be obtained from DISA/JIEO/CFS/TBB, Fort Monmouth, NJ 07703-5613. Copies of NITF Version 1.1 may be obtained from DISA/JIEO/CFS/TBCE, Parkridge III, 10701 Parkridge Blvd., Reston, VA 22091-4398.)

2.2 Non-Government publications. The following document(s) form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DOD adopted are those listed in the issue of the DODISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS are the issues of the documents cited in the solicitation.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI X3.4	-	American Standard Code for Information Interchange (ASCII).

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 7498 - 1983	-	Basic Reference Model for Open Systems Interconnection.

INTERNATIONAL TELEGRAPH AND TELEPHONE CONSULTATIVE COMMITTEE

CCITT Recommendation T.4	-	Standardization of Group 3 Facsimile Apparatus for Document Transmission (Red Book).

Roy Hunter and A. Harry Robinson, "International Digital Facsimile Coding Standards," Proc. IEEE, vol 68, no 7, July 1980, pp. 854-867.

(Non-Government standards and publications are usually available from the organizations that prepare or distribute the documents. These documents also may be available in or through libraries or other informational services.)

2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. DEFINITIONS

3.1 Purpose. The purpose of this glossary is to provide a comprehensive compilation of the technical terms, acronyms, and abbreviations used in NITFS documentation and a limited list of terms commonly used in image processing and communications. In addition, terms used in the NITFS documentation and defined in the FED-STD-1037B shall use the FED-STD-1037B definition unless noted.

3.2 Acronyms. The acronyms used in the NITFS documentation are defined as follows:

a.	AL	Attachment Level
b.	ANSI	American National Standards Institute
c.	AP	Application Profiles
d.	ARIDPCM	Adaptive Recursive Interpolated Differential Pulse Code Modulation
e.	ARQ	Automatic Repeat-Request
f.	ASCII	American Standard Code for Information Interchange
g.	ASD(C^3I)	Assistant Secretary of Defense for C^3I
h.	ASN.1	Abstract Syntax Notation One
i.	AUTODIN	Automatic Digital Network
j.	BAM	Bit Assignment Matrix
k.	BBN	Bolt, Bernek, and Nawman, Inc.
l.	BCH Code	Bose-Chaudhuri-Hocquenghem Code
m.	BEN	Basic Encyclopedia Number
n.	BER	Bit Error Ratio
o.	BERT	Bit Error Ratio Test
p.	BIT	Binary Digit
q.	bpp	bits per pixel
r.	BPS	Bits Per Second

s.	BPSK	Binary Phase Shift Keying
t.	BWC	BandWidth Compression
u.	CAWS	Commercial Analyst Workstation
v.	CCIR	International Radio Consultative Committee
w.	CCITT	International Telegraph and Telephone Consultative Committee
x.	CFS	Center for Standards
y.	CGM	Computer Graphics Metafile
z.	CIO	Central Imagery Office
aa.	CMY	Cyan, Magenta, Yellow
ab.	CMYK	Cyan, Magenta, Yellow and Black
ac.	COMIREX	Committee on Imagery Requirements and Exploitation
ad.	COMRAT	Compression Rate Code
ae.	COMSEC	Communications Security
af.	CRC	Cyclic Redundancy Check
ag.	CRT	Cathode Ray Tube
ah.	CTE	Certification Test and Evaluation
ai.	C^3I	Command, Control, Communications, and Intelligence
aj.	DAMA	Demand Assignment Multiple Access
ak.	DCE	Data Circuit - terminating Equipment
al.	DCPS	Data Communications Protocol Standards
am.	DCT	Discrete Cosine Transform
an.	DDN	Defense Data Network (now DISN)
ao.	DES	Data Extension Segment

ap .	DIA	Defense Intelligence Agency
aq.	DIAM	Defense Intelligence Agency Manual
ar.	DISA	Defense Information Systems Agency
as.	DISN	Defense Information Systems Network (formerly DDN)
at.	DL	Display Level
au.	DLED	Dedicated Loop Encryption Device (KG-84)
av.	DMA	(1) Direct Memory Access (2) Defense Mapping Agency
aw.	DOD	Department of Defense
ax.	DODISS	Department of Defense Index Specifications and Standards
ay.	DPCM	Differential Pulse Code Modulation
az.	DSPO	Defense Support Project Office
ba.	DSVT	Digital Subscriber Voice Terminal (KY-68)
bb.	DTE	Data Terminal Equipment
bc.	EBCDIC	Extended Binary Coded Decimal Interchange Code
bd.	ECC	Error-Correcting Code
be.	EDAC	Error Detection and Correction
bf.	EIA	Electronic Industries Association
bg.	EOL	End of Line
bh.	FCS	Frame Check Sequence
bi.	FDCT	Forward Discrete Cosine Transform
bj.	FEC	Forward Error Correction
bk.	FIPS	Federal Information Processing Standard
bl.	FTP	File Transfer Protocol

bm.	GOSIP	Government Open Systems Interconnection Profile
bn.	HD	Half-Duplex
bo.	HDLC	High-level Data Link Control
bp.	HF	High Frequency
bq.	Hz	Hertz
br.	IBM	International Business Machine
bs.	IC	(1) Intelligence Community (2) Image Compression
bt.	ICMP	Internet Control Message Protocol
bu.	IDCT	Inverse Discrete Cosine Transform
bv.	IEEE	Institute of Electrical and Electronic Engineers
bw.	IHL	Internet Header Length
bx.	INCA	Intelligence Communications Architecture Project Office
by.	IP	Internet Protocol
bz.	ISO	International Organization for Standardization
ca.	ITS	Information Technology Standards
cb.	ITU	International Telecommunication Union
cc.	JANAP	Joint Army-Navy-Air Force Publication
cd.	JIEO	Joint Interoperability and Engineering Organization
ce.	JINTACCS	Joint Interoperability Tactical Command and Control System (now USMTF)
cf.	JITC	Joint Interoperability Test Center
cg.	JPEG	Joint Photgraphic Experts Group
ch.	JTC^{3}A	Joint Tactical Command, Control, and Communications Agency

ci.	kHz	kiloHertz (1000 Hz)
cj.	LOS	Line of Sight
ck.	LSB	Least Significant Bit
cl.	LUT	Look-Up Table
cm.	MBZ	Must Be Zero
cn.	MCU	Minimum Coded Unit
co.	MHz	MegaHertz
cp.	MOA	Memoranda of Agreement
cq.	MSB	Most Significant Bit
cr.	MSE	Mobile Subscriber Equipment
cs.	msec	Milliseconds
ct.	MTF	Message Text Format
cu.	MXF	Message Transfer Facility
cv.	NAK	Negative-Acknowledgement Character
cw.	NATO	North Atlantic Treaty Organization
cx.	NBPC	Number of Bits Per Column
cy.	NBPP	Number of Bits Per Pixel
cz.	NBPR	Number of Bits Per Row
da.	NCCB	National Imagery Transmission Format Standard Configuration Control Board
db.	NETBLT	Network Block Transfer
dc.	NITF	National Imagery Transmission Format
dd.	NITFS	National Imagery Transmission Format Standard
de.	NITFTP	National Imagery Transmission Format Transfer Protocol

df.	NPI	Non-static Presentation Information
dg.	NRTS	National Imagery Transmission Format Reliable Transfer Server
dh.	NTB	National Imagery Transmission Format Standard Technical Board
di.	NTSC	National Television Standards Committee
dj.	NUMI	Number of Images
dk.	OADR	Originating Agency's Determination is Required
dl.	OASD(C^3I)	Office of the Assistant Secretary of Defense for Command, Control, Communications and Intelligence
dm.	OSD(C^3I)	Office of the Secretary of Defense for Command, Communications, Control and Intelligence
dn.	OSE	Open Systems Environment
do.	OSI	Open Systems Interconnection
dp.	PCM	Pulse-Code Modulation
dq.	RFC	(1) Request for Comment (Internet environment) (2) Request for Change (NITFS environment)
dr.	RGB	Red, Green, Blue
ds.	RR	Reduced Resolution
dt.	RRDS	Reduced Resolution Data Set
du.	RQ	Repeat-Request
dv.	RS	(1) Recommended Specification (2) Requirement Submission
dw.	RTC	Return to Control
dx.	SID	Secondary Imagery Dissemination
dy.	SIDS	Secondary Imagery Dissemination System
dz.	SLIP	Serial Line Internet Protocol

ea.	STANAG	NATO Standardization Agreement
eb.	TACO2	Tactical Communications Protocol 2
ec.	TBR	To Be Resolved
ed.	TCF	Technical Control Facility
ee.	TCP	Transmission Control Protocol
ef.	TDM	Time Division Multiplexing
eg.	TIS	Technical Interface Specification
eh.	TRI-TAC	Tri-Service Tactical Communications
ei.	UDHD	User Defined Data field
ej.	UDID	User Defined Image Data field
ek.	UDP	User Datagram Protocol
el.	UHF	Ultra High Frequency
em.	UI	Unnumbered Information
en.	UID	Unique Identifier
eo.	UN	United Nations
ep.	USMTF	United States Message Text Format (formerly JINTACCS)
eq.	VDC	(1) Virtual Device Coordinates (2) Virtual Display Coordinates
er.	VHF	Very High Frequency
es.	VHSIC	Very High Speed Integrated Circuit
et.	VMF	(1) Variable Message Format (2) Voice Message Format
eu.	VQ	Vector Quantization
ev.	XHD	Extended Header Data

ew.	YCbCr	Y = Brightness of signal, Cb = Chrominance (blue), Cr = Chrominance (red)
ex.	YCM	Yellow, Cyan, Magenta
ey.	YIQ	Intensity, Inphase, Quadrature

3.3 Definition of terms. The definitions used in the NITFS documentation are defined as follows:

a. Abbreviated format - A representation of compressed image data that is missing some or all of the table specifications required for decoding.

b. AC coefficient - Any Discrete Cosine Transform (DCT) coefficient for which the frequency is not zero in at least one dimension.

c. Address - 1. In communications, the coded representation of the source or destination of a message. 2. In data processing, a character or group of characters that identifies a register, a particular part of storage, or some other data source or destination. 3. To assign to a device or item of data a label to identify its location. 4. The part of a selection signal that indicates the destination of a call. 5. To refer to a device or data item by its address.

d. Aliasing - An undesirable phenomenon that generates artifacts when a signal is sampled at less than twice the rate of the highest frequency contained in the signal.

e. Alphanumeric - For the purpose of MIL-STD-2500A, fields that may contain any printable American Standard Code for Information Interchange (ASCII) characters (including punctuation marks) are indicated as "Alphanumeric" in the Value Range specification. The reader is warned that this is a nonstandard use of the term. The allowable range of values for numeric fields typically is indicated in the form N-M, where N and M are the minimum and maximum values, respectively.

f. American Standard Code for Information Interchange (ASCII) - The standard code, using a coded character set consisting of 7-bit coded characters (8 bits including parity check), used for information interchange among data processing systems, data communications systems, and associated equipment.

g. Arithmetic decoder - An embodiment of an arithmetic decoding procedure.

h. Arithmetic decoding - An entropy decoding procedure that recovers the sequence of symbols from the sequence of bits produced by the arithmetic encoder.

i. Arithmetic encoder - An embodiment of an arithmetic encoding procedure.

j. Arithmetic encoding - An entropy encoding procedure that codes by means of a recursive subdivision of the probability of the sequence of symbols coded up to that point.

k. Asynchronous transmission - Data transmission in which the instant that each character, or block of characters, starts is arbitrary; once started, the time of occurrence of each signal representing a bit within the character, or block, has the same relationship to significant instants of a fixed time frame.

l. Automatic repeat-request - A system of error control for data transmission in which the receive terminal is arranged to detect a transmission error and automatically transmit a repeat-request (RQ) signal to the transmit terminal. The transmit terminal then retransmits the character, code block, or message until it is either correctly received or the error persists beyond a predetermined number of transmittals.

m. Band - For the purpose of NITFS, used interchangeably with component. (See component.)

n. Bandwidth - 1. The difference between the limiting frequencies within which performance of a device, in respect to some characteristic, falls within specified limits. 2. The difference between the limiting frequencies of a continuous frequency band.

o. Baseband signal - 1. The spectral band occupied by an unmodulated signal. Note: Baseband transmission is usually characterized by being much lower in frequency than the signal that results if the baseband signal is used to modulate a carrier or subcarrier. 2. In facsimile, the frequency of a signal equal in width to between zero frequency and maximum keying frequency.

p. Baseline (sequential) - A particular sequential DCT-based encoding and decoding process specified in this standard; required for all DCT-based decoding processes.

q. Baud - 1. A unit of modulation rate. One baud corresponds to a rate of one unit interval per second, where the modulation rate is expressed as the reciprocal of the duration in seconds of the shortest unit interval. 2. A unit of signaling speed equal to the number of discrete signal conditions, variations, or events per second. Note: If the duration of the unit interval is 20 milliseconds, the signaling speed is 50 baud. If the signal transmitted during each unit interval can take on any one of M discrete states, the bit rate is equal to the rate in baud times $\log_2 M$. The technique used to encode the allowable signal states may be any combination of amplitude, frequency, or phase modulation, but it cannot use a further time-division multiplexing technique to subdivide the unit intervals into multiple subintervals. In some signaling systems, non-information-carrying signals may be inserted to facilitate synchronization; for example, in certain forms of binary modulation coding, there is a forced inversion of the signal state at the center of the bit interval. In these cases, the synchronization signals are included in the calculation of the rate in baud, but not in the computation of bit rate.

r. Bi-level image - Image information where each pixel is represented with one bit.

s. Bi-level overlay - A separate layer of graphical or textual information represented by one bit-per-pixel. This generally accompanies a separate layer of image information.

t. Binary Phase Shift Keying (BPSK) - A type of modulation characterized is a sine wave which has one of two distinct phase values over each data interval.

