MOTION IMAGERY STANDARDS PROFILE

Department of Defense/Intelligence Community/
National System for Geospatial Intelligence
(DoD/IC/NSG)
Motion Imagery Standards Board

MISP Version 5.1

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STANDARDS, INTEROPERABILITY PROFILES, RECOMMENDED PRACTICES AND ENGINEERING GUIDELINES FOR DoD/IC/NSG IMPLEMENTATIONS OF ELECTRO-OPTICAL MOTION IMAGERY SYSTEMS 19

PREFACE

This document summarizes the Motion Imagery Standards Profile (MISP), formerly known as the Video Imagery Standards Profile (VISP), work to-date by the Department of Defense/Intelligence Community/National System for Geospatial Intelligence (DoD/IC/NSG) Motion Imagery Standards Board (MISB), formerly known as the Video Working Group (VWG). MISB Points of Contact include:

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INTRODUCTION

Scope

In accordance with Department Of Defense Directive Number 5105.60 [1], which established the National Geospatial-Intelligence Agency (NGA); and whereas: "The NGA shall provide timely, relevant, and accurate imagery, imagery intelligence, and geospatial information in support of the national security objectives of the United States"; and whereas NGA shall: "Prescribe and mandate standards and end-to-end technical architectures related to imagery, imagery intelligence, and geospatial information for the DoD Components and for the non-DoD elements of the Intelligence Community…" to include:

> "Standards for end-to-end architectures related to imagery, imagery intelligence, and geospatial information"
>
> "Technical guidance and direction to all the DoD Components and the non-DoD members of the Intelligence Community regarding standardization and interoperability of systems requiring geospatial information or imagery support", and "for exploitation and dissemination of imagery and imagery intelligence products and geospatial information"

And whereas NGA shall: "Develop policies and provide DoD participation in national and international imagery, imagery intelligence, and geospatial information activities…"

The Motion Imagery Standards Board (MISB) is hereby designated as the organization, under the auspices of the National Center for Geospatial Intelligence Standards (NCGIS) Geospatial-Intelligence Standards Working Group (GWG) of the Information Technology Standards Committee (ITSC), to formulate, review and recommend standards for motion imagery, associated metadata, audio and other related systems for use within the Department of Defense / Intelligence Community / National System for Geospatial-Intelligence (DoD/IC/NSG). The MISB will formulate and make recommendations to the NCGIS on all proposed motion imagery, associated metadata, audio, and other related systems standards for compliance with the technical goals of the DoD Joint Technical Architecture (JTA), which is now the DoD IT Standards Registry (DISR), and NSG Technical Architecture (NTA). The MISB will therefore monitor and participate in changes to, and the implementation of, related motion imagery, metadata, audio, and associated systems standards in national and international arenas for impacts to DoD/IC/NSG Systems.

Motion Imagery Standards Board Mission

Whereas, motion (video) imagery has been recognized by the DoD/IC/NSG as a fundamentally important source of imagery intelligence, and whereas; improved battle-space/intelligence-space awareness using motion imagery (video) sensors has been identified as a key developing technology area in policy documents such as DoD Joint

Vision 2010; the mission of the MISB is to ensure the development, application and implementation of standards that maintain interoperability and quality for motion imagery, associated metadata, audio and other related systems in the DoD/IC/NSG. The MISB will monitor and participate in the development of and changes to adopted standards and assess their impacts on systems and DoD/IC/NSG architectures through community input and discussion. Additionally, the MISB will participate in the North Atlantic Treaty Organization (NATO) Standards Agreement (STANAG) process for coalition force interoperability and also participate in US and international standards bodies to monitor, advocate, and represent DoD/IC/NSG interests for motion imagery, associated metadata, audio, and related systems to support global interoperability and protect image and information quality.

This DoD/IC/NSG Motion Imagery Standards Profile (MISP) is a direct expression of the MISB mission and serves as the master baseline standards document prepared and managed by the MISB. The DISR (formerly JTA), NTA, and NATO will reference the MISB as shown in Figure 1–1 yielding seamless international interoperability for coalition force operations.

The following chronology illustrates the version development of the VISP/MISP:

- Version 1.00 was approved as the baseline document by GSMC-ISMC on 12 June 1997.
- VISP Version 1.10 was approved by GSMC-ISMC on 26 September 1997.
- VISP 1.20 was provisionally approved by the VWG on 19 November 1997.
- VISP 1.21, approved by the VWG on 7 January 1998, was the baseline motion imagery standards document for the Joint Technical Architecture (JTA) Version 2.0.
- VISP 1.30, approved by the ISMC on 6 March 1998, was initially proposed as the motion imagery standards baseline document for the JTA 3.0.
- VISP 1.4, approved by the ISMC on 12 August 1999, was the final baseline motion imagery standards document for the JTA, Version 3.0 and the NSG Technical Architecture, Revision A, 26 January 1999.
- VISP 1.5 was approved by the GSMC-ISMC on 24 February 2000.
- MISP 1.6 is the motion imagery standards baseline document for the JTA 4.0.
- MISP 1.7 was approved by the GSMC-ISMC on 1 March 2001.
- MISP 2.0 is the motion imagery standards baseline document for the JTA 6.0 and the ICSIS Horizontal Integration Baseline Document.
- MISP 2.4 is the motion imagery standards baseline document for DISR 05-1.0
- MISP 3.0 incorporated Infrared (IR) motion imagery standards.
- MISP 3.1 incorporated H.264 Compression

- MISP 3.2 added new MISM Levels for Situational Awareness
- MISP 3.3 recommends modes for IEEE 1394
- MISP 3.4: EG for UAV Datalink Metadata, RP for Universal Metadata Set
- MISP 3.5: RP for JPEG2000 and MJPEG2000 for WALF, EG for Metadata Registry, Standard for IR Digital Interface
- MISP 4.0 incorporated Draft RP's on Time References, Time Code in HD, Infrared Capture, Imagery ID, and Security Metadata
- MISP 4.1: RP0604 added; EG 0104 obliquity angle error identified; RP 0608 added; STUDY 0606 added.
- MISP 4.2: EG 0601updated to 0601.1 and mapping to EG 104.5; RP 0602 updated to 0602.1; RP 0604: MISB approved; RP 0608: updated to RP 0608.1; RP 0701: added and MISB approved; Added language for IR resolutions and frame rates; RP 0405: Metadata for IR: deleted
- MISP 4.3: Updated: RP 0102.2 to RP 0102.3; RP 0301 to RP 0301.2; EG 0601 to EG 0601.1; RP 0605 to RP 0605.1; RP 0608 to RP 0608.1; Added: RP 0705 on LVSD compression; Study 0701 on high bit-depth Infrared compression.
- MISP 4.4: Updated RP 0102.3 to RP 0102.4; made editorial changes to EG 0601.1; made changes to RP 0608.1; Added Study 0702 on ISO Base Media Format; and updated References.
- MISP 4.5: See Appendix D for updates.
- MISP 5.0: See Appendix D for updates.
- MISP 5.1: See Appendix D for updates.

All DoD/IC/NSG organizations that use motion imagery technologies are encouraged to participate in MISB activities and represent their specific requirements and issues.

MISP Document Format

Chapter 1 provides introductory material applicable to the entire MISP document. Chapter 2 documents APPROVED Commercial Standards, Interoperability Profiles, Recommended Practices and Engineering Guidelines for DoD/IC/NSG implementations. Please note several special cases in Chapter 2 where clearly identified sub-elements of an approved item still remain in STUDY status. Appendix A outlines EMERGING Standards, Profiles, and Recommended Practices (RP) that are still in STUDY status.

To address the need for balance between simply noting a standard and noting the why and how such a standard should be used, the MISP includes appendices which provide supplemental information users can refer to in order to better understand the underlying technical concepts of this document. Appendix B provides detailed citations and references for standards specified in the MISP. Appendix C identifies acronyms and abbreviations and Appendix D is a record of revisions.

The MISP points to a number of documents as normative references. As shown in Figure 1-1 they fall into the categories of Industry Standards that are the due-process standards followed by commercial vendors and developers; and MISB documents specifically developed for motion imagery applications when there are no industry standards to meet specific DoD/IC/NSG needs. Documents developed by the MISB include various Recommended Practices, Engineering Guidelines, and white papers describing among other things core metadata used in analog closed captioning systems, the updated versions to be used in digital systems, the use of KLV metadata in MPEG-2 system streams, the metadata dictionary and encoding document for placing metadata in digital bit streams, NITF wrappers for motion imagery, advanced file formats, and security/releasability marking of motion imagery and associated metadata.

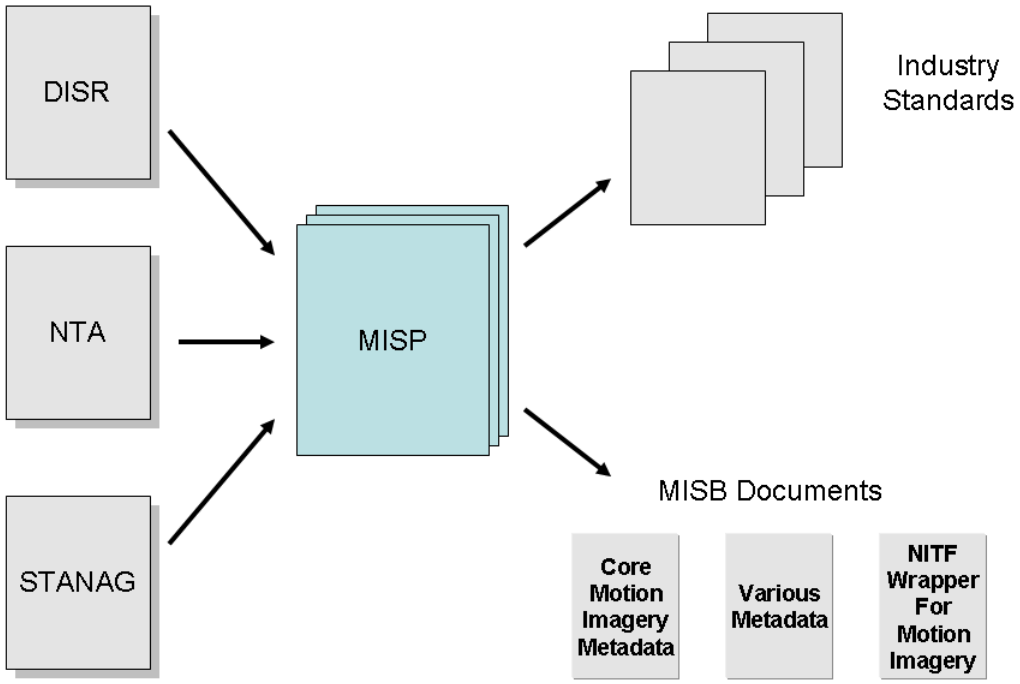

Figure 1-1. Other MISP Referenced Document Categories

Classes of Motion Imagery and Related Systems

In the broadest context of imagery applications, the major divisions are:

STILL Imagery / MOTION Imagery / SYNTHETIC Imagery

This document addresses applications associated with MOTION Imagery.

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, and must be sufficient to characterize the desired dynamic phenomena. Motion Imagery is defined as including metadata and nominally beginning at frame rates of 1 Hz (1 frame per second) or higher within a common field of regard. Full Motion Video (FMV) falls within the context of these standards.

Within the major division of MOTION Imagery, the following domains are currently specified:

1) Electro Optical (including Video and Television)
2) Infrared (including low-light television)
3) Multispectral (MSI) / Hyperspectral (HSI)

Electro Optical Domain

Within the Motion Imagery Electro-Optical domain, specific definitions are given for Video and Television sub-domains:

Video is defined as Electro-Optical motion imagery technologies defined by standards developed by the International Organization for Standards (ISO), International Telecommunication Union (ITU), Society of Motion Picture and Television Engineers (SMPTE), European Broadcasters Union (EBU), etc., reviewed, adopted and profiled for DoD/IC/NSG applications by designated DoD/IC/NSG standards bodies such as the MISB.

Television is defined as Video formats and implementations defined by Government Transmission Regulations such as NTSC, PAL, SECAM, FCC 4th Report and Order; reviewed, adopted and profiled for DoD/IC/NSG applications by designated DoD/IC/NSG standards bodies such as the MISB.

For analog technologies, there has always been a direct coupling of television and video waveforms, production, transmission, and receiver designs. With the advent of digital technologies; production, transmission and receiver systems can be de-coupled. Therefore, the requirements and or limitations of transmission regulations, typically specified for civilian (general public) applications, are not necessarily applicable for DoD/IC/NSG applications.

Motion Imagery Sub-Domains

Motion Imagery systems, defined as electro-optical motion imagery whose formats are governed by national and international standards, are divided into four (4) categories:

1. Motion Imagery Systems (used to create, process, manipulate, exploit, store, archive, and disseminate Motion Imagery, nominally video), both for real-

time and other end-user wide area product distribution, in support to imaging applications, including (but not limited to) Intelligence, Surveillance, and Reconnaissance (ISR), Exploitation, and all other motion imagery-based systems not specifically defined below.

2. Video Teleconference Systems provide real-time visual interchange between remote locations typically in support of meetings. When video teleconference systems are used for the display of motion imagery, the standards for motion imagery apply.
3. Video Telemedicine Systems provide real-time visual interchange between remote locations in biomedical applications including fiber optic and video teleconferencing.
4. Video Support Services enable end-user applications associated with motion imagery (video)-based training, newsgathering or other non-critical functions that do not directly support the warfighter. This includes traditional studio and field video productions, which are not associated with DoD warfighter operations.

Infrared

This document presents new standards for infrared systems. The MISB anticipates an intensive effort to add additional standards. When completed, the standards will be promulgated within future versions of the MISP.

Multispectral/Hyperspectral (MSI/HSI)

There are no standards defined for motion imagery MSI or HSI systems in this version of the MISP.

Motion Imagery Standards Profile Applicability to DoD/IC/NSG Communities

The MISP is applicable to all DoD/IC/NSG motion imagery systems that are subject to the DoD Joint Technical Architecture and the NSG Technical Architecture. All new motion imagery systems are required to be compliant with provisions of the MISP as soon as practical. All analog motion imagery systems are considered to be legacy systems as of 12 June 1997. In accordance with the MISP, all new systems are required to be based on digital motion imagery technology.

Note that by reference here, other classes, communities and users of motion imagery systems (Video Teleconference Systems and Video Telemedicine) are specifically excluded from the mandatory requirements of the MISP. However, when any of these other classes of motion imagery systems are used for the purpose of motion imagery data dissemination then the requirements and provisions of the MISP apply.

These and future to-be-defined motion imagery communities are encouraged to review the applicability of the standards given in the MISP and if deemed practical, implement MISP standards and recommended practices to foster broader interoperability across the entire DoD/IC/NSG/Federal spectrum. These separate communities are

specifically invited to join the DoD/IC/NSG MISB and merge their requirements into the ongoing development of the DoD/IC/NSG MISP document.

Definition of Terms

Standards

Where the MISP term STANDARD is used, the MISP item (chosen by specific MISB adoption, and approved by the NCGIS), mandates binding technical implementation policy, and as such, should be identified in Government procurement actions as a mandatory compliance item in order for vendor offerings to be accepted by the Government.

For point of clarification, in commercial practice the majority of identified standards (notably those from SMPTE) are considered to be "voluntary" standards, where equipment manufacturers and users are free to choose to comply or to not comply with the standard. Standards, as represented in this MISP are not considered voluntary for DoD/IC/NSG users and systems. They are mandatory.

Profiles

Where the MISP term PROFILE is used, the MISP item documents an extension to a STANDARD developed or specified to meet DoD/IC/NSG unique mission requirements not normally covered by commercial standards. MISP PROFILES (chosen by specific MISB adoption, and approved by the NCGIS) mandate binding technical implementation policy, and as such, should be identified in Government procurement actions as a mandatory compliance item in order for vendor offerings to be accepted by the Government.

Recommended Practices/Engineering Guidelines

Where the MISP term RECOMMENDED PRACTICE is used, the MISP item documents a recommended implementation or practice that further clarifies the implementation of a STANDARD or PROFILE in order to insure interoperability across DoD/IC/NSG systems. Recommended Practices chosen by specific MISB adoption should be considered to be a technical implementation policy, and as such, may be identified in Government procurement actions as a mandatory compliance item in order for vendor offerings to be accepted by the Government. Engineering Guidelines represent good engineering principals and therefore, should be implemented if at all possible.

Emerging Standards/Studies

Where the MISP term STUDY is used, the MISP identifies a preliminary version of an anticipated and or emerging STANDARD, PROFILE, RECOMMENDED PRACTICE or Engineering Guideline where the primary initial parameters are outlined and understood but additional coordination or engineering analysis is required. Such items will be forwarded to the appropriate MISB sub-group or ad-hoc committees for action item work-off, with TBD completion suspense dates. At the time of formal adoption, the STUDY will become a standard, profile, recommended practice, or

engineering guideline. Until formally adopted by the MISB there is no requirement to implement any portion of any STUDY item.

MISP COMPLIANCE DEFINITION

Motion Imagery Standards Profile (MISP) compliance is based upon compliance to a specified approved version of the MISP (e.g. MISP Version (V) 4.4, MISP V4.5, etc.). The motion imagery system supplier specifies the MISP version for which it is seeking compliance along with three qualifications: the MISM-Level for video compression, the file format for transport or storage, and the metadata RP/EG/STDs used. MISM levels are as defined per the MISP version specified by the system supplier. All signals tested are assumed digital. Supported video compression includes MPEG-2, MPEG-4 Part 10 (i.e. AVC or H.264) and JPEG 2000. Supported file formats include MPEG-2 transport stream, MXF and AAF. Furthermore, if the motion imagery system uses MXF/AAF it shall comply with Standard 0301. Metadata is tested for compliance to the specified version of the MISP and respective EG's/RP's. Draft RPs/EGs will not be tested until approved by the MISB. Additional EG 0104 Metadata, thus not contained within the EG 0104 local dictionary set, may be used from the MISB Metadata Registry and the SMPTE RP210; such metadata is considered optional. All Metadata shall be contained within EG 0104, Standard 0102, Standard 0601, draft RP 0701/2/3, or EG 0801 defined KLV keys. The motion imagery system may include other MISB RPs/EGs of their choice including, for example, RP 0608[56], RP 0602[73] and/or RP 0103[72], although these are not required for compliance. In addition, Security metadata shall comply with MISB Standard 0102.

(18 September 2008- MISB approved)(11 December 2008- MISB approved)

Frame Rate Annotation

The MISP has attempted to use the following consistent scanning format and frame rate annotations throughout all of the specified MISP profiles:

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 This is the frame rate associated with "television" in the United States
25i	=	25 FPS, Interlace Scanned, yielding 50 fields per second
24i	=	24 FPS, Interlace Scanned, yielding 48 fields per second
24i/1.001	=	23.98 FPS (NTSC compatible frame rate), Interlace Scanned

For Infrared motion imagery, frame rates of 25, 30, 50, and 60 are preferred, but lower and higher frame rates are allowed and tolerance in the system should allow for 1/1.001 of 30 Hz and 1/1.001 of 60 Hz.

Standard, Enhanced, and High Definition

The MISP has attempted to use the following consistent scanning format definitions throughout all of the specified MISP profiles (see Recommended Practice 9720, Motion Imagery System Matrix for detailed technical specifications for each format):

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, progressively scanned at temporal rates at or greater than 24 Hz.

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

Note: It is DoD/IC/NSG policy to migrate to all progressive scanning formats as soon as practical. However, it is recognized that 720x480 and 720x576 interlace systems compose the bulk of existing DoD/IC/NSG motion imagery imaging systems, and that such systems will continue to be used until the end of their practical service life. Such existing interlace systems must not be replaced with new interlace systems.

Infrared (IR) motion imagery is defined in a similar manner to that above. The resolution classes of IR are 160x120, 320x240, 640x480 (including 640x512, 720x480, 720x512, and 720x576), 1024x720 (including 1280x720 and 1024x1024), 1920x1080, and 2048x2048 progressively scanned. Interlaced scanning IR systems are to be treated as legacy systems and shall be replaced with progressive systems at the end of their service lives. See Recommended Practice 0401 for details.

Bit Depths

Bit depths of 8 bits are common in electro-optical motion imagery although critical viewing suggests that 10 and 12 bits are preferred. Infrared motion imagery typically has higher bit depths such as 12 and 14 bits, which are preferred.

DoD/IC/NSG Motion Imagery Migration Objectives

DoD/IC/NSG user communities have diverse mission requirements and will select diverse motion imagery systems, across a range of capabilities, to meet system performance objectives. This section outlines the desired end-state of DoD/IC/NSG motion imagery capabilities. Not all users will require a migration to the highest possible spatial and temporal resolution, but all users should be aware of the target end-objectives for motion imagery capabilities for the DoD/IC/NSG as described below:

1) The fundamental end-objective for DoD/IC/NSG motion imagery systems is to move to all digital, progressive scan processing, and square pixels; moving to higher spatial, temporal, and spectral resolutions as technology becomes available.

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

3) Standard definition, digital interlace (ITU-R BT.601-5 [7], 4:2:2 component processing), using serial digital interfaces (SDI, SMPTE 259M/291M) is a logical and most economical upgrade from analog 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.

4) Enhanced definition, digital progressive (720x480x60p and 720x576x50p) can be considered to yield (as of 2000) 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 there are 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.

5) High Definition, progressive scan imagery (SMPTE 296M-2001) is the desired end-state for DoD/IC/NSG motion imagery systems. 1280x720x(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. 1920x1080x(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 1920x1080x24p/25p/30p systems in special limited applications with controlled environments (such as studio production, training, etc.). The anticipated dynamic geo-political landscape and military battlespace environment envisioned by Joint Vision 2010 requires a complex trade space of maximal spatial and temporal resolution, thus 1280x720x(50)60p will remain the objective architecture end-goal.

Situational Awareness

Situational Awareness is the human perception of the elements of the operational environment in the context of forces, space and time, the comprehension of their meaning, and the projection of their status in the near future.

A Situational Awareness Product is a concise, transportable summary of the state of friendly and enemy elements conveyed through information such as full-motion video (FMV), imagery, or other data that can contribute to the development of Situational Awareness either locally or at some distant node.

General Implementation Notes and Document Philosophy

It is the intent of the MISP to give users a consolidated, clear and concise view of the standards they will need to build and operate motion imagery systems. The MISP 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. All of the technology outlined in the MISP document is based on commercially available (or very near term available) systems and components based on defined open standards.

However, no single commercial motion imagery standard provides all of the guidance necessary to build interoperable systems for use across the diverse missions of DoD/IC/NSG. Therefore, the MISP is a collection of standards and practices on how component systems based on commercial standards can interconnect and provide interoperable service to DoD/IC/NSG users. It is useful to consider the MISP to be a specific technology (motion imagery) domain document that defines concepts necessary for building interoperable, end-to-end motion imagery systems that are based on commercial motion imagery technology. One specific example of the need for clearly defined profiles and recommended practices is the case of MPEG-2, where the commercial MPEG-2 standard broadly defines a capability that maximizes flexibility, but does not guarantee interoperability. By carefully selecting "nominal" values from the ranges of choices within a standard, standards management groups and users can better shape interoperability for their classes of applications. It is also noted that in order for standards to achieve interoperability objectives, systems procured for DoD/IC/NSG missions must have certification authorities that warrant that the systems are compliant with applicable standards and that the systems do what the vendors claim they will do.

