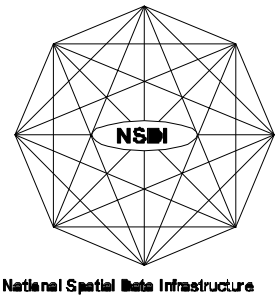
FGDC-STD-002.5-1999



Spatial Data Transfer Standard (SDTS)

Part 5: Raster Profile and Extensions

Subcommittee on Base Cartographic Data
Federal Geographic Data Committee

February 1999

Federal Geographic Data Committee
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Department of housing and Urban Development• Department of Interior• Department of State
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Federal Geographic Data Committee

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SDTS PART 5: RASTER PROFILE and EXTENSIONS

1.1 Introduction

The Spatial Data Transfer Standard (SDTS) defines a general mechanism for the transfer of geographically referenced spatial data and its supporting metadata, i.e., attributes, data quality reports, coordinate reference systems, security information, etc. The overriding principle that SDTS promotes is that the spatial data transfer should be self-documenting. The data set in SDTS should contain all of the information that is needed to assess and (or) use the data for any appropriate GIS application.

The SDTS base specification (ANSI NCITS 320-1998, Parts 1,2 and 3) is implemented via profiles of SDTS. A SDTS profile, in general terms, may be defined as a limited subset of the standard, designed for use with a specific type of data model, i.e., topological vector, point, grid, image, etc. Specific choices are made for encoding possibilities not addressed, left optional, or left with numerous choices within the SDTS base specification. A profile may also specify extensions to the base standard to address changing technologies, and to take advantage of other industry standards.

For raster image data, there are numerous standards, with various properties, restrictions, and degrees of implementation. The SDTS Raster Profile and Extensions (SRPE) permits the use of two other industry standards for image data: ISO/IEC 12087-5 Basic Image Interchange Format (BIIF) and Tagged Image File Format (TIFF). BIIF defines a general mechanism for the transfer of image data and any supporting data, i.e. image parameters, visualization parameters, compression parameters, text annotations, symbols, etc. BIIF is in use in the commercial/military community under a joint profile form of Mil-Std 2500 (National Imagery and Transmission Format) and NATO STANAG 4545 – NATO Secondary Imagery Format (NSIF). TIFF is a general-purpose image file format that is used widely for simple image applications. TIFF is an ad-hoc standard, available for public use, based on a specification owned by Adobe, Inc.

This document, referred to herein as SRPE, is organized into a main body, called the profile core specification, and a number of annexes, both informative and normative. SRPE uses the same major sections found in SDTS Part 1. Specific discussions regarding encoding possibilities in SDTS and BIIF are grouped under each major heading and will include specific references to SDTS Parts 1, 2, or 3, and (or) BIIF where necessary. To aid in the implementation of the optional BIIF extension, a few notes are inserted in appropriate paragraphs to identify potential areas of concern and added capabilities. (These notes are not all inclusive and the implementers should not rely on them to identify all differences or areas of concern.)

Normative annexes provide additional options that may be implemented but are not required. Normative annexes are numbered using uppercase alpha characters. Informative annexes provide additional information that may be useful in the implementation of this profile and the options allowed in the normative annexes. Informative annexes are numbered using numeric characters. Annex A is the profile annex option that permits BIIF to be used for the image data portion of an SDTS transfer. Annex B permits the SDTS color modules to be used. Annex C permits data compression to be used. Annex D permits special purpose transfer where it may be necessary to omit otherwise mandatory information. Annex E permits TIFF to be used for the image data portion of an SDTS transfer. Annex 1 contains a glossary. Annex 2 contains examples to help clarify the implementation of this profile. Annex 3 is a crosswalk between the standards terms and concepts to assist those familiar with only SDTS or BIIF.

1.1.1 Objective

In general, a SDTS profile provides for the transfer of files, records, fields and subfields with the following objectives:

a. to encode in a standard non-proprietary format;
b. to provide for machine and medium independence;
c. to accompany the spatial data with their description;
d. to preserve all meaning and relationships of the data; and,
e. to make use of other industry related standards.

Additionally, the SRPE seeks to take positive action to converge the efforts relating to raster image standards. To meet this objective, new image handling capabilities are made available for use with SDTS by referencing other standards, rather than duplicating the capability within SDTS. This approach is possible because the SDTS was designed with a separation of logical structures and format. The BIIF Extension is a good example of the convergence strategy.

The SRPE seeks to take advantage of the capabilities of both SDTS (raster portion) and BIIF. The SDTS has a geographic information focus and provides the capability of encoding raster grid and image data, georeferencing information, simple color look-up tables, data quality reports, data dictionary information and other such metadata. The BIIF has an image transmission focus and provides an efficient image file format, image compression, image blocking/tiling, variety of color models, and visualization controls. Rather than modify SDTS structures to directly include these more advanced image-handling capabilities, this profile seeks to use BIIF structures as defined. This approach will alleviate redundant development of similar capabilities and facilitate convergence of the military and commercial spatial data communities. To further the convergence of these raster standards, Annex A of this SRPE is intended to be equivalent to the NSIF profile to BIIF.

1.1.2 Scope

The SRPE contains specifications for a profile for use with georeferenced two-dimensional raster data. Both raster image and raster grid data are included within the scope of this profile. The transfer of indirectly referenced images is permitted, i.e., a satellite image of St. Louis, MO where city and state are the only ground based reference included. Excluded are three-dimensional and higher raster data and vector data.

SRPE can accommodate image data, digital terrain data, gridded geographic information system (GIS) layers, remotely sensed images, and any other data that can be conceptualized as a two-dimensional array of data values. For the purposes of SRPE, both gridded data and image data will be referred to as raster data.

1.1.3 Applicability

SRPE can be utilized by the Defense and Civil communities to accommodate exchange of image data, digital terrain data, gridded geographic information system (GIS) layers, remotely sensed images, and any other data that can be conceptualized as a two-dimensional array of data values. Because of its self-documenting nature, SRPE is most appropriate for blind transfers, spatial data archives, and data distribution in a non-proprietary format.

1.1.4 Related and Referenced Standards

The following references contain provisions either by direct reference or relationship, which through references in this paragraph or within this text, constitute provisions of SRPE. At the time of publication, the editions reflect the document versions used for implementing the SRPE. Revisions to referenced standards that post-date this document, and do not cause ambiguity or change to this profile may be used without violating compliance. For clarification, contact the profile maintenance authority.

1.1.4.1 Referenced Standards

The following referenced standards constitute provisions of SRPE by specific reference within the text of SRPE.

ANSI NCITS 320-1998: Spatial Data Transfer Standard (SDTS).
FGDC-STD-001-1998: Content Standards for Digital Geospatial Metadata.
ISO 8211-1984 Data Descriptive File for Information Interchange.

1.1.5 Standards Development Procedures

The SRPE was developed jointly by the U.S. Geological Survey (USGS) and the National Imagery and Mapping Agency (NIMA). The SRPE was developed as an interface and intermediary step to the convergence of SDTS raster capabilities and the BIIF raster transmission standards. The SRPE provides a means of using the archival capabilities, the non-proprietary distribution mechanism, and the geographic information focus of the SDTS and the imagery transmission focus of BIIF.

The SRPE is intended to replace the December 1995 Draft Part 5: Raster Profile. The SRPE retained all the functionality of the previous draft SDTS Raster Profile. Annex A of the SRPE is intended to be equivalent to the NSIF Profile to BIIF to facilitate convergence of these efforts.

Other extensions (Annexes) may be added to SRPE without modifying the profile core specification as long as the implementation of the new Annex does not require the addition of capabilities within the profile core specification.

The ad-hoc working group that consisted of the following members developed the SRPE:

Phyllis Altheide, U.S. Geological Survey
Laura Moore, National Imagery and Mapping Agency
Thomas Hampton, U.S. Geological Survey
Ron Galloni, Joint Interoperability Test Command
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Steve Kerr, Joint Interoperability Test Command
Laura Thompson, National Imagery and Mapping Agency
Canadian Geomatics Standards Board, Raster Subcommittee
Digital Geographic Information Working Group

1.1.6 Maintenance Authority

The maintenance authority for the SDTS Raster Profile and Extensions base profile resides with the US Geological Survey, National Mapping Division (USGS/NMD). The maintenance authority for the NITF profile to BIIF, referenced in ANNEX A, resides with the National Imagery and Mapping Agency (NIMA). Therefore, the maintenance of the SDTS Raster Profile and Extensions will be accomplished by a collaborative effort between the USGS/NMD and the NIMA

1.2 Conformance and Testing

(See also SDTS Part 1, Section 1.2, Conformance, and BIIF clause 5 Conformance profiles and extensions)

There are three types of products and (or) aspects which can be tested or evaluated for conformance to SRPE. Depending on the product capability being evaluated, one or more of the following aspects will be utilized to measure compliance:

(a) SDTS transfers (the actual data sets);
(b) SDTS encoding software; and
(c) SDTS decoding software.

1.2.1 Transfer Conformance

In order to conform to this SRPE a transfer shall:

(a) contain all mandatory spatial objects, modules, fields, and subfields as specified in SRPE;
(b) not contain spatial objects, modules, fields, and subfields which are not permitted by SRPE or its annexes;
(c) conform to all applicable requirements and specifications of BIIF and Parts 1, 2, and 3 of SDTS unless they conflict with SRPE; (profile takes precedent)
(d) conform to all restrictions of SDTS Parts 1, 2, 3 and as specified in SRPE;
(e) be formatted in compliance with ISO 8211 or the applicable adjunct file format as permitted by an annex;
(f) follow all module and file naming requirements of SRPE;
(g) contain any profile options it claims to include; and
(h) adhere to all other requirements specified in SRPE.

1.2.2 Encoder Conformance

In order to conform to this SRPE, an encoder shall:

(a) generate only SRPE transfers which conform to Section 1.2.1 (or be able to be directed to only generate transfers which conform to SRPE);
(b) convert spatial objects in the input system to appropriate SDTS spatial objects;
(c) convert attribute data stored in the input system (such as in a data base) to SDTS Attribute Primary and Secondary modules;
(d) correctly maintain linkages between spatial objects and attributes;
(e) encode raster formats, with the choice of data type (i.e., integer, real, etc.) specified by the user at the time of encoding, and, as an option, be able to create a single transfer with different precessions (i.e., 8-bit, 32-bit, etc.) for each separate layers; and
(f) properly implement all profile options it claims to support.

1.2.3 Decoder Conformance

In order to conform to this SRPE, a decoder shall:

(a) be able to interpret any SRPE transfer which conforms to Section 1.2.1;
(b) be able to decode any module required or permitted by the body of SRPE;
(c) be able to decode any spatial object required or permitted by section 2.1 of SRPE and, to the fullest extent possible, convert it to the receiving systems' corresponding object or equivalent information structure;
(d) be able to decode any Attribute Primary or Secondary Module and convert it to a data base or other format usable by the receiving system;
(e) correctly maintain linkages between spatial objects and Attribute Primary records;
(f) decode multiple precision raster formats, as necessitated by the data type format used in the encoded transfer files; when data precision exceeds system capability then provide notification of action taken;
(g) be able to tolerate the presence of modules, fields, subfields, and adjunct files which are permitted by profile annexes which the decoder does not support;
(h) be able to recover if an error is encountered in a particular record, field, or subfield in the SRPE transfer;
(i) report to a file or output device information describing the position of errors encountered in the SDTS transfer, including Module Name, Record ID, tag, and label of the last successfully decoded data element and, if possible, the Module Name, Record ID, field tag, and subfield label of the data element containing the error; and
(j) properly implement all profile options it claims to support;
(k) be able to decompress all permitted compression methods.

2 Raster Data Concepts

2.1 Spatial Objects

(See SDTS Part 1, Section 2.3 Definition of Spatial Objects)

The SRPE permits only the Digital Image or Grid (object code G2) raster object. All other object representation codes are not permitted. A conformant transfer must contain at least one G2 object. This profile further restricts the Grid Cell and Pixel spatial objects to be of rectangular geometry, i.e.,

hexagons, triangles, octagons, etc. are not permitted. (An image that has not been corrected geometrically to a rectangular grid can also be transferred. See Section 2.7 Warped Grid.) Any image or grid data that can be conceptualized as a two-dimensional array of values can be transferred under this SRPE.

In this profile, the term *raster* will be used to collectively refer to both digital image and grid, and the term *cell* will be used to collectively refer to both grid cell and pixel, unless otherwise noted. The SRPE requires cell values to be numeric.

2.2 Multiple Raster Objects, Layers, and Partitions

The SRPE permits one or more raster objects to be contained in a single transfer. A raster object may consist of one or more layers with the restriction that all layers of a single raster object have the same geographic extents (i.e., cover the same portion of the earth's surface), and use the same raster object scan reference system (i.e., cell address 2,3 refers to the same cell location in every layer.) The raster objects may occupy the same, overlapping, or different horizontal partitions of the earth's surface.

The data encoder is permitted to encode multiple raster objects in a single transfer, but should be warned that the relationship between the raster objects is undefined. The relationship between the multiple raster objects or between the multiple layers of a single raster object must be explained in the SDTS Logical Consistency Module.

BIIF Note: In the case of using the BIIF option the following applies. A BIIF file is permitted to include multiple images. Each image in BIIF can have one or more bands. Further, the SRPE permits the simultaneous use of both SDTS and BIIF. For example, an SDTS grid may be used to encode a layer of elevation data and the BIIF image may be used to encode an orthoimagery layer of the same geographic extent.

2.3 Non-ragged Grids

(See SDTS Part 1, Section 5.7.6.3 (Raster) Data Dictionary Domain)

The SRPE requires a raster grid to be non-ragged. A data encoder can define a "fill value" to convert a ragged grid to a non-ragged grid. In SDTS a Layer Definition module record defines a raster layer. The Data Dictionary module records further describes the meaning of this layer. An associated Data Dictionary Domain module record(s) defines which pixel value means data not present, and any other special pixel values.

BIIF Note: In the case of using the BIIF option the following applies. If the image data to be encoded is ragged then padding or transparent pixels must be used. BIIF uses "masking techniques" to identify non-valued, or transparent pixels within an image BIIF Clause 4.2.5.2). If an image is partitioned into equal size tiles/blocks, then padding can also be used to fill an empty portion of a block.

2.4 Nongeospatial Dimensions

The use of nongeospatial dimensions is not permitted by SRPE. SRPE only permits the transfer of two dimensional raster data in the x,y coordinate space. (The z coordinate is not permitted in the spatial address. Elevation data values are permitted to be transferred as a raster grid layer under this profile.)

BIIF Note: In the case of using the BIIF option the following applies. Baseline BIIF provides for homogenous pixel values for monochrome or color images. PIKS images provide capability for

heterogeneous pixel values of up to five dimensions--x, y, z, temporal, multispectral. Only baseline BIIF is permitted, with two-dimensional data occurring in the x,y coordinate space. (BIIF Clause 4.2.4.1 Image Subheader)

2.5 Raster Scan Reference System

(See SDTS Part 1, Section 5.7.7)

SDTS raster modules permit the definition of a raster object scan reference system and layer scan reference system which are different. The SRPE requires that the raster object scan reference system and the layer scan reference system be identical so no coordinate conversion is required (i.e. the layer coordinate and the raster object coordinate are the same.) The SRPE requires that the scan origin be located at the top left and the scan pattern be linear and the scan direction be row.

2.6 Band Interleaving (Cell Sequencing Code)

(See SDTS Part 1, Section 5.7.1.1. Raster Definition Module)

SRPE permits the cells of a raster object to be sequenced in one of three modes: layer sequential (code GI), layer
interleaved by line (code GJ), or layer interleaved by pixel (code GL). Only layers from the same raster object are permitted to be interleaved. All layers of the same raster object must be interleaved in the same manner (i.e., not permitted to interleave layers one and two and leave layer three sequential.) A raster object with one layer must be denoted as code GI. Each band may have different data types (e.g. band 1 may have a data type of 8-bit integer and band 2 may have the data type of 16-bit integer).

BIIF Note: In the case of using the BIIF option the following applies. (BIIF Clause 4.2.5.4.2) The band interleaving options permitted are by pixel, block, and row as defined for BIIF element IMODE.

2.7 Warped Grid Raster

No standard mechanism is provided to rectify geospatial imagery. In transferring a warped grid image (non-rectified), the geometric correction information is of utmost importance for the correct utilization of the imagery. The geospatial community recognizes the need for standardization of these geometric correction parameters, however, no single standardized set has been developed as of this writing. SRPE recommends that for the transfer of geometric correction parameters, a widely accepted industry standard be used. Geometric correction parameters should be passed along with the image data or at a minimum referenced to provide the receiver of the data with enough information to identify the appropriate system(s) for processing.

