NATO STANDARDIZATION AGENCY
AGENCE OTAN DE NORMALISATION

15 June 2007 NSA/0554(2007)-AIR/4609

STANAG 4609 AIR (EDITION 2) – NATO DIGITAL MOTION IMAGERY STANDARD

References:

a. NSA/0319-AIR/4609 dated 23 March 2005 (Edition 1)
b. AC/224(JISRCG)D(2006)0009 dated 3 April 2006

1. The enclosed NATO Standardization Agreement, which has been ratified by nations as reflected in the **NATO Standardization Document Database (NSDD)**, is promulgated herewith.

2. The references listed above are to be destroyed in accordance with local document destruction procedures.

ACTION BY NATIONAL STAFFS

3. National staffs are requested to examine page iii of the STANAG and, if they have not already done so, advise the Defence Investment Division through their national delegation as appropriate of their intention regarding its ratification and implementation.

J MAJ
Major General, POL(A)
Director, NSA

Enclosure:
STANAG 4609 (Edition 2)

NATO Standardization Agency – Agence OTAN de Normalisation
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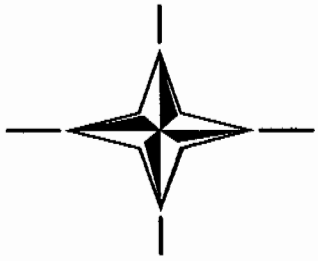
STANAG 4609
(Edition 2)

NORTH ATLANTIC TREATY ORGANISATION (NATO)



NATO STANDARDIZATION AGENCY
(NSA)

STANDARDISATION AGREEMENT (STANAG)

SUBJECT: NATO DIGITAL MOTION IMAGERY FORMAT

Promulgated on 15 June 2007

J. MAJ
Major General, POL(A)
Director, NSA

STANAG 4609
(Edition 2)

RECORD OF AMENDMENTS

No.	Reference/date of Amendment	Date Entered	Signature

EXPLANATORY NOTES

AGREEMENT

1. This NATO Standardization Agreement (STANAG) is promulgated by the Director NATO Standardization Agency under the authority vested in him by the NATO Standardization Organisation Charter.

2. No departure may be made from the agreement without informing the tasking authority in the form of a reservation. Nations may propose changes at any time to the tasking authority where they will be processed in the same manner as the original agreement.

3. Ratifying nations have agreed that national orders, manuals and instructions implementing this STANAG will include a reference to the STANAG number for purposes of identification.

RATIFICATION, IMPLEMENTATION AND RESERVATIONS

4. Ratification, implementation and reservation details are available on request or through the NSA websites (internet http://nsa.nato.int; NATO Secure WAN http://nsa.hq.nato.int).

FEEDBACK

5. Any comments concerning this publication should be directed at NATO Headquarters, AIR Unit, Armaments Directorate, Defence Investment – Bvd Leopold III - 1110 Brussels - Belgium.

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NATO STANDARDIZATION AGREEMENT (STANAG)

NATO DIGITAL MOTION IMAGERY FORMAT

Annexes:

A. Terms and Definitions
B. Motion Imagery System (MIS)
C. Standards

The following Standardization Agreements (STANAGs), Military Standards (MIL-STDs), International Telecommunication Union (ITU) Recommendations and International Standards Organization (ISO) standards contain provisions, which, through references in this text, constitute provisions of this STANAG. At the time of publication, the editions indicated were valid.

Related DOCUMENTS:

AEDP-8	Motion Imagery Allied Engineering Document
Advanced Authoring Format Object Specification, V 1.0, AAF Association, 9 June 2000.	
EIA-608	Recommended Practice for Line 21 Data Service, September 1994.
ETS 300 421	"Digital broadcasting systems for television, sound and data services; framing structure, channel coding and modulation for 11/12 GHz satellite services". (DVB-S)
ETS 300 744	"Digital Video Broadcasting; framing structure, channel coding and modulation for digital Terrestrial television". (DVB-T)
IEEE Std 1394-1995	Standard for a High Performance Serial Bus.
ISO/IEC 13818-1	Information technology - Generic coding of moving pictures and associated audio information, Part 1: Systems, 2000 (also known as MPEG-2 Systems).
ISO/IEC 13818-1:	2000/FPDAM 1: "Information technology -- Generic coding of moving pictures and associated audio information: Systems, AMENDMENT 1: Carriage of metadata over ISO/IEC 13818-1 streams" (DRAFT).
ISO/IEC 13818-2	Information technology - Generic coding of moving pictures and associated audio information, Part 2: Video, 2000 (also known as MPEG-2 Video).
ISO/IEC 13818-3	Information technology - Generic coding of moving pictures and associated audio information, Part 3: Audio, 1998 (also known as MPEG-2 Audio).
ISO/IEC 13818-4	Information technology - Generic coding of moving pictures and associated audio information, Part 4: Compliance Testing, 1998 (also known as MPEG-2 Compliance).

ISO/IEC 13818-6	Information technology - Generic coding of moving pictures and associated audio information, Part 6: Extension for Digital Storage Media Command and Control, 1996 (also known as MPEG-2 DSM-CC).
ISO/IEC 13818-9	Information technology - Generic coding of moving pictures and associated audio information, Part 9: Real-time Interface Specification, 1996 (also known as MPEG-2 RTI).
ISO/IEC 14496-2	Coding of audio-visual objects, Part 2: Visual, 1999 (also known as MPEG-4).
ITU-R BT.1358	Studio Parameters of 525 and 625 Line Progressive Scan Television Systems, 1998.
ITU-R BT.601-5	Studio encoding parameters for digital television for standard 4:3 and wide-screen 16:9 aspect ratios, 1995.
NATO ISRI	(Intelligence, Surveillance, and Reconnaissance) Integration Working Group Terms and Definitions, Draft October 2001.
NIIA Document	26 March 2002
SMPTE 12M-1999	Television, Audio and Film - Time and Control Code.
SMPTE 170M-1999	Television - Composite Analog Video Signal - NTSC for Studio Applications.
SMPTE 259M-1997	Television - 10-Bit 4:2:2 Composite and 4 fsc Composite Digital Signals – Serial Digital Interface.
SMPTE 274M-1998	Television - 1920 x 1080 Scanning and Interface. Progressive Only
SMPTE 291M-1998	Television - Ancillary Data Packet and Space Formatting.
SMPTE 292M-1996	Television - Bit-Serial Digital Interface for High-Definition Television Systems.
SMPTE 294M-2001	Television - 720 x 483 Active Line at 59.94-Hz Progressive Scan Production - Bit-Serial Digital Interfaces.
SMPTE 295M-1997	Television - 1920 x 1080 50-Hz - Scanning and Interface.
SMPTE 296M-2001	Television - 1280 x 720 Progressive Image Sample Structure - Analog and Digital Representation and Analog Interface.
SMPTE 309M	Transmission of Date and Time Zone Information in Binary Groups of Time and Control Code.
SMPTE 335M-2001	Metadata Dictionary Structure.
SMPTE 336M-2001	Data Encoding Protocol Using Key-Length-Value.
SMPTE 349M-2001	Transport of Alternate Source Image Formats though SMPTE 292M.
SMPTE EG 41-2004	Material Exchange Format (MXF) Engineering Guideline (Informative)
SMPTE 377M-2004	Material Exchange Format (MXF) File Format Specification (Standard)
SMPTE 378M-2004	Material Exchange Format (MXF) Operational pattern 1A (Single Item, Single Package)
SMPTE 379M-2004	Material Exchange Format (MXF) MXF Generic Container
SMPTE 380M-2004	Material Exchange Format (MXF) Descriptive Metadata Scheme-1 (Standard, Dynamic)
SMPTE EG 42-2004	Material Exchange Format (MXF) MXF Descriptive Metadata
SMPTE 381M-2005	Material Exchange Format (MXF) Mapping MPEG streams into the MXF Generic