u. Bit - Acronym for binary digit. (value of 0 or 1)

v. Bit Error Ratio (BER) - The number of erroneous bits divided by the total number of bits transmitted, received, or processed over some stipulated period of time. Note: Two examples of bit error ratio are: (a) transmission BER--the number of erroneous bits received divided by the total number of bits transmitted; and (b) information BER--the number of erroneous decoded (corrected) bits divided by the total number of decoded (corrected) bits. The BER is usually expressed as a number and a power of 10; e.g., 2.5 erroneous bits out of 100,000 bits transmitted would be 2.5 in 10^5 or 2.5 x 10^{-5}.

w. Bit Error Ratio Test (BERT) - A function or sequence of functions that compares a received data pattern with a known transmitted pattern to determine the level of transmission quality. Note: Can be used as an adjective, for example, "Bit error ratio test packets" are packets used in a bit error ratio test.

x. Bit-mapped display - A type of memory mapped video where every pixel on the screen has one or more corresponding bits in memory.

y. Bit plane - A one-bit image constructed from the nth bit of each pixel in an image.

z. Bit rate - In a bit stream, the number of bits occurring per unit time, usually expressed as bits-per-second (BPS). Note: For M-ary operations, the bit rate is equal to $\log_2 M$ times the rate (in baud), where M is the number of significant conditions in the signal.

aa. Bit stream - A bit-stream is a sequence of binary digits. The term is principally used to describe data that is being moved internally within a computer, or being transferred between computers. For the purpose of MIL-STD-188-198A, Joint Photographic Experts Group (JPEG), a bit stream is defined as a partially encoded or decoded sequence of bits comprising an entropy-coded segment.

ab. Bit-stuffing - For NITFS, in High-level Data Link Control (HDLC), a technique used to avoid spurious appearances of the flag within a frame.

ac. Bits Per Second (BPS) - The number of bits passing a designated point in a system per second. Note 1: Values of data signaling rate in baud and in bits per second are numerically the same if, and only if, all of the three following conditions are met: (a) All pulses (bits) are of the same length; (b) all pulses (bits) are equal to the unit interval, the time element between the corresponding two significant instants of adjacent pulses; (c) binary operation is used. Note 2: In M-ary operation, bps equals modulation rate in baud multiplied by the logarithm to the base 2 of M, where M is the number of significant conditions in the signal.

ad. Block - For the purpose of MIL-STD-2500A, a block is a rectangular array of pixels. An image consists of the union of one or more nonoverlapping blocks. (Synonymous with tile.)

ae. Block-row - A sequence of eight contiguous component lines that are partitioned into 8x8 blocks.

af. Blocked Image Mask - A structure which identifies the blocks in a blocked (tiled) image which contain no valid data, and which are not recorded/transmitted. The structure allows the receiver to recognize the recorded/transmitted order of the valid image blocks, and provides an offset for each recorded/transmitted block. For example, a 2 x 2 blocked image which contained no valid data in the second block (block 1) would be recorded/transmitted in the order: block 0, block 2, block 3. The blocked image mask would identify block 1 as a non-recorded/non-transmitted block, and would allow the receiving application to construct the image in the correct order.

ag. Bose-Chaudhuri-Hocquenchem (BCH) Codes - An important class of binary, block forward error correction (FEC) codes. BCH Codes offer a great deal of flexibility in terms of code rate and block length. Hamming codes may be thought of as single error-correcting BCH Codes.

ah. Briefing board - A briefing aid that includes an exploited, annotated hardcopy image and other textual and/or graphical material that presents significant intelligence information.

ai. Brightness - An attribute of visual perception, in accordance with which a source appears to emit more or less light. Note 1: Usage should be restricted to nonquantitative reference to physiological sensations and perceptions of light. Note 2: "Brightness" was formerly used as a synonym for the photometric term "luminance" and (incorrectly) for the radiometric term "radiance." For the purpose of NITFS, larger pixel values represent higher intensity, and lower pixel values represent lower intensity levels.

aj. Broadband - (synonym of wideband) 1. An imprecise designation of a signal that occupies a broad frequency spectrum. Note: This term is often used to distinguish it from a narrowband signal, where both terms are subjectively defined relative to the implied context. 2. That property of any circuit having a bandwidth wider than normal for the type of circuit, frequency of operation, and type of modulation carried. Note: The term has many meanings depending upon application. At audio/telephone frequencies, a bandwidth exceeding 4 KiloHertz (kHz) would be considered wideband. At High Frequency (HF) (3-30 MHz) radio frequencies, a bandwidth larger than 3 kHz would be considered wideband. In communications security systems, any bandwidth exceeding that of a nominal 4 kHz telephone channel is considered wideband. 3. That property of any communication facility, equipment, channel, or system in which the transmitted bandwidth is greater than 0.1 percent of the midband frequency. 4. In commercial telephone usage, that property of a circuit having a bandwidth greater than 4 kHz.

ak. Broadcast operation - The transmission of information so that it may be simultaneously received by stations that usually make no acknowledgement.

al. Buffer - 1. A routine or storage used to compensate for a difference in rate of flow of data, or time of occurrence of events, when transferring data from one device to another. Note: Buffers are used for many purposes such as: (a) interconnecting two digital circuits operating at different rates, (b) holding data for use at a later time, (c) allowing timing corrections to be made on a data stream, (d) collecting binary data bits into groups that can then be operated on as a unit, (e)

delaying the transit time of a signal to allow other operations to occur. 2. To allocate and schedule the use of buffers. 3. An isolating circuit used to prevent a driven circuit from influencing the driving circuit. 4. In an optical fiber cable, a component used to encapsulate an optical fiber, thus providing mechanical isolation and/or protection from physical damage. Note: Cable fabrication techniques vary, some resulting in firm contact between fiber and protective buffering, others resulting in a loose fit, permitting the fiber to slide in the buffer tube. Multiple buffer layers may be used for added fiber protection.

am. Busyness codes - A code associated with the Adaptive Recursive Interpolated Differential Pulse Code Modulation (ARIDPCM) image compression algorithm corresponding to the dynamic range of an 8x8 pixel neighborhood.

an. Byte - A sequence of N adjacent binary digits, usually treated as a unit, where N is a nonzero integral number. Note: In pre-1970 literature, "byte" referred to a variable length field. Since that time the usage has changed so that now it almost always refers to an eight-bit field. This usage predominates in computer and data transmission literature; when so used, the term is synonymous with "octet." For the purpose of MIL-STD-188-198A (JPEG), a byte is defined as an eight-bit octet.

ao. Byte stuffing - A procedure in which either the Huffman coder or the arithmetic coder inserts a zero byte into the entropy-coded segment following the generation of an encoded hexadecimal 0xFF byte. For the purpose of NITFS, in Serial Line Internet Protocol (SLIP), a technique used to avoid spurious appearances of the END character within a frame.

ap. C1 - The code used to indicate the Bi-level compression algorithm in the image compression (IC) field of the image subheader.

aq. C2 - The code used to indicate the ARIDPCM compression algorithm in the image compression (IC) field of the image subheader.

ar. C3 - The code used to indicate the JPEG compression algorithm in the image compression (IC) field of the image subheader.

as. C4 - The code used to indicate the Vector Quantization compression algorithm in the image compression (IC) field of the image subheader.

at. Cartesian coordinate system - The image pixel coordinate system used in the NITFS shall be the Cartesian coordinate system with origin (0,0) defined by rows and columns, positive right and down as the image is viewed. The positive row axis (r) is in the direction from the top to the bottom, down the raster scan. The positive column axis (c) is in the direction from the left to the right, along the raster scan direction. Image coordinates shall be given as an ordered pair (r,c) where the first number, r, indicates the row and the second number, c, indicates the column of the pixel.

au. CCITT group 3 - Bi-level image encoding, one- and two-dimensional, as defined in CCITT Recommendation T.4.

av. CCITT X.25 - Interface between data terminal equipment (DTE) and data circuit-terminating (DCE) for circuits operating in the Packet Mode on Public Data Networks, 1980.

aw. Character - 1. A letter, digit, or other symbol that is used as part of the organization, control, or representation of data. 2. One of the units of an alphabet. Note: For MIL-STD-2301, a character (ANSI 3.4-1986 7-bit ASCII code padded into 8-bits) is an unsigned integer between and including 32 and 126 and is specified in this document using the character array C1, C2, ... Cn.

ax. Chromaticity - Property of a color stimulus defined by its chromacity coordinates (for NITFS, use YCbCr601 chromaticity coordinates).

ay. Chrominance - 1. Perceptual color attribute consisting of the hue and saturation of a color. 2. The difference determined by quantitative measurement between a color and a chosen reference color of the same luminous intensity, the reference color having a specified color quality. 3. The quality of the color without reference to brightness.

az. Class (of coding process) - Lossy or lossless coding processes.

ba. Client - An executing program or protocol layer that requests or receives services from a lower protocol layer.

bb. Coding model - A procedure used to convert input data into symbols to be coded.

bc. Coding process - A general term for referring to an encoding process, a decoding process, or both.

bd. Color image - A continuous-tone image that has more than one colorimetry component.

be. Columns - Samples per line in a component.

bf. Commands - For MIL-STD-2301, commands are CGM statements that denote a state to act upon when CGM is read sequentially. The words "command" and "element" are used synonymously throughout MIL-STD-2301.

bg. Component - For the NITFS, one of the two-dimensional arrays that comprise an image. Used interchangeably with band.

bh. Compressed data - Either compressed image data, or table specification data, or both.

bi. Compressed image data - A coded representation of an image, as specified in MIL-STD-188-198A (JPEG).

bj. Compression - For the NITFS, reduction in the number of bits used to represent source image data.

bk Compression rate - The bit representation of the compressed image in bits per pixel.

bl. Compression ratio - The ratio of the original number of bits of data in a block of data to the final number of bits after a process that reduces the number of bits required to convey the required information.

bm. Computer Graphics Metafile - Computer Graphics Metafile (CGM) is a set of basic elements for a computer graphics data interface usable by many graphics-producing systems and applications.

bn. Compression Rate Code (COMRAT) - The compression rate code field in the NITF image subheader used to indicate the quantization matrices used.

bo. Conditional - In the context of NITF, a data field whose existence depends on the value used in a previous field.

bp. Continuous-tone image - An image whose components have more than one bit per sample.

bq. Criticality - Those portions of a message which must be received correctly for the message for be useful are considered critical. Criticality provides a means for identifying those portions of a message.

br. Cyclic Redundancy Check (CRC) - A type of error-detecting scheme that uses parity bits generated by polynomial encoding and decoding algorithms to detect transit-generated errors. Note: Error correcting, when required, is usually accomplished through the use of an Automatic Repeat-Request (ARQ) system.

bs. Data - Representation of facts, concepts, or instructions in a formalized manner suitable for communication, interpretation, or processing by humans or by automatic means. Any representations such as characters or analog quantities to which meaning is or might be assigned.

bt. Datagram - In packet-switching, a self-contained packet, independent of other packets, that carries information sufficient for routing from the originating data terminal equipment to the destination data terminal equipment, without relying on earlier exchanges between the equipment and the network. Note: Unlike virtual call service, there are no call establishment or clearing procedures, and the network does not generally provide protection against loss, duplication, or misdelivery.

bu. Data Circuit-terminating Equipment (DCE) - In a data station, the equipment that provides a signal conversion, coding, and other functions at the network end of the line between the data terminal equipment and the line, and that may be a separate or an integral part of the data terminal equipment or of the intermediate equipment.

bv. Data communication - The transfer of information between functional units by means of data transmission according to a protocol.

bw. Data interface - Refers to the communications interface required for a terminal device to operate properly over a communications channel.

bx. Data link layer - Layer two in the ISO OSI Reference Model. The role of the data link layer is to group the bits of the physical layer into frames, and to deal with transmission errors to allow the sending of frames between adjacent nodes in the network.

by. Data Terminal Equipment (DTE) - 1. Digital end instrument that convert the user information into data signals for transmission, or reconvert the received data signals into user information. 2. The functional unit of a data station that serves as a data source or a data sink and provides for the data communication control function to be performed in accordance with link protocol. Note: The DTE may consist of a single piece of equipment that provides all the required functions necessary to permit the user to intercommunicate, or it may be an interconnected subsystem of multiple pieces of equipment, to perform all the required functions.

bz. Data transfer rate - The average number of bits, characters, or blocks per unit time passing between corresponding equipment in a data transfer system.

ca. Data unit - A block in DCT-based processes; a sample in lossless processes.

cb. DC coefficient - The DC coefficient for which the frequency is zero in both dimensions. Note: The DC coefficient (in the context of JPEG compression) is a measure of the average value of the 64 image samples within an 8x8 block. Because of the usually strong correlation between the DC coefficients of adjacent blocks, the DC coefficients can be very efficiently encoded, and are treated separately from the encoding of the AC coefficients.

cc. DC prediction - The procedure used by DCT-based encoders whereby the quantized DC coefficient from the previously encoded 8x8 block of the same component is subtracted from the current quantized DC coefficient.

cd. DCT coefficient - The amplitude of a specific cosine basis function. Note: The Discrete Cosine Transform changes the representation of an image from a set of numbers representing the brightness of each pixel to another set of numbers that can be used to reconstruct the image mathematically. The process is similar to synthesizing music electronically from separate tones. In this case the "tones" are cosine basis functions, each of which have the properties of amplitude and frequency; but instead of referring to amplitude and frequency as a function of time, these properties relate to each of the two principal directions across the image. For this reason, the term spatial frequency is often used to emphasize that the process involves direction rather than time. The coefficients in the DCT matrix are the amplitudes of these basis functions. There is always one basis function with a zero frequency in both directions. In simple terms, "zero frequency" implies a constant, and the coefficient of this wave is labeled DC. All other coefficients have at least one non-zero directional component, and are labeled AC. The terms DC and AC are analogous to the zero-frequency (DC) and non-zero frequency (AC) components in electrical circuits.

ce. Decoder - An embodiment of a decoding process.

cf. Decoding process - For the NITFS, a process that takes compressed image data as its inputs and outputs a continuous-tone image.