The SRPE will permit the transfer of warped grid images. To indicate the transfer of a warped grid image, the object representation code of G2 will have a "W" appended to it, yielding "G2W". A decoder that cannot perform automatic rectification will minimally display the image as a normal grid and warn the data user that this has been done. If the geometric correction parameters are included in the transfer, then the data encoder will encode these geometric correction parameters in SDTS Attribute Primary Module(s) records that are referenced by the Raster Definition Module record.

A conformant decoder must be able to display a G2W object code as if it were a G2 code, with appropriate warnings to the data consumer. Full support of the G2W object representation code is optional for conforming encoders and decoders.

2.8 Tesseral Indexing/Blocking

(See SDTS Part 1 Section 5.7.6 and BIIF Clause 4.2.5.1 Blocked Images)

The SRPE does not permit tesseral indexing.

BIIF Note: In the case of using the BIIF option the following applies. Blocked images are permitted. If compression is used, the entire image (each tile) must be compressed using the same algorithm. If interleaving is used, each tile must be interleaved in the same fashion.

2.9 Compression

(See SDTS Part 1 Section 5.7.10)

The SRPE does not permit compression. (Compression is permitted in Annex A, C, and E.)

Decompression must be supported. This requirement is based on the assumption that compressing is more complex than decompressing, and that data encoders can optionally chose to implement compression. A data decoding capability must support decompression as described below to facilitate data exchange.

Decompression of run length encoding as described in SDTS Part 1 Section 5.7.10.1 must be supported.

BIIF Note: In the case of using the BIIF option the following applies. The NSIF BIIF Profile requires decompression of VQ, Bi-level, and JPEG (lossy and lossless), and compression using JPEG. Compression using VQ and bi-level are optional.

3 Spatial Data Quality

(See SDTS Part 1, Section 3 Spatial Data Quality)

In addition to SDTS Part 1, Section 3 the following requirements must be satisfied.

3.1 Lineage

A report of lineage must include a description of the source material and how it was used. The Federal Geographic Data Committee (FGDC) Content Standards for Digital Geospatial Metadata, Section 2.5 elements are highly recommended to be included in the transfer.

For a remotely sensed image, radiometric information is of utmost importance for correct utilization of the imagery. The SDTS is capable of encoding this information, however, no single standardized set of radiometric parameters has been developed. Any parameters encoded as SDTS attributes need to be fully defined using the SDTS Data Dictionary modules. The Lineage Module should contain a description of how to apply the parameters or reference a document that describes the process.

Separate processing histories pertaining to, for example, separate raster data layers, must be documented. If data are collected from an aerial photograph, then a statement explaining the rectification process is

highly recommended. If the raster has undergone multiple lossy compressions, then a report regarding the compression history is highly recommended.

In general, the more that has been done to the raster data, the more there is to put in the Lineage report. The table below shows a progression of raster products with increasing lineage reporting requirements proceeding from left to right.

Table 3.1 - Raster Spectrum - from Natural to Synthetic

Remote Sensing Thematic Mapper -LandSat	Aerial Photograph scan	Rectified Aerial Photo Scan	Map/Chart Scan	Regular Grid	Feature Coded; Land characterization

BIIF Note: In the case of using the BIIF option the following applies. Lineage information may be carried in the History Tagged Record Extension and the Geospatial Support Data Extension. Lineage information in BIIF and SDTS should cross-reference each other, so the data consumer is aware of all relevant information.

3.2 Positional Accuracy

In reporting positional accuracy, use of a standard reporting method is highly recommended. If no other standard reporting method applies, the FGDC Content Standards for Digital Geospatial Metadata, Section 2.4 elements should be used for encoding.

BIIF Note: In the case of using the BIIF option the following applies. DIGEST Annex D outlines the Geospatial Support Data Extension Segment (DES) through which accuracy data can be included in a BIIF file. BIIF DES also supports reporting of positional accuracy that varies by region within a data set coverage area. Positional accuracy information in BIIF and SDTS should cross-reference each other, so the data consumer is aware of all relevant information.

3.3 Attribute Accuracy

For raster data, attribute accuracy refers to the accuracy of the pixel/cell values for a layer.

For qualitative or categorical attributes, such as land classification or soil type (non-numeric), attribute accuracy is a degree of the reliability of the measurement. For quantitative attributes, such as elevation or temperature values, the accuracy data is a statistical measurement, i.e. standard deviation, or root mean square error (RMSE).

If the raster layer contains elevation measurements, use the Positional Accuracy Module to describe the accuracy of the elevation measurements.

3.4 Logical Consistency

Logical consistency addresses the fidelity of the relationships between spatial objects. With regard to raster data, this addresses the relationships between grids, images, and layers. There are already subfields in the raster modules for describing the number of layers and bands and what each represents. The Data Quality/Logical Consistency module "comment" field includes other information (as textual narration)

that would be useful for human-interpretation. If multiple raster objects are included in the transfer then the relationship between the raster objects must be described.

The Logical Consistency module must contain a description of the NULL scheme used to indicate not relevant missing data and relevant but not known data. (See 4.4 of SRPE for more information.)

BIIF Note: In the case of using the BIIF option the following applies. If raster objects are in SDTS and in BIIF, their relationship must be described in the Logical Consistency Module. If BIIF is used to encode image and sub-image relationships, a statement to this effect should be included in the Logical Consistency Module. If the visual representation of the raster data is also being transferred, include statements in the Logical Consistency module that describe why the visual representation is included and how the information is being included. If BIIF is to be used for display control on a receiver's system, then include a statement in the Logical Consistency module explaining this and to what extent the display is being controlled. For a BIIF image file, a mechanism for specifying display levels and attachment levels assigns a hierarchy coding to each element of the image.

3.5 Completeness

(See SDTS Part 1, Section 3.5 Completeness)

If the original raster data was a ragged grid, state how the grid has been made regular.

BIIF Note: In the case of using the BIIF option the following applies. If pad values or transparent pixels are used, then state that they are present and why, if applicable.

4 General Specification

(See also SDTS Part 1, Section 4.1.3, The Transfer Model)

4.1 Standard Module Names

The SRPE module names (the unique name of each individual module) will be standardized, and consist of four characters according to the following rules.

All modules must be named the same as the primary module field mnemonic. For any module type that can occur multiple times in a transfer, the last 1, 2, or 3 characters of the name can be used to show a series. For example, if a particular SDTS raster transfer contained three distinct Cell modules, the encoder could choose CEL1, CEL2, and CEL3 as the module names. Cell modules must not be named CATD, CATX, CATS, or CLR*. Which of the module types can occur more than once in a transfer and the number of characters in the name that can be varied to signify multiple occurrences are identified in Table 5.1. The complete list of standard module names for SRPE is in Table 4.1.

Table 4.1 - Standard Module Names	
IDEN (Identification),	CATD (Catalog/Directory),
CATX (Catalog/Cross Reference),	CATS (Catalog/Spatial Domain),
SCUR (Security),	IREF (Internal Spatial Reference),
XREF (External Spatial Reference),	RGIS (Registration)
SPDM (Spatial Domain),	DDDF (Data Dictionary/Definition),
DDOM (Data Dictionary/Domain),	DDSH (Data Dictionary/Schema),
STAT (Transfer Statistics),	DQHL (Data Quality/Lineage),
DQPA (Data Quality/Positional Accuracy),	DQAA (Data Quality/Attribute Accuracy),
DQLC (Data Quality/Logical Consistency),	DQCG (Data Quality/Completeness).
CLRX (Color Index)	
RSDF (Raster Definition)	LDEF (Layer Definition)
Cell (Cell) (cannot be CATD, CATX, CATS, CLR*)	Attp (Attribute Primary)
Bttp (Attribute Secondary)	

4.2 Order of Records, Fields, and Subfields within Modules

Records within modules must be ordered, in ascending order, by Record ID. But the actual Record ID integer values need not start with "1," and records in sequence may skip integers arbitrarily, up to (2^{31} – 1).

The subfields within fields and fields within records must be ordered as in the SDTS module specification layout tables found in SDTS Part 1, Section 5.

4.3 Spatial Reference System

(See also SDTS Part 1, Section 4.1.3.5, Spatial Registration)

There must be only one external coordinate frame of reference within a transfer. SDTS External Spatial Reference Conformance level 1, 2, or 3 (unspecified) is permitted. Level 1 must be one of the preferred external reference systems, level 2 must be a known and well-defined system and level 3 indicates indirect referencing or a warped grid system, with an unspecified relationship to latitude and longitude. For additional information see SDTS Part 1 paragraph 4.1.3.5.

Each raster object may have its own internal coordinate system (referenced to the external spatial reference system by translation and scaling parameters in an Internal Spatial Reference module record). Horizontal and vertical datums are specified in the External Spatial Reference module under the HDAT and VDAT subfields respectively.

BIIF Note: In the case of using the BIIF option the following applies. (See DIGEST Annex D Geospatial SDE) - Each image can have its own external spatial reference system.

4.3.1 External Spatial Reference Conformance Level

(See SDTS Part 1, Section 5.2.4.2 External Spatial Reference)

For External Spatial Reference Conformance level 1,

a) The External Spatial Reference EXSP subfield of the Conformance field of the Identification Module must have the value "1" indicating that, YES, one of three recommended systems is used; and,
b) The Reference System Name RSNM subfield in the External Spatial Reference Module primary field must have the value "GEO", "SPCS", "UTM", or "UPS".

For External Spatial Reference Conformance level 2,

a) The External Spatial Reference EXSP subfield of the Conformance field of the Identification Module must have the value "2" indicating that a projection other than the three recommended systems is used;
b) The Reference System Name RSNM subfield in the External Spatial Reference Module primary field must have the value "OTHR";
c) The Projection PROJ subfield in the External Spatial Reference Module primary field must have the name and (or) description of the projection and reference system used; and,
d) The Reference Documentation RDOC subfield in the External Spatial Reference Module must contain the document where the projection is defined. It is recommended that the projection named be defined in the General Cartographic Transformation Package (GCTP[1]).

For External Spatial Reference Conformance level 3,

a) The External Spatial Reference EXSP subfield of the Conformance field of the Identification Module must have the value "3" indicating that georeferencing is unspecified;
b) The Reference System Name RSNM subfield in the External Spatial Reference Module primary field must have the value "UNSP"; and,
c) The Reference Documentation RDOC subfield in the External Spatial Reference Module may contain the document where the rectifying method is described, if applicable.

4.3.2 Internal Representation of Spatial Addresses

The internal representation of X and Y coordinates is permitted by SRPE to be Integer (“I”), Real (“R”), 32-bit signed binary integer ("BI32"), 32-bit unsigned binary integer (“BUI32”), or 32- or 64-bit binary floating point (“BFP32”, “BFP64”) . Signed binary integers are represented in "two's complement" format as defined in ANSI X3.122 - 1986 CGM Part 3 Binary Encoding, SDTS Part 3, Section 5.1, pages 10-11. This standard requires "big-endian" bit ordering in which the most significant bit is stored first (see also ISO 8632-3, and SDTS Part 3, Section 9.3, Binary Data.) Binary floating point values are encoded as specified by ANSI/IEEE 754-1985, Standard for Binary Floating Point Arithmetic. The “I” and “R” types are encoded as per ISO 6093 for numeric values in character string format.

[1] GCTP is the General Cartographic Transformation Package developed by the US Geological Survey and National Oceanic and Atmospheric Administration. Refer to: Snyder, J.P., 1987, Map projections - A working manual: U.S. Geological Survey Professional Paper 1395, 383 p. and/or GCTP Software Documentation.

Internal coordinates can be converted to external coordinates by applying the scaling and translation values from an Internal Spatial Reference module (see SDTS Part 1, Sections 5.2.4.1 Internal Spatial Reference, and 5.7.7.1 Rules for assigning Layer Coordinates to Cell Values).

4.3.3 Restrictions on X and Y Subfields

The X subfield of spatial addresses must only be used to transfer longitude and easting values; and, the Y subfield must only be used to transfer latitude or northing. Only the X and Y geospatial dimensions are permitted. No other geospatial or nongeospatial dimensions are permitted.

4.4 NULL (and Like) Values

(See also SDTS Part 1, Section 4.1.3.3.9, Nulls and Defaults)

The SRPE permits null values for user-defined attributes and cell values to be defined in the Data Dictionary modules. For standard subfields or implementation restrictions, the scheme below is recommended. The SRPE requires that the NULL scheme used be described in the Logical Consistency Module.

When a transfer uses fixed length fields in an ISO 8211 file, special consideration must be given to handling NULL values. NULL values are defined in two general categories:

a. undefined, not relevant;

b. relevant, but unknown or missing.

The data encoder determines null values. When appropriate, the following text will be encoded in the Comment subfield of a Logical Consistency module record, and implemented:

> When a subfield, either user-defined in Attribute Primary and Attribute Secondary module records, or in other SDTS module records, is implemented as fixed-length, the following null scheme is used:
>
> a. when information to be encoded in the subfield is known to be not applicable (undefined, not relevant), then the subfield is valued by a string of spaces; and
>
> b. when the information to be encoded is relevant but unknown (or missing), then the subfield is valued by a string of question marks "?".

The Logical Consistency module with the above text must be associated to applicable modules through the Catalog/Cross-Reference module.

4.5 Attributes

(See also SDTS Part 1, Annex B, Section B.6 Suggested Code Sets)

SRPE highly recommends the use of established FIPS codes where applicable, such as FIPS PUB 6-4 (31 August 1990) Counties and Equivalent Entities Codes. SRPE permits any level of feature conformance (1-4), but highly recommends the use of standardized entities (i.e., layer names for raster) and attributes.

The entire raster or any of its layers may have attributes. Attributes are not permitted on individual cells.

4.6 Relationships between Modules and Raster Objects

There must be one Raster Definition module, one Layer Definition module, at least one Cell module and one Internal Spatial Reference module. The Raster Definition module may have one or more records; one record for each raster object. The Layer Definition module contains one record for every raster layer. The Cell module(s) contain the Cell data for the raster layers.

5 Transfer Module Specification

(See also SDTS Part 1, Section 5 Transfer Module Specification)

This section addresses the module level restrictions as they apply to a transfer. Certain requirements of SDTS Part 1 are repeated here for clarity. Following the module level restrictions/requirements, any restrictions on field/subfield values are noted for each module. The order of coverage follows that of SDTS Part 1, Section 5.

Table 5.1 contains the inclusion, exclusion, and cardinality rules for each module. The standardized module names are included, along with the minimum and maximum number of occurrences of the module type. A lowercase "n" indicates that the upper limit is user defined. Any lowercase letters in the module name means that multiple modules of this type can be named as a series by replacing the lowercase characters with uppercase alphanumeric characters.

Table 5.1 - Module Level Restrictions and Requirements

Module Type	Name	Min. No.	Max. No.
Global Information Modules (See also SDTS Part 1, Section 5.2, Global Information Modules			
Identification	IDEN	1	1
Catalog/Directory	CATD	1	1
Catalog/Cross Reference	CATX	0	1
Catalog/Spatial Domain	CATS	1	1
Security	SCUr	0	n
Internal Spatial Reference	IREF	1	1
External Spatial Reference	XREF	1	1
Registration	RGIS	0	n
Dimension Definition	DMDF	0	0
Spatial Domain	SPDm	0	n
Data Dictionary/Definition	DDDf	1[2]	n[3]
Data Dictionary/Domain	DDOm	1[2]	n[3]
Data Dictionary/Schema	DDSh	1[2]	n[3]

[2]) The DDDF defines each raster layer, the DDSH defines the format for a layer's cells, and the DDOM provides the minimum and maximum as well as special, or enumerated, cell values for each layer.

[3]) A maximum of one module is recommended.