The technology of the commercial motion imagery industry, some that DoD/IC/NSG users procure and use to meet government missions is in a significant transition phase from analog to digital. Over many years, organizations such as SMPTE have worked to standardize motion imagery systems to facilitate interoperability for the highest quality production environments. Such standardization has supported the production industry by giving broadcasters and production centers confidence that systems from multiple vendors would work interchangeably within the production environment, while also preserving the highest possible quality. Migration to digital motion imagery production technology has followed similar patterns, where SMPTE standards have been in place for several years to facilitate interoperability of the highest quality digital production systems. Unfortunately, open standards have not been defined for very low bandwidth motion imagery. For such low bandwidth cases, universal interoperability is rightly a significant concern for DoD/IC/NSG managers. There are proprietary vendor products that claim "standard" status based on market share, but such proprietary products do not presently meet DoD/IC/NSG guidelines for adoption as approved standards.

Therefore, the MISP identifies commercial standards that define interoperability for high-image-quality environments and systems (such as common control vans, interconnections nodes, and DoD/IC/NSG command centers), including high bandwidth

transmission of uncompressed and lower bandwidth transmission of compressed motion imagery (video) signals. The MISP also identifies approaches for interoperability between high bandwidth and low bandwidth systems. DoD users that adopt proprietary compression systems for extremely low bandwidth applications are cautioned that such systems are generally not supported by DoD/IC/NSG, and that the interoperability of such systems is not assured.

The Profiles, Recommended Practices and Studies of this document are included to expressly focus DoD/IC/NSG uses of commercial standards in order to better manage and support mission interoperability. Table 1-1 summarizes the Standards, Interoperability Profiles and Recommended Practices for DoD/IC/NSG Implementations, and Motion System Recommended Practices forming the basis of this Motion Imagery Standards Profile document. However, Table 1-1 shall not be used in lieu of the detailed descriptions of this document. Table 1-2 summarizes studies for potential emerging Standards, Interoperability Profiles and Recommended Practices for DoD/IC/NSG Implementations.

Table 1-1. Summary of MISB Standards (STD), Recommended Practices (RP), and Engineering Guidelines (EG)

Item		Formal Standard Tailored by MISP	Common Name of Tailored Standard
1.0	**STANDARDS, INTEROPERABILITY PROFILES, RECOMMENDED PRACTICES AND ENGINEERING GUIDELINES FOR DoD/IC/NSG IMPLEMENTATIONS**		
1.1	**Motion Imagery Systems**		
RP 9720	Motion imagery System Descriptions		Motion Imagery System Matrix (MISM)
Study 9720a	Advanced High Definition Motion Imagery		MISM Levels 12-14
RP 9720b	High Definition Motion Imagery		MISM Levels 9-11
RP 9720c	Enhanced Definition Motion Imagery		MISM Levels 6-8
RP 9720d	Standard Definition Motion Imagery		MISM Levels 3-5
RP 9720e	Low Spatial/Temporal Motion Imagery		MISM Levels 1-2
RP 9720f	Very Low Temporal Motion Imagery		MISM Level 0
RP 9721	Motion Imagery Tape Formats		
1.2	**Standard Definition Motion Imagery**		
STD 9601	Standard Definition Digital Motion Imagery, Compression Systems	ISO/IEC 13818 [2,3,4,5]	MPEG-2
STD 9701	Standard Definition Digital Motion Imagery, Compression Systems	ISO/IEC 13818 [2,3,4,5] ITU-T H.264 [6]	MPEG-2 MP @ ML H.264/AVC
STD 9702	Standard Definition Digital Motion Imagery Sampling Structure	ITU-R BT.601 [7]	4:2:2 Component Digital Video
STD 9703	Digital Motion Imagery, Uncompressed Baseband Signal Transport and Processing	SMPTE 259M [8]	Serial Digital Interface (SDI)
STD 9704	Digital Motion Imagery, Compression Conversions	ITU-R BT.601 [7] SMPTE 259M [8]	4:2:2 Component Digital video Serial Digital Interface (SDI)
STD 9705	Standard Definition Digital Motion Imagery, Format Conversions	ITU-R BT.601 [7] SMPTE 259M [8]	4:2:2 Component Digital video Serial Digital Interface (SDI)
STD 9707	Standard Definition Digital Motion Imagery Tape Recorder, Digital Motion Imagery Server, and Similar Systems Input/Output Protocol	SMPTE 259M [8] IEEE 1394 [9]	Serial Digital Interface (SDI) HP Serial Bus
STD 9803	Serial Data Transport Interface	SMPTE 305M [10]	SDTI
STD 9901	Fiber Optic Interfaces Uncompressed Baseband Signal Transport and Processing	SMPTE 297M [11] SMPTE 259M [8]	Fiber Optic Standard Connector Types

RP 9902	Authorized Limited Application of DV Format Video	DV Format IEEE 1394 [9]	DV Format Video HP Serial Bus
EG 0803	Delivery of Low Bandwidth Motion Imagery	ITU H.264 L1.0 -2.2 [6]	MISM L1 and L2
RP 0804	Real Time Protocol for Full Motion Video	IETF RFC 3550 [12]	RTP
Migration to Digital			
STD 9719	Analog Video Migration	ANSI/SMPTE 170M [13] ITU-R BT.601 [7]	Analog video 4:2:2 Component Digital video
STD 9709	Use of Closed Captioning for Core Metadata Analog Video Encoding	EIA-608 [14] 47 CFR 15.119 [EIA-708 [15] for HDTV]	Recommended Practice for Line 21
1.3 Enhanced Definition Motion Imagery			
STD 9811	Progressively Scanned Enhanced Definition Digital Motion Imagery	ITU-R BT.1358 [16] SMPTE 292M [17] SMPTE 349M [18]	Progressive Scan EDTV Serial Interface
1.4 High Definition Motion Imagery			
STD 9710	High Definition Television Systems (HDTV)	SMPTE 274M [19] SMPTE 292M [17] SMPTE 296M [20] SMPTE 295M [21]	1920x1080 HDTV and Interface Bit-Serial Interface 1280x720 HDTV and Interface 1920x1080 50 Hz HDTV and Interface
STD 9723	Compressed High Definition Advanced Television (ATV) and Associated Motion Imagery Systems	ISO/IEC 13818 [2,3,4,5] ATSC Doc. A/53 [22]	MPEG-2 MP @ HL U.S. Advanced Television
STD 9703 Processing	Digital Motion Imagery, Uncompressed Baseband Signal Transport and	SMPTE 292M [17]	Serial Digital Interface (SDI) Bit-Serial Interface
1.5 Low Spatial/Temporal Motion Imagery			
STD 9706	Video Image Still Frames	MIL STD 2500B - NITF 2.1 [23]	Video Still Specification
1.6 Metadata			
STD 9708	Embedded Time Reference for Video Systems	SMPTE 12M [24] SMPTE 309M [25]	SMPTE Time Code MJD
STD 9711	Intelligence Motion Imagery Index, Geospatial Metadata	Core Motion Imagery Metadata Profile	Core Metadata V 1.0 [26]
STD 9712	Intelligence Motion Imagery Index, Content Description Metadata (Dynamic Metadata Dictionary Structure and Contents)	SMPTE 335M [27] SMPTE RP210.9 [28] SMPTE EG 37 [29]	Metadata Dictionary Structure Metadata Dictionary Contents Dictionary Node Structure
STD 9713	Data Encoding Using Key-Length-Value (KLV)	SMPTE 336M [30]	KLV Protocol

STD 9714	Time Code Embedding	ITU-R BT.601 [7] SMPTE 259M [8] SMPTE 292M [17] SMPTE 309M [25]	D-VITC SMPTE Ancillary Time Code SMPTE Ancillary Time Code MJD
STD 9715	Time Reference Synchronization		Time Code synchronized to GPS
STD 9716	Packing KLV Packets into SMPTE 291 Ancillary Data Packets	SMPTE 291M [31]	SDI Bit-Serial Interface Metadata Encoding
STD 9717	Packing KLV Packets into MPEG-2 Systems Streams	ISO/IEC 13818 [2,3,4,5] SMPTE RP 217 [32]	MPEG-2 Metadata Encoding
STD 9718	Packing KLV Packets into AES3 Serial Digital Audio Streams	AES-3 SMPTE 355M [33]	AES-3 Metadata Encoding
RP 0101	Use of MPEG-2 System Streams in Digital Motion Imagery Systems	ISO/IEC 13818-1 [2]	MPEG-2
STD 0102	Security Metadata Universal Set for Digital Motion Imagery	CAPCO Authorized Classification and Control Markings Register	
RP 0103	Timing Reconciliation Universal Metadata Set for Digital Motion Imagery	SMPTE 336M [30]	KLV Protocol
EG 0104	Basic Predator KLV Metadata	SMPTE 336M [30]	KLV Protocol
EG 0107	Bit and Byte Order for Metadata in Motion Imagery Files and Streams		big-endian
STD 0601	UAS Datalink Local Metadata Set		Defines the bit-efficient, extensible SMPTE KLV Local Metadata Set designed for a wireless communications link (Datalink)
EG 0607	Metadata Registry and Processes	SMPTE 335M [27] SMPTE RP210 [34]	Metadata Dictionary Structure Metadata Dictionary Contents
RP 0602	Annotation Universal Metadata Set		Annotation
RP 0603 Motion	Common Time Reference for Digital Imagery using Coordinated Universal Time (UTC)	GPS Standard Positioning Specification, June 2, 2005 Assistant Secretary of Defense for Command, Control, Communications and Intelligence, “Global Positioning Standard Positioning Service Performance Standard”, Sections 1.4, 1.4.2, A-1.3.2.3, A2.4	

STD 0604	Time Stamping of Compressed Motion Imagery	ISO/IEC 13818 -1 [2] MISB RP 0603 [35]	Time stamping Compressed Motion Imagery
RP 0605	Inserting Time Code and Metadata in High Definition Uncompressed Video	SMPTE 12M [24] SMPTE RP 188 36] SMPTE RP 214 [37]	SMPTE Time Code Metadata Dictionary Contents Packing KLV Encoded Metadata and Data Essence into SMPTE 291M Ancillary Data Packets
RP 0606	Authorized Use of JPEG 2000 or Motion JPEG 2000 for Wide Area Large Format Motion Imagery	(ISO/IEC 15444 [38] in various Parts)	More detail on format, and metadata is required
RP 0608	Motion Imagery Identifier		Format and encoding of the Motion Imagery Identifier (MIID). defines the Motion Imagery Stream Identifier (MI_Stream_ID)
RP 0701	Common Metadata Structure		How to organize the sensor/platform data into a hierarchy of KLV Packs and Local Sets that reduces the bandwidth needed to transmit the data.
EG 0801	Photogrammetry Metadata Set		Photogrammetry Metadata
EG 0805	Cursor on Target conversion for KLV Metadata		CoT
EG 0806	Remote Video Terminal Local Data Set		RVT
STD 0807	DoD/IC/NSG Motion Imagery Metadata Registry		Metadata Registry
EG 0809	KLV Representation of Meteorological Data		Meteorological Metadata
1.7 File Formats			
STD 9701	MPEG-2 Transport Stream	ISO/IEC 13818-1 [2]	Xon2
RP 0106	Advanced Authoring Format	AAF	AAF
RP 0107	Material Exchange Format	MXF	MXF
STD 0301	MISB Profile for Aerial Surveillance and Photogrammetry Applications (ASPA)	ASPA Profile	ASPA Profile
EG 0812	Clipping of Streaming Video into Files		Clipping
EG 0813 Integration of Motion Imagery into the Coalition Shared Database			FMV in CSD

Table 1-2. Summary of Studies for Potential Emerging Standards (STD), Recommended Practices (RP), and Engineering Guidelines (EG)

Item	Formal Standard Tailored by MISP	Common Name of Tailored Standard
A. EMERGING STANDARDS, INTEROPERABILITY PROFILES AND RECOMMENDED PRACTICES FOR DoD/IC/NSG IMPLEMENTATIONS		
STUDY 9801 MPEG-4	ISO/IEC 14496 [39]	Coding of Audiovisual Objects
STUDY 9802 MPEG-7	ISO/IEC 15938-1 [40]	Multimedia content description interface
STUDY 9803 Serial Data Transport Interface	SMPTE 305M [10]	SDTI – Content Package
STUDY 9804 Colorimetry		
STUDY 9805 Standard Motion Imagery Test Materials		
STUDY 9808 Still Imagery Derived from Motion Imagery		
STUDY 9809 Audio Interchange	SMPTE 259M [8] SMPTE 292M [17] ISO/IEC 13818–3 [4]	AES3 Audio AES3 Audio MPEG-2 Audio; Dolby AC-3
STUDY 9810 Low Bit-Rate Motion Imagery		
STUDY 9903 MPEG-2 Embedded Subheader	ISO/IEC 13818-1,2 [2,3] MIL STD 2500B - NITF 2.1 [23]	MPEG-2 Video Still Specification
STUDY 9904 NITF Support for Motion Imagery	ISO/IEC 13818-1,2 MIL STD 2500B - NITF 2.1 [23]	MPEG-2 Video Still Specification
STUDY 0002 MPEG and KLV Interoperability		
STUDY 0003 Advanced High Definition Television		
STUDY 0004 Motion Imagery Security, Authentication, and Encryption		
STUDY 0105 Unmanned Vehicle KLV Metadata		
STUDY 0106 Advanced File Formats	AAF, MXF	AAF, MXF
STUDY 0108 Metadata for Scathe View		
STUDY 0109 Precision Engagement Metadata		
STUDY 0201 Motion Imagery Intelligence Annotation Standard and Transport		
STUDY 0202 Transport of H.264 on MPEG-2	ITU-T Rec. H.222 [42]	Xon2
STUDY 0301 DoD/IC/NSG Profile of the SMPTE KLV Metadata Dictionary		
STUDY 0302 60.000/30.000 Frames Per Second Video		

STUDY 0303	AAF – MXF Use Guidance		
STUDY 0304	MPEG-2 Transport Stream Synchronous Metadata		
STUDY 0401	Common Metadata Descriptor Documents		
STUDY 0402	Develop Infrared Motion Imagery Standards		
STUDY 0501	Study and Propose MI Interface Standards where Applicable		
STUDY 0502	Study and Propose MI Standards for Situational Awareness		
STUDY 0503	Study and Propose MI Standards for Delivery of Sensor/Platform Metadata		
STUDY 0601	Study and Propose Compression Methods for Advanced High Definition Motion Imagery Levels L12 and L13		
STUDY 0602	Study and Propose Methods for Time Stamping of Metadata of MI for Reliable Synchronization		
STUDY 0603	MISB Metadata Registry		
STUDY 0604	Cursor-on-Target (CoT)		
STUDY 0605	Encoder Tradeoffs		
STUDY 0606	MI Metadata Only Formats and Distribution Standards		
STUDY 0701	High bit depth Infrared Compression		
STUDY 0702	ISO Base Media Format		

STANDARDS, INTEROPERABILITY PROFILES, RECOMMENDED PRACTICES AND ENGINEERING GUIDELINES FOR DoD/IC/NSG IMPLEMENTATIONS OF ELECTRO-OPTICAL MOTION IMAGERY SYSTEMS

Motion Imagery Systems

All MISP compliant systems shall decode all MPEG-2 transport streams with MPEG-2 compressed data types (Standard Definition, Enhanced Definition, High Definition) up to and including Level 9M and all H.264 compressed data types up to and including Level 9H, but each system may choose to ORIGINATE one, two or all data types. Level 9 is defined in the Motion Imagery System Matrix (MISM) as found below. Likewise, all relevant Infrared MI systems shall decode all MPEG-2 transport streams with MPEG-2 compressed data types up to and including Level 8M and all H.264 compressed data types up to and including Level 8H, but each system may choose to ORIGINATE either compression type at whatever level it chooses. The levels of the Visible Motion Imagery System Matrix are found in RP 9720 below and those of the IR System Matrix are found in RP 0401.

RECOMMENDED PRACTICE 9720 - Motion Imagery System Matrix

A "Motion Imagery Systems (Spatial and Temporal) Matrix" (MISM) shall define a Recommended Practice for the simple identification of broad categories of Motion Imagery Systems. The intent of the MISM is to give user communities an easy to use, common shorthand reference language to describe the fundamental technical capabilities of DoD/IC/NSG motion imagery systems. The "Motion Imagery Systems Matrix" includes tables of Technical Specifications and related Notes.

Furthermore, the "Motion Imagery System Matrix - Levels" (MISM-L0 to MISM-L14, where MISM-L14 defines the highest spatial and temporal resolution systems) should only be applied to a single processing node of the end-to-end motion imagery chain, with the overall system specification equaling, at best case, the lowest motion imagery system processing node specification.

The MISM (RP 9720, Revision 1) is divided into six bands:

9720a	Advanced High Definition Motion Imagery (MISM-L12 to MISM-L14)
9720b	High Definition Motion Imagery (MISM-L9 to MISM-L11)
9720c	Enhanced Definition Motion Imagery (MISM-L6 to MISM-L8)
9720d	Standard Definition Motion Imagery (MISM-L3 to MISM-L5)
9720e	Low Spatial/Temporal Definition Motion Imagery (MISM-L2 to MISM-L1)
9720f	Very Low Temporal Definition Motion Imagery (MISM L0)

Table 2-1 depicts the general outline of the MISM Levels. The following Tables and their accompanying Technical Notes provide detailed technical specifications of the general performance of each MISM-L level. Please note that the technical parameters of

each major MISM-L sub-division will be individually evaluated for adoption by the MISB.

MISM-L includes new tabular descriptions of Motion Imagery system attributes, to include: Spatial Definition (Very High, High, Enhanced, Standard, Low, and Very Low); Temporal Definition (Very High, Medium to High, Standard, Low, and Very Low); Generation Resiliency (High, Medium, Low, Very Low). The levels may be further identified as **M** for MPEG-2 compression and **H** for H.264 compression. For example see Level 7, which can be Level 8M or Level 8H.

RP	MISM - L	Description
9720a	14	Advanced High Definition Motion Imagery
	13	
	12	
9720b	11	High Definition Motion Imagery
	10	
	9	
9720c	8	Enhanced Definition Motion Imagery
	7	
	6	
9720d	5	Standard Definition Motion Imagery
	4	
	3	
9720e	2.2	Low Spatial/Temporal Definition Motion Imagery
	2.1	
	2.0	
	1.3	
	1.2	
	1.1	
	1.0	
9720f	0	Low Temporal Definition Motion Imagery

Table 2-1. Motion Imagery System (Spatial and Temporal) Matrix-Levels (MISM-L)
(VWG, 10 July 1997 - Adopted) (ISMC, 26 September 1997 - Approved) (VWG, 8 June 1999, Language Revised and Recommended to GSMC-ISMC for Approval) (GSMC-ISMC, 12 August 1999 – Approved)(27 July 2000 –Editorial Changes)(10 July 2006 –9720e Changes)

RECOMMENDED PRACTICE 9720a - MISM, Advanced High Definition Motion Imagery

System Level	MISM		
	L14	L13	L12
Common Description/ Intended Application	Advanced High Definition (AHD) / Acquisition	Advanced HD / Processing / Archiving	Advanced HD / Distribution
System Attributes: Spatial Definition	Very High	Very High	Very High
System Attributes: Temporal Definition	Very High	Very High	Very High
System Attributes: Generation Resiliency	High	Medium	Low
Applicable Standard (Note: Other Profiles / Practices may apply)	TBD	TBD	TBD
Horizontal Resolution (Nominal)	≥ 1920	≥ 1920	≥ 1920
Vertical Resolution (Nominal)	≥ 1080p	≥ 1080p	≥ 1080p
Bit Depth (bits) (Nominal)	8 or 10 or 12	8 or 10 or 12	8 or 10 or 12
Frame Rate (FPS)	48 - 120	48 - 120	48 - 120
Compression Ratio (Nominal)	zero	TBD	TBD
Data Rate (Nominal)	3 - 4 Gb/s	TBD	TBD
Data Rate Range	TBD	TBD	TBD
Candidate Transport Channel (Nominal Rates)	OC-96-192	TBD	TBD
Allowed Transport Protocols	TBD	TBD	TBD
Preferred Transport Protocols	TBD	TBD	TBD

Table 2-2. Advanced High Definition Motion Imagery (Study 9720a)

STUDY 9720a - MISM, Advanced High Definition Motion Imagery Technical Notes

MISM-L14 Motion Imagery System Matrix-Level 14 (MISM-L14), Uncompressed Advanced High Definition Motion Imagery, is defined as including the following specific acquisition formats:

Resolution	Frame Rate	Aspect Ratio
1920 x 1080	60p, 50p	16:9
2048 x 1080	48p	1.896
1998 x 1080	48p	1.85
2048 x 858	48p	2.39

MISM-L14 Note 1: Only PROGRESSIVE SCAN formats are authorized for advanced high definition DoD/IC/NSG Motion Imagery acquisition applications (systems used to originate, acquire, produce, process, manipulate, exploit, store, archive and disseminate motion imagery in support to imaging applications, including (but not limited to) Intelligence, Reconnaissance, and Surveillance).

MISM-L13 Motion Imagery System Matrix Level 13 (MISM-L13), Mezzanine Compression Advanced High Definition Motion Imagery is defined as any HD format of MISM-L14 using mild compression. MISM-L13 is intended to describe Advanced HD signals that use mild compression to process and transport Advanced HD signals.

MISM-L12 Motion Imagery System Matrix-Level 12 (MISM-L12) is defined as any HD format of MISM-L14/13 that is highly compressed to use end-user (final link) transport delivery.

Note about bit depths: While multiple bit depths are allowed, greater bit depths are preferred. For example, if 12-bit, 10-bit and 8-bit implementations are allowed under the standard, 12-bit implementations are preferred.

(Recommend for Study 8 June 1999) (27 July 2000 – Editorially Revised) (29 April 2005– MISB approved) (13 December 2007 – MISB approved)

RECOMMENDED PRACTICE 9720b - MISM, High Definition Motion Imagery

System Level	MISM				
	L11	L10M/H		L9M/H	
Common Description/ Intended Application	High Definition / Acquisition	High Definition / Processing / Archiving		High Definition / Distribution	
System Attributes: Spatial Definition	High	High		High	
System Attributes: Temporal Definition	Medium - High	Medium - High		Medium - High	
System Attributes: Generation Resiliency	High	Medium		Low	
Applicable Standard (Note: Other Profiles / Practices may apply)	SMPTE 296 [20], Progressive modes of SMPTE 274M[19], 295M[21], 292M[17]	SMPTE 296M[20], Progressive modes of SMPTE 274M[19], 295M[21] MPEG-2 MP@HL	SMPTE 296M[20], Progressive modes of SMPTE 274M[19], 295M[21] H.264[6] MP@L4.1(8b) H.264 HP@L4.1 (8b) H.264 Hi10P@L4.1 (10b)	SMPTE 296M[20], Progressive modes of SMPTE 274M[19], 295M[21] MPEG-2 MP@HL	SMPTE 296M[20], Progressive modes of SMPTE 274M[19], 295M[21] H.264[6] MP@L3.2(720) H.264 MP@L4.0 H.264 HP@L4.0
Horizontal Resolution (Nominal)	1280 - 1920	1280 -1920		1280 - 1920	
Vertical Resolution (Nominal)	720p - 1080p	720p - 1080p		720p - 1080p	
Bit Depth (bits) (Nominal)	8 or 10	8	8 or 10	8	
Frame Rate (FPS)	24 - 60	24 – 60 (720p) 24 – 30 (1080p)		24 – 60 (720p) 24 – 30 (1080p)	
Compression Ratio (Nominal)	zero	10:1	20:1	45:1	80:1
Data Rate (Nominal)	1.485 Gb/s	80 Mb/s	40 Mb/s	19.4 Mb/s	10 Mb/s
Data Rate Range	0.36 - 2.4 Gb/s	34 - 100 Mb/s	17 - 50 Mb/s	10 - 44.7 Mb/s	5 - 20 Mb/s
Candidate Transport Channel (Nominal Rates)	SMPTE 292M[17], OC-48	SDI, E3, T3, OC-12	T3	TCDL, Half to Full T3, ATM	TCDL
Allowed Transport Protocols	Xon2 MXF/AAF	Xon2 MXF/AAF	Xon2 MXF/AAF	Xon2 MXF/AAF	Xon2 MXF/AAF
Preferred Transport Protocols	MXF Xon2	MXF Xon2	MXF Xon2	MXF Xon2	MXF Xon2

Table 2-3. High Definition Motion Imagery (Recommended Practice 9720b)

RECOMMENDED PRACTICE 9720b - MISM, High Definition Motion Imagery Technical Notes

MISM-L11 Motion Imagery System Matrix-Level 11 (MISM-L11), Uncompressed High Definition Motion Imagery, is defined as including the following specific acquisition formats:

Resolution	Frame Rate	Aspect Ratio
1920 x 1080	30p, 25p, 24p	16:9
1280 x 720	60p, 50p, 30p, 25p, 24p	16:9

MISM-L11 Note 1: Only PROGRESSIVE SCAN formats are authorized for high definition DoD/IC/NSG Motion Imagery acquisition applications (systems used to originate, acquire, produce, process, manipulate, exploit, store, archive and disseminate motion imagery in support to imaging applications, including (but not limited to) Intelligence, Reconnaissance, and Surveillance).