cg. Defense Information Systems Network (DISN) - The Department of Defense integrated packet switching network capable of worldwide multilevel secure and non-secure data transmission.

ch. Delimiter - A bit pattern or character marking the beginning or end of a unit of data.

ci. Dequantization - The inverse procedure to quantization by which the decoder recovers a representation of the DCT coefficients.

cj. Differential Pulse Code Modulation (DPCM) - A version of pulse-code modulation in which an analog signal is sampled, and the difference between the actual value of each sample and its predicted value (derived from the previous sample or samples) is quantized and is converted by encoding to a digital signal. Note: There are several variations on differential pulse-code modulation.

ck. (Digital) reconstructed image (data) - A continuous-tone image that is the output of any decoder defined in MIL-STD-188-198A (JPEG).

cl. (Digital) source image (data) - A continuous-tone image used as input to any encoder defined in MIL-STD-188-198A (JPEG).

cm. (Digital) (still) image - A set of two-dimensional arrays of data.

cn. Discrete Cosine Transform (DCT) - Either the forward discrete cosine transform or the inverse discrete cosine transform.

co. Direct Memory Access (DMA) - A common form of memory-mapped video. A kind of device controller that allows the transfer of data to and from the memory at very high speeds.

cp. Duplex - For the purpose of MIL-STD-2045-44500 (TACO2), an operational mode in which frames may be transferred across a link in both directions.

cq. Effectivity - Some of the capabilities specified in this document are not required as of the issue date of the document. All such capabilities are marked with effectivity numbers, e.g., (Effectivity 1). Each effectivity number will be replaced by a specific date in subsequent releases of this document.

cr. Electronic imagery dissemination - The transmission of imagery or imagery products by any electronic means.

cs. Element - For MIL-STD-2301, elements are CGM statements that denote a state to act upon when the CGM is sequentially read. The words "command" and "element" are synonymously used in MIL-STD-2301.

ct. Embedded FEC - For MIL-STD-2045-44500 (TACO2), FEC is an element of a hardware unit with more general functionality.

cu. Encoder - An embodiment of an encoding process.

cv. Encoding process - A process that takes as its input a continuous-tone image and outputs compressed image data.

cw. Entropy - The lower bound on the number of bits required to encode the output of a source (of information).

cx. Entropy-coded (data) segment - An independently decodable sequence of entropy encoded bytes of compressed image data.

cy. Entropy decoder - A device that processes an encoded data stream to extract the original symbols with no loss of information. The device may be implemented in hardware or software.

cz. Entropy encoding - A lossless procedure that converts a sequence of input symbols into a sequence of bits so that the average number of bits-per-symbol approaches the entropy of the input symbols.

da. Error-Correcting Code (ECC) - A code in which each telegraph or data signal conforms to specific rules of construction so that departures from this construction in the received signals can generally be automatically detected and corrected. If the number of errors is not greater than the maximum correctable threshold of the code, then all errors are corrected. Note 1: Such codes require more signal elements than are necessary to convey the basic information. Note 2: The two main classes of error-correction codes are block codes and convolutional codes.

db. Error Detection and Correction (EDAC) - The application of one or several methods for the detection and correction of errors in a bit stream. For the purpose of MIL-STD-2045-44500 (TACO2), the term EDAC generally is used synonymously with FEC, but is sometimes used to refer to error control systems that make use of a backward channel (for example, retransmission requests).

dc. Extended Binary Coded Decimal Interchange Code (EBCDIC) - An 8-bit alphanumeric coded character set. (Developed and used by International Business Machines (IBM) mainframe computers.)

dd. Extended (DCT-based) process - A descriptive term for DCT-based encoding and decoding processes in which additional capabilities are added to the baseline sequential process.

de. Facsimile - 1. A form of telegraphy for the transmission of fixed images, with or without half-tones, with a view to their reproduction in a permanent form. In this definition the term telegraphy has the same general meaning as defined in the Convention. (RR) 2. A system of telecommunication for the transmission of fixed images with a view to their reception in a permanent form. (JCSI-DOD) (JCSI-NATO) 3. The process, or the result of the process, by which fixed graphic

material, including pictures or images, is scanned and the information converted into electrical signals that may be transmitted over a telecommunication system and used to record a copy of the original. Note 1: Wirephoto and telephoto are facsimile via wire circuits; radiophoto is facsimile via radio. Note 2: Current facsimile systems are designated and defined as follows: (a) group 1 facsimile: A mode of black/white facsimile operation as defined in CCITT Recommendation T.2, which uses double sideband modulation without any special measures to compress the bandwidth. Note 1: A 216x279 mm document (8 1/2 x 11 inches) may be transmitted in approximately 6 minutes via a telephone-type circuit. Additional modes in this group may be designed to operate at a lower resolution suitable for the transmission of documents 216 x 279 mm in a time between 3 and 6 minutes. Note 2: The CCITT frequencies used are 1300 Hz for white and 2300 Hz for black. The North American standard is 1500 Hz for white and either 2300 or 2400 Hz for black. (b) group 2 facsimile: A mode of black/white facsimile operation as defined in CCITT Recommendation T.3, which accomplishes bandwidth compression by using encoding and vestigial sideband, but excludes processing of the document signal to reduce redundancy. Note: A 216 x 279 mm document (8 1/2 x 11 inches) may be transmitted in approximately 3 minutes using a 2100-Hz AM/PM/VSB, over a telephone-type circuit. (c) group 3 facsimile: A mode of black/white facsimile operation as defined in CCITT Recommendation T.4, which incorporates means for reducing the redundant information in the document signal using a one-dimensional run-length coding scheme prior to the modulation process. Note 1: A 216 x 279 mm document (8 1/2 x 11 inches) may be transmitted in approximately 1 minute or less over a telephone-type circuit with twice the group 2 horizontal resolution; vertical resolution may also be doubled. Note 2: Group 3 machines have integral digital modems. Note 3: An optional two-dimensional bandwidth compression scheme also is defined within the group 3 facsimile specification. (d) group 4 facsimile: A mode of black/white facsimile operation as defined in CCITT Recommendations T.5 and T.6. Note: Uses bandwidth compression techniques to transmit an essentially error-free 216 x 179 mm (8 1/2 x 11 inches) document at a nominal resolution of eight lines/mm in less than 1 minute over a public data network voice-grade circuit.

df. File Transfer Protocol (FTP) - A protocol for transferring files from one system to another.

dg. Fill - In NITFS context, optional data inserted at the end of a coded image line. Fill is designated by inserting a variable length of zeroes.

dh. Flag - In data transmission, an indicator, such as a signal, symbol, character, or digit, used for identification. Note: An example is a word mark, a group mark, or letter that signals the occurrence of some condition or event such as the end of a word or block.

di. Forward Discrete Cosine Transform (FDCT) - A mathematical transformation using cosine-based functions that convert a block of samples into a corresponding array of basis function amplitudes.

dj. Forward Error Correction (FEC) - A system of error control for data code transmission wherein the receiving device has the capability to detect and correct any character or block that contains fewer than a predetermined number of symbols in error. Note: FEC is accomplished by adding bits to each transmitted character or code block using a predetermined algorithm.

dk. Frame - 1. For the MIL-STD-2045-44500 (TACO2), in data transmission, a sequence of contiguous bits bracketed by and including uniquely recognizable delimiters. 2. For the MIL-STD-188-198A (JPEG), a group of one or more scans (all using the same DCT-based or lossless process) through the data of one or more of an image.

dl. Frame Check Sequence (FCS) - An error detection technique based on modular addition. Also a check value derived by using this technique.

dm. Frame header - The start-of-frame marker and frame parameters coded at the beginning of a frame.

dn. Frequency - For the MIL-STD-188-198A (JPEG), a two-dimensional index into the two-dimensional array of DCT coefficients.

do. Full-duplex - For the MIL-STD-2045-44500 (TACO2), an operational mode in which packets may be transferred simultaneously across a link in both directions.

dp. Galois field - An algebraic structure commonly used for error correction and cryptographics calculations. A Galois field is a field whose set of elements is finite. The field operations of addition, subtraction, multiplication, and division are defined.

dq. Geocentric latitude - The angle between the equatorial plane and the radius from the geocenter.

dr. Geodetic latitude - The angle between the equatorial plane and the normal to the surface of the ellipsoid.

ds. Gray scale - An optical pattern consisting of discrete steps or shades of gray between black and white.

dt. Half-Duplex (HD) circuit - A circuit that affords communication in either direction but only in one direction at a time. Note: If the transmission direction is reversed sufficiently rapidly, a half-duplex circuit can effectively simulate full-duplex operation.

du. Hierarchical - A mode of operation for coding an image in which the first frame for a given component is followed by frames that code the differences between the source data and the reconstructed data from the previous frame for that component. Resolution changes are allowed between frames.

dv. Hierarchical decoder - A sequence of decoder processes in which the first frame for each component is followed by frames that decode an array of differences for each component and adds it to the reconstructed data from the preceding frame for that component.

dw. Hierarchical encoder - The mode of operation in which the first frame for each component is followed by frame that encode the array of differences between the source data and the reconstructed data from the preceding frame for that component.

dx. Huffman decoder - An embodiment of a Huffman decoding procedure.

dy. Huffman decoding - An entropy decoding procedure that recovers the symbol from each variable length code produced by the Huffman encoder.

dz. Huffman encoder - An embodiment of a Huffman encoding procedure.

ea. Huffman encoding - An entropy encoding procedure that assigns a variable length code to each input symbol.

eb. Huffman table - The set of variable length codes required in a Huffman encoder and Huffman decoder.

ec. IC - The Image Compression field of the NITF image subheader.

ed. Image data - Either source image data or reconstructed image data.

ee. Imagery analyst brief - A briefing board with accompanying text.

ef. IMODE - A field in the NITF image subheader used to indicate whether the image bands are transmitted sequentially or interleaved (by block or pixel).

eg. Integer parameters - For MIL-STD-2301, all integer parameters are 16-bit two's complement signed integers except where specified. Each 16-bit word is numbered from most significant bit to least significant bit using 15 to zero (as illustrated on figure 1). When a 16-bit two's complement integer is used as a parameter in a CGM metafile, the high order byte of the integer is represented as the 8 most significant bits; that is, bits 15 through 8. Bits 7 through zero represent the low order byte of the integer. Note: This is also known as the "Big-Endian" or "Network Byte Order" representation for 16-bit integers.

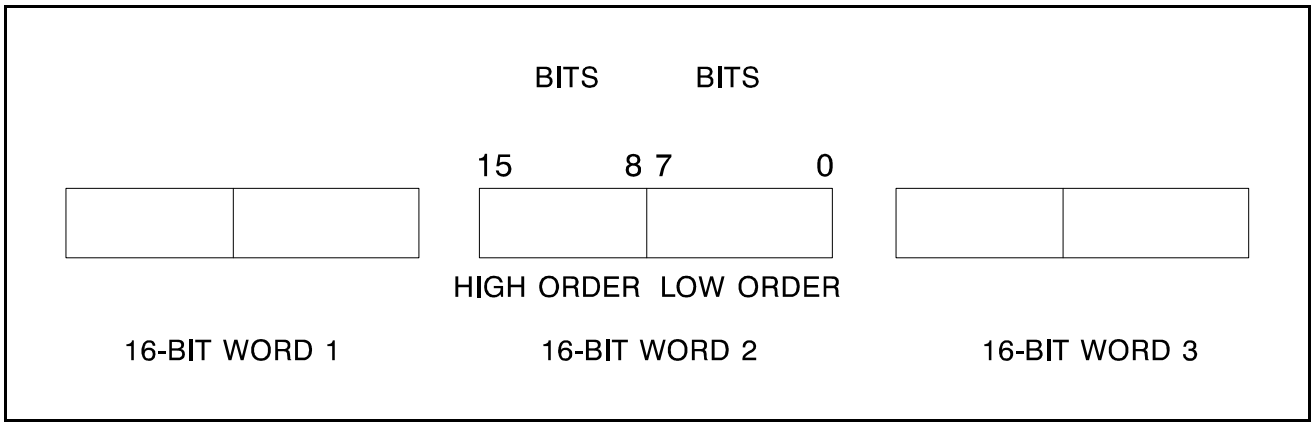

FIGURE 1. Integer parameters.

eh. Interchange format - The representation of compressed image data for exchange between application environments.

ei. Interface - 1. A concept involving the definition of the interconnection between two equipment items or systems. The definition includes the type, quantity, and function of the interconnecting circuits and the type, form, and content of signals to be interchanged via those circuits. Mechanical details of plugs, sockets, and pin numbers, etc., may be included within the context of the definition. 2. A shared boundary, e.g., the boundary between two subsystems or two devices. 3. A boundary or point common to two or more similar or dissimilar command and control systems, subsystems, or other entities against which or at which necessary information flow takes place. 4. A boundary or point common to two or more systems or other entities across which useful information flow takes place. (It is implied that useful information flow requires the definition of the interconnection of the systems which enables them to interoperate.) 5. The process of interrelating two or more dissimilar circuits or systems 6. The point of interconnection between user terminal equipment and commercial communication-service facilities.

ej. Interlace - A system for displaying images on a Cathode Ray Tube (CRT). First the odd lines are sent, then the even lines are sent.

ek. Interleaved - The descriptive term applied to the repetitive multiplexing of small groups of data units from each component in a scan in a specific order.

el. International Organization for Standardization - A global standards body.

em. ISO OSI Reference Model - A seven-layer protocol stack defined by the ISO.

en. International Telecommunication Union (ITU) - A civil international organization established to promote standardized telecommunication on a worldwide basis. Note: The CCIR and CCITT are committees under the ITU. The ITU headquarters is located in Geneva, Switzerland. While older than the United Nations (UN), it is recognized by the UN as the specialized agency for telecommunications.

eo. Interoperability - 1. The ability of systems, units, or forces to provide services to and accept services from other systems, units, or forces and to use the services so exchanged to enable them to operate effectively together. 2. The condition achieved among communications-electronics systems or items of communications-electronics equipment when information or services can be exchanged directly and satisfactorily between them and/or their users. The degree of interoperability should be defined when referring to specific cases. 3. The ability to exchange data in a prescribed manner and the processing of such data to extract intelligible information which can be used to control/coordinate operations.