	Container (Dynamic)
SMPTE 391M	Material Exchange Format (MXF) Operational Pattern 1b (Single Item, Ganged Packages)
SMPTE EG37-2001	Node Structure For the SMPTE Metadata Dictionary.
SMPTE RP 214-2002	Packing KLV Encoded Metadata and Data Essence into SMPTE 291M Ancillary Data Packets.
SMPTE RP 217-2001	Nonsynchronized Mapping of KLV Packets into MPEG-2 System Streams.
SMPTE RP210.9-2005	SMPTE Metadata Dictionary Contents.
STANAG 4545	NATO Secondary Imagery Format
STANAG 4559	Image Product Library Interface Standard (NSILI)
STANAG 4575	Imagery Air Reconnaissance (Digital Storage)
STANAG 4586	UAV Control System (UCS) Architecture
STANAG 7023	Air Reconnaissance Imagery Data Architecture
STANAG 7024	Imagery Air Reconnaissance Tape Recorder Standards
STANAG 7085	Interoperable Data Links for Imaging Systems

AIM

1. The aim of this agreement is to promote interoperability of present and future motion imagery systems in a NATO Combined/Joint Service Environment. Interoperability is required because it will significantly enhance the warfighting capability of the forces and increase flexibility and efficiency to meet mission objectives through sharing of assets and common utilization of information generated from motion imagery systems.

AGREEMENT

2. Participating nations agree to implement the standards presented herein in whole or in part within their respective Motion Imagery systems to achieve interoperability.

DEFINITIONS

3. The terms and definitions used in this document are listed in Annex A.

GENERAL SECTION

4. The outline of this STANAG follows the following format:

- Annex A contains the Terms and Definitions used in the STANAG.
- Annex B contains the description of the Motion Imagery System (MIS)
- Annex C contains the Standards mandated by this STANAG

DETAILS OF AGREEMENT

5. The Motion Imagery Architecture STANAG defines the architectures, interfaces, communication protocols, data elements, message formats and identifies related STANAGs, which compliance with is required.

PROTECTION OF PROPRIETARY RIGHTS (SEE ARTICLE 307)

6. If required.

IMPLEMENTATION OF THE AGREEMENT

7. This STANAG is implemented by a nation when it has issued instructions that all such equipment procured for its forces will be manufactured in accordance with the characteristics detailed in this agreement.

ANNEX A
STANAG 4609
(Edition 2)

TERMS AND DEFINITIONS

1 Acronyms and Abbreviations. The following acronyms are used for the purpose of this agreement. Note: There will only be words associated with this STANAG that are not already included in the ISRIWG Dictionary.

A	
AEDP	Allied Engineering Documentation Publication
AES3	Audio Engineering Society 3
ANSI	American National Standards Institute
AAF	Advanced Authoring Format
ATM	Asynchronous Transfer Mode
ATV	Advanced Television
AVI	Audio /Video interleaved
B	
BNC	British National Connector
C	
C2	Command and Control
C3I	Command Control Communication, and Intelligence
C4I	Command, Control, Communications, Computers and Intelligence
CCD	Charged Coupled Device
CDL	Common Data Link
CGS	Common Ground Segment, Common Ground Station
CIF	Common Image Format (352x288)
COTS	Commercial Off-The-Shelf
D	
DVB-T	Digital Video Broadcast - Terrestrial
DVB-S	Digital Video Broadcast - Satelite
DCGS	Distributed Common Ground Station
DoD	Department of Defense
DTED	Digital Terrain Elevation Data
DV	Digital Video
DVD	Digital Versatile Disk; Digital Video Disk
D-VHS	Digital VHS
D-VITC	Digital VITC
E	
EBU	European Broadcast Union
ED	Enhanced Definition
EG	Engineering Guideline
EIA	Electronic Industries Association
EO	Electro Optical
EO/IR	Electro Optical/Infrared
ETR	European Telecommunications Report
F	
FCC	Federal Communications Commission
FLIR	Forward Looking Infrared
FOV	Field of View
FPS	Frames Per Second

FTP	File Transfer Protocol
G	
GBGB	Gigabyte
Gb	Gigabits
GBS	Global Broadcast Service
GOTS	Government Off-The-Shelf
GPS	Global Positioning System
H	
HD	High Definition
HDTV	High Definition Television
HL	High level
Hz	Hertz
I	
IC	Intelligence Community
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronic Engineers
IMINT	Imagery Intelligence
IP	Internet Protocol/Intellectual Property
IPL	Image Product Library
IR	Infrared
ISDN	Integrated Services Digital Network
ISO	International Standards Organization
ISR	Intelligence, surveillance, reconnaissance
ITU	International Telecommunication Union
J	
JFC	Joint Forces Commanders
JPEG	Joint Photographic Experts Group
JTA	Joint Technical Architecture
JTF	Joint Task Force
JWICS	Joint Worldwide Intelligence Communications System
K	
Kb/s	Kilobit per second
KB/s	Kilobytes per second
Kilo	1,000
KLV	Key-Length-Value
L	
M	
MB/s	Megabytes per second
Mb/s	Megabits per second
MIL	Military
MIL-STD	Military Standard
MISM	Motion Imagery Systems Matrix
MISM-L	Motion Imagery Systems Matrix – Level
MJD	Modified Julian Date
ML	Main Level
MP	Mission Planning; Main Profile

MPEG	Moving Pictures Experts Group
N	
N/A	Not Applicable
NATO	North Atlantic Treaty Organization
NCIS	NATO Common Interoperability Standards
NITFS	National Imagery Transmission Format Standard
NRT	Non Real-Time, Near Real Time
NSIF	NATO Secondary Imagery Format
NSIL	NATO Standard Image Library
NSILI	NATO Standard Image Library Interface
NTIS	NATO Technical Interoperability Standards
NTSC	National Television Standards Committee
O	
OC-3	Fiber Optic Communications Standard (155 Mbps)
OC-12	Fiber Optic Communications Standard (655 Mbps)
P	
PAL	Phase Alternate Line
p	progressive
ps	progressive scan
PS	Program Stream
Q	
QoS	Quality of Service
QSIF	Quarter SIF (176 x 120 Pixels)
R	
RF	Radio Frequency
RP	Recommended Practice
RSTA	Reconnaissance Surveillance and Target Acquisition
Rx	Receive
S	
s	Seconds
SATCOM	Satellite Communications
SD	Standard Definition
SDI	Serial Digital Interface
SDTI	Serial Data Transport Interface
SECAM	System Electronique Couleur Avec Mémoire
SIF	Standard Image Format (352x240 pixels)
SMPTE	Society of Motion Picture and Television Engineers
SNR	Signal to Noise Ratio
STANAG	(NATO) Standardization Agreement
S-VHS	Super Vertical Helical Scan