Table 5.1 - Module Level Restrictions and Requirements			
Transfer Statistics	STAT	1	1
Data Quality Modules (See also SDTS Part 1, Section 5.3, Data Quality Modules)			
Lineage	DQHl	1	n
Positional Accuracy	DQPa	1	n
Attribute Accuracy	DQAa	1	n
Logical Consistency	DQLc	1	n
Completeness	DQCg	1	n
Attribute Modules (See also SDTS Part 1, Section 5.4, Attribute Modules)			
Attribute Primary	Attp	0	n
Attribute Secondary	Bttp	0	n
Raster Modules (See also SDTS Part 1, Section 5.7, Raster Modules)			
Raster Definition	RSDF	1	1
Layer Definition	LDEF	1	1
Cell	Cell[4]	1	n
Graphic Representation Modules (See also SDTS Part 1, Section 5.8, Graphic Representation Modules)			
Color Index	CLRx	0	0 (Annex B)
Text Representation	TEXT	0	0
Line Representation	LNRP	0	0
Symbol Representation	SYRP	0	0
Area Fill Representation	AFIL	0	0
Font Index	FONT	0	0
All Vector Modules	--	0	0
Composite Modules	FFxx	0	0

5.1 Global Information Modules

5.1.1 Module Restrictions/Requirements: Identification Module

(See also SDTS Part 1, Section 5.2.1 and Table 10, Identification)

There will be only one Identification module, and it must contain at least one record.

Specific subfield requirements/restrictions:

a) The Profile Identification PRID subfield must minimally have the value "SRPE: SDTS RASTER PROFILE and EXTENSIONS".

[4]) Where “ell” is any combination of numbers or alpha characters, such as CELL, CEL1, C004, etc.

b) If options described in the Normative Annexes of this profile are implemented in a transfer, each implemented annex must be indicated by adding a "/" and the upper case letter of the annex to the Profile Identification subfield. Any combination of annexes may be implemented in a transfer. For example, if a transfer implements Annex A, Profile Identification PRID subfield would contain an "/A".
c) The Profile Version PRVS subfield must have the version identifier, if applicable, followed by the cover date of the profile. (Example: VER 1.1 1998 01 or JUNE 1998)
d) The Profile Document Reference PDOC subfield must contain "Federal Geographic Data Committee" and any applicable document control numbers. (Example: Federal Geographic Data Committee FGDC-STD-002.5-1998.)
e) The External Spatial Reference EXSP subfield must have the value of "1" indicating that, YES, one of the three recommended systems identified in Section 4.4.1 of this document is used; or, the value "2" indicating that another projection, besides those in level 1, is being used; or, "3" indicating that indirect referencing is used or that a warped grid image is being transferred.
f) The Features Level FTLV subfield is permitted to be either "1", "2", "3" or "4". Note that if SDTS is not the authority for any entity and (or) attribute term, then the Features Level subfield must be valued as "4".
g) The Attribute ID field is permitted and is used to reference global information (i.e., metadata) that applies to the entire transfer.

5.1.2 Module Restrictions/Requirements: Catalog/Directory

(See also SDTS Part 1, Section 5.2.2.1 Catalog/Directory)

To ensure the contents of a transfer are independent of the transfer media, the following restrictions are placed on the primary field of the Catalog/Directory module:

a. The Volume subfield will not be used.

b. The File subfield will not include a directory path, only a file name meeting the requirements of Section 6.5 of this document.

5.1.3 Module Restrictions/Requirements: Catalog/Spatial Domain

(See also SDTS Part 1, Section 5.2.2.3 Catalog/Spatial Domain)

The following requirements apply to the Catalog/Spatial Domain field in the Catalog/Spatial Domain module:

a. Either the Domain or Map subfields or both are required so that the coverage of the module is indicated.

b. The Theme subfield is required for all data sources that separate data into themes.

c. Where appropriate, the Aggregate Object Type subfield must contain the raster object representation codes (G2 or G2W) indicating that the module references a raster.

5.1.4 Module Restrictions/Requirements: Internal Spatial Reference

(See also SDTS Part 1, Section 5.2.4.1 Internal Spatial Reference)

The X subfield of spatial addresses must be used only for longitude, easting, or equivalent values. The Y subfield must be used only for latitude, northing, or equivalent values. Therefore, for SDTS level 1

External Spatial Reference conformance, the Spatial Address X Component Label subfield is restricted to "LONGITUDE" when the external spatial reference system is geographic and "EASTING" when the external spatial reference system is UTM/UPS or SPCS. Also for level 1 conformance, the Spatial Address Y Component Label subfield is restricted to "LATITUDE" when the external spatial reference system is geographic and "NORTHING" when the external spatial reference system is UTM/UPS or SPCS.

The Scale Factor X, Scale Factor Y, X Origin, and Y Origin subfields in the Internal Spatial Reference field are required. These subfields specify the scaling and translation required to transform spatial addresses from the internal spatial reference to the external spatial reference (see SDTS Part 1, Section 5.2.4.1 Internal Spatial Reference). The Registration module can also be used to specify this transformation. If the Registration module is used to convert from internal to external coordinates, subfields containing scaling factors and the origin of the external system are optional. Otherwise, the subfields are mandatory and must not be null. If no transformation is required, scaling factors of 1.0 and origin of 0.0 will indicate the identity transformation.

The Internal Spatial Reference module describes the resolution for the spatial dimension. The External Spatial Reference module defines the units and coordinate system for the resolution. The X Component of Horizontal Resolution (XHRS), Y Component of Horizontal Resolution (YHRS), and the Vertical Resolution Component (VRES) subfields will be real numbers.

The Dimension Id (DMID) field must not be present because nongeospatial dimensions are not permitted.

5.1.5 Module Restrictions/Requirements: External Spatial Reference

(See also SDTS Part 1, Section 5.2.4.2 External Spatial Reference)

There must be only one External Spatial Reference module per transfer, with only one record. All spatial data in the same SDTS transfer must be referenced to the same external spatial reference system.

The Reference System Name RSNM subfield must have the value "GEO", "SPCS", "UTM", "UPS", or "OTHR" depending upon the external spatial reference system being used. In the case of a G2W object, the value “OTHR” must be used.

5.2 Data Quality Modules

(See also SDTS Part 1, Section 5.3, Data Quality Modules)

A common set of Data Quality modules may be used for an entire series of files to be distributed. These Data Quality modules may be made available separately; and they need not be duplicated within each SDTS transfer. If the SDTS Data Quality modules are separate from the individual SDTS transfer data set, then they will be uniquely identified and referenced by the individual SDTS transfer data set. (See SDTS Part 1, Sections 4.1.3.3.1 Modules within a Spatial Data Transfer (clause (e)), and 5.2.2.1 Catalog/Directory, subfields External and Module Version.)

Requirements for contents of data quality modules are as specified in SDTS Part 1, Section 3, and additionally in Section 3 of the SRPE.

5.3 Attribute Modules

(See also SDTS Part 1, Section 5.4 Attribute Modules)

Attribute modules are permitted by the SRPE. Attributes can be specific to individual layers and (or) to the entire raster, but not individual cells within the raster.

5.4 Composite Modules

These modules are not permitted by the SRPE.

5.5 Vector Modules

These modules are not permitted by the SRPE.

5.6 Raster Modules

(See also SDTS Part 1 Section 5.7 Raster Modules)

SRPE permits either the default or non-default implementation. If the transfer is a default implementation, rules in SDTS Part 1, Section 5.7.3 Default Implementation, regarding subfield name and default value apply. The default implementation is strongly recommended for raster transfers.

5.6.1 Module Restrictions/Requirements: Raster Definition

a) One Raster Definition module record represents one raster object.
b) One Raster Definition module may have one or more records.
c) One Raster Definition module record may have one or more Layer Id fields.
d) Each Raster Definition module record must reference different Layer Definition module records.
e) For object code G2W, the data encoder may optionally encode the geometric correction parameters in SDTS Attribute Primary Module(s) records that are referenced by the Raster Definition Module record.
f) Compression and tesseral indexing are not permitted.

5.6.1.1 Specific Subfield Restrictions:

a) Object representation code OBRP must be "G2" or "G2W".
b) Cell Sequencing Code CSCD must be "GI" or "GJ" or "GL".
c) Default Implementation DEFI must be "DEF" (highly recommended) or "NON".
d) Data Compression CMPR must be "NON".
e) Scan Origin SCOR must be "TL" (top left origin).
f) Scan Pattern SCPT must be "LINEAR".
g) Tesseral Indexing TIDX must be "NOTESS".
h) Number of Lines per Alternation ALTN must be "1".
i) First Scan Direction FSCN must be "R" (by row).
j) Raster Dimension Extent RDXT field is not permitted.
k) X-, Y-, Z-, Dimension Axis Label (XXLB, YXLB, ZXLB, DALn) fields are not permitted.

5.6.2 Module Restrictions/Requirements: Layer Definition

a) One Layer Definition module may have many records.
b) One Layer Definition module record describes one layer of a single raster object.
c) One Layer Definition module may contain records describing layers from one or more raster objects.
d) Each Layer Definition module record may be referenced by one and only one Raster Definition module record.
e) One Layer Definition module record will reference one Cell module. More than one Layer Definition module record can reference the same Cell module, and this means that the layers' cell values are interleaved (code GJ and GL). If no interleaving (code GI), then each layer has its own Cell module.

5.6.2.1 Specific Subfield Restrictions:

a) Number of Rows NROW subfield must be equal to the value Row Extent RWXT of the referencing Raster Definition module record.
b) Number of Columns NCOL subfield must be equal to the value Column Extent CLXT of the referencing Raster Definition module record.
c) Scan Origin Row SORI subfield must be "1".
d) Scan Origin Column SOCI subfield must be "1".
e) Row Offset Origin RWOO subfield must be "0".
f) Column Offset Origin CLOO subfield must be "0".

5.6.3 Module Restrictions/Requirements: Cell

a) One Cell module may have many records.
b) One Cell module is not permitted to contain cell values from different raster objects. All of the cell values in all of the module records of a Cell module must be for a single raster object.
c) One Cell module is not permitted to contain cell values from different layers, unless the layers are interleaved with code GL or GJ.
d) One Cell module record contains one or more cell values from a single raster object. If the Cell Sequencing code is GI then one Cell module record contains cell values from only a single layer. If the Cell Sequencing code is GL or GJ then one Cell module record contains cell values from every layer of a single raster object.
e) It is highly recommended that a single Cell module record contain a row worth of data or the entire raster, unless this becomes unreasonably long (as defined by current technology.) A single Cell module record may contain partial, one, or many rows of the raster.
f) The data type of the cell value subfield(s) must be one of binary, integer, or real (specifically I, R, BI8, BI16, BI32, BUI8, BUI16, BUI32, BFP32).

5.6.3.1 Specific Subfield Restrictions/Requirements:

a) Row Index ROWI subfield is required.
b) Column Index COLI subfield is required.
c) Cell Values CVLS field is required.

d) Plane Index PLAI subfield is not permitted.
e) Tesseral Index TIND subfield is not permitted.
f) Dimension Index DNDX Field is not permitted.
g) Attribute Id ATID field is not permitted.
h) Cell Coding Foreign Id CFID field is not permitted.

5.7 Graphic Representation Module

(See also SDTS Part 1, section 5.8, Graphic Representation Modules)

These modules are not permitted by the SRPE.

6 ISO 8211 Specific Decisions

(See also ANSI/ISO 8211-1985 (a.k.a. FIPS PUB 123) Specifications for a Data Descriptive File for Information Interchange, and SDTS Part 3, ISO 8211 Encoding)

6.1 Objective

(See also SDTS Part 3, Sections 1.1 and 1.2, Purpose and Objectives):

SDTS/ISO 8211 is optimized for retrieval and storage (versus interactive decoding); non-SDTS directories/indices may be added to allow such interactive decoding (e.g. on a CD-ROM media). These files are not considered part of the transfer when it comes to determining compliance, and they should not be described in the Catalog/Directory module records.

6.2 Relationship of Modules to ISO 8211 Files

(See also SDTS Part 1, Section 4.1.3 The Transfer Model, and SDTS Part 3, Section 7, Assignment of Fields to Records and Files)

a) A file (an ISO 8211 Data Descriptive File (DDF)) shall contain one and only one module. All raster profile files must have only fields from the same module in any particular record and file, i.e. each file will represent only a single module. Normally, a module will only occupy a single file.
b) A module may span files when the size of a single file would exceed volume capacity or a reasonable size constraint (as determined by current technology). The data encoder should keep files as large as practical, to keep the overall number of files to a minimum.

6.3 Media

(See also SDTS Part 3, Section 10, Media Requirements)

All files belonging to the same transfer must share the same first four characters or base name. A base name of "HYDR" would result in file names like: HYDRIDEN.DDF, HYDRCATD.DDF, HYDRLE01.DDF, etc. When a volume contains a single transfer, the volume name is recommended to begin with the four character base identifier of the transfer. When multiple transfers are contained on a volume, the first four characters of the volume name are recommended to be "SDTS". For multi-volume transfers, the first four characters are recommended to be the base name, and the whole name should consistently reflect the volume sequence.

6.4 Organization of Files on Media

In general, files comprising a single transfer shall be kept separate from any other transfer files and organized as follows:

a) On floppy disk and CD-ROM, or any random access medium, each transfer must be grouped completely in a single directory. Multiple transfers may reside on the same media volume, with each in its own subdirectory.

b) On magnetic tape, or any sequential access medium, files of a single transfer must be ordered by module type, following the order of presentation in SDTS Part 1, Section 5. File adjacency will be used to group transfer files when multiple transfers reside on the same media volume. All files that follow the Identification Module (first file of a transfer) until another Identification Module or an end of media marker is encountered will be considered part of the transfer.

c) A file called "README" is required (see SDTS Part 3, Section 11, Conformance). There may be one such file per medium volume or transfer. (This file must be the first file on sequential media such as a magnetic tape.) Content of the README file is discussed later in this section.

d) To reduce the number of files and file sizes, file packing and compression utilities may be used to facilitate distribution on any media including electronic distribution over a network. However, the transfer file set is only considered for compliance to the SRPE in an unpacked, non file-compressed state. Specifically, all or some of the files may be packed into a single file that may be compressed. (Data providers should insure that utilities to unpack and decompress the files are available to the data consumers.)

6.5 File Names

For consistency among file names from various agencies, the SRPE requires that file names begin with a 4-character base followed by the 4 character module name contained in the file. A single transfer data set must use the same first four characters in the file name of each SDTS ISO 8211 file in the entire transfer. The next four characters in the file name must be the unique name of the module transferred in that file (see naming convention for modules in Section 4.1 of Part 4). The file extension should be ".DDF" to indicate the type of the file is ISO 8211. For example, the files named 6642IDEN.DDF, 6642RSDF.DDF, 6642IREF.DDF would all belong to the same transfer.

In the case of modules that span files, the last character of the file extension or an optional ninth character on the base name may be used to indicate file sequence. For example, if a single file could not contain all the information required for a Cell module, the information would be transferred in files 6642CELL.DDF, 6642CELL.DDG, 6642CELL.DDH or 6642CELL1.DDF, 6642CELL2.DDF, 6642CELL3.DDF. Any file that is not ISO 8211 compliant (e.g. adjunct files) must not have the ".DDx" extension.

Letters in the file names can be upper or lower case. The file names in the Catalog/Directory module records must match the case of the file names when the transfer is originally produced. The file title stored inside of an ISO 8211 file is recommended to match the case of the file name. Copying files between media and operating systems can often change the case of the file name. Robust software should take this into consideration when using the file names from the Catalog/Directory module records to access the files.

6.6 Taking Advantage of Dropped Leader and Directory

(See also SDTS Part 3, Section 6.4, Repeating Fields and Records)

SRPE encourages taking advantage of ISO 8211 mechanisms to reduce file size. All modules are recommended to use fixed size fields whenever practical to allow for the dropping of leader and directory information from the data records in ISO 8211. In the case where there are a few records that exceed the fixed size fields' size, records may be ordered within a file to maximize the use of dropped leaders and directories. This means that exceptional data records (DRs) is recommended be placed first in the DDF. All records that can share a common leader and directory can be grouped at the end of the file. (This is necessary because once the leader and directory are dropped, they cannot be specified later in the file.)

Maximizing the use of dropped leaders and directories needs to be taken into consideration when designing attribute modules. Attributes that range widely in the length of their values (i.e. open text) may be optimally placed in a separate module.

6.7 ISO 8211 DDR Contents

a) Data descriptive fields that have no specified labels may be augmented by user-supplied labels for the identification of subfield data. An import system is not required to recognize user-supplied labels.

b) Subfield labels for the horizontal components of spatial address fields must be "X" and "Y".

c) The first part of the file title must be consistent for all files within the transfer, but the last part should be unique for each file and give some indication of the contents of that file. This file title should be equivalent to the eight character base name (plus the optional ninth character).