MISM-L11 Note 2: Two systems are not recommended: 1920x1080x30i (60 field per second interlace) and 1920x1080x25i (50 field per second interlace), but may be considered for end-user display systems in non-critical applications.

MISM-L10 Motion Imagery System Matrix-Level 10 (MISM-L10), Mezzanine Compression High Definition Motion Imagery is defined as any HD format of MISM-L11 using mild compression. MISM-L10 is intended to describe HD signals that use mild compression to transport and process HD signals using, for example, SMPTE 259M[8] bit-serial interfaces (SDI). Note that a lower data rate can be obtained for the same motion image quality using H.264 versus MPEG-2. H.264 L4.1 can be used for data rates up to 50 Mb/s. The H.264 High profile should be used for 10- and 12- bit motion imagery.

MISM-L9 Motion Imagery System Matrix-Level 9 (MISM-L9) is defined as any HD format of MISM-L11/10 that is highly compressed to use end-user (final link) transport delivery, such as the ATV transport delivery system in the US. MISM-L9 may also include other transport layer delivery systems used by US Treaty partners. Note that a lower data rate can be obtained for the same motion image quality using H.264 versus MPEG-2. H.264 L4.0 can be used for data rates up to 20 Mb/s. The H.264 High profile should be used for 10- and 12- bit motion imagery.

Note about bit depths: While multiple bit depths are allowed, higher bit depths are preferred. For example, if 12-bit, 10-bit and 8-bit implementations are allowed under the standard, 12-bit implementations are preferred.

(VWG, 25 February 1998 - Approved As Amended) (ISMC, 6 March 1998 - Approved) (VWG, 8 June 1999, Language Revised and Recommended to GSMC-ISMC for Approval) (GSMC-ISMC, 12 August 1999 – Approved) (MISB, 27 July 2000 – MISB Standard Recommended and Editorially Revised) (20 November 2003 – MISB approved) (9 December 2004 – MISB approved) (13 December 2007, MISB approved)

RECOMMENDED PRACTICE 9720c - MISM, Enhanced Definition Motion Imagery

System Level	MISM				
	L8	L7M/H		L6M/H	
Common Description/ Intended Application	Enhanced Definition (ED) / Acquisition	Enhance Definition / Processing / Archiving		Enhanced Definition / Distribution	
System Attributes: Spatial Definition	Enhanced	Enhanced		Enhanced	
System Attributes: Temporal Definition	Medium - High	Medium - High		Medium - High	
System Attributes: Generation Resiliency	High	Medium		Low	
Applicable Standard (Note: Other Profiles / Practices may apply)	ITU-R BT.1358[16], SMPTE 294M[43]	ITU-R BT.1358[16], SMPTE 294M[43] MPEG-2 MP@HL	ITU-R BT.1358[16], SMPTE 294M[43] H.264 MP@L3 (L3.1 > 30 FPS)	ITU-R BT.1358[16], SMPTE 294M[43] MPEG-2 MP@HL	ITU-R BT.1358[16], SMPTE 294M[43] H.264 MP@L3 (L3.1 > 30 FPS)
Horizontal Resolution (Nominal)	640 - 960	640 - 960	640 - 960	640 - 960	640 - 960
Vertical Resolution (Nominal)	480p - 576p	480p - 576p	480p - 576p	480p - 576p	480p - 576p
Bit Depth (bits) (Nominal)	8 or 10	8	8	8	8
Frame Rate (FPS)	24 - 60	24 - 60	24 - 60	24 - 60	24 - 60
Compression Ratio (Nominal)	zero	10:1	20 :1	45:1	80 :1
Data Rate (Nominal)	360 Mb/s	25 Mb/s	12 Mb/s	5.5 Mb/s	3 Mb/s
Data Rate Range	135 - 540 Mb/s	10 - 50 Mb/s	5 - 14 Mb/s	3 - 15 Mb/s	2 - 8 Mb/s
Candidate Transport Channel (Nominal Rates)	SDI, OC-12	T3, ATM	T3, ATM	GBS, ATM	GBS, ATM
Allowed Transport Protocols	Xon2 MXF/AAF	Xon2 MXF/AAF	Xon2 MXF/AAF	Xon2 MXF/AAF	Xon2 MXF/AAF
Preferred Transport Protocols	MXF Xon2	MXF Xon2	MXF Xon2	MXF Xon2	MXF Xon2

Table 2-4. Enhanced Definition Motion Imagery (Recommended Practice 9720c)

RECOMMENDED PRACTICE 9720c - MISM, Enhanced Definition Motion Imagery, Technical Notes

MISM-L8 Motion Imagery System Matrix-Level 8 (MISM-L8), Uncompressed Enhanced Definition Motion Imagery, is defined as digital progressive 480-line and 576-line acquisition formats at 24 to 60 frames per second.

MISM-L8 Note 1: MISM-L8 can be considered to yield a good combination of improved spatial and temporal resolution capabilities at minimal increased costs as compared to today's broadcast quality digital interlace (ITU-R BT.601-5[7]) systems. However, 720x480p and 720x576p systems do not utilize square pixels and there are insufficient horizontal pixels to properly deliver a 16:9 aspect ratio image.

MISM-L7 Motion Imagery System Matrix-Level 7 (MISM-L7), Mezzanine Compression Enhanced Definition Motion Imagery is defined as any ED format of MISM-L8 using mild compression. Note that a higher compression rate can be used for H.264 versus MPEG-2. H.264 L3.0 can be used for frame rates up to 30 Hz. H.264 L3.1 must be used for frame rates above 30 Hz.

MISM-L6 Motion Imagery System Matrix-Level 6 (MISM-L6) is defined as any ED format of MISM-L8/7 that is highly compressed to use end-user (final link) transport delivery systems. MISM-L6 includes transport delivery systems used by US Treaty partners. Note that a higher compression rate can be used for H.264 versus MPEG-2. H.264 L3.0 can be used for frame rates up to 30 Hz. H.264 L3.1 must be used for frame rates above 30 Hz.

MISM-L6 Note 1: MISM-L6 has the advantages of: progressive scan, bandwidth efficiency, higher vertical resolution, and lack of interlace artifacts compared to standard definition television (MISM-L3 – MISM-L5).

(VWG, 25 February 1998 - Approved As Amended) (ISMC, 6 March 1998 - Approved) (VWG, 8 June 1999, Language Revised and Recommended to GSMC-ISMC for Approval) (GSMC-ISMC, 12 August 1999 – Approved) (27 July 2000 – Editorially Revised) (20 November 2003 – MISB approved) (8 April 2004, MISB approved) (13 December 2007, MISB approved)

RECOMMENDED PRACTICE 9720d - MISM, Standard Definition Motion Imagery

System Level	MISM				
	L5	L4M	L4H	L3M	L3H
Common Description/ Intended Application	Standard Definition / Acquisition	Standard Definition / Processing / Archiving		Standard Definition / Distribution	
System Attributes: Spatial Definition	Standard	Standard		Standard	
System Attributes: Temporal Definition	Standard	Standard		Standard	
System Attributes: Generation Resiliency	High	Medium		Low	
Applicable Standard (Note: Other Profiles / Practices may apply)	ITU-R BT.601[7], SMPTE 259M[8] (4:2:2)	MPEG-2 MP@ML	H.264 MP@L3	MPEG-2 MP@ML	H.264MP@L3
Horizontal Resolution (Nominal)	720	720	720	720	720
Vertical Resolution (Nominal)	480i - 576i	480i - 576i	480i - 576i	480i - 576i	480i - 576i
Bit Depth (bits) (Nominal)	8 or 10	8	8	8	8
Frame Rate (FPS)	24 - 60	24 - 30	24 - 30	24 - 30	24 - 30
Compression Ratio (Nominal)	zero to 2.5:1	5.5:1 - 10:1	5.5 - 20:1	28:1	56:1
Data Rate (Nominal)	270 Mb/s	15 Mb/s	10 Mb/s	6 Mb/s	3 Mb/s
Data Rate Range	270 - 360 Mb/s	15 Mb/s	10 Mb/s	3 - 10 Mb/s	1.5 - 5 Mb/s
Candidate Transport Channel (Nominal Rates)	SDI, OC-12	Half to Full T3, TCDL, ATM	Half to Full T3, TCDL, ATM	GBS, T2, ATM, DVD	GBS, T2, ATM, DVD
Allowed Transport Protocols	Xon2 MXF/AAF	Xon2 MXF/AAF	Xon2 MXF/AAF	Xon2 MXF/AAF	Xon2 MXF/AAF
Preferred Transport Protocols	MXF Xon2	MXF Xon2	MXF Xon2	MXF Xon2	MXF Xon2

Table 2-5. Standard Definition Motion Imagery (Recommended Practice 9720d)

RECOMMENDED PRACTICE 9720d - MISM, Standard Definition Motion Imagery, Technical Notes

MISM-L5 Motion Imagery System Matrix-Level 5 (MISM-L5), Uncompressed Standard Definition Motion Imagery, is defined as uncompressed, 4:2:2 digital interlace motion imagery, including 720 x 480 (to 576) x 24-60 or ITU-R BT.601-5 [7] (4:2:2) Component Video. Note that while both 10 bit and 8 bit implementations are allowed under MISM-L5, 10 bit implementations are preferred. Note that storage systems (such as some digital motion imagery tape formats) that use bit-serial interface 4:2:2 input/output protocols but use 2.5:1 (near lossless) internal compression will be considered as meeting MISM-L5. Furthermore, all primary routing and distribution hardware systems must comply with SMPTE 259M [8] Level C and D (270/360 Mb/s) implementations to meet MISM-L5. Users are cautioned that true uncompressed processing may be required for the most demanding MISM-L5 applications.

MISM-L4 Digital MPEG-2 compressed motion imagery, with no more than 10:1 compression and H.264 with no more than 20:1 compression defines L-4. Note that 10:1 compression ratio compliant MPEG-2 Main Profile @ Main Level based systems meet MISM-L4 as well as 20:1 compression ratio compliant H.264.

MISM-L3 Digital 4:2:0, MPEG-2 compressed motion imagery, with no more than 28:1 compression, and H.264 with any more than 56:1 compression. Note that both these systems are anticipated to meet MISM-L3.

(VWG, 10 July 1997 - Adopted) (ISMC, 26 September 1997 - Approved)(VWG, 19 Nov 1997, Approved as Amended) (VWG, 25 February 1998 - Approved As Amended) (ISMC, 6 March 1998 - Approved) (VWG, 8 June 1999, Language Revised and Recommended to GSMC-ISMC for Approval) (GSMC-ISMC, 12 August 1999 – Approved) (27 July 2000 – Editorially Revised)(12 June 2003 – Editorial to reflect MP@ML) (8 April 2004, MISB approved) (13 December 2007, MISB approved)

RECOMMENDED PRACTICE 9720e - MISM, Low Bandwidth Motion Imagery

System Level	MISM							
	L2.2H	L2.1H	L2.1M	L2.0M	L1.3H	L1.2H	L1.1H	L1.0H
Common Description/ Intended Application	Medium / Distribution	Low-Medium / Distribution		Low / Distribution	Low / Distribution	Very Low / Distribution	Very Low / Distribution	Lowest / Distribution
System Attributes: Spatial Definition	Medium	Low - Medium		Low	Low	Low	Low	Very Low
System Attributes: Temporal Definition	Medium	Medium		Medium	Medium	Low	Very Low	Low
System Attributes: Generation Resiliency	Low	Low		Very Low	Very Low	Very Low	Very Low	Lowest
Applicable Standard (Note: Other Profiles /Practices may apply)	H.264 L2.2	H.264 L2.1	MPEG2 MP@ML	MPEG-1	H.264 L1.3	H.264 L1.2	H.264 L1.1	H.264 L1.0
Horizontal Resolution (Nominal)	640 - 720	320 - 352		320 - 352		320 - 352		160 - 176
Vertical Resolution (Nominal)	480 - 576	480 - 576		480 - 576	240 - 288p	240 - 288p		120 - 144p
Bit Depth (bits) (Nominal)	8	8		8		8		8
Frame Rate (FPS)	24 - 30	24 - 30		24 - 30		12 - 15	6 - 7	12 - 15
Compression Ratio (Nominal)	110:1	165:1	110:1	165:1	430:1	650:1	1300:1	5200:1
Data Rate (Nominal)	1.5 Mb/s	1.0 Mb/s	1.5 Mb/s	1.0 Mb/s	512 Kb/s	256 Kb/s	128 Kb/s	32 Kb/s
Data Rate Range (Kbits/s)	1,024 -1,500	768 - 1,024	1,024 - 1,500	768 - 1,024	384 - 768	192 - 384	56 - 192	< 56
Candidate Transport Channel (Nominal Rates)	T1/ E1	T1/ E1		T1/ E1	Partial T1/E1	Wireless	Wireless	Wireless
Allowed Transport Protocols	Xon2	Xon2		Xon2	Xon2 RTP/RTSP	Xon2 RTP/RTSP	Xon2 RTP/RTSP	Xon2 RTP/RTSP
Recommended Transport Protocols	Xon2	Xon2		Xon2	RTP/RTSP	RTP/RTSP	RTP/RTSP	RTP/RTSP

Table 2-6. Low Bandwidth Motion Imagery (Recommended Practice 9720e)

RECOMMENDED PRACTICE 9720e - MISM, Low Bandwidth Motion Imagery, Technical Notes

MISM-L2H.264 L2.1–2.2 Digital MPEG-2 (half horizontal resolution using Adaptive Field Frame techniques) or MPEG-1 compressed video, using SIF image resolution decimation at 25-30 FPS temporal rate can be used for MISM-L2. Level 2.0 using MPEG-1 is included for legacy purposes. H.264 will provide image quality equal to MPEG-2 at less than half the data rate. Therefore, the preferred compression method for Levels 2.1 and 2.2 is H.264, which will yield higher quality motion imagery at these data rates. The following data rates are recommended for H.264:

- 1,024 - 1,500 kb/s use H.264 L2.2 at full resolution and 24-30 FPS
- 768 - 1,024 kb/s use H.264 L2.1 at half horizontal resolution and 24-30 FPS

(VWG, 10 July 1997 - Adopted) (ISMC, 26 September 1997 - Approved)(VWG, 19 Nov 1997, Approved as Amended) (VWG, 25 February 1998 - Approved As Amended) (ISMC, 6 March 1998 - Approved) (27 July 2000 – Editorially Revised)(21 November 2002- Added TBD (H.264))(12June 2003 – Removed TBD from H.264 and listed it first)(20 November 2003 – MISB approved) (25 August 2005 – Amended to include levels 2.1 – 2.2 – MISB approved)(13 December 2007 – MISB approved)

MISM-L1 H.264 is expected to meet the requirements for MISM-L1. Digital MPEG-2 (4:2:0, using Adaptive Field Frame techniques) and MPEG-1 at SIF resolutions are not usable at these data rates. The following data rates are recommended for H.264:

- 384 to 768 kb/s use H.264 L1.3 at CIF[1], SIF[2] or QVGA[3] resolution and 24-30 fps
- 192 to 384 kb/s use H.264 L1.2 at CIF, SIF, or QVGA resolution and approximately 12-15 fps
- 56 to 192 kb/s use H.264 L1.1 at CIF, SIF, or QVGA resolution and approximately 6-7 fps
- Less than 56 kb/s use H.264 L1.0 at QCIF[4], QSIF[5], or QQVGA[6] resolution and 5-15 fps

(VWG, 26 March 1997 - Approved for Study) (27 July 2000 – Editorially Revised) (21 November 2002- Added H.264) (12 June 2003 –H.264 adopted) (20 November 2003 – MISB approved) (29 April 2005 – MISB approved) (25 August 2005 – Amended – MISM approved) (13 December 2007 – MISB approved)

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[1] 352 x 288
[2] 352 x 240
[3] 320 x 240
[4] 176 x 144
[5] 176 x 120
[6] 160 x 120

RECOMMENDED PRACTICE 9720f - MISM, Very Low Temporal Definition Motion Imagery

System Level	MISM
	L0
Common Description/ Intended Application	Very Low Temporal Motion Imagery / Distribution
System Attributes: Spatial Definition	High
System Attributes: Temporal Definition	Very Low
System Attributes: Generation Resiliency	Variable
Applicable Standard (Note: Other Profiles / Practices may apply)	NITF
Horizontal Resolution (Nominal)	720 - 1920
Vertical Resolution (Nominal)	480 - 1080
Bit Depth (bits) (Nominal)	8 or 10 or 12
Frame Rate (FPS)	Still - 2 FPS
Compression Ratio (Nominal)	10:1
Data Rate (Nominal)	256 Kb/s
Data Rate Range	56 - 512 Kb/s
Candidate Transport Channel (Nominal Rates)	Non Real Time POTS, ISDN

Table 2-7. Very Low Temporal Motion Imagery (Recommended Practice 9720f)

RECOMMENDED PRACTICE 9720f - MISM, Very Low Temporal Definition Motion Imagery, Technical Notes

MISM-L0 Low frame rate motion imagery based on digital video sources using full MISM-L11/8/5 spatial resolution but having very limited temporal resolution (on the order of stills to 1 or 2 FPS). At these low temporal rates, the imagery is no longer considered to be video (thus the motion imagery nomenclature). MISM-L0 is intended to describe applications where the most severe bandwidth limitations preclude delivery of true motion video. For these very low bandwidth applications, systems should deliver full spatial resolution but may need to severely decimate temporal elements to the point of producing only still frames (and delivering such frames in non-real-time, based on the data rate capacity of the delivery channel). For the specific cases of still imagery derived from video sources, such imagery shall be formatted to conform to NITF standards (see PROFILE 9706 - Video Image Still Frames).

(VWG, 26 March 1997 - Approved for Study) (VWG, 25 February 1998 - Approved As Amended) (ISMC, 6 March 1998 – Approved) (27 July 2000 – Editorially Revised)

RECOMMENDED PRACTICE 9721 - Motion Imagery Tape Formats

In reference to Recommended Practice 9720, "Motion Imagery Systems Matrix", the Motion Imagery System Practices for DoD/IC/NSG motion imagery tape formats shall be as follows:

Tape MISM - Level 11, MISM - Level 8

There are no specific recommendations for uncompressed MISM-L11 or MISM-L8 motion imagery tape implementations as of this version of the Motion Imagery Standards Profile. However, any digital tape format converted into a "bit-bucket" mode with sufficient data bandwidth to store MISM-L11or MISM-L8 signals may be used provided they also:

a) Transparently transport a minimum of two stereo AES3 audio channels;

b) Transparently transport Digital Vertical Interval Time Code (D-VITC) (Longitudinal Time Code (LTC) internal processing/storage is authorized provided D-VITC input and output is maintained);

c) For MISM-L8, transparently transport a minimum of an additional 6 Mb/s of ancillary data (either as part of the bit-serial interface Ancillary data stream or as additional AES3 audio streams).

(VWG, 26 March 1997 - Approved for Study) (VWG, 25 February 1998 - Language Revised) (VWG, 8 June 1999, Language Revised) (27 July 2000 – Editorially Revised)

Tape MISM - Level 10, MISM - Level 7

Whereas the HD-D5 format has become SMPTE Standard 342, SMPTE 342M[70] (360 Mbps data rate, using mezzanine compression of authorized DoD/IC/NSG high and enhanced definition formats such as 1280x720x60p and 720x480x60p) is an authorized initial motion imagery tape implementation partially meeting MISM-L10, MISM-L7 requirements. Other desired MISM-L10 and MISM-L7 attributes include the ability to:

a) Transparently transport a minimum of two stereo AES3 audio channels;

b) Transparently transport D-VITC (LTC internal processing/storage is authorized provided D-VITC input and output is maintained);

c) Transparently transport a minimum of an additional 6 Mb/s of ancillary data (either as part of the bit-serial interface Ancillary data stream or as additional AES3 audio streams).

(VWG, 26 March 1997 - Approved for Study) (VWG, 25 February 1998 - Language Revised) (VWG, 8 June 1999, Language Revised) (27 July 2000 – Editorially Revised)(21 November 2002- Added SMPTE 342M))

Tape MISM - Level 9, MISM - Level 6

The MISB expects that there will be a number of inexpensive tape systems for handling MISM-L9 and MISM-L6 including D-VHS.

(VWG, 26 March 1997 - Approved for Study) (VWG, 25 February 1998 - Language Revised) (VWG, 8 June 1999, Language Revised) (27 July 2000 – Editorially Revised)

Tape MISM - Level 5

For MISM-L5 implementations authorized motion imagery tape formats may include widely accepted commercial systems that:

a) Use 4:2:2 digital processing,
b) Use no compression or use no more than 2.5:1 compression,
c) Use bit-serial interface input/output protocols,
d) Transparently transport a minimum of two stereo AES3 audio channels,
e) Transparently transport D-VITC (LTC internal processing/storage is authorized provided D-VITC input and output is maintained),
f) Transparently transport a minimum of an additional 6 Mb/s of ancillary data (either as part of the bit-serial interface Ancillary data stream or as additional AES3 audio streams).

Anticipated MISM-L5 compliant (subject to verification) tape formats may include:

SMPTE D1 videotape format
SMPTE D5 videotape format
Ampex DCT videotape format
Sony Digital Betacam tape format

(VWG, 26 March 1997 - Approved for Study) (VWG, 25 February 1998 - Language Revised) (VWG, 8 June 1999, Language Revised) (27 July 2000 – Editorially Revised)

Tape MISM - Level 4

For MISM-L4 implementations, authorized motion imagery tape formats may include widely accepted commercial systems that:

a) Use 4:2:2 digital processing,
b) Have no more than 5:1 compression,
c) Use bit-serial interface input/output protocols,
d) Transparently transport a minimum of two stereo AES3 audio channels,
e) Transparently transport D-VITC (LTC internal processing is authorized provided D-VITC input and output is maintained),
f) Transparently transport a minimum of an additional 3 Mb/s of ancillary data (either as part of the bit-serial interface data stream or as additional AES3 audio streams).