T	
TBD	To Be Defined
TS	MPEG-2 Transport Stream
TST	Technical Support Team
TUAV	Tactical UAV
TV	Television
TX	Transmit
U	
UAV	Unmanned/Uninhabited Aerial Vehicle
UCAV	Unmanned/ Uninhabited Combat Aerial Vehicle
US	United States
UTC	Universal Time Code Coordinated
V	
VCR	Video Cassette Recorder
VHS	Vertical Helical Scan
VITC	Vertical interval Time Code
W	
X	
XML	Extensible Markup Language
Y	
Z	

2. Terms and Definitions. The following terms and definitions are used for the purpose of this agreement.

Analysis	In intelligence usage, a step in the processing phase of the intelligence cycle in which information is subjected to review in order to identify significant facts for subsequent interpretation.
Byte	Eight bits.
Engineering Guidelines	Engineering Guidelines represent well-defined, informative engineering principals. Engineering Guidelines are not mandated.
Image	A two-dimensional rectangular array of pixels indexed by row and column.
Imagery	A likeness or representation of any natural or man-made feature or related object or activity. Collectively, the representations of objects reproduced electronically or by optical means on film, electronic display devices, or other media.

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.
Intelligence	The product resulting from the collection, processing, integration, analysis, evaluation and interpretation of available information concerning foreign countries or areas.
Interlace Scan	Interlace scanning scans from left to right for one line then skips every other line to form a field of the image. The second field is made up of the lines that were skipped in the first field. The combination of two fields constitutes a frame. It should be noted that motion between fields in the frame causes interlace artifacts in the frame and the loss of vertical and temporal resolution.
Interoperability	Interoperability is the ability of systems, units or forces to provide services to and accept services from other systems, units of forces and to use the services so exchanged to enable them to operate effectively together.
Motion Imagery	Imagery [a likeness or representation of any natural or man-made feature or related object or activity] utilizing sequential or continuous streams of images that enable observation of the dynamic behavior of objects within the scene. Motion Imagery temporal rates, nominally expressed in frames per second, must be sufficient to characterize the desired dynamic phenomenon.
Near-Real-Time	Delay caused by automated processing and display between the occurrence of an event and reception of the data at some other location.
Non-Real Time Processing	Non-flight critical processing accomplished within the host system software including interface to C4I system(s). Pertaining to the timeliness of data or information that has been delayed by the time required for electronic communication and automatic data processing. This implies that there are no significant delays.
Open Systems Interconnect Model	This model is defined in ISO/IEC 7498-1.
Profile	A PROFILE documents a mandated, unique and fully defined configuration of standards and specifications for an application or system under the STANAG 4609.
Progressive Scan	The image is continuously scanned from left to right and from top to bottom using all pixels in the capture. This is opposed to interlace scanning used in conventional television, which scans from left to right for one line then skips every other line to form a field of the image. The second field is made up of the lines that were skipped in the first field. The combination of two fields constitutes a frame. It should be noted that progressive scan systems do not suffer motion in the frame caused by interlace artifacts and the loss of vertical and temporal resolution caused by motion occurring between the scanned fields of an interlaced system.

Protocol	(1) [In general], A set of semantic and syntactic rules that determine the behavior of functional units in achieving communication. 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. Note: Protocols may govern portions of a network, types of service, or administrative procedures.
Real-time Processing	AV command and control info including antenna positioning and AV video receipt and processing. Pertaining to the timeliness of data or information that has been delayed only by the time required for electronic communication. This implies that there are no noticeable delays.
Recommended Practice	Where the term A RECOMMENDED PRACTICE is used, the item documents a practice that further clarifies the implementation of a STANDARD or PROFILE in order to enforce interoperability across NATO systems.
Reconnaissance	A mission undertaken to obtain, by visual observation or other detection methods, information about the activities and resources of an enemy or potential enemy; or to secure data concerning the meteorological, hydrographic characteristics of a particular area.
Resolution	A measurement of the smallest detail, which can be distinguished by a sensor system under specific conditions.
Secondary Imagery	Secondary Imagery is digital imagery and/or digital imagery products derived from primary imagery or from the further processing of secondary imagery.
Sensor	Equipment, which detects, and may indicate, and/or record objects and activities by means of energy or particles emitted, reflected, or modified by objects.
Software	A set of computer programs, procedures and associated documentation concerned with the operation of a data processing system, e.g. compilers, library routines, manuals, and circuit diagrams.
Standards	The Standardization Agreements (STANAGs), Military Standards (MIL-STDs), International Standards Organization (ISO), International Telecommunications Union (ITU) Recommendations and other International Standards contain provisions which, through references in this text, constitute provisions of this STANAG.
Storage	a) The retention of data in any form, usually for the purpose of orderly retrieval and documentation. b) A device consisting of electronic, electrostatic or electrical hardware or other elements into which data may be entered, and from which data may be obtained.
Surveillance	The systematic observation of aerospace, surface or subsurface areas, places, persons, or things, by visual, aural, electronic, photographic, or other means
System specification (a spec)	The document which accurately describes the essential equipment requirements for items, materials or services, including the procedures by which it will be determined that the requirements have been met.

Technical Architecture	A minimal set of rules governing the arrangement, interaction, and interdependence of the parts or elements whose purpose is to ensure that a conformant system satisfies a specific set of requirements. It identifies system services, interfaces, standards, and their relationships. It provides the framework, upon which engineering specifications can be derived, guiding the implementation of systems. Simply put, it is the "building codes and zoning laws" defining interface and interoperability standards, information technology, security, etc.
Television Imagery	Imagery acquired by a television camera and recorded or transmitted electronically.
Unmanned Aerial Vehicle	A powered, aerial vehicle that does not carry a human operator, uses aerodynamic forces to provide vehicle lift, can fly autonomously or be piloted remotely, can be expendable or recoverable, and can carry a lethal or non-lethal payload. Also called a UAV.
Video Imagery	Images, with metadata collected as a timed sequence in standard motion imagery format, which is managed as a discrete object and displayed in sequence. Video imagery is a subset of the class of motion imagery.