6.8 Use of Data Types for Cell Values

The following data types may be used for cell values:

Table 6.8 – Cell Value Data Types
I (Integer)
R (Real)
BI8,BI16,BI32
BUI8,BUI16,BUI32
BFP32

a) In the case where all DRs in a DDF contain the same number of repetitions, a user-calculated repeat factor is used in the format control for the field. A format control for a cell value type field has the form:

(n(D(w)))

where n = the number of cells
D = indicates cell data type [I | R | B]
w = specifies the width of the value

(225(B(8),B(16),B(8))) Every data record has 225 repetitions of a 3-tuple value set, with first an 8-bit binary, second a 16-bit binary, and third an 8-bit binary. This would indicate a three layer raster encoded as interleaved by pixel.

b) In the case where each DR in a DDF contains a different number of repetitions, the following format control is used:

((D(w)))

where D = indicates cell data type [I | R | B]
w = specifies the width of the value

ISO 8211 does not permit a binary field located after the left parenthesis to implicitly repeat. Therefore, the above format includes an additional pair of parentheses.

6.9 Use of Character Data Type for Dates

(See also SDTS Part 3, Section 9.2 Dates)

Dates in the form YYYYMMDD are to be encoded as ISO 8211 data type = A.

6.10 README File

(See also SDTS Part 3, Section 11 Conformance)

The README file is recommended to contain:

a) volume name, if applicable;
b) date the README was written;
c) information about the SDTS transfer(s) which includes but is not limited to the following:
    1. a list of subdirectories and non-SDTS files, as appropriate;
    2. the file name of the Catalog/Directory module;
    3. the Catalog/Directory location;
    4. an explanation that this file and all other SDTS files are in ISO 8211 format;
    5. an explanation that the Catalog/Directory module carries a complete directory of all other SDTS ISO 8211 files comprising the SDTS transfer;
    6. notes about any non-SDTS adjunct/auxiliary files;
    7. a brief explanation of the spatial domain;
    8. purpose;
    9. authority (e.g., FIPS PUB 173, this profile, other standards used);
    10. source (e.g. agency name);
    11. contacts within the source organization;
    12. description of any issues about the transfer, special purposes (i.e. private agreement transfer) or non-standard uses of modules, etc.

ANNEX A: SDTS BIIF EXTENSION

(Normative)

1 Introduction

This annex option permits the use of the ISO/IEC 12087-5 Basic Image Interchange Format (BIIF) as an adjunct file in an SDTS transfer for the purpose of encoding an image and its related information. All other stipulations of the main body of this profile apply, unless specifically addressed in this annex option. To indicate that this annex option is in effect, an "/A" must be appended to the Profile Identification subfield value of the Identification module record. (Certain sections marked as informative provide explanatory information that does not constitute any binding requirements for conformance.)

1.1 References

The following references contain provisions either by direct reference or relationship, which through references in this paragraph or within this text, constitute provisions of SRPE. At the time of publication, the editions reflect the document versions used for implementing the SRPE. Revisions to referenced standards that post-date this document, and do not cause ambiguity or change to this profile may be used without violating compliance. For clarification, contact the profile maintenance authority.

ISO/IEC 12087-5 - Information Technology Computer Graphics and Image Processing, Image Processing and Interchange Functional Specification Part 5: Basic Image Interchange Format (BIIF), 1998.

NIMA N0105-97: - NITFS Standards Compliance and Interoperability Test and Evaluation Program Plan, 6 March 1998. Supersedes JIEO/JITC Circular 9008.

MIL-STD 2500B National Imagery Transmission Format (NITF) Version 2.1, Draft 1997; Available from the National Imagery and Mapping Agency, Attn: NIMA, Customer Support/COD, Mail Stop P-38, 12310 Sunrise Valley Drive, Reston, VA 20191-3449. (Online information at http://www.itsi.disa.mil or http://jitc-emh.army.mil/nitf/nitf.htm.

MIL-STD 188-198A Joint Photographic Experts Group (JPEG) Image Compression for the NITFS, December 15, 1993.

MIL-STD 188-196 Bi-Level Image Compression for the NITFS, June 18, 1993.

NSIF BIIF Profile, equivalent to the NITF BIIF Profile; To be developed by the Format Working Group under the auspices of the NITF Technical Board based on MIL-STD 2500B; Not Yet Drafted; Scheduled for completion November 1998.

STANAG 4545 NATO Secondary Imagery Format (NSIF), Ratification Draft 1, 15 April 1997. (See DIGEST Annex D for the Geospatial Support Data Extension)

DMA Technical Manual 8358.1 Datums, Ellipsoids, Grids, and Grid Reference Systems, Edition 1, September 1990. The DMA Technical Manual 8358.1 provides information that is useful when implementing datums, ellipsoids, grids and grid reference systems.

ISO/IEC 8632-3:1994 Information technology - Computer graphics - Metafile for the storage and transfer of picture description information - Part 3: Binary encoding Amendment 1:1994 to ISO/IEC 8632-1:1992 Rules for profiles Amendment 2:1995 to ISO/IEC 8632-1:1992 Application structuring extensions.

STANAG 7074/A GeoP-3A Digital Geographic Information Exchange Standard (DIGEST), Edition 2, June 1997. Online at http://www.digest.org. Note: Annex D of DIGEST Part 2 provides the source for the geospatial extension to the NSIF BIIF Profile.

1.2 Background of BIIF *(Informative)*

BIIF was developed from a complement of military, ANSI, ISO, and NATO standards which were derived from the U.S. Military Standard 2500 National Imagery Transmission Format Standard (NITFS) and JIEO/JITC Circular 9008. The NITFS is a format initially developed for the transmission of military intelligence and digital mapping, charting and geodetic products, and is now being expanded to include commercial requirements.

BIIF is formally recognized as ISO/IEC 12087-5, approved in April 1998. NITF is ratified as a military standard and is implemented. NATO is sponsoring the development of STANAG 4545 - National Secondary Image Format (NSIF) which is a NATO implementation of NITF, and is currently a Ratification Draft. Because the NSIF and NITF are fundamentally similar documents, the evolution of the BIIF profile will be a collaboration of NATO and US military standards under NSIF.

BIIF defines a general mechanism for the transfer of image data and any supporting data (i.e. image parameters, visualization parameters, compression parameters, text annotations, symbols, etc.) BIIF is a standard developed to provide a foundation for interoperability in the interchange of imagery and imagery-related data among applications. BIIF is intended to be used to transfer any digital image---x-rays, fingerprints, portraits, aerial photography, remotely sensed data, etc. An profile to BIIF is prepared and registered based on the requirements of a data producer/user community for a certain application domain. Registration of profiles will encourage collaborative interface of data between domains. For example, potential profiles for the law enforcement community and medical community might include a common method for dealing with personal identification data, i.e., fingerprints, photo id, DNA-mapping, and x-rays. The BIIF profile for NSIF/NITF will herein be referred to as the NSIF Profile.

2 BIIF Restrictions/Requirements

The restrictions and/or requirements placed on the use of BIIF originate from the following sources: 1) the ISO 12087-5 standard; 2) the NSIF profile to BIIF; and, 3) this profile annex option which includes the BIIF notes in the base SRPE standard.

All requirements of the NSIF profile and its references to the BIIF standard apply in this annex unless specifically addressed by this profile annex option. A BIIF file compliant to the NSIF Profile shall herein be referred to as a “BIIF file”. This annex option addresses requirements that are supplemental or alternative to the NSIF ISP.

2.1 BIIF Standard Data Types

(See BIIF Clause 4.1.1.2 Standard Data Types)

BIIF recognizes three standard types of data: image, symbol, and text. A BIIF file can include zero, one, or more data segments of each standard type. As per BIIF clause 4.1.1.2, the order of data segments in a BIIF file must be all image data segments, followed by all symbol data segments, followed by all text data segments, followed by any extension segments.

All restrictions and requirements placed on the use of BIIF data segments by the NSIF Profile apply, unless specifically addressed by this profile annex option. This profile annex option requires the BIIF file to include at least one image data segment. A conformant decoder under this profile annex option must be able to decode any image data segment, and optionally may decode any symbol or text segments. In all cases, a decoder must report the presence of all segments, whether it can decode them or not.

2.2 Two Dimensions

(BIIF Clause 4.1.4 Logical structure of pixel storage)

BIIF images are two-dimensional. PIKS images can be up to five-dimensional (BIIF Clause 4.2.5.7 PIKS Objects). This profile annex option only requires a decoder to support the x and y spatial dimensions of a baseline BIIF image.

2.3 BIIF Data Extensions

(See BIIF Clause 4.1.1.3 Extensions)

BIIF extensions are a way to include information not explicitly accounted for in the standard. There are three types of extensions: tagged record extensions (TRE), data extension segments (DES), and reserved extension segments (RES). A Tagged Record Extension (TRE) is a way to provide additional description about BIIF standard data segments not provided for in BIIF standard defined fields. The DES and RES are intended primarily for adding support for new types of data (other than image, symbol, and text). (Although, a data encoder may use this in place of a standard data segment this practice is discouraged as it limits the ability to decode the data.)

All restrictions and requirements placed on the use of BIIF extensions by the NSIF Profile apply, unless specifically addressed by this profile annex option. A conformant decoder implementing this annex option must be able to handle the receipt of unknown extension types by ignoring them without program error, and reporting the existence to the data consumer.

2.3.1 Geospatial Support Data Extension Segment

This annex option permits an image in BIIF to be georeferenced or not. When a BIIF file is used to transfer georeferenced data, the BIIF Geospatial Support Data Extension Segment must be used to encode the georeferencing parameters. The georeferencing parameters may be duplicated in both SDTS and BIIF. This profile annex option does not permit an image to be encoded in BIIF and its georeferencing to be encoded only in SDTS structures. (Since georeferencing is machine processable information it should be as integrated as possible.)

2.3.2 Lineage-related Tagged Record Extensions

There are some TREs that provide for lineage or processing and source description information. SDTS also provides structures through its Data Quality Modules and attribute mechanism for encoding lineage type information. Lineage information is often textual narration and generally read and acted on by the user, rather than being trusted to machine interpretation and use. The SRPE highly recommends that the lineage content be based on the elements in the FGDC Content Standards for Digital Geospatial Metadata. This profile annex option highly recommends that the majority of the Lineage information and other such data quality information be encoded in SDTS structures, thus keeping the "non-machine processable" information in the BIIF file to a minimum. (This recommendation is in the interest of convergence, i.e., rather than duplicating the geospatial information requirements in a general purpose image standard, use an existing geospatial transfer standard for this.)

The data encoder shall not encode data where the relationship between the metadata and the image data is ambiguous. The relationship between the SDTS structures and the BIIF structures must be stated in the SDTS Logical Consistency module.

2.4 Compression

Compression is permitted as specified by the NSIF Profile. JPEG compression is permitted as per MIL-STD 188-198A. Bi-level is permitted as per MIL-STD 188-196. Vector Quantization(VQ) is permitted as per ISO/IEC 12087-5 (BIIF) Annex B: Vector Quantization. Other compression formats and methods are not permitted.
The NSIF profile requires decompression of VQ, Bi-level, JPEG (lossy and lossless) and compression using JPEG. Compression support for VQ and Bi-level are optional.

2.5 BIIF File Header

(See BIIF Clause 4.2.3 Header, Table 1: Header)

To indicate that this SDTS profile option is in effect in a BIIF file, the Originator Identification (OID) field of the BIIF File Header, may optionally include the value "SDTS-SRPE" in addition to any other values.

2.6 BIIF Image Subheader

(See BIIF Clause 4.2.4 Image Segment, Table 3: Image Subheader)

To indicate that this image is part of an SDTS transfer, the Image Information (IINFO) field may optionally include a statement to alert the data consumer of additional information in SDTS files.

3 SDTS Restrictions/Requirements

A BIIF file with or without georeferencing is permitted to be included in an SDTS Transfer. One or more BIIF files are permitted in a single SDTS transfer file set. Each separate BIIF file must contain at least one image.

The BIIF file is intended to be a substitute for the SDTS Cell Module encoded in ISO 8211 format. In this case, the Layer Definition module record would reference the BIIF file id and there would be no SDTS

Cell Module file. All other modules in the transfer would be the same as if the raster data were encoded in the Cell Module, except they need to describe the data as it is encoded in the BIIF file.

This profile annex option permits a BIIF file to be included as a supplement to a SDTS Cell Module. In this case, the Layer Definition module record would reference the Cell Module, as before. The BIIF file would be related to the Cell Module through a Catalog/Cross-reference module record, where the comment field would explain the relationship.

All methods of georeferencing supported by the Geospatial Support Data Extension Segment are permitted in this profile annex option. In the event the georeferencing method encoded with the Geospatial Support DES is not supported by SDTS, the georeferencing method will be encoded in SDTS descriptions as "unspecified". If the georeferencing method is a projected coordinate system, then the projection parameters must be encoded in the Geospatial Support DES structure and are not required to be encoded as SDTS attributes.

The NSIF profile permits bi-level, vector quantization, and JPEG (lossy and lossless) compression. This profile annex options permits any of these compression options, or no compression. The data should be described as it is encoded in the BIIF file.

3.1 SDTS Restrictions/Requirements: Identification Module

To indicate that this profile annex option is in effect, an "/A" must be appended to the value in the Profile Identification (PRID) subfield.

The External Spatial Reference (EXSP) subfield must be "1", if UTM/UPS, SPCS, or Geographic is encoded in the Geospatial Support DES; "2", if a projected system is encoded in the Geospatial Support DES; "3", if the georeferencing method encoded using the Geospatial Support DES is not supported by SDTS, or if no Geospatial Support DES is used.

The Coding Level (CDLV) subfield must be "1" when a BIIF file is substituted for a Cell Module.

3.2 SDTS Restrictions/Requirements: Catalog/Directory Module

The Name (NAME) subfield must contain an identifier to uniquely reference a single BIIF file.

The Type (TYPE) subfield must contain "BIIF".

The External (EXTR) subfield must contain "A", indicating an adjunct file is included.

3.3 SDTS Restrictions/Requirements: Catalog/Cross-Reference Module

If a BIIF file is a supplement to a Cell Module, then this relationship must be expressed through a Catalog/Cross-reference module record with the relationship explained in the Comment subfield.

3.4 SDTS Restrictions/Requirements: External Spatial Reference Module

The Reference System Name (RSNM) subfield must be "GEO" when a latitude and longitude system is used; "SPCS" when State Plane Coordinate System is used; "UTM" when UTM is used; "UPS" when UPS is used; "OTHR" when a Projected Coordinate system is used; or, "UNSP" when anything else or when the Geospatial Support DES is not used at all.

The Attribute ID (ATID) subfield is not required, when Reference System Name is "OTHR". This means that the projection parameters are not required to be encoded as SDTS attributes because they are already encoded in the Geospatial Support DES structures.

3.5 SDTS Restrictions/Requirements: Data Dictionary/Schema Module

The Type (TYPE) subfield should contain "CELL" even when the raster data is in a BIIF file.

3.6 SDTS Restrictions/Requirements: Data Quality Modules

If there are multiple BIIF files included in a single SDTS transfer file set, then the relationship among the files and the images they contain must be explained in the Logical Consistency module, at a minimum.

If a BIIF file represents a visualization of more fundamental raster data stored in a SDTS Cell Module, then the process used to generate the image must be described in the Lineage Module, at a minimum.

3.7 SDTS Restrictions/Requirements: Raster Definition Module

If BIIF file uses the JPEG option, then the Data Compression Method (CMMD) subfield must contain "NITF-JPEG"; if vector quantization, then "NITF-VQ"; if bi-level, then "NITF-BILEVEL".

The Decompression parameters (DCOM) subfield is not required, as the BIIF file must contain all information needed to decompress the data.

The Coding Method (METH) subfield must contain "BIIF" to indicate that a BIIF file is used to encode the data for this raster object, instead of a SDTS Cell Module.

3.8 SDTS Restrictions/Requirements: Layer Definition Module

The Cell Module Name or Adjunct File id (CMNM) subfield must contain the identifier for the BIIF file. This must match the identifier used in the Catalog/Directory module.

3.9 SDTS Restrictions/Requirements: Cell Module

If the BIIF file is substituted for the Cell Module, then no Cell module is present.

If a BIIF file is just a supplement, then the Cell Module is present, as before.

3.10 File Naming Convention

In addition to the file naming conventions in the core SRPE, any adjunct BIIF file is recommended to have the file extension ".bif". The file name is recommended to start with the same four characters as the rest of the SDTS files in the transfer.

