Geographic information – Imagery and gridded data

Technical Report

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Content

Introduction

This technical report seeks to identify the manner by which ISO/TC 211 should handle imagery and gridded data in the context of its standards.

A natural image is a radiometric representation of the real world, as seen by an optical or other sensor. A synthetic image is a generated depiction of spatial data in a visual form. Both natural and synthetic image data are being used increasingly in the area of geographic information/geomatics. Gridded data is the representation of attribute values in terms of a spatial grid. All three of these forms of spatial information can be handled in a similar manner by representation in terms of a raster or matrix structure. Both a raster and a matrix are array structures that may be coded somewhat differently due to the characteristics of the data.

An increasingly large volume of natural and synthetic image and gridded data is being produced. For example, current imaging satellites include LandSAT, RADARSAT, SPOT, ERS, MOS, JERS, and NOAA. Also, there are military satellite images and other public and private domain image sources. There are current plans to launch more than one hundred Earth observing satellites by the year 2005, with 60 of those scheduled for launch by the end of 1999, with some of these satellites generating as many as 22 000 scenes per day. Digital orthophoto mapping is another field in which major financial investment is being made and in which a large volume of raster data is being produced. Obviously, there will be great demand for this imagery to be in a standard format in order to be useful with other sources of data.

Large volumes of synthetic imagery are being produced by the scanning of the current large inventory of paper maps and charts, and it is expected that the volume of this data will exceed the production of vector based data sets for a long time. Synthetic raster maps include scanned paper map products, such as topographic maps, nautical charts, soil and vegetation maps and other such products. They also include raster data sets generated directly from vector data sets. Since the demand for image and gridded data is large and will be rapidly increasing in the near future, it is necessary to address this form of data in ISO/TC 211. Many countries and international organizations are producing Digital Elevation Models (DEMs). Many other forms of gridded data such as georeferenced socio-economic data including land use data, meteorological and bathymetric data are being compiled in large volumes.

Earth observation networks and information infrastructures are being developed in many countries to further improve the access and use of remote sensing data, products and services, with the objective to provide state-of-the-art interfaces between the data archives and their users. The interoperability between data archives – an important element of which is interoperable standards – will greatly facilitate a more effective operation by government bodies and the value-added sector.

The specific aim of this work item is to analyse the characteristics of imagery and gridded data and make recommendations with respect to how this data can be handled in ISO/TC 211. There is a significant overlap between many of the current ISO/TC 211 work items and those areas that require standardization to support imagery and gridded data. For example, it is possible to share many metadata elements between vector and raster representations, but some unique metadata will be required to handle particular raster related aspects.

The main interests that will benefit from the standardization of raster and matrix data formats will be the distributors and end users of raster data. Currently, each satellite effectively defines its own "standard" based on the characteristics of its sensors. There also exists a large number of "standard" formats for the exchange and distribution of synthetic raster data such as scanned paper maps. Integration of data is difficult at best.

Although there are some aspects of sensor characteristics that are unique to particular data sources, there is a high degree of commonality underlying the basic parameters. In addition many of the aspects of the existing ISO/TC 211 work on vector standards, such as geographic referencing, quality, metadata, positioning services, and portrayal are applicable to raster and matrix data.

Geographic information — Imagery and gridded data

1 Scope

This technical report reviews the manner in which raster and gridded data is currently being handled in the Geomatics community in order to propose how this type of data should be supported by the geographic information standards.

This report identifies those aspects of imagery and gridded data that have been standardized or are being standardized in other ISO committees and external standards organizations, and that influence or support the establishment of raster and gridded data standards for geographic information. It also describes the components of those identified ISO and external imagery and gridded data standards that can be harmonized with the ISO 19100 series of Geographic information/Geomatics standards.

A plan is presented for ISO/TC 211 to address imagery and gridded data in an integrated manner, within the ISO 19100 series of geographic information standards.

2 References

The following Standards and publicly available specifications contain provisions that, through reference in this text, constitute provisions of this report. At the time of publication, the editions indicated were valid. All standards and publicly available specifications are subject to revision and parties to agreements based on this report are encouraged to investigate the possibility of applying the most recent editions of standards and public specifications listed below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 19101, *Geographic information — Reference model* [1)]

ISO 19103, *Geographic information — Conceptual schema language* [1)]

ISO 19104, *Geographic information — Terminology* [1)]

ISO 19105, *Geographic information — Conformance and testing* [1)]

ISO 19106, *Geographic information — Profiles* [1)]

ISO 19107, *Geographic information — Spatial schema* [1)]

ISO 19108, *Geographic information — Temporal schema* [1)]