ep. Inverse Discrete Cosine Transform (IDCT) - A mathematical transformation using cosine base functions that convert an array of basis function amplitudes into a corresponding block of samples.

eq. IREP - A field in the NITF image subheader used to indicate the color space (for example, YCbCr601) for compression.

er. IRIPBAND - A field in the NITF image subheader used to identify a component of the color space (for example, Y or Cb or Cr).

es. Keepalive - A signal whose purpose is to inform a process that a connection is still in operation.

et. Layer - 1. In radio-wave propagation, a stratum in the ionosphere in which the variation of free electron density with height attains a maximum value or has some other specified characteristic. 2. One of the units into which a telecommunication network architecture may be partitioned.

eu. Level shift - A procedure used by DCT-based encoders and decoders, whereby each input sample either is converted from an unsigned representation to a two's complement representation or from a two's complement representation to an unsigned representation.

ev. Look-Up Table (LUT) - A table where each data value of a pixel corresponds to an entry in the table.

ew. Lossless - A descriptive term for encoding and decoding processes and procedures in which the output of the decoding procedure(s) is identical to the input to the encoding procedure(s).

ex. Lossless coding - The mode of operation that refers to any one of the coding processes defined in this standard in which all of the procedures are lossless.

ey. Lossy - A descriptive term for encoding and decoding processes that are not lossless.

ez. Luminance - 1. The monochromatic signal used to convey brightness information. 2. In a given direction, at a given point in the path of a beam, the luminous intensity per unit projected area.

fa. M0 - the code used to indicate a masked image compressed using a user defined algorithm in the image compression (IC) field of the image subheader.

fb. M3 - The code used to indicate a masked image compressed using the JPEG algorithm in the image compression (IC) field of the image subheader.

fc. M4 - The code used to indicate a masked image compressed using the Vector Quantization algorithm in the image compression (IC) field of the image subheader.
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fd. Make-up code word - Huffman code word used for run lengths greater than 64 pixels and up to 2560 pixels. A make-up code word is followed by a terminating code word.

fe. Map - A record of where various pieces of information are stored. (In memory or on a disk, for example.)

ff. Marker - A two-byte code in which the first byte is hexadecimal FF (0xFF) and the second byte is a value between 1 and hexadecimal FE (0xFE).

fg. Marker segment - A marker and associated set of parameters.

fh. Megahertz (MHz) - A unit of frequency denoting one million (10^6) Hertz.

fi. Memory mapped video - A system for transmitting information to a screen by reading it directly from memory.

fj. Metafile - A mechanism for retaining and transferring graphical data and control information. The information contains a device independent of one or more graphic images.

fk. Metamessage - A collection of information related to a NITF message, which is transmitted in association with the message.

fl. MIL-STD-188-100 - Common Long-Haul and Tactical Communications System Standards.

fm. MIL-STD-188-114 - Electrical Characteristics of Digital Interface Circuits.

fn. MIL-STD-810 - Environmental Test Methods.

fo. Minimum Coded Unit (MCU) - The smallest group of data units that is coded.

fp. Minimum compliance - The ability to create and output NITF messages and/or to accept NITF messages and recognize the component parts as prescribed in Volume II of the DOD NITF Certification Plan.

fq. Modem - Acronym for Modulator-Demodulator. A device that modulates and demodulates signals. Note: 1. Modems are primarily used for converting digital signals into quasi-analog signals for transmission over analog communication channels and for reconverting the quasi-analog signals into digital signals. Note: 2. Many additional functions may be added to a modem to provide for customer service and control features.

fr. Modes (of operation) - The four main categories of image compression processes defined in MIL-STD-188-198A (JPEG).

fs. Multicast - Transmission of a single message to a group of receivers.

ft. Multiplex - In NITFS context, use of a common channel to make two or more channels, either by splitting the frequency band transmitted by the common channel into narrower bands, each of which is used to constitute a distinct channel (frequency division multiplex), or by allotting this common channel to users in turn, to constitute different intermittent channels (time division multiplex).

fu. National Television Systems Committee (NTSC) - The North American standard for the generation, transmission, and reception of television communication wherein the 525-line picture is the standard. Note 1: The picture information is transmitted in AM and the sound information is transmitted in FM. Compatible with CCIR Standard M. Note 2: This standard is used also in Central America, a number of South American countries, and some Asian countries, including Japan.

fv. Negative-acknowledge character (NAK) - A transmission control character sent by a station as a negative response to the station with which the connection has been set up. Note 1: In binary synchronous communication protocol, used to indicate that an error was detected in the previously received block and that the receiver is ready to accept retransmission of the erroneous block. Note 2: In multipoint systems, used as the not-ready reply to a poll.

fw. Neighborhood - An 8x8 blocked region of pixels.

fx. Network - 1. An interconnection of three or more communicating entities and (usually) one or more nodes. 2. A combination of passive or active electronic components that serves a given purpose.

fy. Network layer - Layer three in the ISO OSI Reference Model. The role of the network layer is to transfer packets from their source node to their destination node by hopping through the intermediate nodes.

fz. NITF message - A persistent sequence of bytes that has a structure consistent with the NITF definition.

ga. NITF Reliable Transfer Server (NRTS) - The entity in the layer responsible for delivering message segments over one hop, from the source system to the destination(s) for that hop.

gb. NITF Transfer Protocol (NITFTP) - The peer protocol used for end-to-end transfer of NITF messages when they might have to be relayed via intermediate NITF systems.

gc. Node - 1. In network topology, a terminal of any branch of a network or an interconnection common to two or more branches of a network. 2. In a switched network, one of the switches forming the network backbone. 3. A technical control facility (TCF). 4. A point in a standing or stationary wave at which the amplitude is a minimum.

gd. Non-differential frame - The first frame for any components in a hierarchical encoder or decoder. The components are encoded or decoded without subtraction from reference components. The term refers also to any frame in modes other than the hierarchical mode.

ge. Non-interleaved - The descriptive term applied to the data unit processing sequence when the scan has only one component.

gf. NM - The code used to indicate a masked, non-compressed image in the Image Compression (IC) field of the image subheader.

gg. Object code - The output from an assembler or compiler. Compare source code.

gh. Object notations - A predefined set of graphics and symbols which are stored in a data base.

gi. Octet - A byte of eight binary digits usually operated upon as an entity.

gj. Open Systems Interconnection (OSI) - A logical structure for network operations standardized within the ISO; a seven-layer network architecture being used for the definition of network protocol standards to enable any OSI-compliant computer or device to communicate with any other OSI-compliant computer or device for a meaningful exchange of information.

gk. Optional - In the context of NITF, a data field that must be present, but may not have valid data.

gl. Packet - In data communication, a sequence of binary digits, including data and control signals, that is transmitted and switched as a composite whole. The data, control signals, and possibly error control information are arranged in a specific format.

gm. Parameter K - Parameter used for two-dimensional coding of the bi-level data. Specifies that every K line will be coded one-dimensionally. After the K^{th} line has been coded one-dimensionally, the subsequent K-1 lines will be coded two-dimensionally.

gn. Parameters - Fixed length integers four, eight, or 16 bits in length, used in the compressed data formats.

go. Parity - In binary-coded systems, the oddness or evenness of the number of ones in a finite binary stream. Note: By the addition of one extra bit, a bit stream can be forced to a specified parity state. This is often used as a simple error-detection check and will detect (but not correct) the occurrences of any single bit error in the field.

gp. Physical layer - Layer one in the ISO OSI Reference Model. The role of the physical layer is that of raw transmission of unformatted information.

gq. Pixel - For the purpose of NITFS, the smallest element from an N band image. Each pixel consists of N samples taken from corresponding locations in each of the image bands. For a single band image, sample and pixel can be used interchangeably.

gr. Pointer - An address that tells a program where to find something.

gs. Point transform - Scaling of a sample or DCT coefficient.

gt. Point-to-point link - A data communications link connecting only two stations.

gu. Port - For the NITFS, the identifier that transport protocols use to distinguish among multiple destinations in a host computer.

gv. Precision - For the NITFS, the number of bits allocated to a particular sample or DCT coefficient.

gw. Predictor - A linear combination of previously encoded reconstructed values (in lossless mode coding).

gx. Primary imagery dissemination - The electronic transmission and receipt of unexploited original or near-original quality imagery in near-real time through a primary imagery dissemination system.

gy. Primary imagery dissemination system - The equipment and procedures used in the electronic transmission and receipt of unexploited original/near-original quality imagery in near-real time.

gz. Printable American Standard Code for Information Interchange - A subset of the ASCII code that causes a character to be printed.

ha. Procedure - A set of steps that accomplishes one of the tasks comprising an encoding or decoding process.

hb. Progressive (coding) - One of the DCT-based or hierarchical processes defined in this standard in which each scan typically improves the quality of the reconstructed image.

hc. Progressive DCT-based - The mode of operation that refers to any one of the processes defined in 5.3 of this standard.

hd. Protocol - 1. [In general], A set of semantic and syntactic rules that determines the behavior of functional units in achieving communication. Note: Protocols may govern portions of a network, types of service, or administrative procedures. For example, a data link protocol is the specification of methods whereby data communication over a data link is performed in terms of the particular transmission mode, control procedures, and recovery procedures. 2. In layered communication system architecture, a formal set of procedures that are adopted to facilitate functional interoperation within the layered hierarchy.

he. Protocol stack - A set of multiple layers that describe the function of a network or communication system with the uppermost layer is being associated with the application and the lowest layer's being associated with the physical communications channel.

hf. Pseudocolor - A user-defined mapping of N bits into arbitrary colors.

hg. Quantization table - The set of 64 quantization values used to quantize the DCT coefficients.

hh. Quantization value - An integer value used in the quantization procedure.

hi. Quantize - The act of performing the quantization procedure for a DCT coefficient.

hj. Reduced Resolution Data Set (RRDS) - A series of images, each at half the resolution of the previous one. R0 (Resolution 0) is the largest file, and R7 is the smallest. An RRDS will be a set of separate NITF files. The image magnification field will contain a magnification that correlates with the level of the RRDS. A naming convention will be used for NITF files that collectively, make up an RRDS, such as image_id.ro through image_id.r7.

hk. Reed-Solomon code - For the purpose of NITF, a class of FEC codes in which the input and output symbols are multi-bit symbols and are treated as Finite Field elements.

hl. Required - In the NITF context, a data field that must be present and filled with valid data.

hm. Resolution - 1. The minimum difference between two discrete values that can be distinguished by a measuring device. Note: High resolution does not necessarily imply high accuracy. 2. The degree of precision to which a quantity can be measured or determined. 3. A measurement of the smallest detail that can be distinguished by a sensor system under specific conditions.

hn. Restart interval - The integer number of Minimum Coded Units (MCUs) processed as an independent sequence within a scan.

ho. Restart marker - The marker that separates two restart intervals in a scan.

hp. RS-170 - The Electronic Industries Association (EIA) standard that specifies the format for television signals as implemented by the National Television Systems Committee standard used for monochrome television.

hq. RS-170A - The EIA standard that specifies the format for television signals as implemented by the NTSC standard used for color television.

hr. RS-232C - An EIA standard that specifies the electrical characteristics and plug/socket interface (25 pin) for relatively slow (normally less than 20,000 bits-per-second) bit serial circuits.

hs. RS-422 - An EIA standard that specifies the electrical characteristics of bit serial circuits with balanced voltage interface circuitry and operates at a maximum of 10,000,000 bits-per-second at 12 meters.

ht. RS-423 - An EIA standard that specifies the electrical characteristics of bit serial circuits with unbalanced voltage interface circuitry. RS-423 circuits operate at a maximum of 300,000 bits-per-second at ten meters and are electrically interoperable with RS-232 circuits.

hu. RS-449 - An EIA standard that specifies a 37-pin socket and a 9-pin socket intended for use with RS-422/423.

hv. Run (length) - Number of consecutive symbols of the same value.

hw. Run-length encoding - 1. A redundancy-reduction technique for facsimile in which a run of consecutive picture elements having the same state (gray scale or color) is encoded into a single codeword.

hx. Sample - For the NITFS, one element in the two-dimensional array that comprises a band of the image.

hy. Scan - For the MIL-STD-188-198A (JPEG), a single pass through the data for one or more of the components in an image.

hz. Scan header - The start-of-scan marker and scan parameters that are coded at the beginning of a scan.

ia. Secondary Imagery Dissemination (SID) - The process of post-collection electronic dissemination of Command, Control, Communications, and Intelligence (C^3I) digital imagery and associated data, over a time interval ranging from near-real time to a period of days, at a level of quality determined by receiver requirements.

ib. Secondary Imagery Dissemination System (SIDS) - The equipment and procedures used in the electronic transmission and receipt of exploited nonoriginal quality imagery and imagery products in other than real or near-real time.

ic. Sequential (coding) - One of the lossless or DCT-based coding processes defined in this standard in which each component of the image is encoded within a single scan.

id. Sequential DCT-based - The mode of operation that refers to any one of the processes defined in MIL-STD-188-198A (JPEG).

ie. Simplex - For NITFS, providing transmission in only one preassigned direction.

if. Source code - Essentially, a computer program written by a programmer. Source code must be processed by an assembler, interpreter, or compiler and converted to an executable form before execution.

ig. Subvoice-grade channel - A channel with a bandwidth narrower than that of a voice-grade channel. Note: Such a channel is often a subchannel of a voice-grade line.

ih. Synchronous - Pertaining to two or more processes that depend upon simultaneous occurrence of specific events such as a common timing signal. Note: "Isochronous" and "anisochronous" are characteristics, while "synchronous" and "asynchronous" are relationships.

ii. Synchronous transmission - Data transmission in which the time of occurrence of each signal representing a bit is related to a fixed time base. Note: "Isochronous" and "anisochronous" are characteristics, while "synchronous" and "asynchronous" are relationships.