ANNEX B: COLOR INDEX MODULE OPTION

(Normative)

1 Introduction

This annex option permits the use of the SDTS Color Index Module (SDTS Part 1, Section 5.8.5, Color Index) to carry color table information for raster data. All other stipulations of the main body of this profile apply, unless specifically addressed in this annex option. To indicate that this annex option is in effect, a "/B" must be appended to the Profile Identification subfield value of the Identification module record.

(Note: For color model options other than provided by this annex, see Annex A BIIF Extension and Annex E GeoTIFF Extension.)

BIIF Note: In the case of using the BIIF option the following applies. If BIIF is used to encode an image, then use the BIIF color mechanism to encode color information. BIIF Clause 4.2.4.2 Look-up Tables (LUTS) and Table 3: Image subheader Fields IREP and IREPBAND1 describe options for encoding color.

2 SDTS Restrictions/Requirements

The SDTS Color Index Module must only be used to describe color information for raster data in a SDTS Cell Module. The Color Index module is used to transfer color palettes. A color palette's (color table) values for red, green, blue and/or black, are converted to the corresponding red, green, blue, and/or black component subfields of the color index module records. Color values are real numbers normalized between 0.0 and 1.0. The encoder decides the number of significant digits.

The method for associating color values with a pixel is as follows. A SDTS Cell Module and its Color Index Module are related by a SDTS Catalog/Cross-Reference module record that minimally contains the phrase "Color lookup for raster" in the Comment subfield. The raster cell value (which must be of data type integer) is used to reference a module record in the associated Color Index Module. The normalized red, green, blue and optional black color component values from the module record with the record id matching the raster cell value are used to display a device dependent color for the corresponding pixel.

2.1 Module Restrictions/Requirements: Identification Module

To indicate that this profile annex option is in effect, an "/B" must be appended to the value in the Profile Identification (PRID) subfield.

2.2 Module Restrictions/Requirements: Catalog/Cross-reference Module

There must be one module record to describe each Cell Module and Color Index Module relationship. The Comment (COMT) subfield must, minimally, include the phrase "color lookup for raster".

2.3 Module Restrictions/Requirements: Color Index Module

Multiple Color Index modules are permitted in one SDTS Transfer. One Color Index module corresponds to one color palette. Each SDTS Cell Module can be associated with zero or one Color Index Module. One Color Index module can be associated with one or more Cell Modules.

2.3.1 Color Index Module Names

If a single Color Index module is used, then its name will be CLRX. If two or more color palettes are transferred, the first module name and primary field name must be CLR0. The second module name and primary field name must be CLR1. This pattern will continue through CLR9. Once the module names CLR0 and CLR9 are used, the names must continue through CLRA, CLRB, CLRC, etc.

ANNEX C: COMPRESSED RASTER OPTION

(Normative)

1 Introduction

This annex option permits the transfer of compressed raster data. Compression algorithms other than those identified herein are not permitted by this annex option. All other stipulations of the main body of this profile apply, unless specifically addressed in this annex option. To indicate that this annex option is in effect, a "/C" must be appended to the Profile Identification subfield value of the Identification module record. This annex option is limited to compression of the raster data, not general file compression (see SRPE Section 6.4d.)

1.1 References

The following references contain provisions either by direct reference or relationship, which through references in this paragraph or within this text, constitute provisions of this annex option. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on SRPE should investigate any recent editions of the references listed below.

ISO/IEC 10918-1:1994 Information Technology - Digital Compression and Coding of Continuous Tone Still Images: Requirements and Guidelines (a.k.a. JPEG)

JPEG File Interchange Format (JFIF), Version 1.02, available on-line from ftp://ftp.uu.net/graphics/jpeg

Pennebaker, William B. and Joan L. Mitchell, JPEG Still Image Data Compression Standard, 1993, Van Nostrand Reinhold, ISBN 0-442-01272-1. (Book contains complete text of DIS 10918-1 and 10918-2.)

2 Compression Methods

This profile annex option specifies the permitted compression methods for use within an SDTS module and within stand-alone adjunct files (a combination of a compression algorithm and a file format). Note: Compression methods applied to BIIF files or TIFF files are not controlled by this annex option. Refer to Annex A and E, respectively, for permitted extension compression methods.

Lossy methods must not be used on gridded data.

2.1 Run Length Encoding Compression

Run length encoding as described in SDTS Part 1, Section 5.7.10.1 is permitted by this annex option. This compression method works within the fields of the SDTS Cell Module (not requiring an adjunct file.) This compression method is most applicable to gridded raster data, and is lossless.

2.2 JPEG Compression in JFIF

The ISO/IEC 10918-1 documents JPEG compression algorithms, which can be used in many contexts. The JPEG File Interchange Format (JFIF) is a specification of a file format to use with JPEG compression techniques. Although any JPEG process is supported by the syntax of the JFIF, it is recommended that the

baseline algorithm in ISO/IEC 10918-1 be used to ensure maximum compatibility with all applications supporting JPEG.

This annex option permits the use of JPEG compression algorithms to compress raster data and encode in a standalone file as per the JFIF specification. The JFIF file must then be treated as an adjunct file in a SDTS transfer. Both lossless and lossy methods are permitted. The JPEG compression methods are most applicable to image data. (For an alternate way to use JPEG methods, see SRPE Annex A BIIF Extension, Section 2.4.)

2.3 Decompression Support

A conformant decoder must support decompression of SDTS Run Length Encoding and JPEG JFIF methods. A conformant encoder must provide RLE compression for gridded raster data and JPEG compression for image data.

3 SDTS Restrictions/Requirements

In SDTS, compression is specified at the raster object level; all layers of a single raster object are compressed as a whole, or no compression is used. This annex permits each raster object to specify compression independent of other raster objects in the same transfer.

One or more JFIF files are permitted in a single SDTS transfer file set.

The JFIF file is intended to be a substitute for the SDTS Cell Module encoded in ISO 8211 format. The Layer Definition module record must reference the JFIF file id and there will be no SDTS Cell Module file. All other modules in the transfer would be the same as if the raster data were encoded in the Cell Module, except they need to describe the data as it is encoded in the JFIF file.

3.1 SDTS Restrictions/Requirements: Identification Module

To indicate that this profile annex option is in effect, a "/C" must be appended to the value in the Profile Identification (PRID) subfield.

The Coding Level (CDLV) subfield must be "1" when a JFIF file is substituted for a Cell Module. CDLV must be a zero or absent when the SDTS RLE is used within a Cell Module. The CDLV must be set to the highest applicable value for the entire transfer.

3.2 SDTS Restrictions/Requirements: Catalog/Directory Module

In the case of using JFIF the following applies:

The Name (NAME) subfield must contain an identifier to uniquely reference a single JFIF file.
The Type (TYPE) subfield must contain "JFIF".
The External (EXTR) subfield must contain " A", indicating an adjunct file is included.

3.3 SDTS Restrictions/Requirements: Data Dictionary Modules

In the Data Dictionary/Schema Module, the Type (TYPE) subfield must contain "CELL" even when the raster data is in a JFIF file.

For the case of the SDTS RLE option, the Cell Values (CVLS) fields' subfield of RLECOUNT must be referenced in the Data Dictionary modules with an Attribute Authority of "SDTS-RLE".

3.4 SDTS Restrictions/Requirements: Data Quality Modules

If there are multiple JFIF files included in a single SDTS transfer file set, then the relationship among the files and the images they contain must be explained in the Logical Consistency module, at a minimum.

If a lossy compression is used, then the process used to generate the file must be described in the Lineage Module, at a minimum.

3.5 SDTS Restrictions/Requirements: Raster Definition Module

For the case of using the JFIF option the following applies:

The Data Compression (CMPR) subfield must contain "COM".
The Data Compression Method (CMMD) subfield must contain "JPEG-JFIF".
The Decompression Parameters (DCOM) subfield may optionally reference an attribute record containing decompression parameters.
The Coding Method (METH) subfield must contain "JFIF" to indicate that a JFIF file is used to encode the data for this raster object, instead of a SDTS Cell Module.

For the case of using the SDTS RLE option the following applies:

The Data Compression (CMPR) subfield must contain "COM".
The Data Compression Method (CMMD) subfield must contain "RLE".
The Decompression Parameters (DCOM) subfield must not be present.
The Coding Method (METH) subfield must contain "ISO8211".

3.6 SDTS Restrictions/Requirements: Layer Definition Module

The Cell Module Name or Adjunct File id (CMNM) subfield must contain the identifier for the JFIF file or the cell module name. This must match the identifier or module name used in the Catalog/Directory module.

3.7 SDTS Restrictions/Requirements: Cell Module

If the JFIF file is substituted for the Cell Module, then no Cell module is present.
If the SDTS RLE option is used, the Cell Values (CVLS) field must have two subfields: a cell value subfield defined by the data encoder, and subfield RLECOUNT.

3.8 File Naming Convention

In addition to the file naming conventions in the core SRPE, any adjunct JPEG files is recommended to have the file extension ".jpg". The file name is recommended to start with the same four characters as the rest of the SDTS files in the transfer.

ANNEX D: SPECIAL PURPOSE TRANSFERS

(Normative)

1 Introduction

This annex option permits certain information that is otherwise mandatory to be not present in an SDTS transfer. All other stipulations of the main body of this profile apply, unless specifically addressed in this annex option. To indicate that this annex option is in effect, a "/D" must be appended to the Profile Identification subfield value of the Identification module record. (Certain sections marked as informative provide explanatory information that does not constitute any binding requirements for conformance.)

The requirements of the SDTS are founded in the principles of self-documenting transfers. These type of transfers are not necessary in every transfer situation. This annex option permits special purpose transfers that contain abbreviated or minimal information, which can be correctly interpreted by the intended recipient. This annex option in effect is decoupling the information requirements of SDTS from the format mechanics. Standard file formats and minimal content are still required to insure data reuse and interoperability between different systems. The scope of this annex option is to provide a data set transfer mechanism for situations with a pre-established context, data consumers known a priori, and the requirement for interoperability between different systems. (The physical network connection and transmission protocols are not within the scope of this profile.)

To use this annex option properly, the data consumer and their application for the data transfer should be known to the data provider. This profile annex option can be used in conjunction with annexes A, B, and C.

1.1 Rapid Transmission Example (Informative)

This profile annex option is included to satisfy the needs of data encoders for cases of time critical spatial data transmissions, very limited bandwidth, and (or) other such special purposes. Rapid transmission defines a scenario that identifies the need to provide imagery data in near real-time for field employment (includes battlefields, fires, floods, etc.) Table D.1 provides a comparison of characteristics to assist in determining the appropriate transmission option. Characteristics on the left are generally not appropriate situations for using this profile annex option, whereas characteristics on the right are appropriate.

Table D.1 - Transmission Comparison	
Blind transfer/Archive Characteristics	Rapid Transmission Characteristics
Data of Historical Significance ("long term value") usually	Data expires rapidly
Sender Known, Receiver Unknown: Send maximum information (self-contained transfer)	Sender Known, Receiver Known: Send minimal information because context is pre-established
One-way Communication	One-way Communication
Data Assessment /Interpretation/Analysis done afterwards; transmitted data useful for many possible applications	Data Assessment /Interpretation/Analysis done beforehand; transmitted data for a very specific application
Blind/Broadcast (open) - Public FTP, Sales Counter	Point-to-Point/Broadcast (secure)

Rapid transmission always involves communication from a known sender to a known receiver. In this situation much of the metadata that would normally be required is unnecessary because it can be correctly assumed or implied. The format, data fields, spatial objects from SDTS and/or BIIF are valid in this situation, i.e. there is no reason it won't work. However, a data set that has been sent with abbreviated content is not something that would get archived or kept for later use.

2 SDTS Restrictions/Requirements

In this profile annex option certain mandatory SDTS metadata requirements become optional. They are:

a) SDTS Quality Report (SDTS requirement)
b) SDTS Data Dictionary (SDTS requirement)
c) SDTS External and Internal Spatial Reference Module

The subsections that follow state the effects of this on each module.

2.1 Module Restrictions/Requirements: Identification Module

The Identification Module must be present. The following subfields are mandatory, with all others becoming optional: Module Name (MODN), Record Id (RCID), Profile Identification (PRID), and Comment (COMT).

To indicate that this profile annex option is in effect, a "/D" must be appended to the value in the Profile Identification (PRID) subfield.

The Comment (COMT) subfield must state that the transfer is for a special purpose and may not contain all content typical of a SDTS transfer.

2.2 Module Restrictions/Requirements: Catalog/Directory

The Catalog/Directory Module must be present if two or more files are in the transfer. It must contain a record for every file that belongs to the special purpose transfer, except referencing itself is optional. The following subfields are mandatory, with all others becoming optional: Module Name (MODN), Record Id (RCID), Name (NAME), Type (TYPE), and File (FILE).

2.3 Module Restrictions/Requirements: External and Internal Spatial Reference System Modules

The External Spatial Reference module (XREF) and the Internal Spatial Reference module (IREF) are only required if the data type for the spatial addresses fields (subfield HFMT in IREF module) needs to be encoded, and (or) the georeferencing needs to be encoded.

2.4 Module Restrictions/Requirements: All Other Modules

All other modules not addressed in the preceding sections, that are otherwise permitted and required by the SRPE, are optional. All fields and subfields become optional on the assumption that any subfield value critical to the correct application of the transmitted data is known in advance or can be implied by the recipient.

ANNEX E: SDTS GEOTIFF EXTENSION

(Normative)

1 Introduction

This annex option permits a tagged image file format (TIFF) compliant file with GeoTIFF tags to be included in an SDTS transfer for the purpose of encoding an image. All other stipulations of the main body of this profile apply, unless specifically addressed in this annex option. To indicate that this annex option is in effect, a "/E" must be appended to the Profile Identification subfield value of the Identification module record. (Certain sections marked as informative provide explanatory information that does not constitute any binding requirements for conformance.)

1.1 References

The following references contain provisions either by direct reference or relationship, which through references in this paragraph or within this text, constitute provisions of this profile annex option. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on SRPE should investigate any recent editions of the references listed below.

Ritter, N.D., and Ruth, M., 1995, GeoTIFF Format Specification, Revision 1.0, (final November 10, 1995). Available at ftp://sdts.er.usgs.gov/release/geotiff/jpl_mirror/spec/

Aldus Corporation, 1992, TIFF, revision 6.0. Aldus Corporation, 411 First Avenue South, Seattle, WA 98104. Phone number 206-628-6593. On-line at ftp.adobe.com in directory /pub/adobe/DeveloperSupport/TechNotes/PDFfiles/TIFF6.pdf; or access as ftp://ftp.adobe.com/pub/adobe/devrelations/devtechnotes/pdffiles/tiff6.pdf

1.2 Background of GeoTIFF *(Informative)*

TIFF is a general purpose image format widely used in applications like electronic publishing, clip art, and general image distribution. TIFF is a registered trademark of Adobe Corporation, (formerly Aldus), and is available for use without cost or licensing. Increasingly, TIFF is being used to encode images of the earth based on satellite imagery or scanned maps. An industry-standard set of public domain TIFF tags to support georeferencing of a TIFF encoded image is described in the GeoTIFF specification. To encode projection and coordinate system information, the method from the Petrotechnical Open Software Company (POSC)'s implementation of the European Petroleum Survey Group (EPSG)s' Epicentre 2.0 geodetic model was used. The GeoTIFF Specification 1.0 is based on the TIFF Revision 6.0 and the POSC/EPSG tables version 2.2.

1.3 Applicability of this Option *(Informative)*

In the context of this profile annex option, TIFF is most appropriately used to display one visual representation of an image such as a three band red, green, blue visualization of a digital orthophoto or a scan of a map. GeoTIFF is appropriate when this image can be georeferenced (which implies that the geometry has been corrected to a projection space.) The GeoTIFF encoded image can be used for visual analysis, backdrops, and overlays. The use of GeoTIFF is less appropriate for raster image or grid data that could be visualized in many different ways or used to support more sophisticated analysis, such as digital elevation grids or multi-spectral satellite data.

This annex option enables a data provider to offer a single data set package that can meet a wide variety of application needs, from simple visual to more sophisticated analysis. The data consumer purchases the software tools to meet their application needs, and the data provider offers one-size fits all data sets. For applications requiring viewing only, the TIFF portion is accessed; for georeferencing, the GeoTIFF is accessed; for generation of alternate views or more sophisticated analysis, SDTS raster and metadata is accessed.

2 TIFF Restrictions/Requirements

The restrictions and (or) requirements placed on TIFF originate from the following sources: 1) the TIFF Revision 6 specification; 2) the GeoTIFF Format Specification, Revision 1.0; and, 3) this profile annex option itself.