ANNEX B
STANAG 4609
(Edition 2)

MOTION IMAGERY SYSTEMS

1. General

Motion Imagery (MI) is a valuable asset for commanders. It enables them to meet a variety of theatre, operational and tactical objectives for intelligence, reconnaissance and surveillance. STANAG 4609 is intended to provide common methods for exchange of MI across systems within and among NATO nations. STANAG 4609 is intended to give users a consolidated, clear and concise view of the standards they will need to build and operate motion imagery systems. The STANAG includes guidance on uncompressed, compressed, and related motion imagery sampling structures; motion imagery time standards, motion imagery metadata standards, interconnections, and common language descriptions of motion imagery system parameters. STANAG 4609 mandates that all relevant MI systems used by participating nations will be able to decode all MPEG-2 transport streams with MPEG-2 compressed data types (Standard Definition, Enhanced Definition, High Definition) up to and including Level 10 and all H.264 compressed data types up to and including Level 10, but each Nation may choose to ORIGINATE one, two or all data types. Level 10 is defined in the Motion Imagery System Matrix (MISM) as found in AEDP-8. The objective of STANAG 4609 is to provide governance so as to allow participating nations to share MI to meet intelligence, reconnaissance, surveillance and other operational objectives with interoperable MI systems.

2. Relation With Other Standards

The technology outlined in STANAG 4609 is based on commercial systems and components designed to defined open standards. No single commercial motion imagery standard provides all of the guidance necessary to build interoperable systems for use across the diverse missions of NATO; therefore STANAG 4609 is a profile of standards and practices on how component systems based on commercial standards can interconnect and provide interoperable service to NATO users.

STANAG 4609 and associated AEDP identify commercial standards that define interoperability for high image quality environments and systems (such as common control vans, interconnections nodes, and NATO command centres), including high bandwidth transmission of uncompressed and lower bandwidth transmission of compressed motion imagery (video) signals. STANAG 4609 and associated AEDP also identify approaches for interoperability between high bandwidth and low bandwidth systems.

The core attributes of STANAG 4609 can be expressed in a "Simplified Standards Basis Matrix." The corner stone of this Matrix is MPEG-2 or ISO/IEC 13818. The Simplified Standards Basis Matrix follows:

Image / Structure	Bit Serial Interface (for reference only)	Compression	Stream	Simple File	Moderate File	Rich File
	SMPTE 292M					
	SMPTE 349M					
	SMPTE 259M / 305M					

3. Motion Imagery Operations Concept

3.1 Motion Imagery

MOTION Imagery is defined as imagery [a likeness or representation of any natural or man-made feature or related object or activity] utilizing sequential or continuous streams of images that enable observation of the dynamic, (temporal), behavior of objects within the scene. Motion Imagery temporal rates, nominally expressed in frames per second, must be sufficient to characterize the desired dynamic phenomenon.

3.2 Other Video Systems

Video teleconference, telemedicine and support systems are not considered for this STANAG and these are encouraged to review the applicability of the standards given in the STANAG 4609 and if deemed practical, implement STANAG 4609 standards and recommended practices to foster broader interoperability across NATO.

4. Terms of Reference

Standards:

The Standardization Agreements (STANAGs), Military Standards (MIL-STDs), International Standards Organization (ISO), International Telecommunications Union (ITU) Recommendations and other International Standards contain provisions which, through references in this text, constitute provisions of this STANAG. Upgrading of referenced standards is conditional on satisfactory analysis of the impact to the STANAG.

Profiles:

A PROFILE documents a mandated, unique and fully defined configuration of standards and specifications for an application or system under the STANAG 4609.

Recommended Practices:

Where the term RECOMMENDED PRACTICE is used, the item documents a practice that further clarifies the implementation of a STANDARD or PROFILE in order to enhance interoperability across NATO systems. Recommended practices are found in the Allied Engineering Documentation Publication (AEDP)-8.

Engineering Guidelines:

Engineering Guidelines represent well-defined, informative engineering principals. Engineering Guidelines are not mandated and are found in AEDP-8.

5. Frame Rate Annotation

STANAG 4609 uses the following scanning format nomenclature.

60p = 60 Frames Per Second (FPS), Progressively Scanned

60p/1.001 = 59.94 FPS (NTSC compatible frame rate), Progressively Scanned

50p = 50 FPS, Progressively Scanned

30p = 30 FPS, Progressively Scanned

30p/1.001 = 29.97 FPS (NTSC compatible frame rate), Progressively Scanned

25p = 25 FPS, Progressively Scanned

24p = 24 FPS, Progressively Scanned

24p/1.001 = 23.98 FPS (NTSC compatible frame rate), Progressively Scanned

30i = 30 FPS, Interlace Scanned, yielding 60 fields per second

Note that many commercial documents use the term 60i to mean 30i.

30i/1.001 = 29.97 FPS (NTSC frame rate), Interlace Scanned

Note this is the frame rate associated with "television" in the United States.

25i = 25 FPS, Interlace Scanned, yielding 50 fields per second

Note this is the frame rate associated with "television" in Europe.

24i = 24 FPS, Interlace Scanned, yielding 48 fields per second

24i/1.001 = 23.98 FPS (NTSC compatible frame rate), Interlace Scanned

6. Standard, Enhanced, and High Definition

STANAG 4609 uses the following consistent scanning format definitions, defined in the commercial world, throughout all of the specified profiles, (see Motion Imagery System Matrix for detailed technical specifications for each profile):

High Definition (HD) is defined as spatial resolution at or greater than 1280x720 pixels, progressively scanned, at temporal rates at or greater than 24 Hz.

Enhanced Definition (ED) is defined as spatial resolution of at least 720x480 pixels at 60 Hz or 720x576 pixels at 50 Hz, progressively scanned. Enhanced definition provides twice the scanning lines of standard definition outlined below.

Standard Definition (SD) is defined as interlace scanned format at 720x576 at 50 Hz or 720x480 at 60 Hz.

7. Motion Imagery Roadmap

NATO user communities have diverse mission requirements and will select diverse motion imagery systems, across a range of capabilities, across a wide spectrum of available or desired bandwidth and system performance. Not all users will require a migration to the highest possible spatial and temporal resolution, but all users should be aware of a frame of reference that includes a spectrum of capabilities from standard definition to advanced high definition. In a digital Motion Imagery architectural construct, the specific pixel density of an origination system does not directly relate to the end-to-end required bandwidth (Variables include desired image quality/performance, pixel count, bit depth, imagery type and context, compression ratios, desired latency, error robustness, and other engineering trade spaces.). Therefore, the following framework describes a continuum of capabilities that each Nation will consider to meet their specific needs.

The fundamental direction for NATO motion imagery systems is to move to common standards featuring all digital, progressive scan processing, and square pixels; moving to higher spatial, temporal, and spectral resolutions as technology becomes available.

Standard definition, analogue interlace systems are considered the legacy initial state, where such analogue interlace systems are formally considered to be obsolete systems within NATO, and as such must not be replaced with any new analogue systems. Within analogue families, component processing (R:G:B, Y:R-Y:B-Y, Y:C) is always preferred over composite processing. (such as NTSC or PAL).