Anticipated MISM-L4 compliant (subject to verification) tape formats may include:

Any MISM-L5 videotape format
SMPTE D9 (JVC Digital-S) videotape format
Sony Beta-SX videotape format
SMPTE D7 (DVC Pro 4:2:2) videotape format

(VWG, 26 March 1997 - Approved for Study) (VWG, 25 February 1998 - Language Revised) (VWG, 8 June 1999, Language Revised) (27 July 2000 – Editorially Revised)

MISM - Level 3 – MISM - Level 0

For all other Motion Imagery System implementations (MISM-L3-MISM-L0), it is anticipated that information technology based storage systems will be used instead of videotape except for archival purposes. If videotape is used, digital motion imagery tape formats other than MISM-L4 (or higher) may only be used in order to meet specific mission constraints (size, weight, power consumption) that cannot be met with MISM-L4 (or higher) tape formats. In such instances, other such formats may only be used in limited roles such as first generation acquisition, with a requirement to immediately transfer and interface such acquisition formats using SMPTE bit-serial interfaces (with MISM-L4 or higher tape systems) at the first processing interface. See Recommended Practice 9902 for further details.

Anticipated "acquisition-only" tape formats, in order of priority of choice are:

a) Any MISM-L5 motion imagery tape format
b) Any MISM-L4 motion imagery tape format
b) 4:1:1 Digital tape formats
c) Component Analog formats (Y, R-Y, B-Y), such as Betacam-SP or MII

d) High Resolution Analog formats (Y/C), such as Hi8mm or SVHS

(VWG, 26 March 1997 - Approved for Study) (VWG, 25 February 1998 - Language Revised) (VWG, 8 June 1999, Language Revised) (27 July 2000 – Editorially Revised)

Other Video Tape Notes:

"Analog - composite - limited resolution - color under" videotape formats (such as VHS or U-Matic) are not authorized for acquisition, processing or new archive implementations. "Analog-composite-limited resolution-color-under" video tape formats may be authorized as the means for video tape mass distribution of finished intelligence products provided no other digital distribution tape format is widely available. In no case are such formats authorized for new permanent motion imagery archive storage. Existing, legacy archive systems based on "analog-composite-limited-resolution-color-under" tape formats should convert to one of the new, approved digital tape formats as soon as practical.

Digital composite formats (such as D2, D3) are generally not authorized for any new DoD/IC/NSG implementations because of their incompatibility with 4:2:2 component processing systems.

No motion imagery tape formats other than MISM-L5 or higher may be used for any new permanent motion imagery tape archives, where MISM-L5 or higher systems should be used for the most demanding applications.

(VWG, 26 March 1997 - Approved for Study) (VWG, 25 February 1998 - Language Revised) (27 July 2000 – Editorially Revised)

Standard Definition Motion Imagery

STANDARD 9601 - Standard Definition Digital Motion Imagery, Compression Systems

MPEG-2 is the approved motion imagery compression format for DoD/IC/NSG systems (the VWG and ISMC formally adopted this standard in 1996).

STANDARD 9701 - Standard Definition Digital Motion Imagery, Compression Systems

The 1996 VWG adoption of MPEG-2 (item 9601 above) as the approved motion imagery compression format is hereby superseded by a more detailed specification:

ISO/IEC 13818[2,3,4,5] (commonly known as MPEG-2) shall be the DoD/IC/NSG STANDARD for all standard definition compressed motion imagery, with the following PROFILE specifications:

> The "MPEG-2, Main Profile @ Main Level" (MP @ ML) shall be the standard definition motion imagery compression PROFILE for DoD/IC/NSG origination, acquisition, production, manipulation, exploitation, and end-user motion imagery product distribution, including real-time wide area transmissions.

ITU-T Rec. H.264[6] (Baseline, Main, Extended, and High Profiles) shall be the standard for applications constrained by low bandwidth channels (typically less than 1 Mb/s that may not be adequately supported by MPEG-2). The MISP also allows the use of H.264 for higher bandwidth applications. See Motion Imagery System Recommended Practice 9720 for guidelines on the use of MPEG-2 and H.264.

9701 Note 1: See Motion Imagery System Recommended Practice 9902 for guidelines concerning other digital motion imagery compression formats (such as DV).

(ISMC, 6 March 1998- Approved) (VWG, 21 January 1999 - Language Editorially Revised) (GSMC-ISMC, 12 August 1999 – Approved as Amended) (21 November-Revised) (12 June 2003 –MISB approved ITU-T Rec. H.264 for low bandwidth applications)

Xon2

"Xon2" is the name of the DoD activity to support the "seamless" rollout of advanced video compression technologies without disrupting current and future operations and systems. "X" defines existing or future video compression technologies and "on2" refers to the use of MPEG-2 transport streams and files. The DoD has already successfully deployed "2on2" payloads, using standards compliant MPEG-2 compressed video elementary streams, audio elementary streams, and SMPTE KLV encoded metadata as MPEG-2 private data streams in support of UAS operations. Building on this baseline "2on2" capability, "Xon2" will provide a migration path to inject improved compressions technologies, which will yield improved image quality and/or reduced bandwidths. A number of systems anticipate near term fielding of "Xon2" using

advanced video compression technologies, such as H.264 ("264on2"). H.264 can be carried over the MPEG-2 transport streams using ITU-T Rec. H.222.0[42].

(21 November 2002- MISB Adopted)

STANDARD 9702 - Standard Definition Digital Motion Imagery Sampling Structure

ITU-R BT.601-5[7] Component (4:2:2) Digital Video shall be the DoD/IC/NSG STANDARD sampling structure for baseband (uncompressed) standard definition motion imagery signals.

Furthermore, while both 10 bit and 8 bit implementations are allowed under the standard, 10 bit implementations are preferred.

(VWG, 26 March 1997 - Adopted as Amended) (ISMC, 12 June 1997 - Approved)
(VWG, 25 February 1998 - Language Editorially Revised) (ISMC, 6 March 1998 - Approved)

STANDARD 9703 - Digital Motion Imagery, Uncompressed Baseband Signal Transport and Processing

SMPTE 259M[8] (4:2:2) standard definition (270-360 Mb/s Serial Digital Interface - SDI) and SMPTE 292M[17] high definition (1.5 Gb/s Bit-Serial Interface) shall be the uncompressed baseband signal transport and processing DoD/IC/NSG STANDARDS for digital motion imagery, audio and metadata origination, system interface, production / analysis center processing and manipulation.

Furthermore, all DoD/IC/NSG standard definition primary routing and distribution motion imagery hardware systems must comply with SMPTE 259M Levels C and D (270/360 Mb/s) implementations (270 /360 Mb/s data rates allow routing and distribution systems to pass both 4:3 and 16:9 aspect ratio digital motion imagery signals).

Furthermore, within SDI or bit-serial interfaces, one AES3 audio channel (one stereo pair) shall be reserved for mission audio (such as narration), one AES3 audio channel (one stereo pair) shall be reserved for mission metadata encoding.

Furthermore, as much as possible of ancillary data (separate from the AES3 requirements above) shall be reserved for metadata encoding.

Furthermore, bit-serial interfaces shall be the DoD/IC/NSG STANDARD protocol for compression system input signals and decompression system outputs when further processing is required.

9703 Note 1: The "Connector Type" specification given in SMPTE 259M, Section 4, or 292M recommends a preferred connector (BNC) and cable type (coax). For DoD/IC/NSG users, such physical connections and cable types can be considered to be Recommended Practices, not Standards. (Flexibility to use connectors other than BNC is given to accommodate operational directives, which do not allow BNC connectors in aircraft systems.)

(VWG, 26 March 1997 - Adopted as Amended) (ISMC, 12 June 1997 - Approved)
(VWG, 25 February 1998 - Language Editorially Revised) (GSMC-ISMC, 6 March 1998 - Approved)
(VWG, 8 June 1999 – Language Editorially Revised) (GSMC-ISMC, 12 August 1999 – Approved as Amended) (20 November 2003 – MISB approved)

9703 Note 2: Further research is required (see STUDY 9806) to define the anticipated quality degradation of multiple "generation" (compression, decompression) concatenation effects.

(VWG, 26 March - Approved for Study)

STANDARD 9704 - Digital Motion Imagery, Compression Conversions

ITU-R BT.601-5[7] shall be the transitional sampling structure, compression conversion and processing DoD/IC/NSG STANDARD for standard definition digital motion imagery, audio and metadata, where the input compressed motion imagery stream shall be uncompressed into ITU-R BT.601-5 Component (4:2:2) baseband video sampling structure (within bit-serial interface input/output signal processing equipment) and then shall be re-compressed into the target compression format.

9704 Note 1: For guidelines on use of multiple compression-conversion cycles see Motion Imagery System Recommended Practice 9720.

9704 Note 2: The "Connector Type" specification given in SMPTE 259M[8], Section 4, recommends a preferred connector (BNC) and cable type (coax). For DoD/IC/NSG users, such physical connections and cable types can be considered to be Recommended Practices, not Standards.

(VWG, 26 March 1997 - Adopted as Amended) (ISMC, 12 June 1997 - Approved)
(VWG, 25 February 1998 - Language Editorially Revised) (GSMC-ISMC, 6 March 1998 - Approved)

STANDARD 9705 - Standard Definition Digital Motion Imagery, Format Conversions

ITU-R BT.601-5[7] shall be the transitional sampling structure, format conversion and processing DoD/IC/NSG STANDARD for standard definition digital motion imagery, audio and metadata, where the input video format is converted into ITU-R BT.601-5 Component (4:2:2) baseband video (within bit-serial interface input/output signal processing equipment) and is then re-formatted into target formats (such as 625 line component systems).

9705 Note 1: The "Connector Type" specification given in SMPTE 259M, Section 4, recommends a preferred connector (BNC) and cable type (coax). For DoD/IC/NSG users, such physical connections and cable types can be considered to be Recommended Practices, not Standards.

9705 Note 2: This format conversion is intended to facilitate equipment interoperability between 525/30i (American) and 625/25i (NATO and Treaty Partner) motion imagery systems, where the SDI bit-serial interface has been designed for common digital motion imagery parameters wherever practical.

(VWG, 16 Jan 1997 - Adopted as Amended) (ISMC, 12 June 1997 - Approved)
(VWG, 25 February 1998 - Language Editorially Revised) (ISMC, 6 March 1998 - Approved)

STANDARD 9707 - Standard Definition Digital Motion Imagery Tape Recorder, Digital Motion Imagery Servers, and Similar Systems Input / Output Protocol

SMPTE 259M[8] shall be the DoD/IC/NSG STANDARD motion imagery input/output protocol for standard definition digital videotape recorder, digital motion imagery servers, and similar systems.

9707 Note 1: The "Connector Type" specification given in SMPTE 259M[8], Section 4, recommends a preferred connector (BNC) and cable type (coax). For DoD/IC/NSG users, such physical connections and cable types can be considered to be Recommended Practices, not Standards.

Furthermore, "fiber channel" input/output protocols may be considered for digital motion imagery tape recorders, digital motion imagery servers, and similar systems provided such systems also have bit-serial interfaces available.

Furthermore, IEEE 1394[9] input/output protocols may be considered for digital motion imagery sensors, tape recorders, servers, and similar systems. In particular, IIDC 1394-based Digital Camera Specification Version 1.31 Format_0 Mode_3 may be considered for 640x480 YUV, Format_1 Mode_0 may be considered for 800x600 YUV and Format_0 Mode_6 for 640x480 IR. See Study 0501.

9707 Note 2: IEEE 1394 defines a transport channel upon which multiple motion imagery (and other signal) sampling structures may be delivered. Systems that use the IEEE 1394 interface (such as "DV" format tape recorders) may not produce motion imagery sampling structures that meet the standards profiled in this MISP document. Users are cautioned to verify the video sampling structure delivered by any device that claims digital video delivery via IEEE 1394 interfaces.

(VWG, 26 March 1997 - Adopted as Amended) (ISMC, 12 June 1997 - Approved) (VWG, 25 February 1998 - Language Editorially Revised) (ISMC, 6 March 1998 - Approved)

STANDARD 9803 - Serial Data Transport Interface

SMPTE 305M[10], *Serial Data Transport Interface (SDTI),* shall define the DoD/IC/NSG Standard for data stream used to transport packetized data within a studio/production center environment. The data packets and synchronizing signals are compatible with ANSI/SMPTE 259M.

(MISB, 7 February 2001 – SMPTE 305M Adopted; 01 March 2001 GSMC-ISMC Approved)

STANDARD 9901 - Fiber Optic Interfaces Uncompressed Baseband Signal Transport and Processing

SMPTE 297M[11] shall be the fiber optic uncompressed standard definition (270-360 Mb/s Serial Digital Interface for baseband signal transport and processing DoD/IC/NSG STANDARD for digital motion imagery, audio and metadata origination, system interface, production/analysis center processing and manipulation.

Furthermore, all DoD/IC/NSG standard definition primary routing and distribution motion imagery hardware systems must comply with SMPTE 259M Levels C and D (270/360 Mb/s) implementations (270/360 Mb/s data rates allow routing and distribution systems to pass both 4:3 and 16:9 aspect ratio digital motion imagery signals).

Furthermore, within SDI or bit-serial interfaces, one AES3 audio channel (one stereo pair) shall be reserved for mission audio (such as narration), one AES3 audio channel (one stereo pair) shall be reserved for mission metadata encoding.

Furthermore, at least 6 Mb/s of ancillary data (separate from the AES3 requirements above) shall be reserved for metadata encoding.

Furthermore, bit-serial interfaces shall be the DoD/IC/NSG STANDARD protocol for compression system input signals and decompression system outputs when further processing is required.

(VWG, 26 March 1997 - Adopted as Amended) (ISMC, 12 June 1997 - Approved)
(VWG, 25 February 1998 - Language Editorially Revised) (ISMC, 6 March 1998 - Approved)

RECOMMENDED PRACTICE 9902 - Authorized Limited Applications of DV Format Video

Consumer cameras that capture digital motion imagery in near-professional quality using the Digital Video (DV) format are now available commercially and at low cost. In addition, the DV proprietary format is being transitioned from a proprietary standard to a published standard within SMPTE.

For "handheld" motion imagery applications the DV format promises a good tradeoff between image quality and system cost. Therefore, DV video format is authorized for specialized DoD/IC/NSG applications requiring the use of consumer-grade palm-sized camcorders to meet limited, low profile (covert) mission requirements, provided that: 1) No less than first generation DV footage will be directly digitally transferred into computer processing systems using IEEE 1394 interfaces; 2) Such motion imagery DV clips will not be forwarded nor interfaced to any DoD/IC/NSG communications nodes for subsequent processing.

Affordable devices are now commercially available to convert from the DV format to MISP approved digital formats for distribution and exploitation. (For example, a single chip is available that converts 25 Mbps DV to 6 Mbps MPEG-2.) Thus, DV-originated motion imagery that meets the above criteria may be distributed when it is converted to an approved digital format such as MPEG-2.

(VWG, 21 January 1999 – Adopted; VWG, 8 June 1999 – Language Revised) (VWG, 8 June 1999, Recommended to GSMC-ISMC for Approval) (GSMC-ISMC, 12 August 1999 – Approved)

STANDARD 9719 - Analog Video Migration

All DoD/IC/NSG motion imagery production systems that currently use ANSI/SMPTE 170M analog video waveforms (also known as RS-170A) should convert to ITU-R BT.601-5 Component (4:2:2) digital sampling structure as soon as practical.

Furthermore, all new digital baseband motion imagery system production sampling structures shall conform to ITU-R BT.601-5[7] 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.

In addition, systems shall output the original video without burned-in metadata. This requirement also applies to digital systems.

(VWG, 26 March 1997 - Approved for Study) (VWG, 19 November 1997- Approved) (15 May 2008 – MISB approved)

STANDARD 9709 - Use of Closed Captioning for Core Metadata Analog Video Encoding

EIA-608[14] (Data Services), commonly known as closed captioning, shall be the DoD/IC/NSG 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 also conform to all applicable digital motion imagery, audio, and metadata protocols specified in the MISP.

MISP item 9711 shall be the basis for Geospatial metadata descriptions for DoD/IC/NSG systems using Closed Captioning (until replaced by future Motion Imagery Standards Profiles).

MISP item 9714 shall be the basis for time references for analog video vertical interval data. Therefore, Motion Imagery Standards Profile item 9709 implementations should not be burdened with duplicate time reference data.

Furthermore, to facilitate universal inter-operability, DoD/IC/NSG users are encouraged to submit recommended implementations for analog closed captioning systems for consideration and inclusion in this Motion Imagery Standards Profile document by the MISB as numbered Recommended Practices.

(VWG, 16 Jan 1997 - Adopted as Amended) (ISMC, 12 June 1997 - Approved)

ENGINEERING GUIDELINE 0803 - Delivery of Low Bandwidth Motion Imagery

Engineering Guideline EG 0803 provides an overview for creating and distributing Motion Imagery over low bandwidth channels for purposes of additional information relevant to current situations. Typical exploitation quality motion imagery is generated at MISP MISM level 3 and greater. The motion imagery produced at these levels can exceed the bandwidth of the network delivering motion imagery to users at the edges. To meet network constraints motion imagery asset tradeoffs are required; either the imagery must be reduced in spatial resolution, temporal rate, or fidelity. In some cases a combination of reductions is necessary. Alternative measures to meet bandwidth constraints include reducing the quantity of metadata, and transcoding the imagery using different compression.

(18 September 2008 – MISB approved)

RECOMMENDED PRACTICE 0804 - Real Time Protocol

Recommended Practice RP 0804 documents the standards profile for packaging and delivering Full Motion Imagery (FMV) data over the Real-Time Protocol (RTP). This RP provides direction on the packetization and streaming of video and metadata using RTP to support diverse IP based networks. The scope of this RP is limited to

delivery of Full Motion Video (FMV) products and is not intended to replace any other approved standards for other uses; rather it is intended to complement those standards.

(18 September 2008 – MISB approved)

Enhanced Definition Motion Imagery

STANDARD 9811 - Progressively Scanned Enhanced Definition Digital Motion Imagery

ITU-R BT.1358[16] shall define the DoD/IC/NSG STANDARD motion imagery sampling structure for progressively scanned, digital enhanced definition motion imagery systems. Parallel connector interfaces shall not be used if bit-serial interfaces are available.

Furthermore, while both 10 bit and 8 bit implementations are allowed under the standard, 10 bit implementations are preferred.

(VWG, 25 February 1998 - Approved) (ISMC, 6 March 1998 - Approved)(MISB, 24 May 2001, BT.1358 replaces SMPTE 293M)(21 November 2002-Revised)

SMPTE 292M, Television - Bit-Serial Digital Interface for High-Definition Television Systems

SMPTE 292M[17] is the DoD/IC/NSG STANDARD for Enhanced Definition digital motion imagery, audio and metadata bit serial interface for origination, system interface, production/analysis center processing and manipulation.

(21 November 2002- MISB Adopted)

STANDARD 0201 - Uncompressed Enhanced Motion Imagery Baseband Signal Transport

SMPTE 349M[18] "Transport of Alternate Source Image Formats through SMPTE 292M" defines the uncompressed baseband signal transport of 525-line interlaced, 525-line progressive, 625-line interlaced, and 625-line progressive scan source formats through SMPTE 292M, the bit-serial digital interface for high-definition television systems.

(21 November 2002- MISB Adopted)

STANDARD 0202 - Compressed Enhanced Definition Advanced Television (ATV) and Associated Motion Imagery Systems

If compression is needed, ISO/IEC 13818-1[2] (Systems), and [3] (Video) (commonly known as MPEG-2) "High Level", which defines a broad family of enhanced and high definition video compression capabilities, shall be the DoD/IC/NSG STANDARD for compressed enhanced definition motion imagery, with the following PROFILE specification:

The MPEG-2, Main Profile High Level (MP@HL) shall be the enhanced definition motion imagery compression PROFILE for DoD/IC/NSG origination,

acquisition, production, manipulation, exploitation, distribution and archiving.

ITU-T Rec. H.264[6] (Baseline, Main, Extended, and High Profiles) is also allowed for use on enhanced definition motion imagery. See RP 9720c for further guidance.

Note: "Xon2" is the name of the DoD activity to support the "seamless" rollout of advanced video compression technologies without disrupting current and future operations and systems. "X" defines existing or future video compression technologies and "on2" refers to the use of MPEG-2 transport streams and files. The DoD has already successfully deployed "2on2" payloads, using standards compliant MPEG-2 compressed video elementary streams, audio elementary streams, and SMPTE KLV encoded metadata as MPEG-2 private data streams in support of UAS operations. Building on this baseline "2on2" capability, "Xon2" will provide a migration path to inject improved compressions technologies, which will yield improved image quality and / or reduced bandwidths. A number of systems plan near term fielding of "Xon2" using advanced video compression technologies, such as H.264 ("264on2"). H.264 can be carried over the MPEG-2 transport streams using ITU-T Rec. H.222.0[42].

(21 November 2002- MISB Adopted) (8 April 2004 – MISB approved)

High Definition Motion Imagery

STANDARD 9710 - High Definition Television Systems (HDTV)

SMPTE Standard 296M[20] shall define the DoD/IC/NSG STANDARD motion imagery sampling structure for progressively scanned digital high definition systems based on 720 vertical scanning lines. The standard incorporates multiple frame rates such as 24, 25 and 50 Hz. The parallel connector interface defined for SMPTE 296M shall not be used if bit-serial interfaces are available.

SMPTE 292M[17] shall define the DoD/IC/NSG STANDARD for bit-serial interfaces for high definition television systems, including by specific reference SMPTE 296M.

SMPTE 274M[19] (progressive only) shall define the DoD/IC/NSG STANDARD motion imagery sampling structures for progressively scanned digital high definition systems based on 1080 vertical scanning lines.

9710 Note 1: Only progressive scan shall be used for origination of high definition motion imagery for DoD/IC/NSG applications.

(VWG, 25 February 1998 - Approved) (ISMC, 6 March 1998 - Approved) (MISB, 27 July 2000 – Submitted)(02 November 2000 GSMC-ISMC Approved)(MISB, 7 February 2001- SMPTE 296M-2001 adopted; 01 March 2001 GSMC-ISMC Approved)(MISB, 9 December 2004 – Added progressive only)

STANDARD 9723 - Compressed High Definition Advanced Television (ATV) and Associated Motion Imagery Systems

ISO/IEC 13818-1[2] (Systems), and [3] (Video) (commonly known as MPEG-2) "High Level", which defines a broad family of high definition video compression

capabilities, shall be the DoD/IC/NSG 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 DoD/IC/NSG origination, acquisition, production, manipulation, exploitation, and end-user motion imagery product distribution, including real-time wide area transmissions.

ITU-T Rec. H.264[6] (Baseline, Main, Extended, and High Profiles) is also allowed for use on high definition motion imagery. See RP 9720b for further guidance.