ISO 19109, *Geographic information — Rules for application schema* [1)]

ISO 19110, *Geographic information — Feature cataloguing methodology* [1)]

ISO 19111, *Geographic information — Spatial referencing by coordinates* [1)]

1) To be published

ISO 19112, *Geographic information — Spatial referencing by geographic identifiers* [1)]

ISO 19113, *Geographic information — Quality principles* [1)]

ISO 19114, *Geographic information — Quality evaluation procedures* [1)]

ISO 19115, *Geographic information — Metadata* [1)]

ISO 19116, *Geographic information — Positioning services* [1)]

ISO 19117, *Geographic information — Portrayal* [1)]

ISO 19118, *Geographic information — Encoding* [1)]

ISO 19119, *Geographic information — Services* [1)]

ISO TR 19120, *Geographic information — Functional standards* [1)]

3 Review of existing standards

Currently there exist several other efforts at standardizing aspects of imagery and gridded data in different related fields or application areas. For example the DIGEST Functional Standard addresses raster and matrix data. The IHO is currently beginning work on handling synthetic scanned charts as raster data. Of particular importance is the work ongoing in ISO/IEC JTC 1/SC 24 on Computer Graphics and Image Processing. ISO/IEC JTC 1/SC 24 has published the Basic Image Interchange Format (BIIF) which provides a standard image interchange format for a wide variety of imagery applications, including medical imaging and other non-geospatial applications. There has been extensive work done by DGIWG to harmonize the DIGEST standard with the work of ISO/IEC JTC 1/SC 24. Annex D of DIGEST is an encapsulation of DIGEST in terms of BIIF components. Also there is compatibility with the NATO Secondary Imagery Format (NSIF). It is urgent that the formal study of raster and matrix standards begins in ISO/TC 211 to ensure alignment between the suite of ISO base standards and these external standards. Parallel efforts are also underway in JTC 1/SC 32/WG 4 SQL/MM to create supporting data types and operators to manage, query, and disseminate image data. The Open GIS Consortium has recently released an RFP study document on "Coverages" that is of importance for imagery and gridded data.

The following sub sections present the status of each of the external standards efforts related to imagery and gridded data. Primarily international and public domain or open standards developments are addressed. Sub-section 3.9 also lists some of the more important industrial or private developments.

3.1 The International Organization for Standardization (ISO)

The International Organization for Standardization is the principal world standardization organization. It establishes international standards in a broad range of disciplines. In addition to the work in ISO/TC 211 there are several committees within ISO that are of interest with respect to the standardization of raster data.

3.1.1 ISO/IEC JTC 1 – Information technology standards

The International Organization for Standardization/International Electrotechnical Committee Joint Technical Committee 1 is responsible for the standardization of information technology. Several of its subcommittees are of particular importance to the study of raster data.

— ISO/IEC JTC 1/SC 24 – The subcommittee of JTC 1 which deals with computer graphics and image processing.

— ISO/IEC JTC 1/SC 29 – JTC 1 subcommittee responsible for the coded representation of audio, picture, multimedia and hypermedia information.

— ISO/IEC JTC 1/SC 32/WG 3 – JTC 1 subcommittee responsible for data base languages.

3.1.1.1 ISO/IEC JTC 1/SC 24 – Computer Graphics and Image Processing

This JTC 1 subcommittee is responsible for computer graphics and image processing standards and has developed the Image Processing and Interchange, Image Interchange Facility (IPI-IIF). This standard suite provides a framework in which to handle all types of imagery. The standard is being developed in ISO as part of the work on image processing and it is intentionally broad enough to handle very diverse types of imagery, including medical x-rays and images, photographs, satellite and other sensor data, and scanned maps. It is expected that details of the metadata and other adaptations of the basic standard will be developed in different application domains, such as mapping. ISO/IEC 12087:1995; IPI-IIF is a broad multi-part standard with a separate encoding standard, ISO/IEC 12089:1997. The standard provides a platform-independent set of image data types, an Application Programming Interface (API), and an exchange format (IPI-IIF). The underlying encoding is ISO 8824 ASN.1.

The ISO/IEC 12087 IPI-IIF standard contains the following parts:

— Part 1: Common architecture for imaging

— Part 2: Programmer's imaging kernel system application programme interface.

— Part 3: Image Interchange Facility (IPI-IIF)

Another part of the IPI-IIF standard is ISO/IEC 12087-5: Basic Image Interchange Format (BIIF). Development of this standard was based on the collaboration of ISO/IEC JTC 1/SC 24, NATO Air Group IV, Digital Geospatial Information Working Group (DGIWG), and the US Department of Defense. The US National Imagery Transmission Format Standards (NITFS) was used as a base document for BIIF. There has been a US Government activity to harmonize the NITFS with the US Spatial Data Transfer Standard (SDTS).