Standard definition, digital interlace (Rec. 601-5, 4:2:2 component processing), using serial digital interfaces (SDI, SMPTE 259M/291M) is a logical and most economical upgrade from analogue interlace systems. However, the cost differential between standard definition digital interlace and enhanced definition digital progressive systems is minimal and decreasing, therefore a migration to enhanced definition is strongly advised.

Enhanced definition, digital progressive (720 x 480 x 60p and 720 x 576 x 50p) can be considered to yield the best combination of improved spatial and temporal resolution capabilities at minimal increased costs as compared to today's broadcast quality digital interlace (Rec. 601-5) systems. However, 480p and 576p systems do not utilize square pixels and thus have insufficient horizontal pixels to properly deliver 16:9 aspect ratio imagery. Therefore, enhanced definition may be a suitable objective end-state for imagery systems that have no requirement to move to high definition spatial or temporal resolutions and do not require wider (16:9) aspect ratios.

High Definition, progressive scan imagery (SMPTE 296M-2001) is a desired end-state for NATO motion imagery systems. 1280 x 720x (50p) 60p is the target HD imaging format for all existing and currently planned motion imagery collection systems that will be fielded in the next five to ten years. 1920 x 1080 x (50p) 60p is anticipated to become the revised end-objective in approximately five years (when the technology becomes more mature). User communities that do not require high temporal resolution may consider use of 1920 x 1080 x 24p/25p/30p systems in special limited applications with controlled environments (such as studio production, training, etc.). The anticipated dynamic geo-political landscape and military battle space environment requires a complex trade space of maximal spatial and temporal resolution, thus 1280 x 720 x (50) 60p will remain the objective architecture end-goal.

ANNEX C
STANAG 4609
(Edition 2)

STANDARDS

1. Sampling Structures

1.1 STANDARD 0202 – Standard Definition Digital Motion Imagery Sampling Structure

ITU-R BT.601-5 Component (4:2:2) Digital Video shall be the NATO STANDARD sampling structure for baseband (uncompressed) standard definition motion imagery signals.

Furthermore, while both 10 bit and 8 bit (per component) implementations are allowed under the standard, 10 bit implementations are recommended.

Note 1: Once Motion Imagery has been originated in digital format or converted from legacy analog to standardized digital formats, it must remain in its digital format. Dual standard (525/30i / 625/25i) analog display devices may be used as termination elements of an otherwise all-digital motion imagery system.

Note 2: It is recommended that in the event of transitional sampling, compression conversion, format conversion or processing, ITU-R BT.601-5 shall be used as the intermediate sampling structure (within bit-serial interface input/output signal processing equipment) for subsequent use in further processing nodes.

1.2 STANDARD 0219 - Analog Video Migration

All NATO motion imagery production systems that currently use analog video waveforms (to include legacy STANAG 3350 systems) shall convert to ITU-R BT.601-5 Component (4:2:2) digital sampling structure as soon as practical in the image processing chain.

Furthermore, all new digital baseband motion imagery system production sampling structures shall conform to ITU-R BT.601-5 Component (4:2:2) sampling structures.

Furthermore, unique mission systems with legacy analog video waveforms should convert such analog video waveforms to ITU-R BT.601-5 Component (4:2:2) sampling structures as soon as possible in the signal processing chain, with no processing node backwards conversions to analog waveforms allowed.

1.3 STANDARD 0211 – Progressively Scanned Enhanced Definition Digital Motion Imagery

ITU-R BT.1358 shall define the NATO STANDARD motion imagery sampling structure for progressively scanned, digital enhanced definition motion imagery systems.

Furthermore, while both 10 bit and 8 bit (per pixel) implementations are allowed under the standard, 10 bit implementations are recommended.

Note 1: It is mandated that once Motion Imagery has been originated in digital format or converted from legacy analog to standardized digital formats, it must remain in its digital format. Analog display devices may be used as termination elements of an otherwise all-digital motion imagery system.

Note 2: It is recommended that in the event of transitional sampling, compression conversion or processing, ITU-R BT.1358 shall be used as the intermediate sampling structure (within bit-serial interface input/output signal processing equipment) for subsequent use in further processing nodes

1.4 STANDARD 0210 - High Definition Television Systems (HDTV)

SMPTE Standard 296M-2001 shall define the NATO STANDARD motion imagery sampling structure for progressively scanned digital high definition systems based on 720 vertical scanning lines. The parallel connector interface defined for SMPTE 296M-2001 shall not be used.

Furthermore, while both 10 bit and 8 bit (per pixel) implementations are allowed under the standard, 10 bit implementations are recommended.

Note 1: It is mandated that once Motion Imagery has been originated in digital format or converted from legacy analog to standardized digital formats, it must remain in its digital format. Analog display devices may be used as termination elements of an otherwise all-digital motion imagery system.

Note 2: It is recommended that in the event of transitional sampling, compression conversion or processing, SMPTE Standard 296M-2001 shall be used as the intermediate sampling structure (within bit-serial interface input/output signal processing equipment) for subsequent use in further processing nodes

SMPTE 274M-1998 (Progressive Only) shall define the NATO STANDARD motion imagery sampling structures for progressively scanned digital high definition systems based on 1080 vertical scanning lines.

Note 1: It is mandated that once Motion Imagery has been originated in digital format or converted from legacy analog to standardized digital formats, it must remain in its digital format. Analog display devices may be used as termination elements of an otherwise all-digital motion imagery system.

Note 2: It is recommended that in the event of transitional sampling, compression conversion or processing, SMPTE 274M-1998 (Progressive Mode Only) shall be used as the intermediate sampling structure (within bit-serial interface input/output signal processing equipment) for subsequent use in further processing nodes.

1.5 STANDARD 0203 - Digital Motion Imagery, Uncompressed Baseband Signal Transport and Processing

If Nations require interchange of motion imagery in baseband format, the following standards should be used.

SMPTE 259M, Level C (4:2:2) standard definition (270Mb/s Serial Digital Interface - SDI) is the STANDARD for uncompressed baseband signal transport and processing for Standard Definition digital motion imagery, audio and metadata origination, system interface, production/analysis center processing and manipulation.

SMPTE 349M "Transport of Alternate Source Image Formats through SMPTE 292M" is the STANDARD for uncompressed baseband signal transport and processing for Enhanced Definition digital motion imagery, audio and metadata origination, system interface, production/analysis center processing and manipulation.

SMPTE 292M (1.5 Gb/s Bit-Serial Interface) is the STANDARD for uncompressed baseband signal transport and processing for High Definition digital motion imagery, audio and metadata origination, system interface, production/analysis center processing and manipulation.

2. Compression Systems

ISO/IEC 13818 (MPEG-2) or ITU-T Rec. H.264 is the compression standard to be used for motion imagery.

2.1 STANDARD 0201 –Digital Motion Imagery, Compression Systems

ISO/IEC 13818 - 1,2,3,4 (commonly known as MPEG-2) is the established NATO STANDARD for all standard definition, enhanced definition and high definition compressed motion imagery, with the following PROFILE specifications:

For Standard Definition, the "MPEG-2, Main Profile @ Main Level" (MP @ ML) shall be the standard definition motion imagery compression PROFILE;

For Enhanced Definition and High Definition, the "MPEG-2, Main Profile @ High Level" (MP @ HL) shall be the Enhanced Definition and High Definition motion imagery compression PROFILE for NATO origination, acquisition, production, manipulation, exploitation, distribution, archiving and end-user motion imagery product

distribution, including real-time wide area transmissions.