ij. Table specification data - The coded representation from which the tables used in the encoder and decoder are generated.

ik. Terminating code word - Huffman code word used for run lengths of less than 64 pixels. Each encoded run length stream must end with a terminating code word.

il. Tile - (See block).

im. Traffic - 1. The information moved over a communication channel. 2. A quantitative measurement of the total messages and their length, expressed in hundred call-seconds or other units, during a specified period of time.

in. Transparent Pixel - A fill pixel within an image block. Transparent pixels are recorded/transmitted to ensure that each block is filled with contiguous pixel values, but should be interpreted as having no meaning.

io. Transparent Pixel Mask - A data structure which identifies recorded/transmitted image blocks which contain transparent pixels. The transparent pixel mask allows the application to easily identify blocks which require special interpretation due to transparent pixel content.

ip. (Uniform) quantization - For the purpose of MIL-STD-188-198A (JPEG), the procedure by which DCT coefficients are scaled linearly to achieve compression.

iq. Validity - Validity provides a means of identifying those portions of a message known to contain possible errors.

ir. Vector graphics - A computer graphics image technique that codes only the image as a series of lines, according to the Cartesian coordinates of the lines' origins and terminations.

is. Vector Quantization - A compression technique in which many groups of pixels in an image are replaced by a smaller number image codes. A clustering technique is used to develop a codebook of "best fit" pixel groups to be represented by the codes. Compression is achieved because the image codes can be recorded using fewer bits than the original groups of pixels they represent.

it. Virtual Device Coordinates (VDC) - The VDC space defines a coordinate system that is overlaid onto an image to which CGM elements are referenced.

iu. Voice grade - In the public regulated services, a service described by the Code of Federal Regulations, Title 47, part 68. Note: The term does not imply any specific signaling or required supervisory scheme.

iv. Wideband - (synonym of broadband) 1. An imprecise designation of a signal that occupies a broad frequency spectrum. Note: This term is often used to distinguish it from narrowband signal, where both terms are subjectively defined relative to the implied context. 2. That property of any circuit having a bandwidth wider than normal for the type of circuit, frequency of operation, and type of modulation carried. Note: The term has many meanings depending upon

application. At audio/telephone frequencies, a bandwidth exceeding 4 kHz can be considered wideband. At HF radio frequencies, 3-30 MHz, a bandwidth larger than 3 kHz would be considered wideband. In communications security systems, any bandwidth exceeding that of a nominal four kHz telephone channel is considered wideband. 3. That property of any communication facility, equipment, channel, or system in which the transmitted bandwidth is greater than 0.1 percent of the midband frequency. 4. In commercial telephone usage, that property of a circuit having a bandwidth greater than 4 kHz.

iw. YCbCr601 - Luminance, chrominance color representation. Y = Luminance. Cb = Blue color difference. Cr = Red color difference.

ix. YIQ - A combination of brightness and phasing data that defines a color signal. Y = Brightness of signal. I = Inphase color signal (defines the colors orange to cyan). Q = Quadrature of the color signal (defines the colors purple to yellow green).

iy. Zig-zag sequence - A specific sequential ordering of the DCT coefficients from (approximately) lowest spatial frequency to highest.

iz. Zulu - Synonym - Coordinated Universal Time. Formerly a synonym for Greenwich Mean Time.

ja. (8x8) block - An 8x8 array of samples.

jb. 3-sample predictor - A linear combination of the three nearest neighbor reconstructed samples to the left and above (in lossless mode coding).

3.4 Symbols. The symbols used in NITFS documentation are defined as follows:

a.	AC	AC DCT coefficient
b.	BITS	16 byte list containing number of Huffman codes of each length
c.	C_u	horizontal frequency dependent scaling factor in DCT
d.	C_v	vertical frequency dependent scaling factor in DCT
e.	CAT	size category of DC difference of AC coefficient amplitude
f.	CODE	Huffman code value
g.	CODESIZE (V)	code size for symbol V
h.	DC	DC DCT coefficient
i.	DC_i	DC coefficient for i^{th} block in component
j.	DHT	define-Huffman-table marker
k.	DIFF	difference between quantized DC and prediction
l.	DQT	define-quantization-table marker
m.	DRI	define restart interval marker
n.	EHUFCO	Huffman code table for encoder
o.	EHUFSI	encoder table of Huffman code sizes
p.	EOB	end-of-block for sequential; end-of-band for progressive
q.	EOI	end-of-image marker

r. FREQ(V)	frequency of occurrence of symbol V
s. HUFFCODE	list of Huffman codes corresponding to lengths in HUFFSIZE
t. HUFFSIZE	list of code lengths
u. HUFFVAL	list of values assigned to each Huffman code
v. LASTK	largest value of K
w. m	modulo 8 counter for RSTm marker
x. MAXCODE	table with maximum value of Huffman code for each code length
y. MINCODE	table with minimum value of Huffman code for each code length
z. OTHERS(V)	index to next symbol in chain
aa. P	sample precision
ab. PRED	quantized DC coefficient from the most recently coded block of the component
ac. Q1-Q5	Five quality levels with associated default quantization tables for DCT based coding
ad. Q_{vu}	quantization value for DCT coefficient S_{vu}
ae. Q_{00}	quantizer value for DC coefficient
af. r_{yx}	reconstructed image sample
ag. R_{vu}	dequantized DCT coefficient
ah. RST_m	restart marker
ai. RUN	length of run of zero amplitude AC coefficients
aj. s_{yx}	sample from horizontal position x, vertical position y in block
ak. S_{vu}	DCT coefficient at horizontal frequency u, vertical frequency v
al. SI	Huffman code size
am. SOI	start-of-image marker
an. SOF_0	baseline DCT process frame marker
ao. SOF_1	extended sequential DCT frame marker, Huffman coding
ap. SOS	start-of-scan marker
aq. Sq_{vu}	quantized DCT coefficient
ar. V	Symbol or value being either encoded or decoded
as. VALPTR	list of indices for first value in HUFFVAL for each code length
at. V1	symbol value
au. V2	symbol value
av. ZRL	value in HUFFVAL assigned to run of 16 zero coefficients
aw. ZZ_k	k^{th} element in zigzag sequence of DCT coefficients
ax. ZZ_0	quantized DC coefficient in zigzag sequence

4. GENERAL DESCRIPTION

4.1 History. The evolution of computer microprocessor technology in the early 1980s made it feasible to build numbers of systems that could interchange annotated digital imagery. By 1984, the need for a common data format became apparent, and a project to develop such a format was initiated. The original goal was to develop a co-standard that could be added to all of the existing systems and incorporated into new systems during the acquisition process. Version 1.0 of the NITF, which included only the image format, was approved in 1987 for use as a demonstration capability but not as a general implementation baseline. A formal structure was created to continue the development, validation, certification, and integration. A Defense Support Project Office (DSPO) representative was appointed to manage development and co-chair the NTB. An Intelligence Communications Architecture (INCA) Project Office representative was appointed to manage validation, certification, and testing, and to co-chair the NTB.

4.1.1 NITF 1.1. Version 1.1, an improved format, was developed, validated, and proposed as the implementation baseline. The NITF Configuration Control Board (NCCB), chaired by a representative from the Office of the Assistant Secretary of Defense for Command, Control, Communications, and Intelligence OASD(C^3I) approved Version 1.1 for general implementation in March 1989. A certification test facility was established in 1990 under INCA sponsorship. In 1991, the Defense Intelligence Agency (DIA) assumed INCA's responsibilities, and the certification test facility was moved to the Joint Interoperability Test Center (JITC), Ft. Huachuca, AZ. By March 1992, over thirty different system configurations had been certified as compliant with NITF Version 1.1, some with waivers.

4.1.2 NITFS. Development of an improved version of NITF began in 1988. Initially, the new version was called NITF 2.0. The key improvement over the earlier version of NITF was the inclusion of a communications support capability, to enable NITF to be transmitted over tactical circuits. The primary communications support capability was communications protocol TACO2. Additionally, improved image compression, forward error correction, and enhanced graphics algorithms began development. In 1991, NITF began conversion to a DOD standard. To mark this, the name was changed to the NITFS. NITFS now encompasses not only the NITF 2.0 file format, but also includes supporting standards for image compression, transmission protocols, and graphics. Figure 2 shows the document structure for current and anticipated NITFS documentation. This handbook is the top level document in the document structure. The supporting format and data representation standards are shown in the right branch of the tree. In the left branch are embraced protocol standards and Technical Interface Specifications (TIS), the latter providing detailed implementation guidance. In 1992, the Image Handling Standards and Guidelines document for Commercial Analyst Workstation (CAWS) adopted the NITF 2.0 file format (only) as the format for full frame National imagery to be distributed from IDEX II, System III, and Low Cost Media. Also in 1992, development responsibility moved to the Central Imagery Office (CIO) and was incorporated into the Defense Standardization Program under the auspices of the Defense Information Systems Agency (DISA) in 1993.

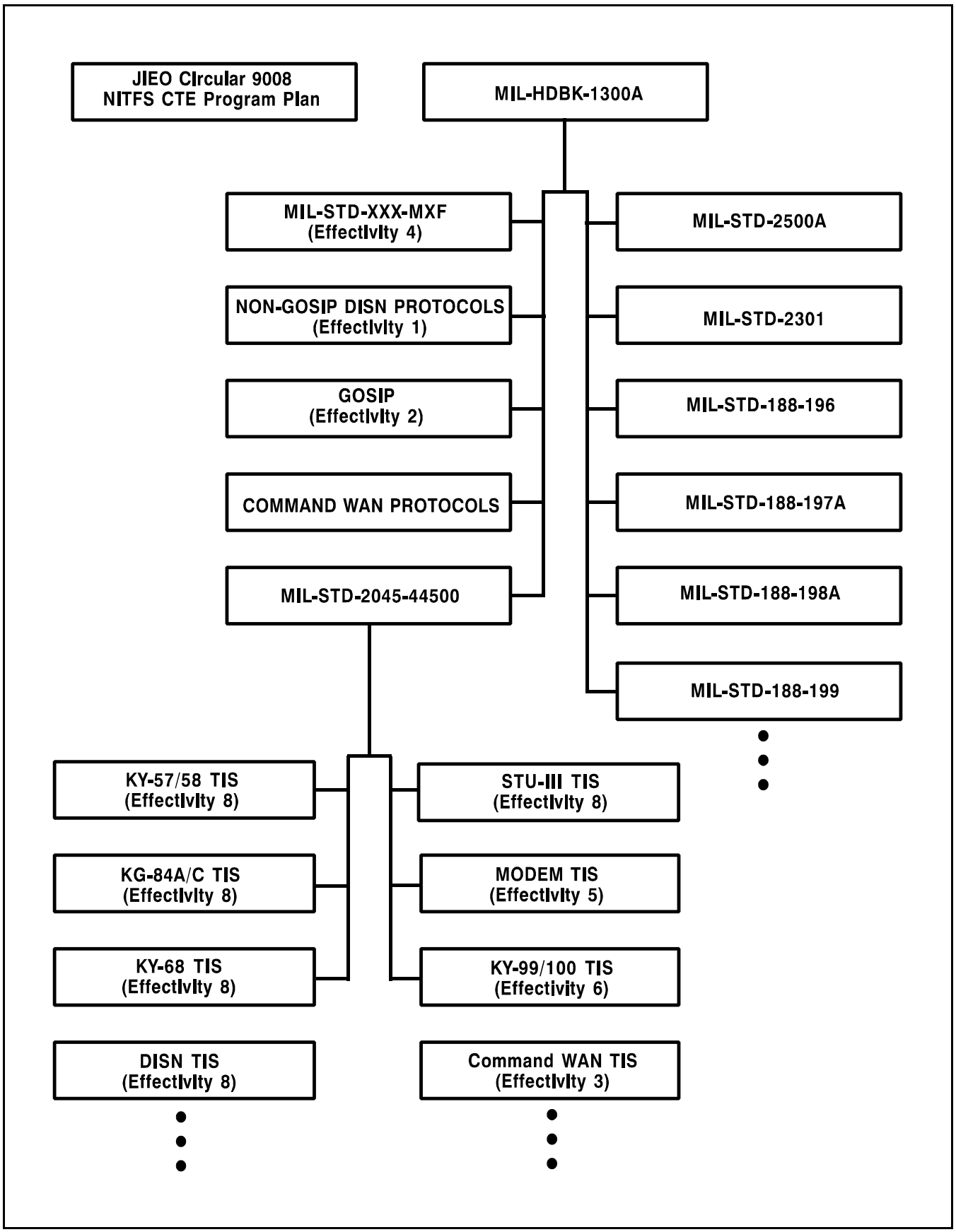

FIGURE 2. Documentation structure.

4.1.3 Implementation. Currently, by Office of the Assistant Secretary of Defense for Command, Control, Communications, and Intelligence (OASDC^{3}I) directive, NITFS is mandated for all DOD SIDS. In May 1989, the Chairman of the Committee on Imagery Requirements and Exploitation (COMIREX) directed the adoption of the NITF as the Intelligence Community standard for the transmission of secondary images.

4.2 Description of NITFS. The purpose of the NITFS is to transmit a file composed of an image accompanied by subimages, symbols, labels, text, and other information that relate to the image. One of the main features of the NITFS is that it allows several items of each data type to be included in one file, yet any data types may be omitted. Figure 3 illustrates the functional relationship of the components of the NITFS. The figure illustrates imagery, graphics, and text (documents and labels) as input to the formation of a NITF file, which incorporates the CGM standard for graphics and accommodates user-selectable compression for images. Then the file is submitted to the Message Transfer Facility (MXF), which allows it to be transferred using any of a set of user-selectable protocols and media. The output is a message which, by conforming to the standards and their use as illustrated, is compliant with the NITFS.