The requirements for TIFF readers and writers as specified in TIFF Part 1 and the additional requirements of GeoTIFF section 2.3 on TIFF implementations apply in this annex. There must be only one image per TIFF file. However, there may be more than one TIFF file included as part of an SDTS Raster Profile with Extensions transfer. The relationship among all images in the transfer, both TIFF and native SDTS, must be explained in the SDTS Logical Consistency module. A TIFF file with no GeoTIFF tags is permitted when georeferencing is not possible (for example, a shaded relief perspective view of a terrain surface.)

The required set of baseline TIFF fields, taken from TIFF Part 1, are listed below:

BitsPerSample (tag id 258)
ColorMap (tag id 320)
Compression (tag id 259)
ImageLength (tag id 257)
ImageWidth (tag id 256)
PhotometricInterpretation (tag id 262)
ResolutionUnit (tag id 296)
RowsPerStrip (tag id 278)
SamplesPerPixel (tag id 277)
StripByteCounts (tag id 279)
StripOffsets (tag id 273)
XResolution (tag id 282)
YResolution (tag id 283)

TIFF implementation requirements to support GeoTIFF, taken from the GeoTIFF Format Specification, Section 2.3, and summarized below:

a) Must support all documented TIFF 6.0 data-types, especially the IEEE double precision floating point "DOUBLE" type tag. (Data types are BYTE, ASCII, SHORT, LONG, RATIONAL, SBYTE, UNDEFINED, SSHORT, SLONG, SRATIONAL, FLOAT, and DOUBLE as defined in TIFF Section 2, Image File Directory; Types.) Modification: This profile annex option only requires support of types ASCII, SHORT, and DOUBLE at a minimum.

b) TIFF specification indicates that the byte-order indicator in the Image File Header must be supported. This means that 4-byte integers and 8-byte double's on opposite order machines will be swapped by the software.

A conformant decoder must, at a minimum, support the required baseline set of TIFF fields, and respective values; fields or values not supported by the decoder should be tolerated or ignored, and should not cause a failure in the processing of the file. A conformant encoder must use the required TIFF baseline fields to their fullest extent. Use of TIFF extension and TIFF private fields is permitted, but these are not required to be supported.

3 GeoTIFF Restrictions/Requirements

The requirements on GeoTIFF implementations are described in the GeoTIFF Format Specification. These requirements are summarized below:

a) A GeoTIFF writer must support baseline TIFF and creation of the GeoTIFF fields; a reader must parse GeoTIFF fields. GeoTIFF fields, taken from GeoTIFF Section 2: Baseline GeoTIFF, are:

GeoKeyDirectoryTag (tag id 34735)
GeoDoubleParamsTag (tag id 34736)
GeoAsciiParamsTag (tag id 34737)
ModelTiepointTag (tag id 33922)
ModelPixelScalTag (tag id 33550)
ModelTransformationTag (tag id 34264)

b) From GeoTIFF Section 2.4 GeoTIFF File and Key Structure, special handling is required for ASCII-valued keys. The null delimiter of each ASCII Key value must be converted to a "|" (pipe) character before being encoded into the ASCII holding tag. " A baseline GeoTIFF reader must check for and convert the final '|' pipe character of a key back into a NULL before returning it to the client software."

c) GeoTIFF writers must store the GeoKey entries in key-sorted order within the CoordSystemInfoTag.

4 SDTS Restrictions/Requirements

A TIFF file with or without GeoTIFF tags is permitted to be included in an SDTS transfer. In this section, the more general term "TIFF file" will be used to refer to either type. One or more TIFF files are permitted in a single SDTS transfer file set. Each separate TIFF file must contain only one image (as encoded in TIFF file structures).

The TIFF file is intended to be a substitute for the SDTS Cell Module encoded in ISO 8211 format. In this case, the Layer Definition module record and the Schema module record would reference the TIFF file id and there would be no SDTS Cell Module file. All other modules in the transfer would be the same as if the raster data were encoded in the Cell Module, except they need to describe the data as it is encoded in the TIFF file.

This profile annex option permits a TIFF file to be included as a supplement to a SDTS Cell Module. In this case, the Layer Definition module record and the Schema module record would reference the Cell Module, as before. The TIFF file is related to the Cell Module through a Catalog/Cross-reference module record, where the comment field would explain the relationship.

All methods of georeferencing supported by GeoTIFF tags are permitted in this profile annex option. If the georeferencing method encoded using GeoTIFF tags is not supported by SDTS, then this will be encoded in SDTS descriptions as "unspecified". If the georeferencing method is a projected coordinate system, then the projection parameters must be encoded in the GeoTIFF structure and are not required to be encoded as SDTS attributes.

The TIFF baseline specification supports packbits compression and a modified Huffman compression. This profile annex option permits either of these compression options, or no compression. The data should be described as it is encoded in the TIFF file.

4.1 SDTS Restrictions/Requirements: Identification Module

To indicate that this profile annex option is in effect, an "/E" must be appended to the value in the Profile Identification (PRID) subfield.

The External Spatial Reference (EXSP) subfield must be "1", if UTM/UPS, SPCS, or Geographic is encoded in the GeoTIFF tags; "2", if a projected system is encoded in the GeoTIFF tags; or, "3", if the georeferencing method encoded using GeoTIFF tags is not supported by SDTS, or no GeoTIFF tags are used.

The Coding Level (CDLV) subfield must be "1" when a TIFF file is substituted for a Cell Module.

4.2 SDTS Restrictions/Requirements: Catalog/Directory Module

The Name (NAME) subfield must contain an identifier to uniquely reference a single TIFF file.

The Type (TYPE) subfield must contain "TIFF".

The External (EXTR) subfield must contain "A", indicating an adjunct file is included.

4.3 SDTS Restrictions/Requirements: Catalog/Cross-Reference Module

If a TIFF file is a supplement to a Cell Module, then this relationship must be expressed through a Catalog/Cross-reference module record with the relationship explained in the Comment subfield.

4.4 SDTS Restrictions/Requirements: External Spatial Reference Module

The Reference System Name (RSNM) subfield must be "GEO" when a latitude and longitude system is used; "SPCS" when State Plane Coordinate System is used; "UTM" when UTM is used; "UPS" when UPS is used; "OTHR" when a Projected Coordinate system is used; or, "UNSP" when geocentric is used or when GeoTIFF tags are not used at all.

The Attribute ID (ATID) subfield is not required, when Reference System Name is "OTHR". This means that the projection parameters are not required to be encoded as SDTS attributes because they are already encoded in the GeoTIFF structures.

4.5 SDTS Restrictions/Requirements: Data Dictionary/Schema Module

When the TIFF file replaces the Cell module, the Name (NAME) subfield must contain the adjunct file id of the TIFF file, defined in the Catalog/Directory module record.

The Type (TYPE) subfield must contain "CELL" even when the raster data is in a TIFF file.

4.6 SDTS Restrictions/Requirements: Data Quality Modules

If there are multiple TIFF files included in a single SDTS transfer file set, then the relationship among the files and the images they contain must be explained in the Logical Consistency module, at a minimum.

If a TIFF file represents a visualization of more fundamental raster data stored in a SDTS Cell Module, then the process used to generate the image must be described in the Lineage Module, at a minimum.

4.7 SDTS Restrictions/Requirements: Raster Definition Module

If the TIFF file uses the PackBits Compression, then the Data Compression Method (CMMD) subfield must contain "PACKBITS"; if modified Huffman, then "MODHUFFMAN".

The Decompression parameters (DCOM) subfield is not required, as the TIFF file must contain all information needed to decompress the data.

The Coding Method (METH) subfield must contain "TIFF" to indicate that a TIFF file is used to encode the data for this raster object, instead of a SDTS Cell Module.

4.8 SDTS Restrictions/Requirements: Layer Definition Module

The Cell Module Name or Adjunct File id (CMNM) subfield must contain the identifier for the TIFF file when it replaces the Cell module. This must match the identifier used in the Catalog/Directory module.

4.9 SDTS Restrictions/Requirements: Cell Module

If the TIFF file is substituted for the Cell Module, then no Cell module is present.

If a TIFF file is just a supplement, then the Cell Module is present, as before.

4.10 File Naming Convention

In addition to the file naming conventions in the core SRPE, any adjunct TIFF files is recommended to have the file extension ".tif". The file name is recommended to start with the same four characters as the rest of the SDTS files in the transfer.

5 Implementation Resources (*Informative*)

Software and information resources useful to implementers of this annex are listed below. All referenced software is public domain, but commercial tools may also be available.

LIBTIFF - Public Domain TIFF library. Available via anonymous FTP from ftp://sgi.com/graphics/tiff.

LIBGEOTIFF - Public Domain GeoTIFF library. Available via anonymous FTP to
ftp://mtritter.jpl.nasa.gov/pub/tiff/geotiff/code
or at its USGS mirror site ftp://sdts.er.usgs.gov/release/geotiff/jpl-mirror/code.

SDTS++ - Public Domain SDTS C++ library. Available from http://mcmcweb.er.usgs.gov/sdts, follow links to SDTS++.

SDTS Home Page is maintained by USGS at URL http://mcmcweb.er.usgs.gov/sdts and contains information on the Spatial Data Transfer Standard, profiles, datasets, software, articles, presentation materials, and standard document.

GeoTIFF Web Page is at http://home.earthlink.net/~ritter/geotiff/geotiff.html.

Ritter, N., and Ruth, M., “The GeoTiff data interchange standard for raster geographic images”, International Journal of Remote Sensing, 1997, Vol. 18, No. 7, pp. 1637-1647. This article is a review of the GeoTIFF development initiative and an overview of the main technical characteristics and principles of the GeoTIFF format

ANNEX 1: DEFINITIONS and ACRONYMS

(Informative)

1 Introduction

This annex to the SDTS Raster Profile and Extensions (SRPE) serves to facilitate the use of the SRPE by providing definitions for terms and acronyms used in this document. Additional definitions are available in SDTS and BIIF.

1.1 Definitions

Bands - commonly used in describing imagery; usually collected at the same time by the same acquisition device. For an image, a group of representation modes such as those visible to the human eye and those detected by other means such as infrared, side-aperture radar, electro-magnetic, etc.

Block - rectangular portion of an image; there is no overlapping of blocks or gaps between adjacent blocks within a single image (BIIF Clause 4.2.5.1.)

Cell - used in this document to refer to both the terms grid cell of a data grid and pixel of image data.

Data Extension Segment (DES) - a construct used to encapsulate different data types, other than image, symbol, and text. (BIIF clause 4.2.8.2)

Data Segment - In BIIF this refers to one section of a BIIF file, as in an image, symbol, or text segment.

Digital Image - A two-dimensional (geospatial) array of regularly spaced picture elements (pixels) constituting a picture. (See SDTS Part 1, Section 2.3.4.1); Object representation code of G2.

Geometric Transformation - an operation that redefines the spatial relationship between points in an image. This includes simple translation, scale, rotation, or something as elaborate as a convoluted transformation. Also called warping.

Georeferenced data - data that has been geographically registered to the earth's surface; this includes performing any geometric corrections to fit the raster data to grid of the projection.

Grid - A two-dimensional (geospatial) set of grid cells forming a regular tessellation of a surface. (See SDTS Part 1, Section 2.3.4.2); Object representation code of G2.

Grid Cell - A two-dimensional (geospatial) object that represents the smallest non-divisible element of a grid (SDTS Part 1 Section 2.3.3.5). (Similar to a pixel for an image.)

Image - uses a two-dimensional reference system and has zero, one, or more data values associated with each cell. Although image has a visual connotation to it, it is often used to refer to any measurement from a remote sensing device that has a two-dimensional spatial orientation. An image may consist of one or more bands. (See Digital Image)

Indirect georeferencing - locating spatial data to the earth’s surface using place names or feature names.

International Standard - terminology used in ISO to refer to an approved and available standard.

Layer - a set of data values (i.e., cell values) all measuring the same phenomena for an image or grid. In SDTS terms, a “layer” refers to one band of an image or a raster grid. For example, if a three-band image was transferred along with a digital elevation grid, this would constitute four layers in SDTS.

Mosaicking - the joining together of several images that may overlap each other to create a single new image.

Pixel - A two-dimensional (geospatial) picture element that is the smallest non-divisible element of a digital image (SDTS Part 1 Section 2.3.3.4). (Similar to a cell of a grid.)

Radiometric [camera] calibration - The calibration of a camera for its spectral recording characteristics.

Radiometric linearity - The gray levels are in linear proportion to the light intensities within a color band.

Radiometric non linearity - The analog to digital conversion system that provides signal to noise (S/N) ratios of the sensors, where the S/N is calculated by the difference of the sensor's average dark signal value divided by the root mean square dark noise value. Intermediate intensities will be linear representations from average white reference to the average dark reference. Intermediate intensities will be represented using a linear tonal transfer curve for each color channel. For example, the error introduced during the digitization process causes gray scale values for a color component (RGB) to be out of linear proportion to the source intensities for that component.

Raster object - One or more related raster data layers collected and/or processed together, registered to a common scan reference system and having similar geographic extents. (SDTS Part 1, Section 2.3.4.4)

Rectification - In photogrammetry, the process of projecting a photograph onto a horizontal reference plane. A rectified print is a photograph in which displacement has been removed from the original negative, and which has been brought to a desired scale.

SDTS Transfer - A spatial data set composed of metadata and one or more data files. The metadata portion of the transfer defines lineage, positional accuracy, security restrictions, definitions of feature and attribute terms, etc. and content of the SDTS transfer.

Synthetic raster data - data derived by digitizing or extensive processing. An example is a scanned map image. Also called derived, symbolized, interpreted, exploited.

Tagged Record Extension (TRE) - A way to provide additional attributes about standard BIIF data segments not contained in the BIIF standard headers. (BIIF Clause 4.2.8.1)

Tile - same as block. A tiled image is equivalent to blocked image.

Transformation - (Photogrammetry) The process of projecting a photograph (mathematically, graphically, or photographically) from its plane onto another plane by translation, rotation, and/or scale change. The

projection is made onto a plane determined by the angular relations of the camera axes and not necessarily onto a horizontal plane.

Visual Representation - for the purposes of this profile, this term is used to indicate a critical need to display the image exactly as the image was generated.

Warped Grid - a two-dimensional set of warped grid cells that are adjacent, non-overlapping and partially overlapping, and some cells are not square. (For example, remotely sensed imagery that has not been rectified, or a scanned image that has not had scanner distortion removed.)

1.2 Acronyms

ANSI - American National Standards Institute
BIIF - Basic Image Interchange Format
CGM - Computer Graphics Metafile
DR - Data Record (ISO 8211 term)
DDR - Data Descriptive Record (ISO 8211 term)
DDF - Data Descriptive File (ISO 8211 term)
FIPS - Federal Information Processing Standard
FGDC - Federal Geographic Data Committee
G2 - SDTS object code for Digital Image or Grid
G2W - Defined by SRPE to indicate warped or non-rectified raster data
GI - SDTS sequencing code for Band Sequential
GJ - SDTS sequencing code for Band Interleaved by Line
GL - SDTS sequencing code for Band Interleaved by Cell
IS - International Standard
ISO - International Standards Organization
IEC - International Electrotechnical Commission
JFIF - JPEG File Interchange Format
JPEG - Joint Photographic Experts Group (often refers to work done on compression algorithms for continuous tone still images)
LUTS - Look up tables, used for color palettes for raster grid data
NIMA - National Imagery and Mapping Agency
NITFS - US National Imagery Transmission Format Standard
NSIF - NATO Secondary Interchange Format
RMSE - Root Mean Square Error
SDTS - Spatial Data Transfer Standard
SRPE - SDTS Raster Profile and Extensions
TIFF - Tagged Image File Format
VQ - Vector Quantization (compression technique in BIIF)
USGS - U.S. Geological Survey

ANNEX 2: DIAGRAMS AND EXAMPLES

(Informative)

1 Introduction

This annex to the SDTS Raster Profile and Extensions (SRPE) serves to facilitate the use of the SRPE by providing diagrammatic illustrations of the relationship between standards and example encodings using SDTS and the various extensions. There are many combinations of options that are permitted by the SRPE, and this annex only illustrates a few.

2 Relationships among Standards

This section explains the relationship among the many standards referenced by various parts of the SRPE. Diagrams are used to facilitate the description of the multi-faceted relationships. One of the objectives of the SRPE is to be a convergence agent in the various geospatial raster data efforts. Rather than duplicate capabilities available in other standards, the SRPE sought to use these directly. Figure 1 shows the image and metadata standards that the SRPE integrates with the fundamental SDTS.