Note "Xon2" is the name of the DoD activity to support the "seamless" rollout of advanced video compression technologies without disrupting current and future operations and systems. "X" defines existing or future video compression technologies and "on2" refers to the use of MPEG-2 transport streams and files. The DoD has already successfully deployed "2on2" payloads, using standards compliant MPEG-2 compressed video elementary streams, audio elementary streams, and SMPTE KLV encoded metadata as MPEG-2 private data streams in support of UAS operations. Building on this baseline "2on2" capability, "Xon2" will provide a migration path to inject improved compressions technologies, which will yield improved image quality and / or reduced bandwidths. NGA's Advanced Airborne Division anticipates accelerating near term fielding of "Xon2" using advanced video compression technologies, such as H.264 ("264on2"). H.264 can be carried over the MPEG-2 transport streams using ITU-T Rec. H.222.0[42] *Transport of AVC data over ISO/IEC 13818-1/ H.222.0 for MPEG2 TS containment for MPEG4 AVC.*

(21 November 2002- MISB Adopted)

Furthermore, for digital terrestrial reception:

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By direction of the MISB and as ratified by the GSMC-ISMC, the following paragraph is temporarily removed (suspended) from mandated Standard status, pending further review by the MISB and the NCGIS. Significant concerns have arisen in the commercial television technology community with regards to the technical viability of the 8VSB RF Modulation standard specified in ATSC Doc. A/53[22]. Therefore, it is prudent to suspend mandated implementation of this standard until further notice.

(1) Within the United States, the DoD/IC/NSG standard for receivers shall be in compliance with the Federal Communication Commission, "Fourth Report and Order," (24 December 1996) which adopted (except for Annex A, Section 5.1.2 Compression format constraints - including Table 3) ATSC Doc. A/53 as the United States Digital Television Standard.

(GSMC-ISMC, 12 August 1999 – Approved)

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(2) Receivers for use in other world regions will need to consider terrestrial broadcast standards for that area. Furthermore, to promote universal interoperability, DoD/IC/NSG

high definition advanced television and motion imagery **RECEIVING** 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:

Resolution	Frame Rate	Aspect Ratio
1920 x 1080	30p, 30p/1.001, 30i, 30i/1.001, 25p, 25i, 24p	16:9
1280 x 720	60p, 60p/1.001, 50p, 30p, 30p/1.001, 25p, 24p	16:9
720 x 576	50p, 25p, 25i, 24p	16:9 or 4:3
720 x 480 (483)	60p, 60p/1.001, 30p, 30p/1.001, 30i, 30i/1.001, 24p, 24p/1.001	16:9 or 4:3
640 x 480	60p, 60p/1.001, 30p, 30p/1.001, 24p, 24p/1.001	4:3

9723 Note 1: For future enhancement and migration options, the following additional formats should be decoded by DoD/IC/NSG 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[19]):

Resolution	Frame Rate	Aspect Ratio
1920 x 1080	60p, 60p/1.001, 50p	16:9

Furthermore, DoD/IC/NSG 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:

Resolution	Frame Rate	Aspect Ratio
1280 x 720	60p, 50p, 30p, 25p, 24p	16:9
1920 x 1080	30p, 25p, 24p	16:9

9723 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 MISB notes that 1080 50p/60p systems are not yet commercially available. Therefore, 1080 50p/60p systems are not mandated under this VISP profile. The MISB will continue to periodically evaluate the availability of 1080 progressive scan format systems for future consideration.

9723 Note 3: Dual mode interlaced and progressive scan systems are authorized under this MISP profile, provided that for DoD/IC/NSG 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:

Resolution	Frame Rate	Aspect Ratio
720 x 576	50p, 25p, 25i, 24p	16:9 or 4:3
720 x 480 (483)	60p, 30p, 30i, 30i/1.001, 24p	16:9 or 4:3
640 x 480	60p, 50p, 30p, 25p, 24p	4:3

9723 Note 4: 720 horizontal pixels are the standard width for DoD/IC/NSG standard and enhanced definition program origination and processing. DoD/IC/NSG systems shall not originate or process imagery content using 704 horizontal pixels.

(VWG, 25 February 1998 - Approved As Amended) (ISMC, 6 March 1998 - Approved)

STANDARD 9703 - Digital Motion Imagery, Uncompressed Baseband Signal Transport and Processing

SMPTE 292M[17] high definition (1.5 Gb/s Bit-Serial Interface) shall be the uncompressed baseband signal transport and processing DoD/IC/NSG STANDARD for digital motion imagery, audio and metadata origination, system interface, production / analysis center processing and manipulation.

9703 Note 1: The "Connector Type" specification given in SMPTE 259M[8], Section 4, or 292M recommends a preferred connector (BNC) and cable type (coax). For DoD/IC/NSG users, such physical connections and cable types can be considered to be Recommended Practices, not Standards. (Flexibility to use connectors other than BNC is given to accommodate operational directives, which do not allow BNC connectors in aircraft systems.)

(VWG, 26 March 1997 - Adopted as Amended) (ISMC, 12 June 1997 - Approved)
(VWG, 25 February 1998 - Language Editorially Revised) (GSMC-ISMC, 6 March 1998 - Approved)
(VWG, 8 June 1999 – Language Editorially Revised) (GSMC-ISMC, 12 August 1999 – Approved as Amended)

Large Volume Streaming Data Motion Imagery

RECOMMENDED PRACTICE 0606 - Authorized Use of JPEG 2000 or Motion JPEG 2000 for Large Volume Streaming Data Imagery

JPEG 2000 (ISO/IEC 15444[38] in various parts) uses a wavelet based compression method and associated file formats with high versatility and scalability. The JPEG 2000 standard allows for region-of-interest encoding and feature scalability, and is an emerging commercial technology used in digital cinema and other large image applications.

New motion imagery sensors for use in Large Volume Streaming Data (LVSD) (also referred to as Wide Area Large Format (WALF)) applications are composed of arrays of individual digital cameras that result in composite imagery frames containing hundreds of millions of pixels (megapixels) produced at rates of one frame per second or greater. JPEG 2000 has extensible features that are able to accommodate these frame

sizes and frame rates and is authorized for use when standards-based compression and file transport are required for system interoperability.

RECOMMENDED PRACTICE 0705[69] - LVSD Compression Profile

The encoding of LVSD motion data is limited to baseline JPEG DCT (ISO/IEC 10918-1[44]: Digital compression and coding of continuous-tone still images requirements and guidelines) and JPEG 2000 Part 1: Image Coding System (ISO/IEC 15444-1[38]) The BIIF Profile BPJ2K01.00 Amendment 1 document[45], defines a new JPEG 2000 compression profile, LPJE (LVSD Preferred JPEG 2000 Encoding). LVSD systems that utilize JPEG 2000 frame-based compression are required to conform to this profile. The LPJE profile is a superset of current JPEG 2000 profiles (NPJE and EPJE defined in BPJ2K01.00) as well as the profile defined in STANAG 7023. The recommended compression for LVSD (Large Volume Streaming Data as referred to by the NATO community), is enumerated in Recommended Practice 0705, which will be submitted as a profile in ISO/IEC BIIF Profile BPJ2K01.00 Amendment 1. When the compression profile is approved by ISO, RP 0705 will simply refer to the profile of the ISO standard. Note: JPEG 2000 is the preferred encoder for LVSD applications, but because of current hardware limitations JPEG DCT is also accepted for simple frame-by-frame data compression.

Further investigation is required to define a more detailed profile and best practice guide for LVSD motion imagery encoding. It is also expected that a profile will be required of JPEG 2000 Part 9: JPIP (ISO/IEC 15444-9: Interactive tools, APIs and protocols[45]) to facilitate the scalability and functionality of the JPEG 2000 standard.

Additional work is needed within the MISB to define metadata carriage and precision time stamping practices. The MISB will investigate and document recommendations on the use of formats and metadata carriage including possible solutions of MISP with KLV, MXF (SMPTE 377M[46]), JPEG 2000 File Format (ISO/IEC 15444-1: Image coding system[38] and 15444-2: Extensions[75]), Motion JPEG 2000 File Format (ISO/IEC 15444-3[76]: Motion JPEG 2000 and 15444-12: ISO Base Media File Format[77]). A draft of the ASPA Profile for LVSD is contained is contained in STANDARD 0301.4.

(MISB, 11 May 2006, Adopted as Amended) (13 September 2007- MISB approved) (18 September 2008 – MISB approved)

Low Spatial/Temporal Motion Imagery

STANDARD 9706 - Motion Imagery Still Frames

The National Imagery Transmission Format (NITF 2.1)[23] shall be the DoD/IC/NSG STANDARD for digital still images that have been extracted from video image sequences. Once an image has been captured for individual still image processing, exploitation and dissemination; the image is no longer considered to be video and is therefore not subject to this Motion Imagery Standards Profile (but must meet all NITF 2.1 image standards).

Furthermore, still images should be extracted from full resolution bit-serial interface video streams, with direct conversion and storage into NITF 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.

(VWG, 16 Jan 1997 - Adopted as Amended) (ISMC, 12 June 1997 - Approved)
(VWG, 25 February 1998 - Language Editorially Revised) (GSMC-ISMC, 6 March 1998 – Approved As Amended)

Metadata

STANDARD 9708 - Imbedded Time Reference for Motion Imagery Systems

MISB Recommended Practice 0603[35], STANDARD 0604[48], and Recommended Practice 0605[49] shall be the DoD/IC/NSG standards for time annotation and imbedded time references for motion imagery systems.

Furthermore, within SMPTE 12M[24], commonly known as SMPTE time code, the 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[25] shall be the DoD/IC/NSG STANDARD for precision time and date imbedding into SMPTE 12M time code data streams.

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

(VWG, 26 March 1997 - Adopted as Amended) (ISMC, 12 June 1997 - Approved)
(VWG, 25 February 1998 - Language Editorially Revised) (ISMC, 6 March 1998 - Approved) (MISB, 10 August 2006 - Approved) (18 September 2008 – MISB approved)

STANDARD 9711 - Intelligence Motion Imagery Index, Geospatial Metadata

The VWG Metadata Sub-Group, "Core Video Metadata Profile," Version 1.0, 14 March 1997 is the DoD/IC/NSG RECOMMENDED PRACTICE for analog video intelligence Geospatial Metadata. This RP for legacy analog video was developed to capture and transmit metadata over analog video services to take advantage of existing metadata previously only available in telemetry. The intention is that when analog motion imagery systems are replaced by digital systems that they will use the more extensible Metadata Dictionary and Encoding described by STANDARDS 9713, 9716-9718.)

(VWG, 26 March 1997 - Adopted) (ISMC, 12 June 1997 - Approved) (VWG, 8 June 1999 – Language Editorially Revised) (GSMC-ISMC, 12 August 1999 – Approved as Amended)

9711 Note 1: This Profile has been nominated by the MISB for candidate harmonization with the SMPTE "Metadata Dictionary" Standard

9711 Note 2: DoD/IC/NSG users may begin system development activities using this Core Geospatial Metadata, with the understanding that metadata parameters may change depending on negotiations and coordination with SMPTE and commercial video equipment manufacturers. The expectation is that the Geospatial metadata forms the initial core of the DoD/IC/NSG requirement set for the broader digital "Motion Imagery Metadata Dictionary" Standard, and once part of the broader standard, will provide significantly enhanced applicability and broad, universal interoperability with commercial index, archive, and Geospatial motion imagery systems. The new SMPTE standard should provide a single standard for both DoD/IC/NSG and commercial systems.

(VWG, 16 January 1997 - Approved for Study)

9711 Note 3: The Core Video Metadata Profile elements have been incorporated into the more extensive VWG "Metadata Dictionary and Encoding" Version 1.0 document. However, it is expected that the analog Core Motion Imagery Metadata Profile will continue as long as legacy analog motion imagery systems are still fielded.

(VWG, 8 June 1999 – Language Editorially Revised)

STANDARD 9712 - Intelligence Motion Imagery Index, Content Description Metadata (Dynamic Metadata Dictionary Structure and Contents)

SMPTE 335M[27], *Metadata Dictionary Structure*, SMPTE RP210.9[28], *SMPTE Metadata Dictionary Contents,* and SMPTE EG37[29], *Node Structure For the SMPTE Metadata Dictionary,* formerly known as the Intelligence Video Index (Video Metadata Dictionary), comprise the DoD/IC/NSG STANDARD for the definition and identification of metadata elements encoded in digital motion imagery products.

All new DoD/IC/NSG motion imagery systems that incorporate metadata shall use these standards for digital encoding of metadata into uncompressed digital motion imagery bit streams as a replacement for the closed captioning of metadata in analog legacy systems [9709]. These digital systems shall NOT encode metadata as digital closed caption information.

(VWG, 16 Jan. 1997 - Approved for Study; VWG, 19 November 1997- Language Revised) (VWG, 8 June 1999 – Language Revised) (VWG, 20 October 1999 - Adopted; Recommended to GSMC-ISMC for Approval) (24 February 2000 – GSMC-ISMC Approval) (MISB, 27 July 2000 – SMPTE Standard Recommended)(02 November 2000 GSMC-ISMC Approved)(MISB, 24 May 2001, Replaced 210.2 by 210.3)(20 November 2003 replaced 210.3 by 210.8))(9 December 2005 replaced 210.8 by 210.9)

STANDARD 9713 - Data Encoding Using Key-Length-Value

SMPTE 336M[30], *Data Encoding Protocol Using Key-Length-Value,* is the DoD/IC/NSG STANDARD protocol for encoding data essence and metadata (such as 9712) into Motion Imagery streams, files, and associated systems.

(VWG, 16 Jan. 1997 - Approved for Study; VWG, 19 November 1997- Language Revised) (VWG, 8 June 1999 – Language Revised) (VWG, 20 October 1999 - Adopted; Recommended to GSMC-ISMC for Approval) (24 February 2000 – GSMC-ISMC Approval) (MISB, 27 July 2000 – SMPTE Standard Recommended)(02 November 2000 GSMC-ISMC Approved)

STANDARD 9714 - Time Code Embedding

Digital Vertical Interval Time Code (D-VITC) shall be imbedded on digital video line 14 of all ITU-R BT.601-5[7] 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 14.

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.

Date and Time Zone information defined by SMPTE 309M[25] shall be used to achieve Year 2000 (Y2K) compliance by all DoD/IC/NSG systems.

(VWG, 26 March 1997 - Approved for Study; VWG, 19 November 1997- Language Revised;) (VWG, 8 June 1999 – Study Completed; Recommended to GSMC-ISMC for Approval) (GSMC-ISMC, 12 August 1999 – Approved)

STANDARD 9715 - Time Reference Synchronization

Universal coordinated time (UTC, also known as "Zulu"), clock signals shall be used as the universal time reference for DoD/IC/NSG 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 DoD/IC/NSG "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, Draft Recommended Practice RP 0603[35], "*Time Stamping Digital Motion Imagery using Coordinated Universal Time (UTC)"* provides a global common reference frequency and absolute timing for digital motion imagery collected from multiple sensors in different locations, multiple sensors on the same platform, and single sensor configurations requiring precise correlation of video and metadata.

(VWG, 19 November 1997, Adopted as Amended) (VWG, 25 February 1998 - Language Revised) (ISMC, 6 March 1998 - Approved) (MISB, 11 May 2006, Adopted as Amended)

STANDARD 9716 - Packing KLV Packets into SMPTE 291 Ancillary Data Packets

SMPTE RP 214[37], "Packing KLV Encoded Metadata and Data Essence into SMPTE 291M Ancillary Data Packets" is the DoD/IC/NSG STANDARD for the encoding of metadata elements into Serial Digital Interface (SDI) SMPTE 291M[31] ancillary data packets.

All new DoD/IC/NSG motion imagery systems that incorporate metadata shall use these standards for digital encoding of metadata into uncompressed digital motion imagery bit streams as a replacement for the closed captioning of metadata in analog legacy systems [9709]. These digital systems shall NOT encode metadata as digital closed caption information.

(VWG, 26 March 1997 - Approved for Study, VWG, 19 November 1997- Language Revised) (VWG, 8 June 1999 – Language Revised) (VWG, 20 October 1999 - Adopted; Recommended to GSMC-ISMC for Approval) (24 February 2000 – GSMC-ISMC Approval)

RECOMMENDED PRACTICE 9717 - Packing KLV Packets into MPEG-2 Systems Streams

SMPTE RP 217[32], *Non-synchronized Mapping of KLV Packets into MPEG-2 System Streams,* is the DoD/IC/NSG Recommend Practice for the non-synchronous encoding of metadata elements into MPEG-2 Systems Streams.

Note: To be MISP compliant, KLV metadata in BOTH the Transport Stream and Program Stream must be identified by the registered format_identifier 0x4B4C5641 ("KLVA"). SMPTE RP 217 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.

ISO/IEC 13818-1[2] is authorized for DoD/IC/NSG use but is not mandated for the synchronous transport of metadata.

All new DoD/IC/NSG motion imagery systems that incorporate metadata shall use these standards for digital encoding of metadata into compressed digital motion imagery bit streams (MPEG-2) as a replacement for the closed captioning of metadata in analog legacy systems [9709]. These digital systems shall NOT encode metadata as digital closed caption information.

(VWG, 26 March 1997 - Approved for Study, VWG, 19 November 1997- Language Revised) (VWG, 8 June 1999 – Language Revised) (VWG, 20 October 1999 - Adopted; Recommended to GSMC-ISMC for Approval) (24 February 2000 – GSMC-ISMC Approved) (MISB, 11 October 2001 – Submitted for Approval)(Revised 29 November 2001 for GSMC/ISMC approval)

STANDARD 9718 - Packing KLV Packets into AES3 Serial Digital Audio Streams

SMPTE 355M[27] *Format for Non-PCM Audio,* SMPTE 337[74] *Format for Non-PCM Audio and Data in an AES3 Serial Digital Audio Interface*, and SMPTE 339[50] *Format for Non-PCM Audio and data in AES3-Generic Data Types* are the DoD/IC/NSG STANDARDs for the encoding of metadata elements into AES3 data streams.

(VWG, 26 March 1997 - Approved for Study, VWG, 19 November 1997- Language Revised) (VWG, 8 June 1999 – Language Revised) (VWG, 20 October 1999 - Adopted; Recommended to GSMC-ISMC for Approval) (24 February 2000 – GSMC-ISMC Approval) (MISB, 27 July 2000 – SMPTE RP Recommended) (02 November 2000 GSMC-ISMC Approved) (29 April 2005 – MISB approved)

RECOMMENDED PRACTICE 0101 - Use of MPEG-2 System Streams in Digital Motion Imagery Systems

MISB RP 0101[51] shall be the recommended practice for use of MPEG-2 system streams in motion imagery systems.

(7 February 2001 - MISB Adopted; 01 March 2001 GSMC-ISMC Approved)

STANDARD 0102 - Security Metadata Universal Set for Digital Motion Imagery

MISB STANDARD 0102.5[47] shall be the standard for use of security metadata in MPEG-2 digital motion imagery applications.

(7 February 2001 - MISB Adopted; 01 March 2001 GSMC-ISMC Approved) (20 November 2003 – MISB approved)(10 August 2006 - Updated –MISB Adopted) (13 December 2007 - Updated –MISB Adopted) (15 May 2008 – MISB adopted) (18 September 2008 – MISB approved)

RECOMMENDED PRACTICE 0103 - Timing Reconciliation Universal Metadata Set for Digital Motion Imagery

This Recommended Practice (RP) defines a timing reconciliation metadata set to correct (reconcile) the original capture time of metadata with the User Defined Time Stamp stamped timecode 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.

(MISB, 24 May 2001 – Submitted for Approval)

ENGINEERING GUIDELINE 0104 - Basic Predator KLV Metadata

Engineering Guideline (EG) 0104[52] defines the basic and geospatially adjusted Predator UAS (Unmanned Aircraft System) metadata to be encoded into a standard SMPTE KLV Metadata Universal Metadata Sets. This EG provides direction on the creation of a standard metadata sets for reliable exchange of Predator closed caption (CC) data among digital motion imagery systems.

The scope of this EG is strictly limited to metadata that originates as closed caption metadata in analog video from the Predator UAS. Analog video and closed caption metadata are legacy systems, which shall be updated to all-digital sensors and information infrastructures as soon as practical. This EG facilitates that transition only and does not constitute an approved end-system implementation.

(MISB, 24 May 2001 – Submitted for Approval) (20 November 2003 – MISB approved)(8 April 2004 – MISB approved)(10 August 2006 – MISB approved)(14 December 2006 – MISB approved)(18 September 2008 – MISB approved)

STANDARD 0107 - Bit and Byte Order for Metadata in Motion Imagery Files and Streams

The MISB STANDARD 0107[53], "Bit and Byte Order for Metadata in Motion Imagery Files and Streams", defines the selection of big-endian for bit and Byte order (msb-first and MSB-first). This is applicable only to KLV metadata encoding. Bit and Byte order of essence is not affected.

(MISB, 11 October 2001 – Submitted for Approval by Metadata Working Group)

STANDARD 0601 - UAS Datalink Local Metadata Set

The MISB STANDARD 0601[54], "UAS Datalink Local Metadata Set", defines the bit-efficient, extensible SMPTE KLV Local Metadata Set designed for transmission through a wireless communications link (Datalink).

This standard provides direction on the creation of a standard KLV Local Data Set for a reliable, bandwidth-efficient exchange of metadata among digital motion imagery systems on UAS platforms. The standard also provides a mapping to EG 104.5 and Predator Exploitation Support Data (ESD) for continued support of existing metadata systems.

MISP Minimum KLV Metadata Elements using STANDARD 0601

The following paragraphs and table reflect the KLV metadata implementation that was agreed to by STANAG 4586 on UAS and STANAG 4609 on digital motion imagery and adopted by the MISB. This section contains information regarding common metadata parameters which should be used by a STANAG 4586 compliant Unmanned Air Vehicle

Control System (UCS). Table 2.8 provides the comprehensive list of metadata elements from MISB Standard 0601[54], UAS Datalink Local Metadata Set, which has been adopted by many existing UAV systems.

An "X" in the first column indicates that the particular element should be implemented in a STANAG 4586 compliant UCS in order to enhance imagery exploitation for that system and is required for MISP compliance and STANAG 4609 compliance. If the particular element is implemented, then it shall be applicable to the UCS interface specified in the second column of the table - either the Command and Control Interface (CCI) only, or both the CCI and Data Link Interface (DLI) as defined in STANAG 4586. This table also specifies for each element which unique DLI message/field is to be used for a STANAG 4586 implementation.