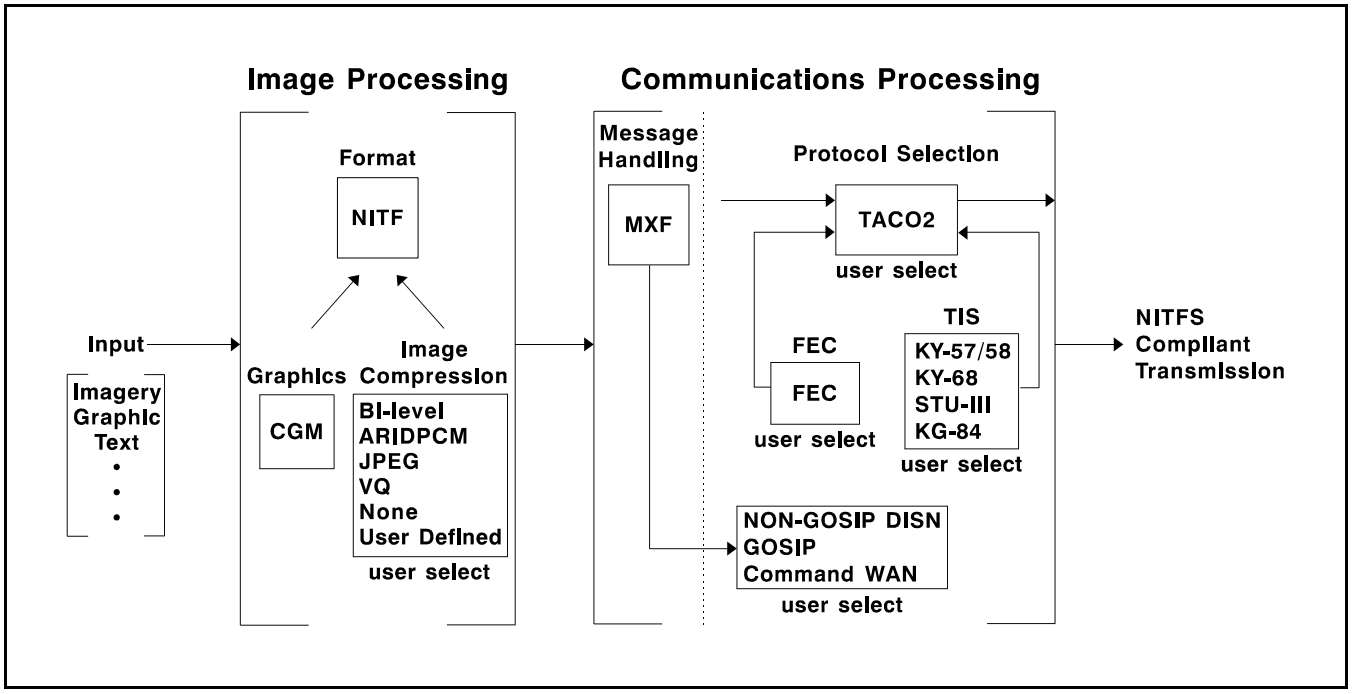

FIGURE 3. NITFS component relationships.

4.3 Certification Test and Evaluation (CTE) Program. Assistant Secretary of Defense for Command, Control, Communications, and Intelligence (ASD(C^3I)) has mandated compliance with the NITFS for all DOD SIDS. In 1989, on behalf of the Intelligence Community, COMIREX established the NITFS as the standard for imagery transmission. The Central Imagery Office (CIO) oversees the NITFS Certification Test and Evaluation (CTE) Program that determines compliance with the NITFS. The Defense Information Systems Agency's Joint Interoperability Test Center (JITC), located at Ft. Huachucha, Arizona, serves as CIO's Executive Agent for execution of NITFS test-related activities. The JITC has established a NITFS CTE Facility that supports certification testing of NITFS capable systems, validation testing of proposed additions to NITFS, and other test activities related to NITFS. A register of NITFS certified systems is also maintained at the CTE Facility. Detailed information concerning the NITFS Certification Test and Evaluation Program, including the established certification test criteria, is contained in DISA/JIEO Circular 9008.

4.4 Configuration Management of NITFS. As mandated by ASD(C^3I) memo dated September 1991, subject: "Executive Agent for DOD Information Standards," NITFS configuration management is managed by the Defense Information Systems Agency (DISA), Joint Interoperability and Engineering Organization (JIEO), Center for Standards (CFS), in accordance with DOD Instruction 5000.2, Defense Acquisition Management Policies and Procedures, 23 February 1991.

5. DETAILED DESCRIPTION

5.1 Overview. The image and communications processing components of the NITFS are described in this section. It includes data structure, graphics, and image compression algorithms. The communications components include communications protocols and error correction methods.

5.2 Format.

5.2.1 Data structure.

5.2.1.1 Preface. NITF is the designated format for transmission of digital imagery and image-related products by the DOD and other members of the Intelligence Community. The NITF provides a common basis for the digital interchange of images and associated data among a variety of existing and future systems.

5.2.1.2 Goal. The goal of the NITF is to provide a common format for transferring imagery and image-associated data among a wide range of existing and future systems, while minimizing overhead processing and storage requirements. To serve adequately a varied group of users communicating multiple types of data using differing hardware and software systems, the standard format must possess the following characteristics:

a. Completeness - allows transmission of imagery and image related data.

b. Simplicity - requires minimal preprocessing and postprocessing of transmitted data.

c. Minimal overhead - minimizes overhead, particularly for users transmitting only a small amount of data and for bandwidth-limited users.

d. Universality - provides universal features and functions without requiring commonality of hardware or non-NITF software.

5.2.1.3 Objectives. The objectives of the NITF are as follows:

a. To provide a way that diverse systems can share imagery and associated data.

b. To allow a system with one transmission to send information to users of varying needs or capabilities, so that each user selects from the transmission only those data items that correspond to the needs and capabilities of the recipient.

c. To minimize the cost and schedule impacts of hardware and software implementation required to achieve such capability.

5.2.1.4 Concept. In the NITF concept, data interchange among systems is enabled by a cross-translation process. Each system will have processors to translate between the system's internal

representation for files and data and the NITFS file format, NITF. A system from which data are to be transferred is envisioned to have a translation module that accepts information structured according to the system's internal representation for images, text files, and other data and assembles this information together into one file in the standard NITF format. The file will be transmitted to one or more recipients as a message using a user-chosen communication protocol. NITFS specifies TACO2 for use in tactical communications. The receiving systems will reformat the message, converting it into one or more files structured as required by the internal representation of the receiving station. The functional architecture of this cross-translation process is shown on figure 4. In the diagram, the terms "Native$_1$ Files" and "Native$_2$ Files" refer to fields represented in a way potentially unique to the sending (system 1) or receiving (system 2) system, respectively. Using the NITFS, each system must comply with all other participating systems. The standard format allows a system to send data to several other systems with one transmission, since each receiving station converts the message into its own internally acceptable form. Because each receiving station can translate selectively and permanently store only those portions of data in the received file that are of interest, a station may transmit all of its data in one message containing the one filed, even though some of the target systems may be unable to process certain elements of the data usefully.

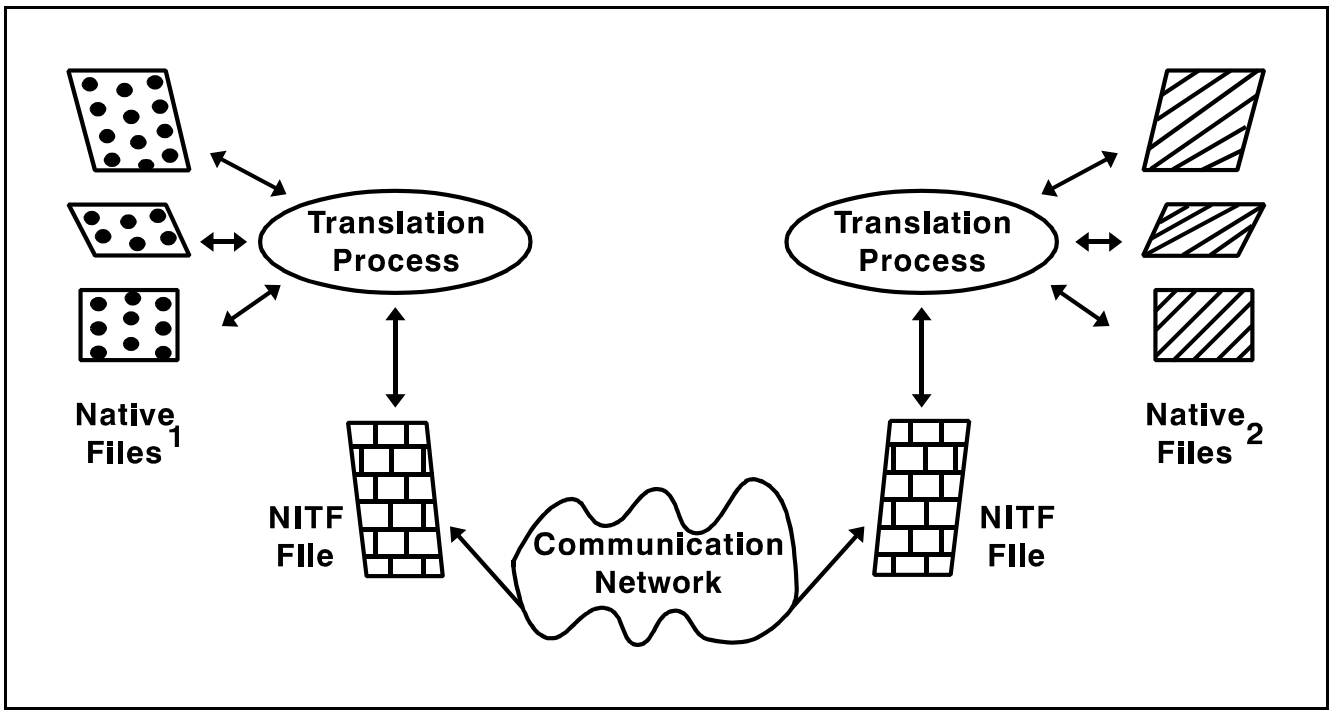

FIGURE 4. Functional architecture.

5.2.1.5 Format description. The NITF is a byte oriented format. All information, including numbers, contained in the NITF header and subheaders is given in the printable ASCII character set, with eight bits (one byte) per character.

5.2.1.6 Format structure. Data transmitted using the NITF are preceded by the NITF header, which includes identification and descriptive information related to the file as a whole. To ensure that all required data are provided to the end user, the NITF header and subheaders include data

elements that may duplicate communication protocol standards (for example, originator, classification, date-time-group). A diagram of the NITF file structure is shown on figure 5.

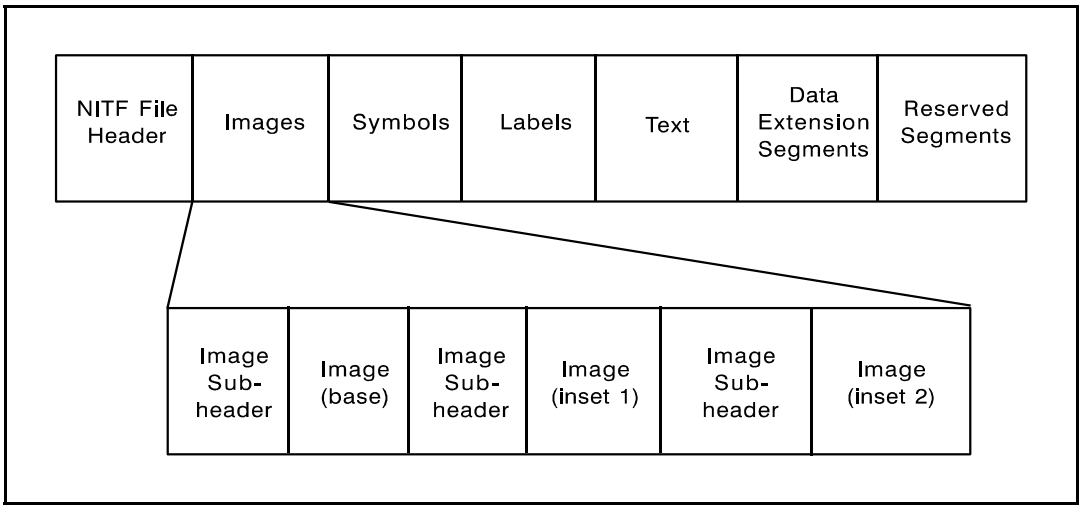

FIGURE 5. NITF file structure.

5.3 Data types. The NITF explicitly supports inclusion of four types or kinds of data: images, symbols, labels, and text. In addition, the NITF accommodates future needs and user-specific needs by providing a structured way to incorporate new kinds of data.

5.3.1 Images. The image data type is used in the NITF to store the image data, which encompasses multispectral imagery and images intended to be displayed as monochrome (shades of gray), color-mapped, or true color. That is, an image may include multiple data bands and color LUT, the latter within the image's header fields. True color images (three band) may be specified to be interpreted using either the RGB (Red, Green, Blue) or the YCbCr601 (Y = Brightness of signal, Cb = Chrominance (blue), Cr = Chrominance (red)) color system. Images may be represented with user-selectable (from a variety of choices) blocking and interleaving of the image pixel values.

5.3.1.1 Blocked images. In some instances, an NITF image may be represented by an orderly set of subimages (or subarrays) called blocks. Image blocks are of uniform size within a single image, and are arranged in *n* rows and *m* columns to form a complete image. The blocks are recorded/transmitted sequentially, in row major order; that is, all of the blocks of the first row are recorded/transmitted, followed by all of the blocks for the second row, and so on. Image blocks must be complete, so pad (transparent) pixels are added to fill out the images to the nearest block boundary.

5.3.1.2 Blocked image masking. In some instances, a blocked image may have a considerable number of empty blocks. This might occur when a rectangular image is not north aligned, but has been rotated to a north up orientation. In this case, it is sometimes useful to not record or transmit empty blocks. However, if empty blocks are not recorded/transmitted, the image loses its logical structure as an image with *n* x *m* blocks. In order to preclude the loss of logical structure, and to allow the exclusion of empty blocks, a mask structure has been defined. The mask identifies the location of non-empty blocks, and tags empty blocks so that the using application can

reconstruct the image correctly. If the image is band sequential (IMODE = S), there will be multiple block image masks--one for each band. The block image masks will be arranged in the same order as the image bands, with each mask containing number of bits per row (NBPR) x number of bits per column (NBPC) records. Block image masks can be used in conjunction with a transparent pixel mask, as described below. A block image mask may also be used to provide random access within the blocked image data for large images even if all blocks are recorded.