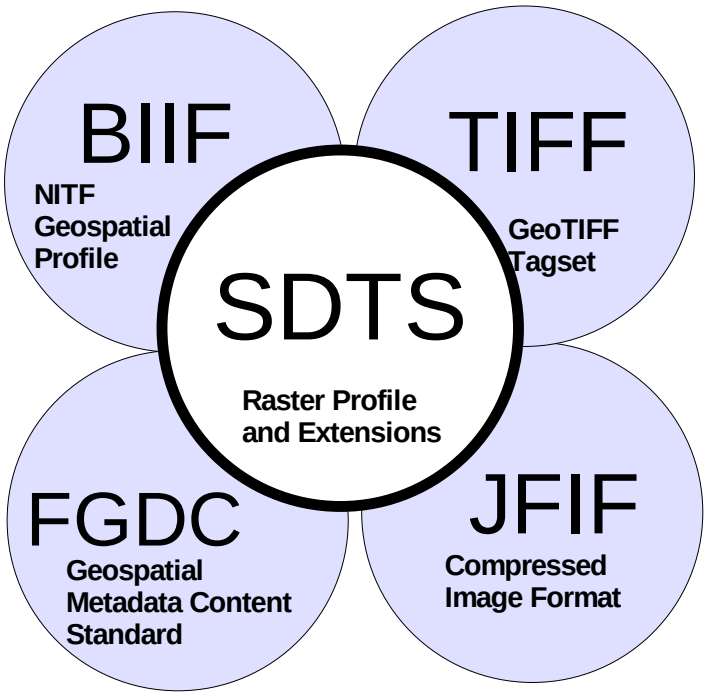

Figure 1: Relationship Among Standards

The Federal Geographic Data Committee (FGDC) under its authority to develop standards for the National Spatial Data Infrastructure (NSDI) developed a content standard for geospatial metadata. The SRPE requires the use of this content standard to encode certain types of information.

When it comes to image format standards, there are quite a few. The SRPE therefore permits images to be encoded in other formats, offering additional capabilities to SDTS data encoders immediately without duplicating efforts. The military community has been working on developing a joint ANSI/ISO standard for imagery applications based on their military standard National Imagery Transmission Format (NITF). The SRPE permits BIIF, specifically the NSIF Profile, as an image format in Annex A. Satellite image providers have taken a popular image format TIFF and added georeferencing capability. The SRPE permits a TIFF file with or without GeoTags to be included in an SDTS transfer in Annex E. The SRPE permits the use of the JPEG compression algorithms, and specifically the JPEG File Interchange Format (JFIF) to encode a compressed image in Annex C.

2.1.1 SDTS and BIIF

This section serves to explain the relationship between the SDTS standard, its SRPE (Profile), and the BIIF Standard, and the proposed NSIF/NITF Profile. The relationship is explained in Annex A, section 1.2, and is depicted in Figure 2.

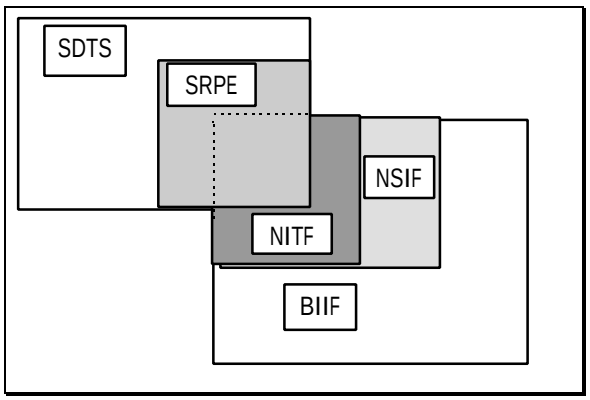

Figure 2: Conceptual Delineation of SRPE

The SRPE is fundamentally comprised of SDTS, and optionally includes BIIF extensions, delineated by the overlap of SRPE and NITF/NSIF profile to BIIF. BIIF as an international standard will be implemented through national profiles, and the NSIF will become the US profile. For compatibility, the NITF profile will be a subset of the NSIF requirements.

2.1.2 SDTS and GeoTIFF

This section serves to explain the relationship between the SDTS standard, the TIFF specification, and the GeoTIFF specification. The relationship is depicted in Figure 3.

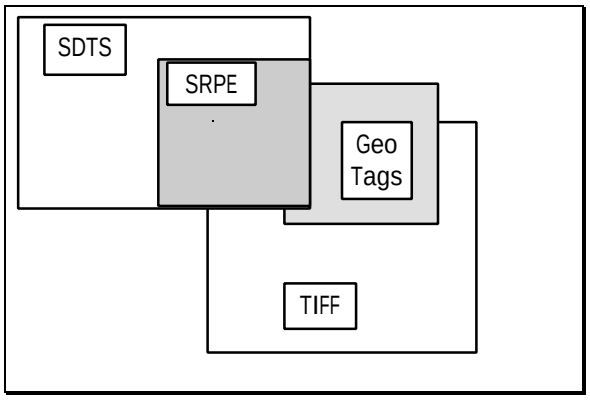

Figure 3: SDTS and GeoTIFF Relationship

The SRPE permits the use of TIFF to encode images in Annex E. If the image is capable of being georeferenced, then the GeoTags are required to encode this information. The GeoTags are an extension of the TIFF specification to support georeferencing in an open, non-proprietary manner. The GeoTag structure duplicates the tag mechanism used within TIFF to offer a hierarchy of tags.

2.1.3 SDTS and JPEG

The relationship between JPEG and SDTS is defined by the SRPE in Annex C. The base SDTS leaves the specification of compression up to the profile. The JPEG is a suite of compression methods, lossy and lossless, for continuous tone images. The JFIF is a format for compressed image transfer that is neutral on the compression method used, but compatible with JPEG. The relationship permitted in SRPE Annex C is depicted in Figure 4.

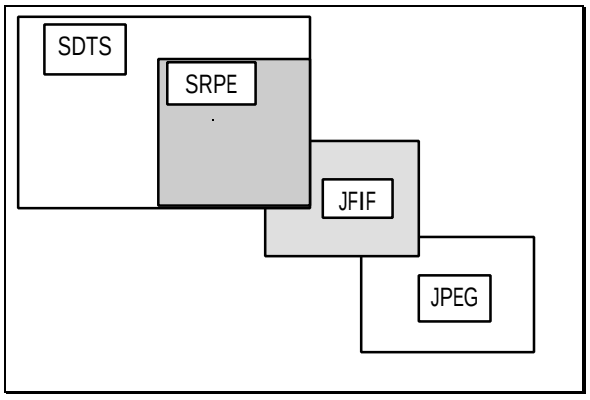

Figure 4: SDTS and JPEG Relationship

The SRPE permits the use of the JPEG compression methods by permitting the use of JFIF for compressed image transfer. (Similar to the SDTS, both BIIF and TIFF extensions address the use of JPEG. This offers multiple paths to JPEG for a user of the SRPE, through the Annex A BIIF and Annex E TIFF extensions.)

3 Example Encodings

This section will describe some example encodings down to the file level. These illustrate the file level impact of the various extensions and options available in the SRPE. For details about the content and structure of each file, refer to the appropriate annex and standard or specification. References for each are listed in the annex that permits the extension.

The order of the examples proceeds from the base or core of the SRPE, to any permitted SDTS options (such as use of the Color Index Module), and through the permitted extensions.

3.1 Case: SRPE Base Transfer

This section describes a transfer that uses SDTS only as permitted by the base of the SRPE. A gridded elevation data set will be used as an example. In Figure 5, the transfer is shown as a set of files. Each of these files corresponds to an SDTS module type. The permitted module types and permitted number of each type is stated in the SRPE Section 4 and 5. These requirements are used to determine the number and kind of modules needed for a specific data set. A typical transfer of a single layer of gridded raster data would consist of the eighteen files shown in Figure 5.

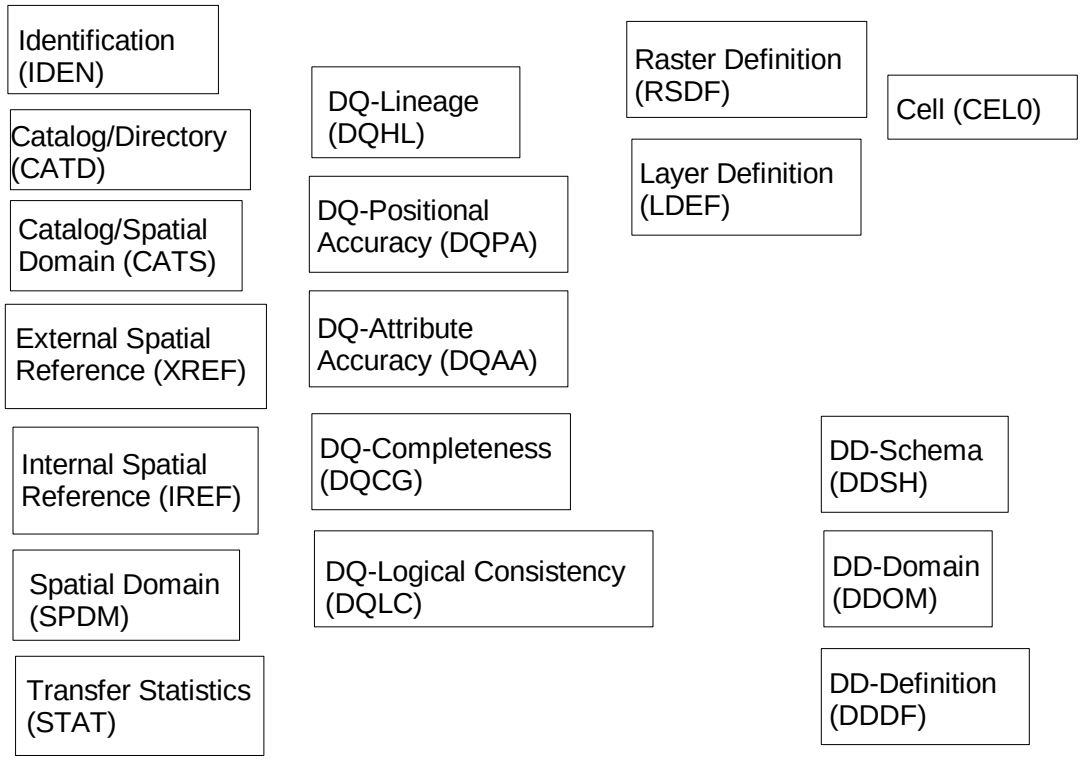

Figure 5: File Level View of SDTS Raster Transfer

Most of the files are file level metadata (IDEN, CATD, STAT), data quality (DQ) information, data dictionary (DD) information or georeferencing (XREF, IREF, SPDM) information. The raster data and description is the largest part of the data set even though it only occupies three files (RSDF, LDEF, CEL0).

3.1.1 Option: Addition of Color Index Module

In this section, the base transfer from above is modified to show the effect of using Annex B: Color Index Module. Annex B permits the SDTS Color Index Module to encode color palettes for the raster data in a SDTS Cell Module. This is most appropriate for gridded raster data and not image raster data.

For example, a color palette could be used to show elevation intervals in our elevation data. To use the Color Index Module, the cell values (in this case elevation measurements) need to be encoded as integers. Then there needs to be a module record in the Color Index Module for every different elevation value in the data set. To associate the Color Index module file to the Cell module file, there needs to be a Catalog/Cross-Reference Module. At the file level, the effect of Annex B in this example is to add two files. In Figure 6a, the two additional files are CLRX and CATX.

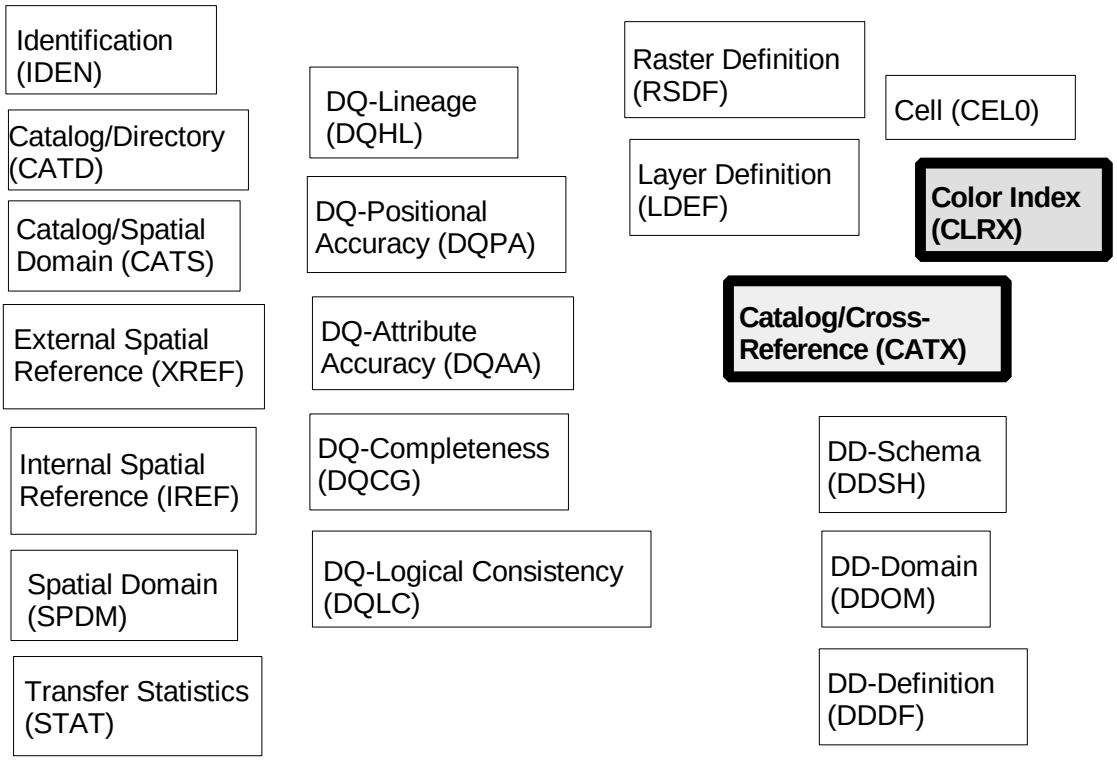

Figure 6a: File Level View of SDTS Raster Transfer with Color Option

Notice that these two files are in addition to all the other files, and are not replacing any files. If a decoder does not support optional Annex B, then there is no lost access to the actual raster data.

3.1.2 Option: Addition of Compression

In this section, the base transfer from section 3.1 is modified to show the effect of using Annex C: Compressed Raster Data. There are two types of compression permitted by Annex C. The Run Length Encoding method is appropriate for gridded raster data, and it effects the subfield structure within the Cell Module record. The file level illustration would be the same as in Section 3.1, Figure 5. The base SRPE requires that a decoder support decompression of SDTS RLE (see SRPE Section 2.9), so there is no lost data access to a decoder that does not support Annex C.

The JPEG method is actually a family of compression schemes and it creates an entire new file that replaces the Cell module file. If the transfer was of an image, and JPEG compression was used, the file level view would be as in Figure 6b.