Table 2.8 MISB Standard 0601.2 KLV Metadata Elements and DLI/CCI Mapping Requirements

Mandatory Elements [2]	DLI / CCI [3]	UAS LDS Key [1]	Name [1]	DLI Unique identifier
X	Co	1	Checksum	-
X	D&C	2	UNIX Time Stamp	0101.01
X	Co	3	Mission ID	0020.10
	Co	4	Platform Tail Number	0020.09
X	D&C	5	Platform Heading Angle	0101.16
X	D&C	6	Platform Pitch Angle	0101.15
X	D&C	7	Platform Roll Angle	0101.14
	Co	8	Platform True Airspeed	0102.06
	Co	9	Platform Indicated Airspeed	0102.07
X	Co	10	Platform Designation	0020.06 & 0020.07
X	D&C	11	Image Source Sensor	-
X	Co	12	Image Coordinate System	-
X	D&C	13	Sensor Latitude	0101.04
X	D&C	14	Sensor Longitude	0101.05
X	D&C	15	Sensor True Altitude	0101.06
X	D&C	16	Sensor Horizontal Field of View	0302.13
X	D&C	17	Sensor Vertical Field of View	0302.11
X	D&C	18	Sensor Relative Azimuth Angle	0302.12
X	D&C	19	Sensor Relative Elevation Angle	0302.10
X	D&C	20	Sensor Relative Roll Angle	0302.14

Mandatory Elements [2]	DLI / CCI [3]	UAS LDS Key [1]	Name [1]	DLI Unique identifier
X	Co	21	Slant Range	-
X	Co	22	Target Width	-
X	Co	23	Frame Center Latitude	0302.16
X	Co	24	Frame Center Longitude	0302.17
X	Co	25	Frame Center Elevation	0302.18
	Co	26	Offset Corner Latitude Point 1	-
	Co	27	Offset Corner Longitude Point 1	-
	Co	28	Offset Corner Latitude Point 2	-
	Co	29	Offset Corner Longitude Point 2	-
	Co	30	Offset Corner Latitude Point 3	-
	Co	31	Offset Corner Longitude Point 3	-
	Co	32	Offset Corner Latitude Point 4	-
	Co	33	Offset Corner Longitude Point 4	-
	D&C	34	Icing Detected	-
	Co	35	Wind Direction	0102.09 & 0102.10
	Co	36	Wind Speed	0102.09 & 0102.10
	D&C	37	Static Pressure	0102.14
	D&C	38	Density Altitude	0102.08 & 0102.14
	D&C	39	Outside Air Temperature	0102.08
	Co	40	Target Location Latitude	-
	Co	41	Target Location Longitude	-
	Co	42	Target Location Elevation	-
	Co	43	Target Track Gate Width	-
	Co	44	Target Track Gate Height	-
	Co	45	Target Error Estimate - CE90	-
	Co	46	Target Error Estimate - LE90	-
	Co	47	Generic Flag Data 01	-
X	Co	48	Security Local Metadata Set	-
	D&C	49	Differential Pressure	0102.07
	D&C	50	Platform Angle of Attack	0102.04
	D&C	51	Platform Vertical Speed	0101.10
	D&C	52	Platform Sideslip Angle	0102.05

Mandatory Elements [2]	DLI / CCI [3]	UAS LDS Key [1]	Name [1]	DLI Unique identifier
	Co	53	Airfield Barometric Pressure	-
	Co	54	Airfield Elevation	-
	Co	55	Relative Humidity	-
	D&C	56	Platform Ground Speed	0102.17 & 0102.18
	Co	57	Ground Range	-
	D&C	58	Platform Fuel Remaining	0104.16
	Co	59	Platform Call Sign	0020.08
	Co	60	Weapon Load	-
	Co	61	Weapon Fired	-
	Co	62	Laser PRF Code	0302.24
	Co	63	Sensor Field of View Name	-
	D&C	64	Platform Magnetic Heading	0101.16 & 0101.20
X	D&C	65	UAS LDS Version Number	-
	Co	66	Target Location Covariance Matrix	-
	D&C	67	Alternate Platform Latitude	-
	D&C	68	Alternate Platform Longitude	-
	D&C	69	Alternate Platform Altitude	-
	D&C	70	Alternate Platform Name	-
	D&C	71	Alternate Platform Heading	-
	Co	72	Event Start Time - UTC	-
	Co	73	RVT Local Data Set Conversion	-

Table notes:

1. The element name and tag refers to MISB STANDARD 0601.2 UAS Datalink Local Metadata Set
2. Elements marked ”X” are to be included in a STANAG 4586 UCS as an extended list of elements oriented for image exploitation
3. (Co): The element shall be available at the CCI only
   (D&C): The element shall be available at the DLI and the CCI

(12 January 2006 - MISB Approved) (14 June 2007- MISB Approved) (13 December 2007- MISB Approved)(15 May 2008 – MISB Approved) (18 September 2008 – MISB approved) (11 December 2008 – MISB approved)

RECOMMENDED PRACTICE 0602 - Annotation Universal Metadata Set

The MISB Recommended Practice 0602.1[73] documents the basic SMPTE KLV metadata sets used to encode Video Annotation data associated within a motion imagery data stream. This RP provides direction on the creation of "Annotation" KLV metadata to allow for the creation, dissemination, and display of visual cues to enhance the exploitation of MISP-compliant motion imagery data.

(12 January 2006 - MISB Approved) (14 June 2007 - MISB Approved)

RECOMMENDED PRACTICE 0603 - Time Reference for Digital Motion Imagery Using UTC

The MISB Recommended Practice 0603[35] defines the Recommended Practice (RP) for setting and using common UTC time reference for digital motion imagery.

(10August 2006 - MISB Adopted)

STANDARD 0604 - Time Stamping of Compressed Motion Imagery

The MISB STANDARD 0604[48] defines the standard for time stamping compressed digital motion imagery.

(10August 2006 - MISB draft for review) (14 June 2007- MISB Approved)(18 September 2008 – MISB approved)

RECOMMENDED PRACTICE 0605 - Inserting Time Code and Metadata in High Definition Uncompressed Video

The MISB Recommended Practice 0605[49] defines the Recommended Practice (RP) for time stamping uncompressed digital motion imagery.

(10August 2006 - MISB Adopted) (13 September 2007- MISB approved)

ENGINEERING GUIDELINE 0607 - MISB Metadata Registry and Processes

MISB Engineering Guideline 0607[55] shall be the engineering guideline for structure of the MISB Metadata Registry and administrative practices for requesting, assigning, approving, and managing metadata identifiers (KLV keys) and operation of an on-line registry database. The registry contains information about Universal Label (UL) metadata identifiers reserved for private use by motion imagery systems in the Department of Defense (DoD), Intelligence Community (IC), and National System for Geospatial-Intelligence (NSG).

(11 May 2006 – MISB adopted with 30-day silence procedures)(18 September 2008 – MISB approved number change from EG 0602 to EG 0607)

RECOMMENDED PRACTICE 0608 - Motion Imagery Identifier

The MISB Recommended Practice 0608[56] defines the Recommended Practice (RP) for format and encoding of the Motion Imagery Identifier (MIID) required by segments of the National System for Geospatial-Intelligence (NSG). The RP also defines the Motion Imagery Stream Identifier (MI_Stream_ID) used to uniquely identify streams of motion imagery from their source and to be included in the MIID.

(14 December 2006 - MISB Adopted) (Updated 14 June 2007- MISB Adopted) (13 September 2007- MISB up for review)

RECOMMENDED PRACTICE 0701 - Common Metadata Structure

The MISB Recommended Practice 0701[57] defines the Structure of the Common Metadata System (CMS). The CMS is a list of metadata items embedded in KLV data structures that can be used across any sensor/platform and motion imagery system. RP0702, to follow, describes the Content definition.

RP 0701 describes how to organize the sensor/platform data into a hierarchy of KLV Packs and Local Sets that reduces the bandwidth needed to transmit the data. This RP also defines the required data elements but all other data elements (Content elements) are defined in companion document RP0702.

(14 June 2007- MISB Approved)

ENGINEERING GUIDELINE 0801 - Photogrammetry Metadata Set

The MISB Engineering Guideline 0801[58] presents the KLV metadata and metadata structures necessary for the dissemination of data required for the photogrammetric exploitation of motion imagery. The metadata structures are designed to allow for flexible, bit-efficient packaging of the necessary data. This document concerns itself solely with the metadata and metadata structures specific to photogrammetry; metadata necessary for the primary exploitation of the motion imagery (including such elements as mission number, sensor type, platform type, *etc.*) and security metadata are ***not*** addressed in this Engineering Guideline.

(18 September 2008 – MISB approved)

ENGINEERING GUIDELINE 0805 - Cursor on Target

Engineering Guideline 0805[59] defines the Motion Imagery Standards Board (MISB) metadata items used for fields in Cursor on Target (CoT) Situational Awareness (SA) messages. Two CoT message conversions from MISB-standard Key Length Value (KLV) metadata sets are described in this document – Platform Position and Sensor Point of Interest (SPI). Conversions from both MISB EG 0601[54] UAS Datalink Local Data Set and MISB EG 0104[52] Predator Universal Metadata Set are included here. The intent of this standard is to provide a method of generating CoT messages either in real time or at a later date from motion imagery files and the results should be the same in either case.

(18 September 2008 – MISB approved)

ENGINEERING GUIDELINE 0806 - Remote Video Terminal Local Data Set

Engineering Guideline 0806[60] defines the Remote Video Terminal (RVT) Local Data Set (LDS), lays out the relationship between the RVT LDS and other relevant Standards, and gives implementation guidance for the RVT LDS.

(18 September 2008 – MISB approved)(11 December 2008 – MISB approved)

STANDARD 0807 - MISB DoD/IC/NSG KLV Metadata Registry

MISB STANDARD 0807[61] shall be the standard which defines the KLV elements and the conventions of their use within the DoD/IC/NSG community. The registry is maintained by the Motion Imagery Standards Board as registered private data in accordance with SMPTE 335M[27].

(18 September 2008 – MISB approved)

ENGINEERING GUIDELINE 0809 - KLV Representation of Meteorological Data

MISB Engineering Guideline 0809[62] defines KLV metadata elements to convey meteorological information and a metadata construct for the efficient expression of these KLV elements. Fundamental to almost all Advanced Geospatial Intelligence techniques is the characterization of the atmosphere between an observed object/activity and the sensor that records it. This EG provides both the language with which to describe the atmosphere and the mechanisms to convey that knowledge.

(11 December 2008 – MISB approved)

File Formats

STANDARD 9701 - MPEG-2 Transport Stream

STANDARD 9701 mandates the use of ISO/IEC 13818-1[2] (MPEG-2) transport stream and the Xon2 implementation. "X" defines existing or future video compression technologies and "on2" refers to the use of MPEG-2 transport streams and files. The DoD has successfully deployed "2on2" payloads, using standards compliant MPEG-2 compressed video elementary streams, audio elementary streams, and SMPTE KLV encoded metadata as MPEG-2 private data streams in support of UAS operations. Building on this baseline "2on2" capability, "Xon2" provides a migration path to inject improved compressions technologies, which will yield improved image quality and/or reduced bandwidths. H.264 can be carried over the MPEG-2 transport streams using ITU-T Rec. H.222.0[42]: Transport of AVC data over ISO/IEC 13818-1/ H.222.0 for MPEG2 TS containment for MPEG4 AVC.

(18 September 2008 – MISB approved)

RECOMMENDED PRACTICE 0106 - Advanced Authoring Format

Advanced Authoring Format (AAF), Advanced Authoring Format Object Specification, V 1.01, AAF Association, Jan. 2004, is recommended for DoD/IC/NSG use but is not mandated for the 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. The MISB anticipates mandating AAF in a future revision of the MISP.

(MISB, 24 May 2001 – Submitted for Approval) (21 November 2002- MISB Adopted) (12 June 2003-MISB approved changing from authorized to recommended) (20 November 2003 – MISB approved pending 30-day comments)

RECOMMENDED PRACTICE 0107 - Material Exchange Format

Material Exchange Format (MXF), SMPTE 377M[46], is recommended for DoD/IC/NSG use but is not mandated for interchange of motion imagery for single programs, finished material between an archive and user and distribution of tailored sections of a finished work to satisfy a user's specific request.

In 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 and provides advanced features for easy access and exchange over communication networks.

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 entities:

- Only operational patterns 1a (OP-1a) and 1b (OP-1b) as per SMPTE 378M[68] and 391M[71], respectively, will be used for file exchange.
- The essence will be wrapped frame by frame using the generic container as per SMPTE 379M[63] and SMPTE 381M[64].
- From the complete list of metadata sets and properties given by SMPTE 380M[65], the participating parties will be required to interpret only a minimum profile (derived from ASPA Profile). 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 with the body.

(MISB, 24 May 2001 – Submitted for Approval)(12 June 2003-MISB approved changing from authorized to recommended)(Amended 25 August 2005)(13 December 2007 – MISB approved)

STANDARD 0301 - MISB Profile for Aerial Surveillance and Photogrammetry Applications

The MISB mandates STANDARD 0301[66] for Aerial Surveillance and Photogrammetry Applications (ASPA) when using the Advanced Authoring Format (AAF) and/or the Material eXchange Format (MXF). The profile constrains the contents of AAF and MXF files to those in accordance with the Motion Imagery Standards Profile (MISP). The ASPA Profile addresses specific operational needs and forms the basis of MXF and AAF developments. The version 0301.4 includes Large Volume Streaming Data (LVSD).

(18 September 2008 – MISB approved)

ENGINEERING GUIDELINE 0812 - Clipping of Streaming Video into Files

This Engineering Guideline documents the best practices for the creation of motion imagery clip files from an MPEG-2 transport stream. The guidelines herein are set forth with the intent of creating standalone files with minimal overhead. This EG is technically identical to NATO Recommended Practice 0802.

(11 December 2008 – MISB approved)

ENGINEERING GUIDELINE 0813 - Integration of Motion Imagery into the Coalition Shared Database

This Engineering Guideline describes the necessary conditions for integration of motion imagery products into the Coalition Shared Database (CSD). It is technically identical to NATO RP0803.

(11 December 2008 – MISB approved)

INFRARED STANDARDS, INTEROPERABILITY PROFILES, RECOMMENDED PRACTICES AND ENGINEERING GUIDELINES FOR DoD/IC/NSG IMPLEMENTATIONS

Infrared Motion Imagery Systems

Infrared (IR) motion imagery is defined as being in the spectral wavelengths from 1 to 14 um. Standards and Recommended Practices for IR are similar to those in the motion imagery standards levels (MISL) discussed in the previous section for the electro-optical or visible spectrum. This section enumerates the standards, recommended practices, interoperability profiles, and engineering guidelines specifically designed for IR. Collectively this range of standards shall also be referred herein as "infrared" or "IR". It is beneficial for IR to use motion imagery standards whenever possible to achieve the advantage of the higher volume, lower cost motion imagery product availability, utilize the same or similar modules for IR and EO motion imagery, and aid in fused products.

For Infrared motion imagery, frame rates of 25, 30, 50, and 60 are preferred, but lower and higher frame rates are allowed and tolerance in the system should allow for 1/1.001 of 30 Hz and 1/1.001 of 60 Hz. The resolution classes of IR are 160x120, 320x240, 640x480 (including 640x512, 720x480, 720x512, and 720x576), 1024x720 (including 1280x720 and 1024x1024), 1920x1080, and 2048x2048 progressively scanned. Interlaced scanning IR systems are to be treated as legacy systems and shall be replaced with progressive systems at the end of their service lives. Infrared motion imagery typically has higher bit depths such as 12 and 14 bits, which are preferred.

RECOMMENDED PRACTICE 0401 - Infrared Motion Imagery System Matrix

An Infrared (IR) Motion Imagery Systems Matrix" (IRSM) shall define a Recommended Practice for the simple identification of broad categories of IR Motion Imagery Systems. The intent of the IRSM is to give user communities an easy to use, common shorthand reference language to describe the fundamental technical capabilities of DoD/IC/NSG IR motion imagery systems. The IRSM is similar to the MISM, but is listed in order of increasing resolution. The tables refer to progressive capture of IR imagery. Interlace is sometimes used in legacy systems but must be replaced at the end of useful life with progressive systems.

The IRSM (RP 0401) has six general bands:

0401a	Very Low Definition IR	(IRSM-L1 to IRSM-L3)
0401b	Low Definition IR	(IRSM-L4 to IRSM-L6)
0401c	Medium Definition IR	(IRSM-L7 to IRSM-L9)
0401d	High Definition IR	(IRSM-L10 to IRSM-L12)
0401e	Very High Definition IR	(IRSM-L13 to IRSM-L15)
0401f	Super High Definition IR	(IRSM-L16 to IRSM-L18)

Note that 0401f is a STUDY.

Table 3-1 depicts the general outline of the IRSM-L. The following Tables and their accompanying Technical Notes provide detailed technical specifications of the general performance of each IRSM-L level. The levels may be further identified as M for MPEG-2 compression and H for H.264 compression. For example see Level 7, which can be Level 8M or Level 8H.

RP	IRSM-L	Description
0401a	1	Very Low Definition IR – Distribution Compression
	2	Very Low Definition IR – Mild Compression
	3	Very Low Definition IR – No Compression
0401b	4	Low Definition IR - Distribution Compression
	5	Low Definition IR - Mild Compression
	6	Low Definition IR - No Compression
0401c	7	Medium Definition IR - Distribution Compression
	8	Medium Definition IR - Mild Compression
	9	Medium Definition IR - No Compression
0401d	10	High Definition IR - Distribution Compression
	11	High Definition IR - Mild Compression
	12	High Definition IR - No Compression
0401e	13	Very High Definition IR - Distribution Compression
	14	Very High Definition IR - Mild Compression
	15	Very High Definition IR - No Compression
0401f (Study)	16	Super High Definition IR - Distribution Compression
	17	Super High Definition IR - Mild Compression
	18	Super High Definition IR - No Compression

Table 3-1. Infrared Motion Imagery System Matrix-Level

RECOMMENDED PRACTICE 0401a - Infrared System Matrix, Very Low Definition IR

System Level	IRSM-L		
	L3	L2H	L1H
Common Description/ Intended Application	Low Definition / Acquisition	Low Definition / Processing / Archiving	Low Definition / Distribution
System Attributes: Spatial Definition	Very Low	Very Low	Very Low
System Attributes: Temporal Definition	Standard	Standard	Standard
System Attributes: Generation Resiliency	High	Medium	Low
Applicable Standard (Note: Other Profiles / Practices may apply)	SMPTE 259M[8] or 292M[17]	H.264 MP@L1.3	H.264 MP@L1.2
Horizontal Resolution (Nominal)	160 - 180	160 - 180	160 - 180
Vertical Resolution (Nominal)	120 - 144	120 - 144	120 - 144
Bit Depth (bits) (Nominal)	8 - 14	8	8
Frame Rate (FPS)	25 - 60	25 - 60	15 - 30
Compression Ratio (Nominal)	zero	20:1	80:1
Data Rate (Nominal)	10 Mb/s	512 Kb/s	128 Kb/s
Data Rate Range	4 - 22 Mb/s	256 - 768 Kb/s	64 - 384 Kb/s
Candidate Transport Channel (Nominal Rates)	Partial T3, TCDL, ATM	Partial T1, TCDL, ATM	Partial T1, Wireless

Table 3-2. Very Low Definition Infrared Motion Imagery (Recommended Practice 0401a)
(26August 2004 - MISB Adopted)

RECOMMENDED PRACTICE 0401b - Infrared System Matrix, Low Definition IR

System Level	IRSM-L		
	L6	L5H	L4H
Common Description/ Intended Application	Low Definition / Acquisition	Low Definition / Processing / Archiving	Low Definition / Distribution
System Attributes: Spatial Definition	Low	Low	Low
System Attributes: Temporal Definition	Standard	Standard	Standard
System Attributes: Generation Resiliency	High	Medium	Low
Applicable Standard (Note: Other Profiles / Practices may apply)	SMPTE 259M[8] or 292M[17]	H.264 MP@L2.2 H.264 HP4@L2.2	H.264MP@L1.3 H.264 HP4@L1.3
Horizontal Resolution (Nominal)	320 - 360	320 - 360	320 - 360
Vertical Resolution (Nominal)	240 - 288	240 - 288	240 - 288
Bit Depth (bits) (Nominal)	8 - 14	8 8 - 12	8 8 - 12
Frame Rate (FPS)	25 - 60	25 - 30	15 - 30
Compression Ratio (Nominal)	zero	20:1	80:1
Data Rate (Nominal)	44 Mb/s	1.5 Mb/s	512 Kb/s
Data Rate Range	15 - 90 Mb/s	1 - 2 Mb/s	256 - 768 Kb/s
Candidate Transport Channel (Nominal Rates)	T3, TCDL, ATM	T1, TCDL, ATM	Partial T1, Wireless

Table 3-3. Low Definition Infrared Motion Imagery (Recommended Practice 0401b)

Note about bit depths: While multiple bit depths are allowed, higher bit depths are preferred. For example, if 12-bit, 10-bit and 8-bit implementations are allowed under the standard, 12-bit implementations are preferred.
(26August 2004 - MISB Adopted)

RECOMMENDED PRACTICE 0401c - Infrared System Matrix, Medium Definition IR

System Level	IRSM-L				
	L9	L8M	L8H	L7M	L7H
Common Description/ Intended Application	Medium Definition / Acquisition	Medium Definition / Processing / Archiving		Medium Definition / Distribution	
System Attributes: Spatial Definition	Medium	Medium		Medium	
System Attributes: Temporal Definition	Standard	Standard		Standard	
System Attributes: Generation Resiliency	High	Medium		Low	
Applicable Standard (Note: Other Profiles / Practices may apply)	SMPTE 292M[17]	MPEG-2 MP@ML	H.264 HP4@L3.1 H.264 MP@L3.1	MPEG-2 MP@ML	H.264 HP4@L3 (L3.1 > 30 FPS) H.264 MP@L3 (L3.1 > 30 FPS)
Horizontal Resolution (Nominal)	640 - 720	640 - 720		640 - 720	
Vertical Resolution (Nominal)	480 - 576	480 - 576		480 - 576	
Bit Depth (bits) (Nominal)	8 - 14	8	8 - 12 8	8	8 - 12 8
Frame Rate (FPS)	25 - 60	25 - 60		25 - 60	
Compression Ratio (Nominal)	zero	10:1	20:1	45:1	80:1
Data Rate (Nominal)	200 Mb/s	22 Mb/s	10 Mb/s	4.5 Mb/s	2.5 Mb/s
Data Rate Range	62 - 360 Mb/s	6 - 36 Mb/s	3 - 14 Mb/s	1.5 - 8 Mb/s	768 Kb/s - 4 Mb/s
Candidate Transport Channel (Nominal Rates)	SDI, OC-12	Half to Full T3, TCDL, ATM	Half T3, TCDL, ATM	GBS, T2, ATM, DVD	GBS, 2xT1, ATM, DVD

Table 3-4. Medium Definition Infrared Motion Imagery (Recommended Practice 0401c)

Note about bit depths: While multiple bit depths are allowed, higher bit depths are preferred. For example, if 12-bit, 10-bit and 8-bit implementations are allowed under the standard, 12-bit implementations are preferred.
(26August 2004 - MISB Adopted)

RECOMMENDED PRACTICE 0401d - Infrared System Matrix, High Definition IR

System Level	IRSM-L				
	L12	L11M	L11H	L10M	L10H
Common Description/ Intended Application	High Definition / Acquisition	High Definition / Processing / Archiving		High Definition / Distribution	
System Attributes: Spatial Definition	High	High		High	
System Attributes: Temporal Definition	Standard	Standard		Standard	
System Attributes: Generation Resiliency	High	Medium		Low	
Applicable Standard (Note: Other Profiles / Practices may apply)	SMPTE 292M[17]	MPEG-2 MP@ML, MP@HL (>30FPS)	H.264 HP4@L4.2 H.264 MP@L4.2	MPEG-2 MP@ML, MP@HL (>30 FPS)	H.264HP4@L3.2 H.264MP@L3.2
Horizontal Resolution (Nominal)	1024 - 1280	1024 - 1280		1024 - 1280	
Vertical Resolution (Nominal)	720 - 1024	720 - 1024		720 - 1024	
Bit Depth (bits) (Nominal)	8 - 14	8	8 - 12 8	8	8 - 12 8
Frame Rate (FPS)	25 - 60	25 - 60		25 - 60	
Compression Ratio (Nominal)	zero	10:1	20:1	45:1	80:1
Data Rate (Nominal)	330 Mb/s	33 Mb/s	17 Mb/s	7 Mb/s	4 Mb/s
Data Rate Range	150 - 1,100 Mb/s	15 - 110 Mb/s	7.5 - 50 Mb/s	3.5 - 24 Mb/s	2 - 14 Mb/s
Candidate Transport Channel (Nominal Rates)	HD-SDI, OC-12, OC-48	T3, TCDL, ATM	Partial T3, TCDL, ATM	GBS, T2, ATM, DVD	GBS, T2, ATM, DVD

Table 3-5. High Definition Infrared Motion Imagery (Recommended Practice 0401d)

Note about bit depths: While multiple bit depths are allowed, higher bit depths are preferred. For example, if 12-bit, 10-bit and 8-bit implementations are allowed under the standard, 12-bit implementations are preferred.