5.3.2 Symbols (graphics). The symbol data type used in the NITF to store a two-dimensional graphical symbol represented as a bit-map, as an NITF-defined "object," or as a CGM. A symbol may be black and white, gray scale, or color. Examples of symbols are circles, ellipses, rectangles, arrows, lines, triangles, logos, unit designators, object designators (ships, aircraft), alphanumeric labels, and special characters. A symbol is stored as a distinct unit in the NITF file allowing it to be manipulated and displayed nondestructively relative to the images, labels, and other symbols in the file. Computer graphic metafile symbols form a subset of national and international standards, and provide the user with more display flexibility than either bit-mapped or object graphics. CGM often requires less stored data than bit-mapped graphics and fewer limitations than object graphics. MIL-STD-2301 defines the subset of commands (correlated with the minimum implementation subset of commands specified in MIL-D-28003A) applicable for graphic annotation of imagery within the NITFS.

5.3.3 Labels. The label data type in the NITF is used to store a label composed of printable ASCII characters plus carriage returns and line feeds. The intent is for the label to be nondestructively overlaid upon one or more images and/or symbols to serve as textual annotation. However, it is recommended that label information be represented using the CGM symbol data type construct rather than the label data type construct. The label data type may not be included in future releases of the standard.

5.3.4 Text. The text data type in the NITF is used to store a file or item of text, such as a word processing file or document. Text data types are intended to convey information about the image product contained in the NITF file. The format of the text is conveyed by information in the Text Subheader.

5.4 Format extensions. Extension of the NITF is supported by built-in mechanisms and procedures that allow inclusion of user-defined data and data characteristics without changing the standard. In addition, there are Extension Segments that provide space within the file structure for entirely unspecified future purposes. Variations of the same basic extension mechanism, tagged records, are used for all specified types of extensions. The three varieties of tagged record extensions are registered extensions, controlled extensions, and encapsulated extensions.

5.4.1 Registered extensions. Each registered tagged record extension consists of three required fields: an identifier, or tag; a length; and a data field. These extensions are entirely user-defined; only the six character tag field is registered with the NTB. The purpose of registering the tags is to avoid having two users use the same tag to mean different extensions. The NITF provides several places within a NITF file to embed registered tagged record extensions.

5.4.2 Controlled extensions. These extensions are defined and submitted to the NTB for approval, and once accepted, are subject to formal configuration management. The tagged record

format for controlled tagged record extensions can appear in any of several locations within a NITF file.

5.4.3 Encapsulated extensions. These extensions are structurally similar to the registered extensions in that each has a tag. The tag and, in this case, the tag version are registered with the NTB. Each encapsulated extension appears in its own Data Extension Segment (DES), the minimal structure of which is defined by the NITF. The data in an encapsulated extension are anticipated typically to be defined by a specific standard or product specification (which may or may not be under the control of the NTB). Encapsulated extensions provide a way to incorporate arbitrary, but specified, data products in a NITF file.

5.5 Image processing component.

5.5.1 Bandwidth Compression (BWC). Bandwidth compression reduces the amount of data needed to represent image information. Compression algorithms generally may fall into the class of lossless and numerically lossy algorithms. Lossless algorithms preserve the original image data without any numerical losses. Lossy algorithms inherently introduce numerical changes compared to the original. A general tradeoff exists between the compression rate, that is the number of bits-per-pixel (bpp) required to represent the original data, and image quality. Lower compression rates may result in a more visually objectionable reconstructed image; whereas, higher compression rates may result in visually imperceptible losses in the reconstructed image. The NITFS has defined several compression alternatives: no compression, bi-level compression, ARIDPCM gray scale compression, JPEG compression, vector quantization compression, and user defined compression. The bi-level compression losslessly encodes image and overlay information represented by one bpp. ARIDPCM gray scale compression is a lossy scheme that may be used to compress 8- and 11-bit image information. JPEG provides a lossy algorithm for compressing 8- and 12-bit image data and a lossless algorithm for compressing all image data. Vector quantization provides a lossy compression algorithm for gray scale and color images of any bit depth. Table I provides application guidance for use of bandwidth compression algorithms.

TABLE I. Application guidance for bandwidth compression algorithms.

Compression Algorithm	Image Type	Use
No compression (IC field code NC or NM)	All	· When numerical loss of data is not tolerable. · When image size is small or when transmission bandwidth is large and compression is not needed.
User Defined (IC field code C0 or M0)	User determined	· It is the user's responsibility to ensure that the receiving system has access to the same algorithm to decompress the image. · The user defined algorithm should perform better than that of the NITFS specified compression algorithm.
Bi-level (IC field code C1)	Binary one-bit per pixel images	· Best on data with large areas (run lengths) of uniform color (graphics, maps, overlay). · May increase size of bi-level image data.

TABLE I. Application guidance for bandwidth compression algorithms - Continued

Compression Algorithm	Image Type	Use
ARIDPCM (IC field code C2)	Grayscale/color eight-bits, 11-bits per pixel unblocked images	· When speed of compression or rate control of the compressed data is more important than image quality. The JPEG should be used for compression for all other instances of grayscale/color images. · NITF 2.0 implementations are not required to compress images using ARIDPCM, but must be capable of interpreting them.
JPEG DCT (IC field code C3 or M3)	Grayscale/color eight-bits, 12-bits per pixel images	· This is the default for compressing grayscale/color images. This provides greater compression than ARIDPCM for similar image quality.
Vector Quantization (IC field code C4 or M4)	Gray scale/color, any pixel depth	· Very fast decompression, slow compression · Good for static images (i.e. map backgrounds, etc.) · Good image quality at moderate compression ratios (4:1 to 8:1) · Can easily be combined with color quantization to increase compression ratios (12:1 to 24:1)

5.5.1.1 Bi-level compression. The bi-level compression algorithm is used for encoding bi-level image and overlay information. This algorithm is consistent with the one- and two-dimension coding algorithms specified by Recommendation T.4 of the International Telegraph and Telephone Consultative Committee (CCITT) and MIL-STD-188-161 for group 3 facsimile devices. Uncoded or uncompressed data are represented by on bpp. This encoded data are composed of alternating run lengths of pixels of identical color with a maximum of 2560 pixels in one horizontal scan line or binary overlay information. Compression is achieved by encoding the run lengths with a series of specified Huffman codes. The one-dimensional algorithm codes individual scan lines. The two-dimensional algorithm is an extension of the one-dimensional method where vertical correlation between pixels is encoded in addition to the horizontal correlation. These algorithms are a lossless coding of bi-level information that can be decoded without incurring any degradation in the data. More detail on this specific algorithm can be found in MIL-STD-188-196.

5.5.1.2 ARIDPCM. The ARIDPCM is a compression algorithm that compresses 8- and 11-bit gray scale image data. This algorithm met the needs of the NITF in 1984 for low complexity or high speed compression on a PC-AT class personal computer. ARIDPCM is a spatial compression algorithm that uses simple linear and bilinear interpolation to predict image pixel values that are subtracted from the original values to produce delta values in a local 8 x 8 neighborhood. These delta values are quantized using a static look-up table. Figures 6 and 7 show the procedure for the ARIDPCM compression and decompression. Three modes of the ARIDPCM: are nondriven, driven, and composite. The nondriven mode is chosen when a specific quality is desired, but the length of the coded image is variable. To guarantee a specific average number of bpp over the entire image, the driven mode is chosen. The driven mode is defined with four selectable compression rates (4.5, 2.3, 1.4, and 0.75 bpp) for 8-bit data and four compression rates (6.4, 4.5, 2.3, and 1.4 bpp) for 11-

bit data. The composite mode compresses areas of low interest more than areas of high interest. Decompression is identical for all three modes. More details on this specific algorithm may be found in MIL-STD-188-197A.

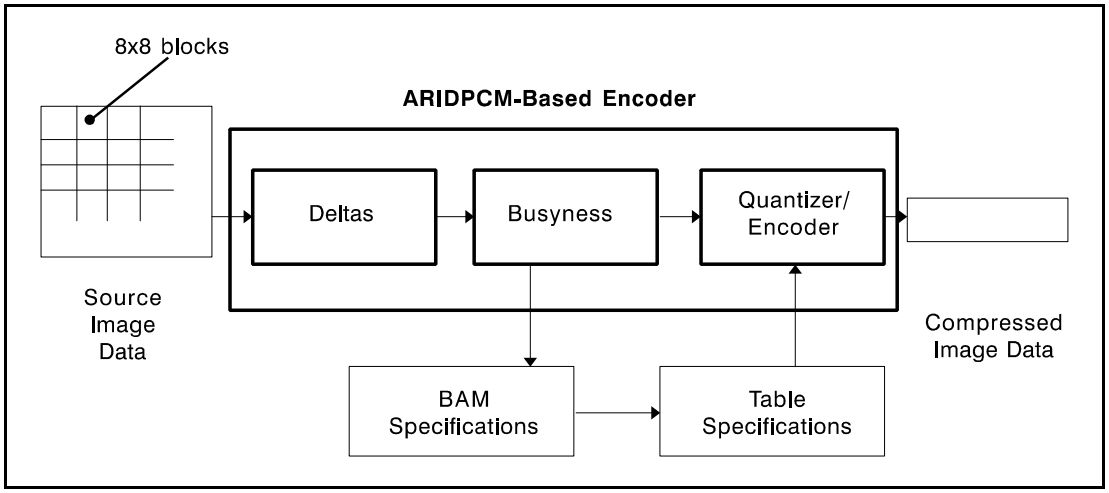

FIGURE 6. ARIDPCM encoder.

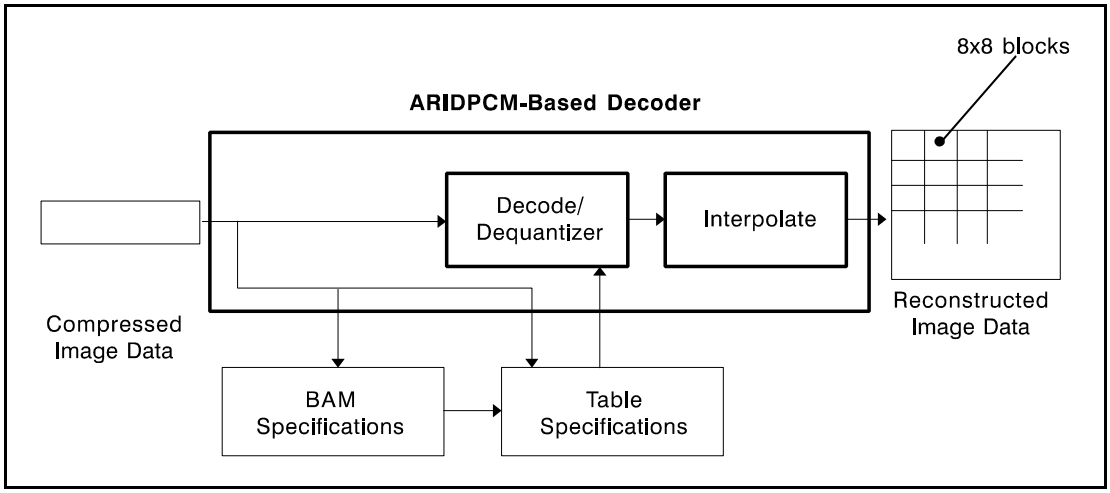

FIGURE 7. ARIDPCM decoder.

5.5.1.3 JPEG. Joint Photographic Experts Group (JPEG) image compression is a compression algorithm that compresses 8- and 12-bit gray scale and 24-bit color image data. The MIL-STD-188-198A specifies the portions of the JPEG standard in ISO Draft IS 10918-1/CCITT Draft Recommendation T.81 implemented in NITFS. JPEG provides greater compression than the ARIDPCM with similar image quality. Two classes of JPEG are lossless and lossy compression. Four distinct modes of operation defining the coding processes are sequential DCT-based, progressive DCT-based, lossless, and hierarchical. The NITFS specifies only the sequential DCT-based mode using Huffman encoding. Figures 8 and 9 show the general compression and decompression with this algorithm. The amount of compression provided by any process depends on the characteristics of the image being compressed, as well as the picture quality desired by the application. More details on this specific algorithm may be found in MIL-STD-188-198A.

5.5.1.4 Vector Quantization. Vector quantization is a compression method that is suitable for gray scale and color images of any pixel depth. Compression is very slow and computationally intensive. For this reason, it is not normally used for the distribution of near real time data. However, decompression without special hardware is very fast (as little as one-tenth the time of JPEG), so it is often used for static data, such as maps or broad area imagery. Image quality is good at moderate compression ratios. Vector Quantization compression is defined in more detail in MIL-STD-188-199.