Note 1: See Motion Imagery AEDP Recommended Practice 0220 for guidelines concerning applications constrained by low bandwidth channels and low motion imagery data rates

Note 2: See Motion Imagery AEDP Recommended Practice 0200 for guidelines concerning other digital motion imagery compression formats.

Note 3: Latency concerns for some applications (example UAV flight control and targeting) which require a low-latency compression mode, a low-latency compression mode is recommended, using a lower buffer-size and no B frames.

2.2 Advanced Digital Motion Imagery Compression Systems

ITU-T Rec. H.264 (Baseline, Main, Extended, and High Profiles – to be defined) is an advanced compression standard beneficial for applications constrained by bandwidth, which may not be adequately supported by MPEG-2. H.264 shall be carried over the MPEG-2 transport streams using ISO/IEC 13818-1:2000/AMD 3: "Information technology -- Generic coding of moving pictures and associated audio: Systems, AMENDMENT 3: Transport of ISO/IEC 14496 part 10 [ITU-T H.264] video data over ISO/IEC 13818-1". See AEDP-8 for recommended practices.

2.3 STANDARD 0204 - Use of MPEG-2 System Streams

For streaming applications, MPEG-2 Transport Streams will be used for NATO applications.

2.4 STANDARD 0223 – Compressed High Definition Advanced Television (ATV) and Associated Motion Imagery Systems

ISO/IEC 13818 – 1 (Systems), 2 (Video) (commonly known as MPEG-2) "High Level", which defines a broad family of high definition video compression capabilities, shall be the NATO STANDARD for compressed high definition advanced television and motion imagery, with the following PROFILE specifications:

The MPEG-2, Main Profile (4:2:0) @ High Level (MP @ HL), shall be the high definition motion imagery compression PROFILE for NATO end-user motion imagery product distribution, including real-time wide area transmissions.

Furthermore, to promote universal interoperability, NATO high definition advanced television and motion imagery systems must be able to decode, process and display all of the diverse sampling structures and temporal rates within the MPEG-2 High Level profiles specified above, where the systems may either display the received signal in its native format or the signals may be re-formatted to the highest common progressive format supported by the system. The following specific motion imagery sampling formats and temporal rates are noted as a mandatory sub-set under the broader MPEG-2 High Level receiver umbrella:

1920 x 1080, frame rates 30p, 30p/1.001, 30i, 30i/1.001, 25p, 25i, 24p;
16:9 Aspect Ratios
1280 x 720, frame rates 60p, 60p/1.001, 50p, 30p, 30p/1.001, 25p, 24p;
16:9 Aspect Ratios
720 x 576, frame rates 50p, 25p, 25i, 24p;
16:9 and 4:3 Aspect Ratios
720 x 480 (483), frame rates 60p, 60p/1.001, 30p, 30p/1.001, 30i, 30i/1.001, 24p, 24p/1.001; 16:9 and 4:3 Aspect Ratios
640 x 480, frame rates 60p, 60p/1.001, 30p, 30p/1.001, 24p, 24p/1.001; 4:3 Aspect Ratios

Note 1: For future enhancement and migration options, the following additional formats should be decoded by NATO MP@HL receiving systems, where the systems may either display the received signal in its native format or the signals may be re-formatted to the highest common progressive format supported by the display (See SMPTE 274-1998):

1920 x 1080, frame rates 60p, 60p/1.001, 50p; 16:9 Aspect Ratios

Furthermore, NATO high definition advanced television and motion imagery **ORIGINATION, ACQUISITION, PRODUCTION, MANIPULATION**, and or **PROCESSING** systems must generate at least one of the following sampling formats and its associated temporal rates:

For High Definition applications:

1280 x 720, frame rates 60p, 50p, 30p, 25p, 24p; 16:9 Aspect Ratios
1920 x 1080, frame rates 30p, 25p, 24p; 16:9 Aspect Ratios

Note 2: For future enhancement and migration options, 1080 progressive scan formats (50p/60p) are included as future objectives for high definition motion imagery applications, but the MI TST notes that 1080 50p/60p systems are not yet commercially available. Therefore, 1080 50p/60p systems are not mandated under this STANAG. The MI TST will continue to periodically evaluate the availability of 1080 progressive scan format systems for future consideration.

Note 3: Dual mode interlaced and progressive scan systems are authorized under this STANAG profile, provided that for NATO applications, 1) only the progressive scan mode shall be used and 2) provided that the progressive scan mode is derived from a native progressive capture and is not derived from an interlaced image capture.

For Standard Definition applications **ORIGINATION, ACQUISITION, PRODUCTION, MANIPULATION**, and or **PROCESSING** systems must generate at least one of the following sampling formats and its associated temporal rates:

720 x 576, frame rates 50p, 25p, 25i, 24p; 16:9 or 4:3 Aspect Ratios
720 x 480 (483), frame rates 60p, 30p, 30i, 30i/1.001, 24p;
16:9 or 4:3 Aspect Ratios
640 x 480, frame rates 60p, 50p, 30p, 25p, 24p; 4:3 Aspect Ratios

Note 4: 720 horizontal pixels are the standard width for NATO standard and enhanced definition program origination and processing. NATO systems shall not originate imagery content using 704 horizontal pixels.

2.5 STANDARD 0206 - Motion Imagery Still Frames

STANAG 4545 (NSIF 1.0) shall be the NATO STANDARD for digital still images that have been extracted from motion imagery sequences. Once an image has been captured for individual still image processing, exploitation and dissemination; the image is no longer considered to be motion imagery and is therefore not subject to this STANAG (but must meet STANAG 4545 image standards).

Furthermore, still images should be extracted from full resolution bit-serial interface video streams, with direct conversion and storage into STANAG 4545 image formats (using no transitional analog processing steps).

Furthermore, still images may be directly extracted from MPEG-2 digital files provided there are no transitional analog processing steps.

3. Metadata

All STANAG 4609 compliant systems will be designed to exploit, as a minimum, the set of metadata commonly agreed between the participating nations as required for interoperability; but, they will also accept, and pass-through without any system performance degradation, whatever syntax-compliant metadata is encountered.

3.1 STANDARD 0212 – Motion Imagery Metadata Dictionary Structure

SMPTE 335M-2001, *Metadata Dictionary Structure*, is the NATO STANDARD for the interchange and structure definition of metadata dictionaries used by digital motion imagery systems/products.

3.2 STANDARD 0213 – Data Encoding using Key-Length-Value

SMPTE 336M-2001, *Data Encoding Protocol Using Key-Length-Value,* is the NATO STANDARD protocol for encoding data essence and metadata into Motion Imagery streams, files, and associated systems. Universal sets are mandated for NATO use.