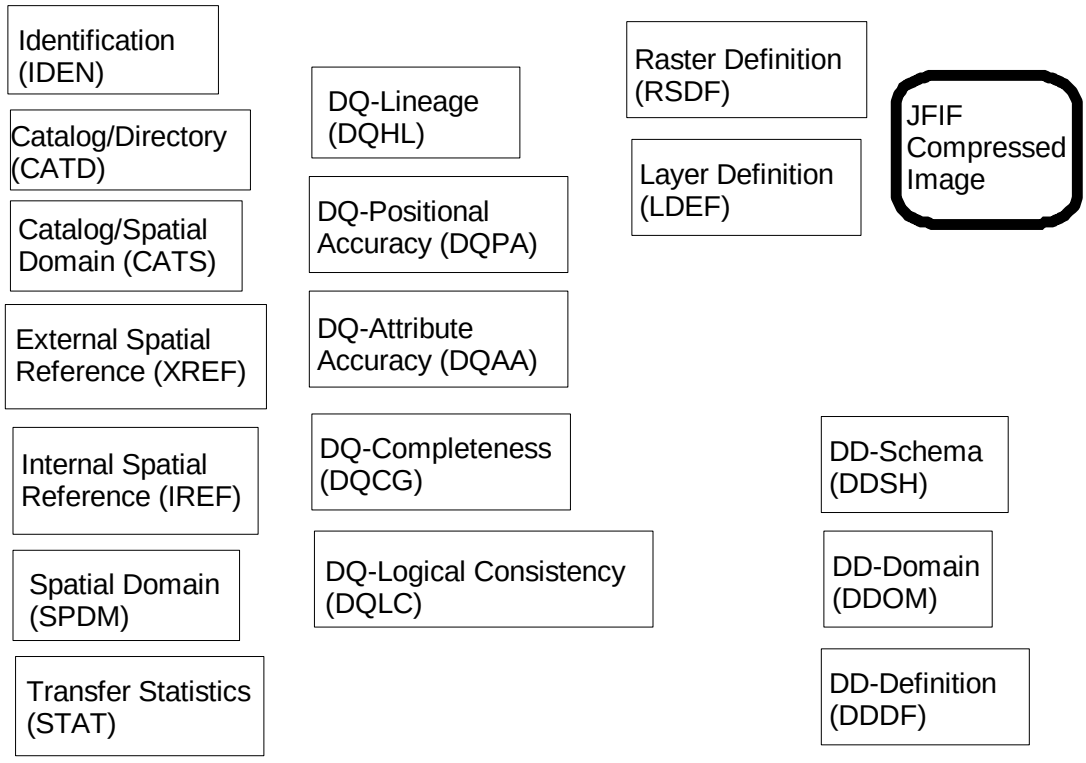

Figure 6b: File Level View of SDTS Raster Transfer with JFIF Option

In Figure 6b, the Cell module has been removed and the JFIF file takes its place. The other SDTS modules would now describe the JFIF file. The base SRPE does not require support for decoding JPEG. A decoder that does not support Annex C might not be capable of accessing the image data.

3.2 Case: Using the BIIF Extension

This section will illustrate the case of using Annex A: BIIF Extension. Annex A includes many options within it, so this example serves only to illustrate some of them. The BIIF is included as a single file in an SDTS Transfer file set. In BIIF implementation terminology, this single file may be "unpacked" into its component parts as a processing step. The internal structure of a BIIF file is briefly described to highlight its component parts.

3.2.1 BIIF File Structure

The BIIF image transfer is encoded in a single file that consists of a varying number and type of data segments. The order of the segments is shown in Figure 7.

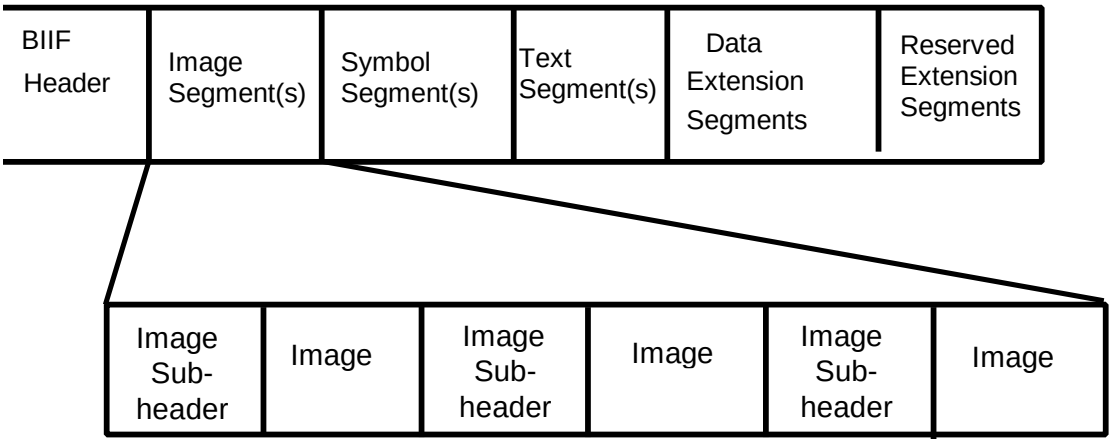

Figure 7: BIIF File Structure Showing Segment Order

Each segment starts with a header followed by the data of the segment. The BIIF file header contains counts and lengths of all the segments in the file. Figure 8 depicts a BIIF file consisting of a single image, no symbols, no text, and with georeferencing through a data extension segment.

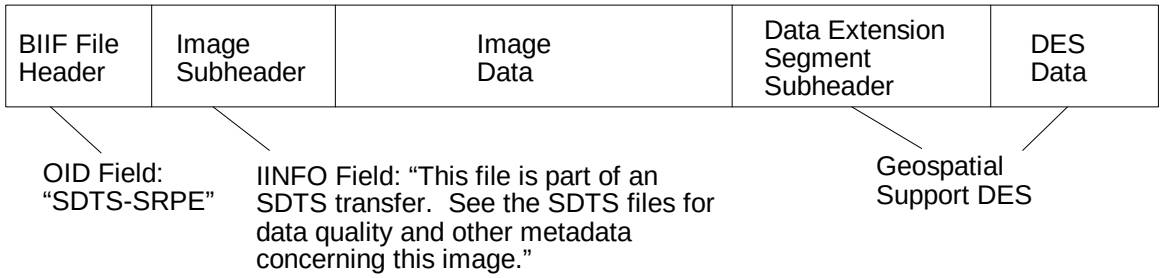

Figure 8: BIIF File Example for SDTS Transfer

As Figure 8 shows, the BIIF File Header, Field OID, may include the characters “SDTS-SRPE” to permit decoding software to know of the presence of additional information in SDTS files. The Image Subheader, Field IINFO, should also include a note to a data consumer so they are aware of the extra information. The georeferencing information for the image is carried in the Data Extension Segment as defined by the NSIF Profile.

The file level view of the SDTS transfer with BIIF option would be similar to Figure 6 in Section 3.1.2 with the JFIF block replaced by a BIIF file containing the image data. The SDTS modules would now be describing the image as in the BIIF file.

A decoder that does not support Annex A will not be able to access the image data in the BIIF file. (Similarly, a NITF BIIF reader that does not support SDTS, will not be able to access the information in the SDTS files.)

3.3 Case: Using the GeoTIFF Extension

The section will illustrate the case of using Annex E: GeoTIFF Extension. Annex E includes many options within it, so this example serves only to illustrate some of them.

Consider the case of encoding a digital orthophoto using the GeoTIFF option. The image is grayscale and has been geometrically corrected and sampled to conform to a projected coordinate system grid. The image is encoded in the TIFF as a grayscale image, and the georeferencing is encoded in the GeoTags for a projected coordinate system. The SDTS files contain all of the other metadata which describe production processes, accuracy, resolution, and perhaps even the geographical footprint of the image. For this case, the file level view of the SDTS transfer is shown in Figure 9.

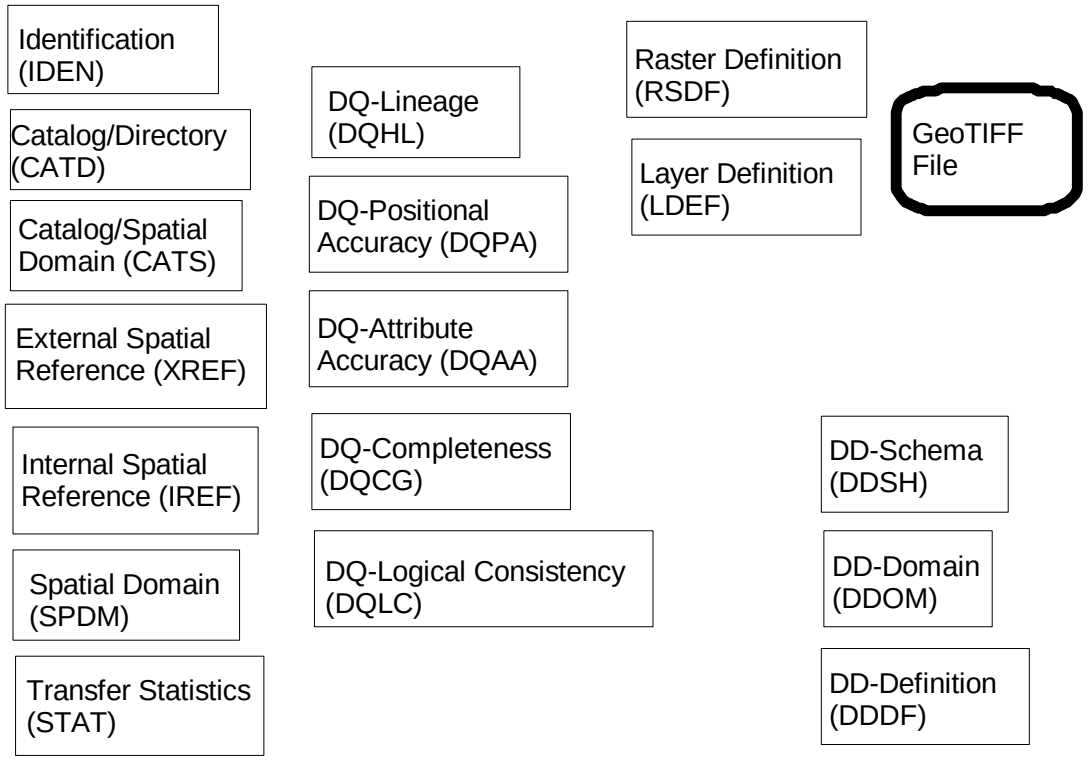

Figure 9: File Level View of SDTS Transfer using GeoTIFF Option

In this case, the GeoTIFF file replaces the Cell Module file. A decoder that does not support Annex E will not be able to access the raster data. A decoder that supports TIFF, but not GeoTags, will still be able to access the image, but will not be able to georeference it.

Consider the case of encoding a visual representation of a digital elevation grid using TIFF. The image is an interval based visualization of the elevation values, viewed from a 30 degree angle above the horizon. The image is encoded in TIFF as RGB image and there is no georeferencing. The grid of elevation values, used to generate the visual display, is encoded in the SDTS Cell module. The relationship between the Cell module and the TIFF file is explained in the Catalog/Cross-Reference file. The process used to generate the visual display, or the details about the viewing angle, light source, etc. can be described in the Data Quality Lineage module. . For this case, the file level view of the SDTS transfer is shown in Figure 10.

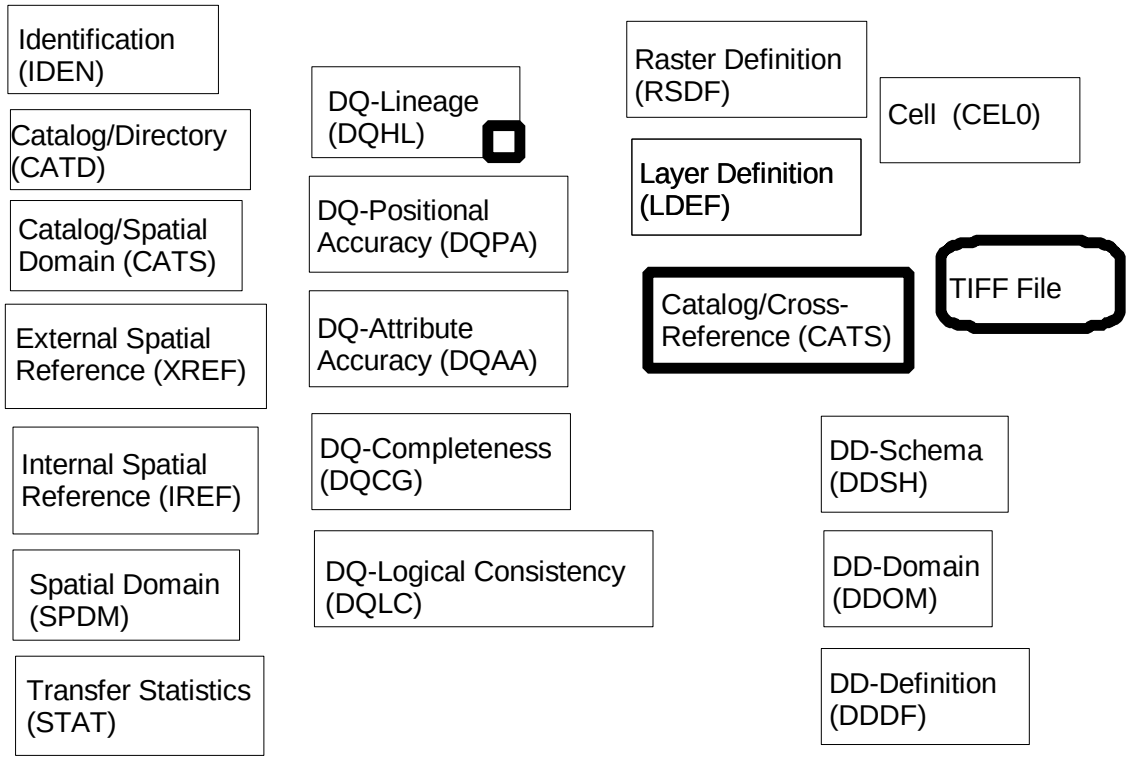

Figure 10: File Level View of SDTS Transfer using TIFF Supplement

In this case, the TIFF file is a supplement to the Cell Module file. Even if a decoder does not support Annex E, access to the raster data is supported.

ANNEX 3: BIIF to SDTS Crosswalk

(Informative)

This annex to the SDTS Raster Profile and Extensions (SRPE) compares and contrast terminology used in the Basic Image Interchange Format (BIIF) part of SRPE and the SDTS Raster Profile. This table is intended to identify terms not to be used interchangeably by the standards, and more importantly, common concepts termed differently. Attempts have been made in the SRPE to be sensitive to the high potential for confusion and efforts to dispel that confusion include this annex. Refer to glossary in Annex 1 of this document for definitions of each term.

Table Annex 3.1 - SDTS and BIIF Term Crosswalk

SDTS term	BIIF term
transfer - composed of modules and adjunct files	BIIF file - a file is composed of one or more data segments. Defined segments contain specified types of data. Within the SDTS Raster Profile - the BIIF file(s) is part of the SDTS Transfer
adjunct file - Within the SDTS Raster Profile, the BIIF file(s) are defined as adjunct files. This is restricted to be image data.	file - Within BIIF, restrictions on content are not applied.
module - Within the SDTS, this is a conceptually related set of information.	data segment - encodes a data type - in BIIF this term means image, symbol or text (and not integer, real, etc.)
field - set of related subfields	conditional fields groups - Sets of BIIF fields that are defined consecutively in the BIIF specification as conditional on previous fields
subfield - contains the data	field - contains the data
field - SDTS fields can repeat as permitted in the specification rules for the field	repeating fields (identified by a field that specifies the number found in the file) and may be found as a group. When no valid data is available, the bytes are blank filled.
mandatory subfield - data or spaces	required fields - data or spaces
User defined subfields are allowed only in the SDTS Attribute Modules.	Tagged Record Extension and Data Extension Segments - BIIF mechanism for unique user defined elements.
Similar to permitting adjunct files.	data extension segment - BIIF mechanism for encapsulated data, i.e. RPF. Could be stand alone data.
Profile - subset of a base standard.	Profile - subset of a base standard.
Conformance Field in IDEN module and Transfer Statistics - gives decoder some rough indication of what they will encounter	Complexity Level - in BIIF allows a specification of a nesting of complex capabilities, like large file size, blocking, compression, etc.

Table Annex 3.1 - SDTS and BIIF Term Crosswalk	
Identification Module - Contains Conformance Level field and includes standard identification and profile.	BIIF File header fields - identify the profile, version and standard.
Layer - image related	Band - one of the two-dimensional (row/column) pixel value arrays that comprise an image. In the case of 24-bit true color images, the representation is three two-dimensional arrays (RGB).
Pixel - The smallest non-divisible picture element.	Pixel - The smallest non-divisible picture element.
Grid Cell - The smallest data element in an array of gridded data.	No equivalent - BIIF intended for images more than grids.
Tile – equivalent	Block - equivalent

Table 3.2 is a crosswalk of fields from BIIF that deal with lineage information and their equivalent in the FGDC Content Standard for Digital Geospatial Metadata.

Table Annex 3.2 - NITF Format Requirements on Lineage		
BIIF field	**NITF/BIIF Location**	**FGDC Field**
OID - Originator Id	File Header	Point of Contact 1.9
FDT - File date	File Header	
ISORCE - Image source	Image Subheader	Source Information 2.5.1
IDATIM - Image Date and Time	Image Subheader	Time period of content 1.3
(Proposed TRE for use by NITF BIIF Profile:) History Tag	Tagged Record Extension in Image Subheader	Process Steps 2.5.2