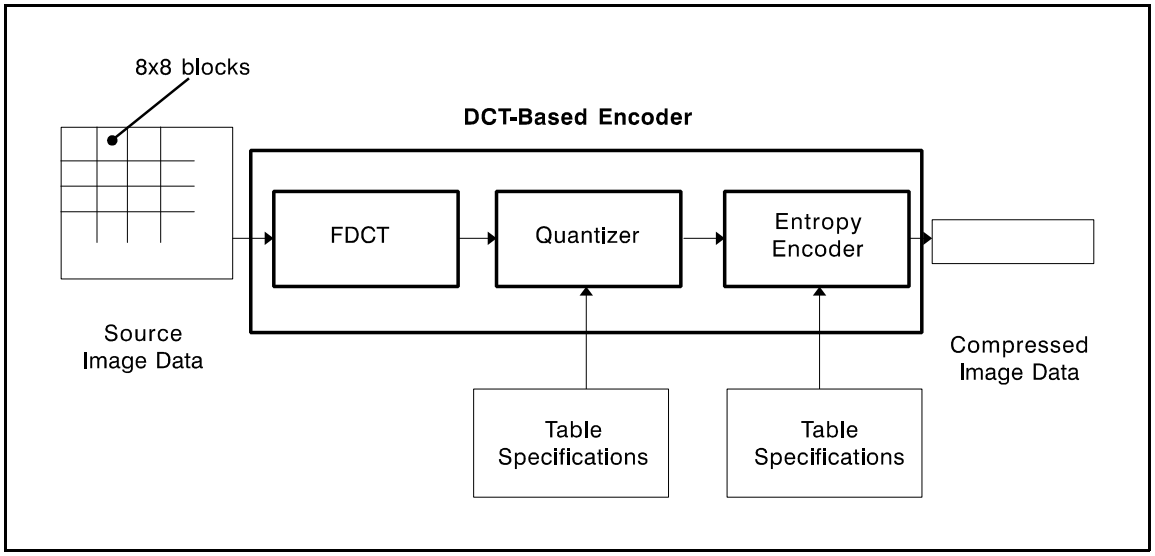

FIGURE 8. General JPEG DCT-based encoder.

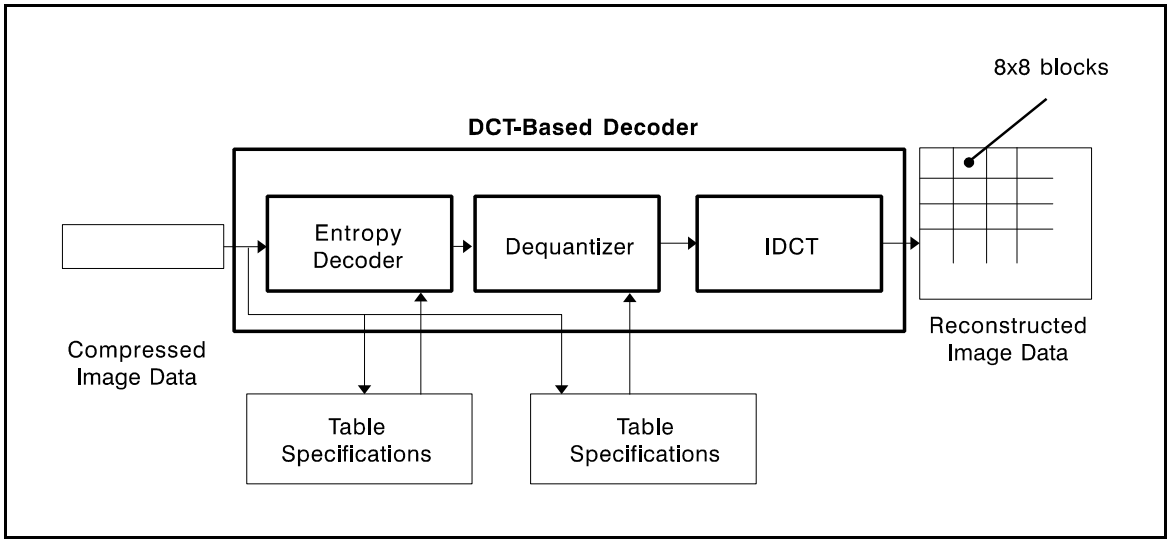

FIGURE 9. General JPEG DCT based decoder.

5.5.1.5 None. No compression is used when the user desires to send the imagery at full resolution with no quality loss. The image data are blocked left to right, top to bottom, according to the values supplied in the image subheader.

5.5.1.6 User defined. User-defined compression may include any compression algorithm of the user's choosing. It is the user's responsibility to ensure that the receiving SIDS has access to the same algorithm to decompress the image.

5.6 Communications component. The exchange of NITF files among systems requires transfer protocols and communications media. For well-established networks (DISN), the common transfer protocols and interfaces may be used. For networks that lack common transfer protocols, the TACO2 will be used.

5.6.1 TACO2. TACO2 uses a layered model, similar in philosophy to the ISO Open Systems Interconnection Reference Model. The TACO2 model is shown on figure 10. The NRTS layer provides the interface between the user process and the lower layers of the TACO2 protocol stack. The Network Block Transfer (NETBLT) layer is based on a multiple buffer paradigm, which can use most of the available data communication bandwidth efficiently, even on lossy, long-latency links. The other lower layers of TACO2 use protocols that accommodate the needs of tactical circuits.

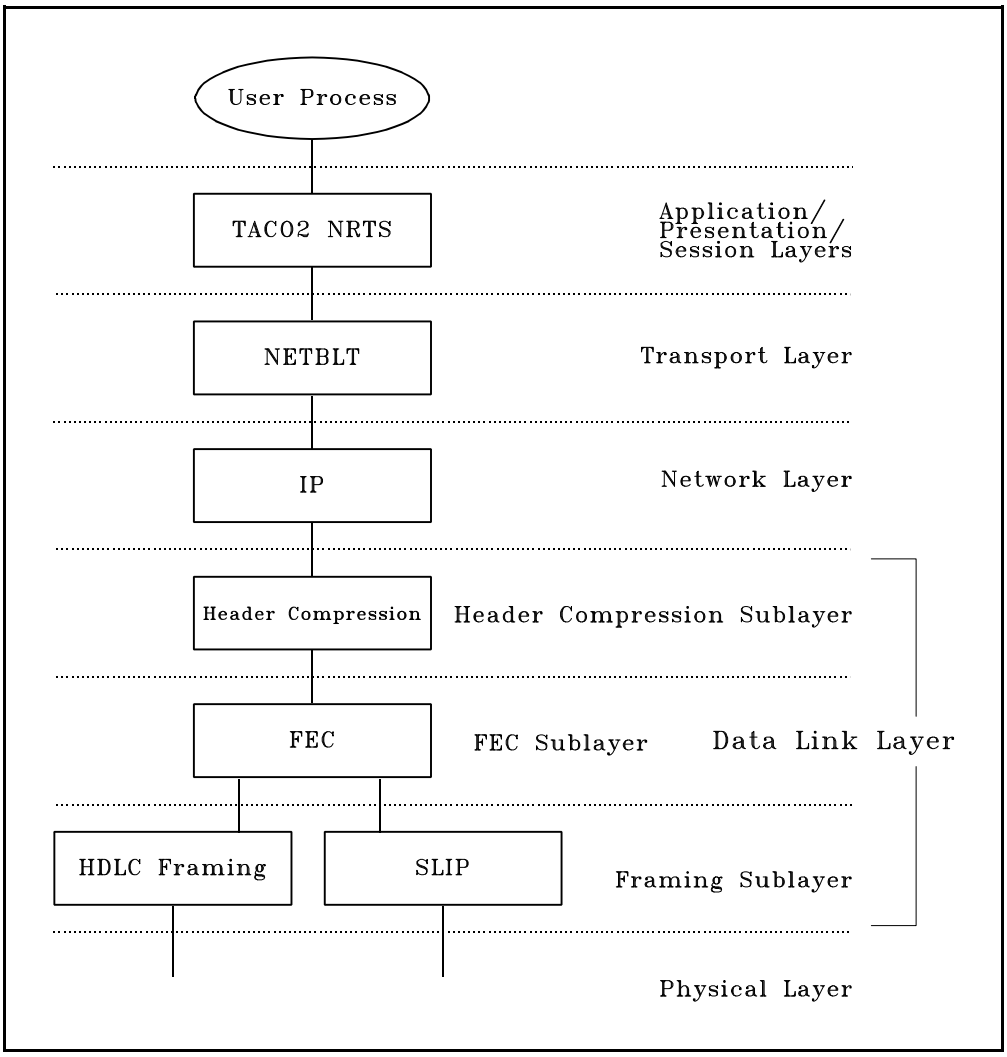

FIGURE 10. The TACO2 message transfer reference model.

TACO2 provides message transfer over a wide variety of tactical communications circuits. TACO2 is particularly appropriate for transferring data over circuits where other protocol suites operate poorly or not at all. It provides a flexible, reliable data communications protocol that operates in full-duplex, and simplex modes. TACO2 operates in synchronous and asynchronous modes. TACO2 operates with forward errorcorrection devices, encryption devices, and communication channels such as satellites, telephones, or local area networks. The mandatory ranges of various parameters are specified in the MIL-STD-2045-44500.

5.6.2 Technical Interface Specifications (TIS). The series of TIS documents outline the specific requirements for using various Communication Security Equipments (COMSEC) with the TACO2 protocol suite. The documents used as tested technical guidance for communications interfaces. The current TIS documents are describe interfaces to four types of COMSEC equipment. The KY-57/58 TIS covers applications using the Vinson Half-Duplex Combat Net Radio voice and data encryption equipment. The KY-68 Digital Subscriber Voice Terminal TIS covers applications using the Tri-Service Tactical Communications (TRI-TAC) and Mobile Subscriber Equipment (MSE) voice and data encryption equipment. The KG-84 TIS covers applications using the general purpose digital data encryption equipment. The STU-III TIS covers applications using the Secure Telephone Unit-Third Generation over public and government voice telephone circuits.

5.6.3 Forward Error Correction (FEC). Devices communicating over tactical data circuits generally require forward error correction to achieve the desired reliability and throughput. In many cases, FEC methods vary from system to system and are specific to modems, radios, and other elements of communication hardware. To avoid the interoperability problems that arise from incompatible FEC methods, TACO2 systems are required to implement specified standard FEC protocols (Effectivity 7) and, to the extent possible, should be able to bypass any nonstandard protocols or devices. The FEC method for TACO2, as specified in MIL-STD-2045-44500, is based on an efficient, byte-oriented Reed-Solomon coding scheme. These coding methods are implementable in the same software environments that support TACO2 network protocols and are specified for use with the HDLC and SLIP datalinks defined by TACO2. No special processing power is necessary to implement the FEC software. The routine inclusion of standard FEC protocols as part of TACO2 implementations provides high throughput, reliable data transfer, and a level of interoperability among disparate systems that would be absent otherwise. BERT also is specified for TACO2 systems, allowing the systems to be configured more readily for various communications resources.

5.6.4 Non GOSIP DISN protocols. (Effectivity 1).

5.6.5 GOSIP protocols. (Effectivity 2).

5.6.6 Command WAN protocols. (Effectivity 3).

6. NOTES

6.1 Effectivity summary. Definition of Effectivity: "Some of the capabilities specified in this document are not required as of the issue date of the document. All such capabilities are marked with effectivity numbers, for example (Effectivity 1). Each effectivity number will be replaced by a specific date in subsequent releases of the document."

a. Effectivity 1 - Non-GOSIP DISN protocols

5.6.4 Non-GOSIP DISN protocols. (Effectivity 1)

b. Effectivity 2 - GOSIP protocols

5.6.5 GOSIP protocols. (Effectivity 2)

c. Effectivity 3 - Command WAN protocols

5.6.6 Command WAN protocols. (Effectivity 3)

d. Effectivity 4 - MIL-STD-XXX-MXF

FIGURE 1 - MIL-STD-XXX-MXF (Effectivity 4)

e. Effectivity 5 - MODEM TIS

FIGURE 1 - MODEM TIS (Effectivity 5)

f. Effectivity 6 - KY-99/100 TIS

FIGURE 1 - KY-99/100 TIS (Effectivity 6)

g. Effectivity 7 - Forward Error Correction (FEC)

h. Effectivity 8 - Defense Information Systems Network (DISN)

- DISA/JIEO Specification 9137
- DISA/JIEO Specification 9138
- DISA/JIEO Specification 9139
- DISA/JIEO Specification 9140

6.2 Subject term (key word) listing.

Annotation, Imagery
BWC
Compression Algorithm
DCT, Discrete Cosine Transform
Error detection
Facsimile Compression
File Format
Forward Error Correction (FEC)
Gray scale imagery
Group 3 facsimile
HDLC
Huffman coding
Image
Image Compression
Image Dissemination
Image Transmission
IP
Message Transfer Facility
NETBLT
Quantization Matrices
Secondary Imagery Dissemination Systems
SIDS
SLIP
Symbol

6.3 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

CONCLUDING MATERIAL

Custodians:
Army - SC
Navy - OM
Air Force - 02
Misc - DC

Preparing activity:
Misc - DC

Agent:
Not applicable

(Project INST-0001)

Review activities:
OASD - SO, DO, HP, IR
Army - AM, AR, MI, TM, MD,
CE, SC, IE, ET, AC, PT
Navy - OM
Air Force - 02
DLA - DH
Misc - NS, MP, DI, NA,CI

User activities:
OASD - SO, DO, HP, IR
Army - AM, AR, MI, TM, MD,
CE, SC, IE, ET, AC, PT
Navy - OM
Air Force - 02
DLA - DH
Misc - NS, MP, DI, NA

Civil agency coordinating activities:
USDA - AFS, APS
COM - NIST
DOE
EPA
GPO
HHS - NIH
DOI - BLM, GES, MIN
DOT - CGCT

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1,2, 3, and 8. In block 1, both the document number and revision letter should be given.
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I RECOMMEND A CHANGE:	1. DOCUMENT NUMBER	2. DOCUMENT DATE (YYMMDD)
	MIL-HDBK-1300A	941012

3. DOCUMENT TITLE NATIONAL IMAGERY TRANSMISSION FORMAT STANDARD (NITFS)

4. NATURE OF CHANGE *(Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)*

5. REASON FOR RECOMMENDATION

6. SUBMITTER

a. NAME *(Last, First, Middle Initial)*	b. ORGANIZATION	
c. ADDRESS *(Include Zip Code)*	d. TELEPHONE *(Include Area Code)* (1) Commercial (2) AUTOVON *(If applicable)*	7. DATE SUBMITTED *(YYMMDD)*

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c. ADDRESS *(Include Zip Code)* Parkridge III 10701 Parkridge Boulevard Reston, VA 22091-4398	**IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT:** Defense Quality and Standardization Office 5203 Leesburg Pike, Suite 1403, Falls Church, VA 22041-3466 Telephone (703) 756-2340 AUTOVON 289-2340