3.3 STANDARD 0207 – Metadata Dictionary

SMPTE RP210.9-2005, *SMPTE Metadata Dictionary Contents is the* NATO STANDARD for the identification of metadata elements encoded in digital motion imagery products.

3.4 STANDARD 0208 - Imbedded Time Reference for Motion Imagery Systems

SMPTE 12M-1999, commonly known as SMPTE time code, shall be the NATO STANDARD for time annotation and imbedded time references for motion imagery systems.

Furthermore, within SMPTE 12M, Drop Frame Time Code shall be used for 60/1.001, 30/1.001, 24/1.001 frames per second (FPS) systems. Non-Drop Frame Time Code shall be used for 60, 50, 30, 25, and 24 FPS systems.

SMPTE 309M shall be the NATO STANDARD for precision time and date imbedding into SMPTE 12M time code data streams.

Furthermore, within SMPTE 309M, NATO users will use the Modified Julian Date (MJD) (Y2K compliant) date encoding format and Universal Coordinated Time (UTC) as the time zone format.

Note: If Motion Imagery time code data is used as a data element for transference to other NATO systems (example NSIF still imagery), then the MJD / Time Code data will need to be translated to an appropriate date/time format for the application.

3.5 STANDARD 0214 - Time Code Embedding

If KLV Metadata is not available, and traditional time code (see standard SMPTE 12M / 309M above) is used for date/time information, the following standards apply:

Digital Vertical Interval Time Code (D-VITC) shall be imbedded on digital video line 9 of all ITU-R BT.601-5 Component (4:2:2) and bit-serial interface systems. Users may implement LTC for internal processing (such as in tape recorders) provided D-VITC is always forwarded to the next processing element on digital video line 9.

Furthermore, SMPTE Ancillary Time Code (embedded in the bit-serial interface Ancillary data space) may be used instead of D-VITC, provided such time code data is part of other metadata delivered by the ancillary data stream.

3.6 STANDARD 0215 - Time Reference Synchronization

Universal coordinated time (UTC, also known as "Zulu"), clock signals shall be used as the universal time reference for NATO SMPTE 12M time code systems, allowing systems using time code to accurately depict the actual Zulu time of day of motion imagery acquisition / collection / operations.

Furthermore, when NATO "original video acquisition" motion imagery sequences are used as sources for editing onto new "edit master" sequences, the "edit master" sequence may have a new, continuous time code track. The time code for the new sequence should reflect the "document date" of the new motion imagery product.

Furthermore, Global Positioning System time, corrected to UTC, is the standard for the source of time data.

3.7 STANDARD 0218 - Timing Reconciliation Universal Metadata Set for Digital Motion Imagery

This standard (Appendix 1) defines a timing reconciliation metadata set to correct (reconcile) the original capture time of metadata with a User Defined Time Stamp usually associated with the capture time of the digital motion imagery or audio essence. Timing reconciliation metadata is not required if the application using the metadata does not depend on the amount of timing error or uncertainty between the metadata capture and the video or audio essence capture.

3.8 STANDARD 0216 – Packing KLV Packets into SMPTE 291 Ancillary Data Packets

If a Serial Digital Interface (see STANDARD 0203) is used, SMPTE RP 214-2002, "Packing KLV Encoded Metadata and Data Essence into SMPTE 291M Ancillary Data Packets" is the NATO STANDARD for the encoding of metadata elements into Serial Digital Interface (SDI) SMPTE 291M ancillary data packets.

3.9 STANDARD 0217 - Packing KLV Packets into MPEG-2 Systems Streams

If MPEG-2 is used with Nonsynchronized metadata, SMPTE RP 217-2001, *Nonsynchronized Mapping of KLV Packets into MPEG-2 System Streams,* is the NATO STANDARD for the non-synchronous encoding of metadata elements into MPEG-2 Systems Streams.

Note: To be STANAG compliant, KLV metadata in BOTH the Transport Stream and Program Stream must be identified by the registered format_identifier 0x4B4C5641 ("KLVA"). SMPTE RP 217-2001 states that 0x4B4C5641 is the format_identifier to be used for the Transport Stream, but 0x4B4C5641 or "some other descriptor" may be used for the Program Stream.

If MPEG-2 is used with Synchronized metadata, ISO/IEC 13818-1:2000/FPDAM 1: "Information technology -- Generic coding of moving pictures and associated audio information: Systems, AMENDMENT 1: Carriage of metadata over ISO/IEC 13818-1 streams" is mandated for the synchronous encoding of metadata for exchange of motion imagery and metadata files for collaboration of production work in progress among analysts; storage of work in progress for access by multiple users; and permanent archive of all contributions to a finished work.

3.10 STANDARD 0224 - Bit and Byte Order for Metadata in Motion Imagery Files and Streams

KLV Metadata in NATO Motion Imagery systems shall use Big-Endian in Byte order and Big-Endian in Bit order.

Note: this is consistent with STANAG 4545 and STANAG 7023.

3.11 STANDARD 0209 - Use of Closed Captioning for Core Metadata Legacy Analog Video Encoding

EIA-608 (Data Services), commonly known as closed captioning, shall be the NATO STANDARD for legacy system analog video vertical interval metadata encoding using video line 21.

Note that any such analog video system data encoding is to be considered for legacy analog systems and may also be implemented by new systems for redundancy. New systems shall NOT use Closed Captioning, but must conform to all applicable digital motion imagery, audio, and metadata protocols specified in the STANAG.

Furthermore, unique mission systems with legacy closed caption shall convert such closed caption data into KLV Metadata as soon as possible in the signal processing chain, with no processing node backwards conversions to closed captioning allowed.

4. File Formats

4.1 STANDARD 0205 - Use of MPEG-2 System Streams for Simple File Applications

For simple file applications, MPEG-2 Transport or Program Streams may be used for NATO applications. All NATO systems must be able to receive and decode both Transport and Program Stream files.

4.2 STANDARD 0206 - Advanced File Format

In the other applications, where digital video files need to be exchanged, real-time or not, between collection platforms, users and data-bases with random access to the motion imagery based on metadata indexing, the Material Exchange Format (MXF), SMPTE 377M, can be used. This format makes use of the sampling, compression, and metadata rules defined in the present Annex and provides advanced features for easy access and exchange over communication networks. It is expected that this standard will be mandated in future revisions of this STANAG.

As MXF covers a large number of options and application domains, the present standard restricts as follows the applicable MXF possibilities to a minimum level mandated to achieve interoperability between the implementing nations:

- Only operational patterns 1a (OP-1a) and 1b (OP-1b) as per SMPTE 378M and SMPTE 391M, respectively, will be used for file exchange.
- The essence will be wrapped frame by frame using the generic container as per SMPTE 379M and SMPTE 381M.
- From the complete list of metadata sets and properties given by SMPTE 380M, the participating parties will be required to interpret only a minimum profile (derived from ASPA Profile) listed in AEDP-8 Edition 2. It must be noted that it is a design rule of MXF players to accept dark (unknown) data which obviously will not be interpreted.
- The dynamic metadata will be interleaved within the body.