(26August 2004 - MISB Adopted)

RECOMMENDED PRACTICE 0401e - Infrared System Matrix, Very High Definition IR

System Level	IRSM-L				
	L15	L14M	L14H	L13M	L13H
Common Description/ Intended Application	Very High Definition / Acquisition	Very High Definition / Processing / Archiving		Very High Definition / Distribution	
System Attributes: Spatial Definition	Very High	Very High		Very High	
System Attributes: Temporal Definition	Standard	Standard		Standard	
System Attributes: Generation Resiliency	High	Medium		Low	
Applicable Standard (Note: Other Profiles / Practices may apply)	SMPTE 292M[17] (≤30FPS) SMPTE 372M[67]	MPEG-2 MP@ML	H.264 HP4@L4.2	MPEG-2 MP@ML	H.264 HP4@L4.2
Horizontal Resolution (Nominal)	1920 - 2048	1920 - 2048		1920 - 2048	
Vertical Resolution (Nominal)	1080 - 1152	1080 - 1152		1080 - 1152	
Bit Depth (bits) (Nominal)	8 - 14	8	8 - 12	8	8 - 12
Frame Rate (FPS)	25 - 60	25 - 60		25 - 60	
Compression Ratio (Nominal)	zero	10:1	25:1	45:1	80:1
Data Rate (Nominal)	1250 Mb/s	125 Mb/s	50 Mb/s	28 Mb/s	16 Mb/s
Data Rate Range	415 - 1750 Mb/s	44 - 175 Mb/s	22 - 50 Mb/s	10 - 44 Mb/s	5 - 22 Mb/s
Candidate Transport Channel (Nominal Rates)	OC-48	T3, CDL, ATM	T3, CDL, ATM	GBS, T3, ATM, DVD	GBS, Partial T3

Table 3-6. Very High Definition Infrared Motion Imagery (Recommended Practice 0401e)

Note about bit depths: While multiple bit depths are allowed, higher bit depths are preferred. For example, if 12-bit, 10-bit and 8-bit implementations are allowed under the standard, 12-bit implementations are preferred.

(26August 2004 - MISB Adopted)

(9 December 2004 – Added proposed Digital Cinema resolutions)

STUDY 0401f - Infrared System Matrix, Super High Definition IR

System Level	IRSM-L		
	L18	L17H	L16H
Common Description/ Intended Application	Super High Definition / Acquisition	Super High Definition / Processing / Archiving	Super High Definition / Distribution
System Attributes: Spatial Definition	Super High	Super High	Super High
System Attributes: Temporal Definition	Standard	Standard	Standard
System Attributes: Generation Resiliency	High	Medium	Low
Applicable Standard (Note: Other Profiles / Practices may apply)	SMPTE 292M[17] SMPTE 372M[67]	H.264 HP4@L5.1	H.264 HP4@L5.1
Horizontal Resolution (Nominal)	2048 - 3840	2048 - 3840	2048 - 3840
Vertical Resolution (Nominal)	1152 - 2160	1152 - 2160	1152 - 2160
Bit Depth (bits) (Nominal)	8 - 14	8 - 12	8 - 12
Frame Rate (FPS)	25 - 60	25 - 60	25 - 60
Compression Ratio (Nominal)	zero	20:1	80:1
Data Rate (Nominal)	2000 Mb/s	100 Mb/s	25 Mb/s
Data Rate Range	840 - 3600 Mb/s	44 - 180 Mb/s	10.5 - 44 Mb/s
Candidate Transport Channel (Nominal Rates)	OC-48	T3, CDL, ATM	TCDL, T3, ATM

Table 3-7. Super High Definition Infrared Motion Imagery (STUDY 0401f)

Note about bit depths: While multiple bit depths are allowed, higher bit depths are preferred. For example, if 12-bit, 10-bit and 8-bit implementations are allowed under the standard, 12-bit implementations are preferred.
(26August 2004 - MISB Adopted)

RECOMMENDED PRACTICE 0402 - Infrared Image Capture

The DoD/IC/NSG STANDARD IR sampling structure for progressively scanned, infrared motion imagery systems is found in Recommended Practice 0402 for resolutions of 640x480, 720x480, and 1280x720 at 60 Hz and 720x576 and 1280x720 at 50 Hz. The resolution classes of IR are 160x120, 320x240, 640x480 (including 640x512, 720x480, 720x512 and 720x576), 1024x720 (including 1280x720 and 1024x1024), 1920x1080, and 2048x2048 progressively scanned. Interlaced scanning IR systems are to be treated as legacy systems and shall be replaced with progressive systems at the end of their service lives. Furthermore, while 8, 10, 12, 14-bit and 16-bit implementations are allowed under the standard, at least 12 bits are preferred. For Infrared motion imagery, frame rates of 25, 30, 50, and 60 are preferred, but lower and higher frame rates are allowed and tolerance should be in the system to allow 1/1.001 of 30 Hz and 1/1.001 of 60 Hz.

(26August 2004 - MISB Adopted) (9 December 2004 – Added 16 bit) (11 May 2006 – MISB adopted)(10 August 2006 – MISB adopted)

STANDARD 0402 - Parallel Interface for Infrared Motion Imagery

The MISB STANDARD 0402, also called the B-Kit Interface Control Document, defines a parallel interface for Infrared systems with frame sizes less than or equal to those found in RP 0401c.

(26August 2004 - MISB Adopted)

STANDARD 0403 - Bit-Serial Digital Interface for Infrared Motion Imagery

SMPTE 292M[17] high definition (1.5 Gb/s Bit-Serial Interface, HD-SDI) shall be the uncompressed baseband signal transport and processing DoD/IC/NSG STANDARD for digital IR with frame sizes found in RP 0401c, RP 0401d, and RP 0401e for all imagery, audio and metadata origination, system interface, production/analysis center processing and manipulation.

The MISB STANDARD 0403 defines the mapping into SMPTE 292M for IR systems with 640x480, 720x480, and 1280x720 at 60 Hz and 720x576 and 1280x720 at 50 Hz frame rates.

IEEE 1394 input/output protocols may be considered for digital motion imagery sensors, recorders, servers, and similar systems. In particular, IIDC 1394-based Digital Camera Specification Version 1.31 Format_0 Mode_6 may be used for 640x480 IR. See Study 0501.

(26August 2004 - MISB Adopted) (11 May 2006 – MISB adopted)

STANDARD 0404 - Compression for Infrared Motion Imagery

If compression is needed, ISO/IEC 13818 (Systems[2]), and (Video[3]) (commonly known as MPEG-2) and ITU-T Rec. H.264[6] shall be the DoD/IC/NSG STANDARDs for compressed infrared motion imagery, with the following PROFILE specification:

The MPEG-2, Main Profile Main Level (MP@ML) shall be the compression PROFILE for infrared motion imagery 720x480/30Hz and 720x576/25Hz for DoD/IC/NSG origination, acquisition, production, manipulation, exploitation, distribution and archiving. The MPEG-2, Main Profile @ High Level (MP@HL) shall be the compression PROFILE for infrared motion imagery 1280x720/60Hz for DoD/IC/NSG origination, acquisition, production, manipulation, exploitation, distribution and archiving.

ITU-T Rec. H.264[6] is recommended over MPEG-2 for providing higher bit depth, monochrome operation, and superior compression performance. An emerging new High 4:4:4 Profile operated in monochrome mode, under development (May, 2006) may be considered for experimental systems because it provides 14-bit depth magnitude monochrome operation, and the H.264 compression performance.

Note: "Xon2" is the name of the DoD activity to support the "seamless" rollout of advanced video compression technologies without disrupting current and future operations and systems. "X" defines existing or future video compression technologies and "on2" refers to the use of MPEG-2 transport streams and files. The DoD has already successfully deployed "2on2" payloads, using standards compliant MPEG-2 compressed video elementary streams, audio elementary streams, and SMPTE KLV encoded metadata as MPEG-2 private data streams in support of unmanned aerial vehicle (UAS) operations. Building on this baseline "2on2" capability, "Xon2" will provide a migration path to inject improved compressions technologies, which will yield improved image quality and / or reduced bandwidths. H.264 can be carried over the MPEG-2 transport streams using ITU-T Rec. H.222.0[42].

(26August 2004 - MISB Adopted) (9 December 2004 – Added H.264 FREext) (11 May 2006 – MISB adopted)

APPENDIX A – EMERGING STANDARDS, INTEROPERABILITY PROFILES, RECOMMENDED PRACTICES, AND ENGINEERING GUIDELINES FOR DoD/IC/NSG IMPLEMENTATIONS

Note: MISP Studies that have been completed and approved as standards, recommended practices, or engineering guidelines are moved to Section 2.0.

STUDY 9801 - MPEG-4

(21 November 2002 – Approved by MISB)

STUDY 9802 - MPEG-7

Evaluate and/or support development of the emerging MPEG-7 standard for DoD/IC/NSG applications.

(VWG, 19 Nov 1997 - Approved for Study)

STUDY 9803 - Serial Data Transport Interface

(Accepted; Moved to Section 2.0)

STUDY 9804 - Colorimetry

Evaluate existing and/or support development of emerging standards for motion imagery colorimetry for DoD/IC/NSG applications.

(VWG, 19 Nov 1997 - Approved for Study)

STUDY 9805 - Standard Motion Imagery Test Materials

Evaluate existing and/or support emerging standards for motion imagery test materials, including standard definition and high definition sequences, for DoD/IC/NSG applications.

(VWG, 19 Nov 1997 - Approved for Study)

STUDY 9806 - Motion Imagery Concatenation Image Quality Protection

Evaluate and/or support development of emerging standards for systems that reduce or eliminate motion imagery encoding concatenation errors for DoD/IC/NSG applications.

Three draft SMPTE standards relevant to this Study are in technical review by SMPTE Technical Committee N26, File Management and Networking Technology: "The MPEG-2 Re-Coding Data Set", "Transporting MPEG-2 Re-Coding Information through 4:2:2 Component Digital Interfaces", "Transporting MPEG-2 Re-Coding Information through High-Definition Digital Interfaces". COTS implementations of these draft standards are already available.

Once SMPTE adopts the family of MPEG-2 re-coding standards and they have been evaluated by the MISB as meeting DoD/IC/NSG requirements, the SMPTE MPEG-2 re-coding Standards will become a DoD/IC/NSG STANDARD for the transfer of re-coded MPEG-2 digital waveforms for motion imagery systems.

(VWG, 19 Nov 1997 - Approved for Study; VWG, 8 June 1999 – Language Revised)

STUDY 9807 - Motion Imagery Quality Metrics

Evaluate and/or support development of emerging standards for systems based on "Just Noticeable Difference" (JND) techniques for automatic motion imagery image quality measurements, for DoD/IC/NSG applications.

(VWG, 19 Nov 1997 - Approved for Study)

STUDY 9808 - Still Imagery Derived from Video Motion Imagery

Evaluate and/or support development of emerging standards such as NITF 2.1, NSIF, and or BIIF, for the carriage of still imagery derived from motion imagery and for the future carriage of native motion imagery segments and related metadata.

Note: Under this Study NGA has developed the capability to directly capture still images from MPEG-2 streams and output them in TIFF or NITF formats on the Windows NT platform. This prototype GFE software is available for use by Government agencies from the NGA Persistent Surveillance Office. COTS versions of this software are also available. These software products significantly preserve image quality as compared to traditional MPEG-2 decompression to base band video and subsequent frame grabs and storage to NITF file formats.

(VWG, 19 Nov 1997 - Approved for Study; VWG, 8 June 1999 – Language Revised)

STUDY 9809 - Audio Interchange

Evaluate audio standards for DoD/IC/NSG applications. Initial study activities will include standards such as AES-3, MPEG-2 Audio, Dolby AC3, MPEG-4 ISO/IEC 14496-3:2005 High Efficiency-Advanced Audio Coding (HE-AAC) Profile at Level 2 with support for up to 2 channels and 48 kHz sampling, and ITU-T Rec. G.722 for 7 kHz audio within 64 kbps (ADPCM).

(VWG, 19 Nov 1997 - Approved for Study) (15 May 2008 – Approved for Study)

STUDY 9810 - Low Bit-Rate Motion Imagery

Evaluate low bit-rate motion imagery for DoD/IC/NSG applications.

(VWG, 19 Nov 1997 - Approved for Study)

STUDY 9903 - MPEG-2 Embedded Subheader

Develop concept and detailed technical implementation to embed the information content of the NITF header/subheader at a defined location in an MPEG-2 Program Stream (PS). This study includes preparation of format specifications for this information. The resulting program stream must be fully interoperable with commercial off-the-shelf MPEG-2 decoders and viewers.

(VWG, 8 June 1999 - Approved for Study)

STUDY 9904 - NITF Support for Motion Imagery

Develop RFC for addition of MPEG-1 and MPEG-2 (future growth: MPEG-4) support to the NITFS. This study includes preparation of format specifications. The

resulting NITF files must be interoperable (with software modifications to process the motion imagery content) with existing systems that support NITF.

(VWG, 8 June 1999 - Approved for Study)

STUDY 0002 - MPEG and KLV Interoperability

(MISB, 27 July 2000 - Approved for Study) (Adopted)

STUDY 0003 - Advanced High Definition Television

Motion Imagery System Matrix Level 14 (MISM-L14), Uncompressed Advanced High Definition Motion Imagery, should be refined to reflect technology in the laboratory. Examine compressed and uncompressed Advanced HD motion imagery taking into account multispectral sensor outputs.

Note 1: Only PROGRESSIVE SCAN formats are authorized for advanced high definition DoD/IC/NSG motion imagery acquisition applications (systems used to originate, acquire, produce, process, manipulate, exploit, store, archive and disseminate motion imagery in support to imaging applications, including (but not limited to) Intelligence, Reconnaissance, and Surveillance).

(MISB, 27 July 2000 - Approved for Study)

STUDY 0004 - Motion Imagery Security, Authentication, and Encryption

Evaluate and/or support development of emerging standards in security/ releasability marking, digital signatures, digital watermarking, steganography, and encryption as applied to motion imagery and associated metadata for DoD/IC/NSG applications.

(MISB, 27 July 2000 - Approved for Study)

STUDY 0105 - Motion Imagery Sensor/Collection Metadata

Enumerate digital metadata to be captured from sensors and vehicle subsystems on generic unmanned vehicles. Research the available documentation from unmanned aircraft system (UAS), unmanned combat air vehicle (UCAV), unmanned ground vehicle (UGV), unmanned subsurface vehicle (UUV), and fixed-site surveillance sources. Focus of this study shall be on all metadata that directly supports the advanced collection, processing, exploitation, storage, retrieval, distribution, and use of motion imagery. Coordinate with ongoing UAS, UCAV, UGV, UUV, and fixed-site surveillance programs to compile a Recommended Practice describing a metadata schema to be embedded into digital motion imagery sensor bit streams.

(MISB, 7 February 2001 - Approved for Study)(MISB, 24 May 2001, Changed Title)

STUDY 0106 - Advanced File Formats

Evaluate and/or support development of emerging standards for advanced digital media file formats for the exchange of motion imagery and metadata files across systems and applications.

(01 March 2001 GSMC-ISMC Approved for Study)

STUDY 0108 - Metadata for Scathe View

Evaluate and/or support development of emerging standards for Scathe View Metadata.

(11 October 2001 MISB Approved for Study)

STUDY 0109 - Precision Engagement Metadata

Evaluate and/or support development of emerging standards for Precision Engagement Metadata.

(11 October 2001 MISB Approved for Study)

STUDY 0201 - Motion Imagery Intelligence Annotation Standard and Transport

Assess and recommend graphic/text annotation standards (i.e. CGM, etc) for creation and management of static and dynamic graphic/text overlay annotations to be added to motion imagery intelligence products. Assess and recommend transport of annotation constructs within MISP standards (MPEG-2 TS w KLV PDS, KLV, X-on2, DoD AAF profile, etc.). Employ prototype tools to validate recommendations. Prepare draft MISP Standard / Recommended Practice for submission to IWG / MWG and MISB.

(21 November 2002- MISB Approved for Study)

STUDY 0202 - Transport of H.264 on MPEG-2

(21 November 2002- MISB Approved for Study) (Adopted)

STUDY 0301 - DoD/IC/NSG Profile of the SMPTE KLV Metadata Dictionary

Develop a Profile of the SMPTE Metadata Dictionary (335M and RP210) that is a subset focused on DoD/IC/NSG applications and that further defines, clarifies and/or limits material in the SMPTE 336M and RP210. Consider creation of new metadata elements unique to DoD/IC/NSG applications, that comply with SMPTE 336M (KLV protocol), but will not appear in the SMPTE-published Dictionary. Also consider the establishment of a separate Groups (Sets, Packs, and Labels) Dictionary for only DoD/IC/NSG applications.

(12 June 2003 – MISB approved for study)

STUDY 0302 - 60.000/30.000 Frames Per Second Video

Evaluate acquisition of video imagery at true 60 and 30 Frames Per Second versus 59.94 and 29.97 for DoD/IC/NSG applications. Investigate commercial product availability and examine operation with synchronous GPS/UTC time stamped metadata. Investigate conversion to 59.97 Hz for those that must display on standard definition receivers.

(20 November 2003- MISB Approved for Study)

STUDY 0303 - AAF – MXF Use Guidance

Evaluate AAF and MXF properties and features to provide guidance on the most appropriate use of each in DoD/IC/NSG applications

(20 November 2003- MISB Approved for Study)

STUDY 0304 - MPEG-2 Transport Stream Synchronous Metadata

Develop MISB RP or EG defining application of MPEG-2 systems Amendment 1 to synchronous KLV metadata transport in MPEG-2 private data streams.

(20 November 2003- MISB Approved for Study)

STUDY 0401 - Common Metadata Descriptor Documents

Investigate the current usage of the EG104.x as a **Predator** only document. The current definition of the metadata set(s) is based on the source of the data (i.e. Predator) and not the usage of the data (exploitation, general viewing, etc). Ideally the goal of all exploitation views the Motion Imagery independent of the platform – "its just video with KLV" not "Predator video with Predator KLV" or "Fire Scout video with Fire Scout KLV". The idea is to convert all forms of sensor metadata to common "exploitation" metadata set(s) based on the intended usage and processing.

Produce a document to be a "common" metadata description for more than one platform. All of the existing Predator specifications would be retained in the document as an appendix. Any new platforms that use this EG would also be included as appendices in later versions of the document. Additionally the study should provide two other suggestions, primitive set and extended set. The "primitive" set is the least amount of information needed from small sensors (example: position and time). The "extended" set would contain larger amounts of information for more sophisticated processing e.g. geo-registration.

(8 April 2004 - MISB Approved for Study)

STUDY 0402 - Develop Infrared Motion Imagery Standards

Develop MISB standards, profiles of standards, recommended practices, and engineering guidelines pertaining to infrared motion imagery for inclusion in the MISP.

(26 August 2004 - MISB Approved for Study)

STUDY 0501 - Study and Propose Motion Imagery Computer and Consumer Interface Standards where Applicable

Study and propose computer interface standards for applicability and recommendation for inclusion in the MISP. In particular, compare IEEE 1394 A and B, USB2, and CameraLink with SMPTE292 and 259.

(25 August 2005 - MISB Approved for Study)

STUDY 0502 - Study and Propose Motion Imagery Standards for Situational Awareness

Develop standards, recommended practices, and engineering guidelines for compression, transport, and distribution of MISM L1 and L2 situational awareness motion imagery

(25 August 2005 - MISB Approved for Study)

STUDY 0503 - Study and Propose Motion Imagery Standards for Interfaces and Delivery of Sensor / Platform Metadata

Develop standards, recommended practices, and engineering guidelines for interfaces and delivery of sensor / platform metadata

(25 August 2005 - MISB Approved for Study)

STUDY 0601 - Study and Propose Compression Methods for Advanced High Definition Motion Imagery Levels L12 and L13

Establish user community requirements for advanced compression, such as JPEG2000, especially for large format motion imagery. Define metadata transport and synchronization recommendation. Define motion imagery frame control. Recommend additions to the MISP, MISM, as well as new or modified Standards, Recommended Practices, and Engineering Guidelines.

(12 January 2006 - MISB Approved for Study)

STUDY 0602 - Study and Propose Methods for Time Stamping of Metadata and Motion Imagery for reliable Synchronization

A. Develop RP(s) defining implementation of temporally correlated motion imagery, including precision time stamped motion imagery and metadata.
B. Develop RP(s) defining implementation of transport for temporally correlated motion imagery, for net-centric DoD internet distribution. This includes TS, MXF, RTP, MPEG-4 transport, compression such as MPEG-2, H.264, and future compression, and files.

(12 January 2006 - MISB Approved for Study)

STUDY 0603 - MISB Metadata Registry

(12 January 2006 - MISB Approved for Study) (Adopted)

STUDY 0604 - Cursor-on-Target (CoT)

Develop standards, recommended practices, and engineering guidelines for the export of selected KLV metadata into CoT schemas, import of CoT messages into metadata streams, and association of imagery with parallel CoT messages.

(12 January 2006 - MISB Approved for Study)

STUDY 0605 - Encoder Tradeoffs

The government has currently deployed MPEG2 (and H.264) encoder systems which were built and tuned to support the commercial broadcast industry. The governments ISR video has very different characteristics in which the video quality or bandwidth efficiency may be improved if the encoders were tuned differently. Examples of these characteristics are: for UAS video much of the content is staring at one building or scene – relatively static image. Another example is that in IR modes the video has no color component. The purpose of this study is to:

1) Identify all of the different encoder parameters – some may be vendor specific,

2) Determine what effect each encoder parameter has on the video content and bandwidth. Also determine the effects that one parameter has on the other.
3) Research the effects on the ISR video of each parameter.

Examples:

With IR video – if the color can be shut off there should be more bits for other areas of improvement (better quality of edges, etc.)

When staring at one point on the ground for long periods of time what effect does the GOP length have on bandwidth, etc.
(11 May 2006 – MISB approved for study)

STUDY 0606 - Motion Imagery Metadata Only Formats and Distribution Standards

Perform study to identify community needs for distribution of motion imagery metadata only. Identify metadata authorities within DoD and intelligence community that may have authorities, metadata standards, and transport standards that provide the needed standards guidance (examples include GWG, Cursor-on-Target (COT) program, and others). Recommend and draft MISP references, EG, or RP to explicitly provide guidance to acquisition authorities, developers, certification authority (JITC), and programs / systems that will receive motion imagery metadata only distributions. This guidance may include recommendations to simply refer to other metadata authorities or it may include explicit MISP motion imagery metadata standards. Prepare metadata mapping from MISP KLV to metadata distribution standards, such as CoT and others as applicable.

(14 December 2006 – MISB approved for study)

STUDY 0701 - High Bit depth Infrared Compression

Develop and perform a comparison of MISP compliant infrared compression techniques on high bit-depth Infrared motion imagery. The study will include H.264 and JPEG 2000 evaluations against an MPEG-2 baseline. The driving purpose behind this study is to determine the preferred methods for configuring and performing compression that best preserves data integrity after high bit-depth conversion.