5. Appendix 1

5.1 STANDARD 0218 - Timing Reconciliation Universal Metadata Set for Digital Motion Imagery

5.1.1 Scope

This Recommended Practice (RP) defines a timing reconciliation metadata set to correct (reconcile) the original capture time of metadata with a User Defined Time Stamp usually associated with the capture time of the digital motion imagery or audio essence. Timing reconciliation metadata is not required if the application using the metadata does not depend on the amount of timing error or uncertainty between the metadata capture and the video or audio essence capture.

5.1.2 Introduction

The time of metadata insertion into an encoded essence stream, file, or frame can be different from the time of its initial capture or sampling by as much as several seconds. In addition, the capture time of the metadata may be different from the capture time of the essence. As a result, the stream, file, or frame time stamp associated with an element or set (or pack) of metadata will be incorrect. When an application requires more precise information about the time of metadata capture this RP shall be used to convey the metadata capture time as a metadata set that is linked to another set or pack of metadata or to an individual metadata element. All metadata shall be represented using big-endian (most significant byte – MSB - first) encoding. Bytes shall be big-endian bit encoding (most significant bit – msb - first).

5.1.3 Timing Reconciliation Metadata for Digital Motion Imagery

The following time stamp metadata element shall be used to link accurate capture time of metadata to other metadata or essence as described in this section:

06 0E 2B 34 01 01 01 04 07 02 01 01 01 05 01 00 User Defined Time Stamp
Microseconds since 1970 (msb first)

5.1.3.1 Timing Reconciliation Metadata Inside Metadata Sets or Packs

The User Defined Time Stamp metadata element alone may be placed within a metadata set or pack when it unambiguously applies to each and every element of metadata within the set or pack. Its presence in the metadata set or pack shall be the only indication that it is the creation or capture date and time for the contents of that entire set or pack and, if used, it shall always be the first element of metadata within the applicable set or pack. When only a Timing Bias Correction is present in the set it shall be applied to the time to which it is linked or to the time in the set to which it is linked. When both a User Defined Time and Timing Bias Correction are present in the set the Time Bias Correction shall be applied to the User Defined Time in the set.

5.1.3.2 Timing Reconciliation Universal Metadata Set Linked to Other Metadata

The User Defined Time Stamp and a Timing Bias Correction (if needed) may be linked selectively to individual metadata elements or to metadata sets, packs or labels using the Timing Reconciliation Metadata Set (detailed in Table 10).

16-byte Set Designator[1]		Metadata Set or Element Name
Universal Set		
06 0E 2B 34 02 01 01 01	**07 02 01 03 01 00 00 00**	**Timing Reconciliation Metadata Set**
06 0E 2B 34 01 01 01 04	07 02 01 01 01 05 01 00	User Defined Time Stamp – Microseconds since 1970 (msb first)
06 0E 2B 34 01 01 01 04	03 01 03 03 03 01 00 00	Timing Bias Correction (microseconds – msb first)
06 0E 2B 34 01 01 01 03	03 01 03 03 04 00 00 00	Description of Timing Bias Correction
06 0E 2B 34 01 01 01 03	01 03 02 00 00 00 00 00	Item Designator ID

Table 10 –Timing Reconciliation Metadata Set

When a single metadata element is linked to a Timing Reconciliation Universal Metadata Set the Timing Reconciliation Universal Metadata Set shall contain an Item Designator ID whose Value is the 16-byte Universal Label Key for the single metadata element to which it is linked. The Timing Reconciliation Universal Metadata Set shall always preceed the metadata element to which it is linked. Figure 1 is an informative example of a Timing Reconciliation Universal Metadata Set linked to one metadata element.

When some but not all metadata elements within a set or pack must be linked to a Timing Reconciliation Unversal Metadata Set the Timing Reconciliation Universal Metadata Set shall contain one individual Item Designator ID for each metadata element to which it is linked. The Timing Reconciliation Universal Metadata Set shall always preceed all of the elements of the metadata set or pack to which it is linked.

When all metadata elements within a set or pack are linked to a Timing Reconciliation Universal Metadata Set and use of the method in 4.1 above may be ambiguous, the Timing Reconciliation Universal Metadata Set shall contain one individual Item Designator ID for the metadata set or pack to which it is linked. The Timing Reconciliation Universal Metadata Set shall always preceed the metadata set or pack to which it is linked.

5.1.3.3 Timing Reconciliation Universal Metadata Set Placement in Streams

When a Timing Reconciliation Universal Metadata Set is used within an MPEG-2 stream it the metadata linked to it shall always appear in each "I" frame. This does not preclude it also being used in "P" and /or "B" frames but its use in each "I" frame is mandatory.

[1] All Set UL Designators are tentative and may be changed as the SMPTE Sets Registry is developed.

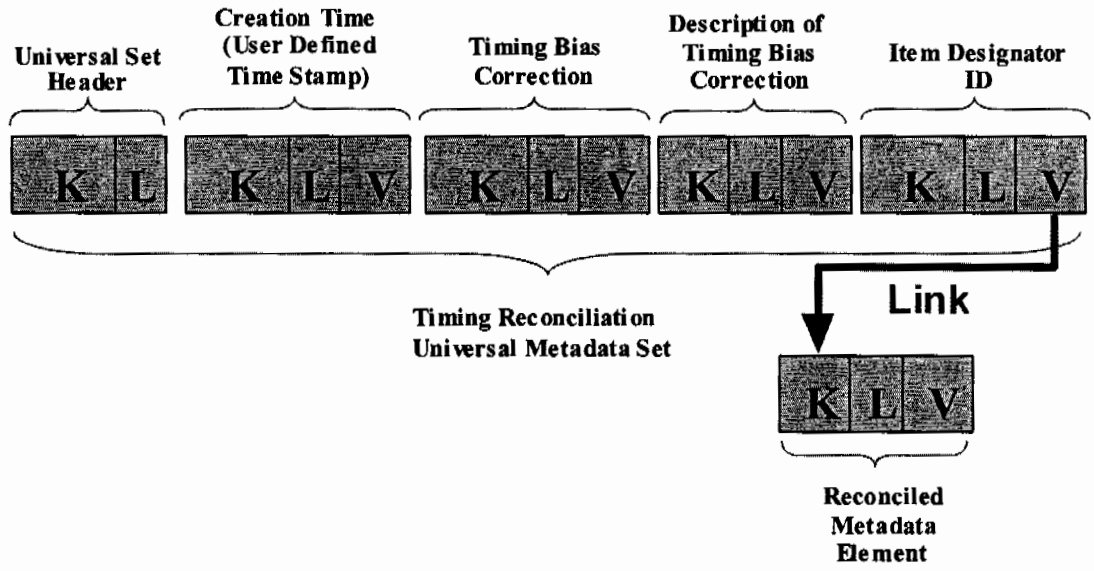

Figure 1 - Example of a Timing Reconciliation Universal Metadata Set Linked to a Metadata Element