(13 September 2007 – MISB approved for study)

STUDY 0702 - Study to consider ISO Base Media Format as a MISP-compliant file format

Media file wrappers serve numerous purposes, such as for storage, transfer, distribution, and streaming of content. Because of these different uses of content it is important to consider the system implications in standardizing on one common file format as opposed to no set standard, in which case developers would need to rely on content servers to format content according to their needs. The ISO Base Media Format serves as a baseline format for AVC, SVC, JPEG2000, MP4, and 3GPP. For this reason, it may be an optimal choice for use in MI systems. This study is intended to answer this question, and

determine whether the ISO Base Media Format can offer future stability and growth in maintaining MI asset interoperability.

(13 December 2007 – MISB approved for study)

STUDY 0802 - Study of Minimum Metadata for Situational Awareness

In support to USIP 1, develop a minimum metadata set to support situational awareness motion imagery systems.

(15 May 2008) – MISB approved for study)

APPENDIX B – REFERENCES AND BIBLIOGRAPHY

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[78] ISO/IEC 15444-3	Information technology - JPEG 2000 image coding system - Part 3: Motion JPEG 2000: 2007

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ISO/IEC 15444-1:2004 AMD1	JPEG 2000 Image Coding System -- Part 1: Image Coding System: Profiles for digital cinema applications: 2006
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NSG Technical Architecture	Revision A, 26 Jan 1999
IIDC 1394-based Digital Camera Specification, Version 1.31, 1394 Trade Association: 2004	
MISB EG 0802	H.264/AVC Coding and Multiplexing: Sept 2008
MISB EG 0803	Delivery of Low Bandwidth Motion Imagery: Apr 2008
MISB RP 0804	Real-Time Protocol for Full Motion Video: Mar 2008
MISB EG 0812	Clipping of Streaming Video into Files: Dec 2008
MISB EG 0813	Integration of Motion Imagery into the Shared Coalition Database: Dec 2008
SMPTE 393M-2004	Material Exchange Format (MXF) Operational Pattern 2b (Play-List Items, Ganged Packages)
SMPTE 422M-2006	Material Exchange Format – Mapping JPEG 2000 Codestreams into MXF Generic Container

SMPTE 424M-2006	Television - 3 Gb/s Signal/Data Serial Interface
SMPTE 435-1, 2, 3-2007	10 Gb/s Serial Signal Data Interface - Part 1: Basic Stream Distribution; Part 2: 10.692 Gb/s Stream - Basic Stream Data Mapping; Part 3: 10.692 Gb/s Optical Fiber Interface
SMPTE EG 41-2004	Material Exchange Format (MXF) Engineering Guideline
SMPTE EG 42-2004	Material Exchange Format (MXF) - MXF Descriptive Metadata

APPENDIX C – ACRONYMS AND ABBREVIATIONS

A

AES3	Audio Engineering Society 3
ANSI	American National Standards Institute
ATM	Asynchronous Transfer Mode
ATSC	Advanced Television Systems Committee
ATV	Advanced Television
AVI	Audio / Video Interleaved

B

BIIF	Basic Image Interchange Format
BNC	British National Connector

C

CFR	Code of Federal Regulations
COTS	Commercial Off-the-Shelf

D

DISR	DoD Information Technology Standards Registry
DoD	Department of Defense
DV	Digital Video
DVB	Digital Video Broadcasting
DVD	Digital Versatile Disk; Digital Video Disk
D-VHS	Digital VHS
D-VITC	Digital VITC

E

EBU	European Broadcast Union
ED	Enhanced Definition
EIA	Electronics Industries Association
ELT	Electronic Light Table
EO	Electro-optical
ETR	European Telecommunications Report
ETS	European Telecommunications Standard

F

FCC	Federal Communications Commission
FMV	Full Motion Video
FOV	Field of View
FPS	Frames per Second

G

GFE	Government Furnished Equipment
GPS	Global Positioning System
GSMC	Geospatial Standards Management Committee

H

HD	High Definition
HDTV	High Definition Television
HL	High Level

I

IC	Intelligence Community
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IOC	Initial Operational Capability

IPL	Image Product Library
ISDN	Integrated Services Digital Network
ISMC	Imagery Standards Management Committee
ISO	International Organization for Standardization
ITU	International Telecommunication Union
ITU-R	International Telecommunication Union – Radiocommunications Sector
J	
JPEG	Joint Picture Experts Group
JND	Just Noticeable Difference
JPIP	JPEG Interactive Protocol
JTA	Joint Technical Architecture
K	
KLV	Key-Length-Value
L	
LTC	Longitudinal Time Code
LVSD	Large Volume Streaming Data (a.k.a. WALF)
M	
MASINT	Measurement and Signature Intelligence
MIL-STD	Military Standard
MIPO	Motion Imagery Program Office
MISB	Motion Imagery Standards Board
MISM-L	Motion Imagery Systems Matrix -Level
MISM	Motion Imagery Systems Matrix
MISP	Motion Imagery Standards Profile
MJD	Modified Julian Date
ML	Main Level
MP	Main Profile
MPEG	Moving Picture Experts Group
MTI	Moving Target Indicator
N	
NATO	North Atlantic Treaty Organization
NIIRS	National Imagery Interpretation Rating Scale
NSG	National System for Geospatial-Intelligence
NSIF	NATO Secondary Imagery Format
NTA	NSG Technical Architecture
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 Format
POTS	“Plain Old Telephone Service”
PS	Program Stream
Q	
QSIF	Quarter SIF (176x120 pixels)
R	
RFC	Request for Change
RP	Recommended Practice

RTSP	Real Time Streaming Protocol
RTP	Real Time Protocol
S	
SAR	Segmentation and Re-assembly
SAR	Synthetic Aperture Radar
SD	Standard Definition
SDI	Serial Digital Interface
SDTI	Serial Data Transport Interface
SECAM	System Electronique Couleur Avec Mémoire
SIF	Standard Image Format (352x240 pixels)
SIGINT	Signals Intelligence
SMPTE	Society of Motion Picture and Television Engineers
STANAG	Standardization Agreement (NATO)
S-VHS	Super Vertical Helical Scan
T	
T-1	Telecommunications Link Standards (1.5 Mbps)
T-3	Telecommunications Link Standards (45 Mbps)
TBD	To be Determined
TIFF	Tagged Image File Format
TS	Transport Stream
U	
UAS	Unmanned Aircraft System
UAV	Unmanned Aerial Vehicle
UTC	Coordinated Universal Time
UVID	Universal Video Index and Dictionary
V	
VHS	Vertical Helical Scan
VISP	Video Imagery Standards Profile
VITC	Vertical Interval Time Code
VWG	Video Working Group
W	
WALF	Wide Area Large Format (LVSD preferred)
X	
Y	
Y2K	Year 2000
Z	

APPENDIX D – REVISION RECORD

Date on Document	Version Number	Notes/Status
16 Jan 1997	0.96	Version 0.96 – First VWG VISP document under configuration control. 16 Jan 97 document plus 30-day provisional adoption items. Submitted to VWG and adopted with agreed changes on 26 Mar 97.
26 Mar 1997	0.97	Final baseline version as adopted by VWG (includes agreed changes from 26 Mar 97). Submitted to ISMC for approval. Approved by ISMC on 12 Jun 97 with agreed minor changes.
12 Jun 1997	1.00	Final ISMC approved baseline version (includes agreed minor changes from 12 Jun 97).
26 Sep 1997	1.10	Incorporates the following changes approved by the ISMC on 26 Sep 1997: V97-001 – Video Systems Matrix update - Section 4.0 – Recommended Practice 9720 V97-002 – Change of document title to: "Video Imagery Standards Profile" (Includes editorial changes and reorganization to align with other DoD/IC/NSG standards documents)
19 Nov 1997	1.20	Incorporates the following changes approved by the VWG on 19 Nov 1997: V98-001 – Updates to and adoptions of Standard 9715 (Time Reference Synchronization), Updates to and adoptions of Standard 9723 (Advanced Television). Updates to and adoption of Video Systems Matrix RP 9720a (HD).
7 Jan 1998	1.21	Returns Standard 9723 (Advanced Television) to Emerging status and RP 9720a (HD) to Study status pending formal GSMC-ISMC approval; incorporates Explanatory/editorial changes. Note that 1.21 is the reference baseline for JTA 2.0
25 Feb 1998	1.22	Incorporates revisions to 1.2 (based on 60 days Comments Period); incorporates explanatory/editorial changes. Incorporates changes from 25 Feb VWG.
6 Mar 1998	1.3	GSMC-ISMC Approved As Amended.

REVISION RECORD (continued)

Date on Document	Version Number	Notes/Status
8 June 1999	1.4	Incorporates the following changes provisionally approved by the VWG on 20 Jan 1999 and with language revised by VWG on 8 June 1999: 1) Addition of a DoD/IC/NSG Video Imagery Migration Objective section to Chapter 1. 2) Movement of 9714, Time Code Embedding, from Study to Standard status. 3) Temporary suspension of a portion of 9723 (FCC Fourth Report and Order). 4) Revision of Metadata Studies 9712, 9713, 9716, 9717, 9718 to reflect recent changes in draft SMPTE standards. 5) New Studies 9903, 9904, 9905 for NITF wrapper for motion imagery, MPEG-2 PS subheader, and Concise KLV Encoding. 6) Extensive revision of Recommended Practice 9720 to include addition of Enhanced Definition as a new VSM band with other VSM definitions changed accordingly. Note that the inclusion of this new definition required an extensive re-write of the VSM concept. Therefore, the new VSM scale will hereafter be annotated as VSM Revision 1 (VSM r1). 7) Movement of 9902 from Study to Recommended Practice 9902 status, authorizing limited applications of DV format video 8) Explanatory/editorial changes. a) Added Table of Contents b) Expanded References c) Added Glossary of Acronyms
12 Aug 1999	1.4	GSMC-ISMC Approved
20 Oct 1999	1.5	20 October meeting of VWG approved and recommended to GSMC-ISMC the movement of Metadata Studies 9712, 9713, 9716, 9717, 9718 to STANDARDS status; new Study 9906 on Segmentation and Re-assembly of KLV Packets; identification of relevant VWG documents for metadata standards; update to VISP version chronology; editorial changes.

REVISION RECORD (continued)

Date on Document	Version Number	Notes/Status
24 Feb 2000	1.5	GSMC-ISMC Approved.
27 July 2000	1.6	Presented at the Motion Imagery Standards Board Meeting. Incorporates the following changes: 1) Editorial changes related to the change from VWG to MISB 2) Adoption of SMPTE Standards and Recommended Practices for Metadata Dictionary and KLV encoding protocol 3) Adoption of MISB Standard 001-720P to update to multiple frame rates including 24, 25 and 50 Hz
02 Nov 2000	1.6	GSMC-ISMC Approved.
7 Feb 2001	1.7	Approved by the Motion Imagery Standards Board. Incorporates the following changes: 1) Editorial changes in terminology from video to motion imagery 2) Acceptance of SMPTE 305M, Serial Data Transport Interface; Movement of 9803 from Study status. 3) Acceptance of SMPTE 296M-2001, 1280 x 720 Progressive Image Sample Structure; Replaces the identical MISB Standard 0001-720P, which has been rescinded. 4) Acceptance, upon 30-day review, of RP – 0101, MPEG-2 System Streams 5) Acceptance, upon 30-day review, of RP – 0102, Security Metadata Universal Set; 6) Acceptance of four items for Study; 0103 - Timing Reconciliation; 0104 - Predator Engineering Guideline for Closed Captioning; 0105 - Unmanned Vehicle Metadata Sets; 0106 – Advanced File Formats *(direct request to GSMC/ISMC)* 7) Cancelled Study items 9905 and 9906
1 Mar 2001	1.7	GSMC-ISMC Approved.

REVISION RECORD (continued)

Date on Document	Version Number	Notes/Status
24 May 2001	1.8	Submitted to the Motion Imagery Board for approval on 24 May 2001. Substantive changes are: 1. ITU-R BT.1358 replaces SMPTE 293M as the Enhanced Definition Standard 2. Adopts RP 0103 - Timing Reconciliation Universal Metadata Set for Digital Motion Imagery 3. Adopts Engineering Guideline 0104 - Basic Predator KLV Metadata 4. Adopts RP 0106 on Advanced Authoring Format 5. Adopts RP 0107 on Material Exchange Format 6. Updates to SMPTE RP210.3 metadata dictionary from RP210.2
11 Oct 2001	2.0	Submitted on 11 October 2001 to the Motion Imagery Board for provisional 30-day approval. Substantive changes are: 1. Editorially revised to be NATO friendly 2. 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), includes amendments and replaces 13818-1, 1995 including Amendment 1: Registration Procedure for Copyright Identifier, Amend. 2: Registration of Private Data, and Draft Amendment 3: DSM-CC and Private Data. 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), includes amendments and replaces 13818-2, 1995 including Amendment 1: Registration Procedure for Copyright Identifier, Amendment 2: 4:2:2 Profile, Amendment 3: Multi-view Profile, and Draft Amendment 4: ITU-T Extension Code Assignment. Adopt RP on Bit and Byte Order. Adopt MPEG-2 Amendment for Synchronization of Metadata. Adopt the revised Metadata RPs. Adopt Study on Scathe View Metadata.

REVISION RECORD (continued)

Date on Document	Version Number	Notes/Status
21 Mar 2002	2.0a	Editorial Changes 1. Extended definition and enhanced definition used interchangeably. Use Enhanced throughout the document 2. Change Joint to Coalition 3. Add 25 Hz progressively scanned to frame rate section 4. RP 9720c, d and e – Revise unexplained changes in text from previous version, e.g. 2.1.4.1.1 revised back to T3, ATM 5. Dates updated in References to same as text Added to Acronyms and Abbreviations
21 Nov 2002	2.1	Submitted on 21 November 2002 to the Motion Imagery Board for provisional 60-day approval. Substantive changes are: 1. USIGS to NSG 2. MPEG-2 MP@ML adopted 3. Xon2 4. SMPTE 349M-2001adopted for Enhanced Definition in SMPTE 292M 5. H.264 6. SMPTE 342M for HD-D5 7. SMPTE RP 214-2002 replaces MISB document 8. Removed two studies Added two studies
12 June 2003	2.2	Approved by MISB. If no objection in 30 days from this date, 2.2 will be the approved MISP 1. New chairman 2. Standardized ITU-T Rec. H.264 for low bit rate applications 3. Recommended AAF and MXF New Study

REVISION RECORD (continued)

Date on Document	Version Number	Notes/Status
20 Nov 2003	2.3	Approved by MISB. If no objection in 30 days from this date, 2.3 will be the approved MISP. 1. Recommended the AAF Profile ASPA 0.7 for Aerial Surveillance and Photogrammetry Applications 2. Updated commercial standards references 3. Updated MISP RP 0102.1 to 0102.2 4. Updated MISP EG 0104.1 to 0104.2 5. Added 3 studies 6. Updated data rates for various motion imagery standards levels Added guidance for the use of H.264 for low bit rate applications
8 April 2004	2.4	Approved by MISB. If no objection in 30 days from this date, MISP 2.4 will be the approved MISP. 1. Updated Infrared 2. Update AAF Profile ASPA 0.7 to 0.8 3. Allowed the use of H.264 for Standard Definition and Enhanced Definition Motion Imagery 4. Added data rates for H.264 5. Updated EG 0104.2 to 0104.3 6. Added one study 7. Updated references
26 Aug 2004	3.0	Approved by MISB. If no objection in 60 days from this date, MISP 3.0 will be the approved MISP. 1. Added Section 3 on Infrared Standards 2. Added Study on Infrared Standards 3. Modified recommended practice tables 4. Updated references 5. Modified line for imbedding Vertical Interval Time Code Editorial changes

REVISION RECORD (continued)

Date on Document	Version Number	Notes/Status
9 Dec 2004	3.1	Approved by MISB. If no objection in 60 days from this date, MISP 3.1 will be the approved MISP. 1. SMPTE 210.8 to SMPTE 210.9 2. ASPA 0.8.2 to ASPA 0.8.3 3. MISP STD 0403 Serial Interface STD for IR 4. H.264 for High Definition Motion Imagery 5. Added 16 bit and H.264 for IR
29 Apr 2005	3.2	Approved by MISB. If no objection in 60 days from this date, MISP 3.2 will be the approved MISP. 1. New MISM Levels for situational awareness 2. Changes to MISM Levels for High Definition and Advanced High Definition Revisions to metadata via AES-3
25 Aug 2005	3.3	Approved by MISB. If no objection in 60 days from this date, MISP 3.3 will be the approved MISP. 1. New MISM Levels for situational awareness 2. Engineering Guideline EG 0104.4, "Predator UAV Basic Universal Metadata Set" was updated 3. Recommended modes for IEEE 1394 Added three studies
Jan 2006	3.4	Approved by MISB. If no objection in 60 days from this date, MISP 3.3 will be the approved MISP. 1. Engineering Guideline 0601 – UAV Datalink Local Metadata Set 2. Recommended Practice 0602 – Annotation Universal Metadata Set 3. STUDY 0601 – Study and Propose Compression Methods for Advanced High Definition Motion Imagery Levels L12 and L13 4. STUDY 0602 – Study and Propose Methods for Time Stamping of Metadata and Motion Imagery for reliable Synchronization 5. STUDY 0603 – MISB Metadata Registry 6. STUDY 0604 – Cursor-on-Target (CoT)

REVISION RECORD (continued)

Date on Document	Version Number	Notes/Status
May 2006	3.5	Approved by MISB. If no objection in 60 days from this date, MISP 3.3 will be the approved MISP. 1. Recommended Practice 0606 – Authorized Use of JPEG 2000 or Motion JPEG 2000 for Wide Area Large Format Motion Imagery 2. Engineering Guideline 0602 – MISB Metadata Registry 3. STANDARD 0403 – Bit-Serial Digital Interface for Infrared Motion Imagery (added IEEE 1394 input/output protocols, specifically IIDC 1394-based Digital Camera Specification Version 1.31 Format_0 Mode_6 may be used for 640x480 IR. See Study 0501) 4. Changed references to ITU-T Rec. H.264/ AMD1: 2004, Advanced Video Coding Fidelity Range Extensions, expanded to include the new High 4:4:4 Profile 5. STUDY 0605 – Encoder Tradeoff study
10 Aug 2006	4.0	Approved by MISB. If no objection in 60 days from this date, MISP 4.0 will be the approved MISP. 1. Draft RP 0603 on Common Time Reference for Digital Motion Imagery using Coordinated Universal Time (UTC) 2. Draft RP 0605 on Inserting Time Code and Metadata in High Definition Uncompressed Video 3. Draft RP 0402 on Infrared Motion Image Capture 4. Draft RP 0608 on Motion Imagery ID 5. Draft Update of RP 0102 on Security Metadata Changed UAV to UAS
14 Dec 2006	4.1	Approved by MISB. If no objection in 60 days from this date, MISP 4.1 will be the approved MISP. 1. RP 0604 – Time Stamping of Compressed Motion Imagery; changed formal standard to ISO/IEC 13818-1:2000/AMD 1: 200 2. Changed RECOMMENDED PRACTICE 0102.3 to 102 3. Noted in Engineering Guideline 0104 that an error in obliquity angle in this document will be corrected in the next version. 4. Engineering Guideline (EG) 0104.4 updated to 104.5 5. RP 0608 Motion Imagery Identifier Added 6. Added STUDY 0606 on Motion Imagery Metadata Only Formats and Distribution Standards Updated References

REVISION RECORD (continued)

Date on Document	Version Number	Notes/Status
14 June 2007	4.2	Approved by MISB. If no objection in 60 days from this date, MISP 4.2 will be the approved MISP. 1. EG 0601 – UAS Datalink Local Metadata Set: updated to 0601.1 and mapping to EG 104.5 and issued for 30-day approval 2. RP 102.3 – Security Metadata Universal Set for Digital Motion Imagery issued for 30-day approval 3. RP 0602 – Annotation Universal Metadata Set: updated to 0602.1 and issued for 30-day approval 4. RP 0604 – Time Stamping of Compressed Motion Imagery: 30-day approval. 5. RP 0608 – Motion Imagery Identifier: updated to RP 0608.1 6. RP 0701 – Common Metadata Structure: added and MISB posted for information. 7. Added language for IR resolutions and frame rates. 8. RP 0405: Metadata for IR: deleted 9. Added Dr. Kasner to contact list 10. Updated Web Site
13 Sep 2007	4.3	Approved by MISB. If no objection in 60 days from this date, MISP 4.3 will be the approved MISP. 1. Updated RP 0102.2 to RP 0102.3 2. Updated RP 0301 to RP 0301.2 3. Updated EG 0601 to EG 0601.1 4. Updated RP 0605 to RP 0605.1 5. Updated RP 0608 to RP 0608.1 6. Added RP 0705 on WALFLVSD compression 7. Added Study 0701 on high bit-depth Infrared compression. 8. References updated.
13 Dec 2007	4.4	Approved by MISB. If no objection in 30 days from this date, MISP 4.4 will be the approved MISP. 1. Updated RP 0102.3 to RP 0102.4 2. Editorial changes to RP 0601.1 3. Changes to RP 0608.1 4. Added Study 0702 on ISO Based Media Format 5. References updated.

Date on Document	Version Number	Notes/Status

15 May 2008	4.5	Approved by MISB. If no objection in 30 days from this date, MISP 4.5 will be the approved MISP. 1. New definition for Motion Imagery and Full Motion Video (FMV) 2. Definition for Situational Awareness added 3. Requirement that all MPEG2 MI systems decode up to/including level 9, and that all H.264 MI systems decode up to/including level 9 4. Requirement that all IR MI MPEG2 systems decode up to/including level 8, and that all H.264 IR MI systems decode up to/including level 8. 5. MISM levels identified as M for MPEG2 and H for H.264 6. L10 and L9 limits on frame rates added 7. Video must be output without burned-in metadata 8. RP 0102.5 the new reference document for Security Metadata Universal Set 9. Informative section added: UAS STANAG 4586 KLV Metadata Implementation 10. STUDY 9809 Audio Interchange added 11. STUDY 0802 on Minimum Metadata for Situational Awareness added
18 Sep 2008	5.0	Approved by MISB. If no objection in 30 days from this date, MISP 5.0 will be the approved MISP. 1. RP 0604, 0102, 0301 changed to Standards 2. Updated EG 0601.1 to Standard 0601.2 3. Added EG 0802 H.264/AVC coding 4. Added EG 0803 Delivery of Low Bandwidth Motion Imagery 5. Added RP 0804 Real Time Protocol 6. Added RP 0705.2 LVSD Compression Profile 7. Changed EG 0602 to EG 0607 MISB Metadata Registry & Processes 8. Added EG 0801 Photogrammetry Metadata Set 9. Added EG 0805 CoT 10. Added EG 0806 Remote Video Terminal Local Data Set 11. Added STANDARD 0807 MISB DoD/IC/NSG KLV Metadata Registry 12. Restated STANDARD 9701 MPEG2 Transport Stream in the File Formats Section

Date on Document	Version Number	Notes/Status
11 Dec 2008	5.1	If no objection in 30 days from this date, MISP 5.1, which

		includes a minimum metadata set for standard 0601, will be the approved MISP. Also approved with a 30-day comment period are the following: 1. A new EG 0812 on clipping of motion imagery 2. A new EG 0813 on placing motion imagery in the coalition shared database 3. A new EG 0809 on KLV representation of meteorological data 4. A revision to RP 0806 on Remote Video Terminal 5. Editorial revision to RP 0705.2 6. Added keys to the KLV standards dictionary 0807.1 Also released for review and comment 1. A revision to RP 0602 on annotation 2. RP 0808 on chat 3. EG 0810 on KLV for LVSD 4. RP 0811 on JPIP