This published international standard will make use of International Standardized Profiles to define and organize domain applications of the standard. The US National Imagery Transmission Format (NITF) and the NATO Secondary Imagery Format will be handled as a profile of BIIF. Commercial applications of NITF include ERDAS IMAGINE, ARC-INFO, and a Northrup package.

The BIIF standard provides a detailed description of the overall structure of the format, as well as specification of the format and data domain for all fields defined within BIIF. As part of the ISO/IEC 12087 family of image processing and interchange standards, BIIF conforms to the architectural and data object specifications of ISO/IEC 12087-1, the Common architecture for imaging. BIIF supports a profiling scheme that is a combination of the approaches taken for ISO/IEC 12087-2 Programmer's Imaging Kernel System (PIKS), ISO/IEC 10918 Joint Photographic Experts Group (JPEG), ISO/IEC 8632 Computer Graphic Metafile (CGM), and ISO/IEC 9973 the Procedures and Registration of Graphical Items. Geospatial referencing for the interNational Standard Imagery Format ISP is by way of mandatory inclusion of the geospatial support data extensions defined in Annex D of the DIGEST.

In BIIF, a translation process enables data interchange between disparate systems. Using BIIF, each system must be compliant with only one external format that will be used for communication with all other participating systems. When BIIF is not used as a system's native internal format, each system will translate between the system's internal representation for imagery and the BIIF format. A system from which data is to be transferred has a translation module that accepts information structured according to the system's internal representation for images and related imagery data, and assembles this information in BIIF format. The approach provides the proven capability to implement general purpose BIIF readers (applications) that can present the basic imagery and annotations of any BIIF compliant product file created within the constraints of a given profile of BIIF. Although more robust approaches exist to allow self-defining data structures, these approaches significantly increase the complexity for implementing general-purpose readers (applications) capable of meaningfully interpreting file constructs created by a wide variety of diversely developed generators. More simplistic imagery file formats also exist. These formats are often focused at just portraying a simple digital image and are often too limited in feature sets to meet the needs of somewhat more sophisticated, but still basic imagery applications. BIIF provides a basic capability that bridges the gap between simplistic digital image formats and the extremely sophisticated, self-defining, but potentially complex format. As such, BIIF has some inherent bounds and limitations, but remains as a very capable basic imagery format that satisfies a broad range of imagery applications.

3.1.1.2 ISO/IEC JTC 1/SC 29 – Coding of Audio, Picture, Multimedia and Hypermedia Information

ISO/IEC JTC 1/SC 29 supports a broad range of standards for the exchange of picture and multimedia data. This committee consists of a number of expert groups. The relevant standards are known informally after the names of the groups that developed them.

- WG 1, the Joint Photographic Experts Group (JPEG) for continuous tone pictures, and the Joint Binary Images Group (JBIG) for bi-level, rasterized, images

- WG 11 the Moving Pictures Experts Group (MPEG)

- WG 12 the Multimedia/Hypermedia Information Coding Experts Group (MHEG)

ISO/IEC 11544, *Coded representation of picture and audio information — Progressive bi-level image compression* (JBIG), is a standard sponsored jointly by the UN based International Telegraphic Union (ITU) and ISO. It provides an efficient lossless compression method for coding two tone, black/white images.. The standard supports generic coding techniques for data compression and decompression for bi-level images and for limited bits-per-pixel images such as those with a limited number of grey or colour values. The scope of this work includes techniques for progressive image build-up, from low resolution to higher resolution, and techniques for image resolution reduction.

ISO/IEC 10918, *Digital compression and coding of continuous-tone still images* (JPEG), is sponsored jointly by the ITU and ISO, and is used for continuous-tone (photographic) images. Both lossy transform algorithms and lossless predictive algorithms are available with the lossy form of the standard being very efficient at up to 35:1 compression. JPEG makes use of continuous-tone digital images much more economical by drastically reducing the volume required for storage and the bandwidth required for transmission. JPEG helps enable interchange of images between different vendors, within applications, and between different applications, by providing a common coded representation of compressed image data. ISO/IEC 13818 MPEG-2, Generic coding of moving pictures and associated audio information, provides a unified coded representation of audio-visual information that supports multiple application requirements while maximising interworking. It makes use of a profile/level approach. The broad acceptance of this standard in industry enables the gradual replacement of the existing costly analogue equipment and stimulates the interworking of hitherto separate multimedia applications.

ISO/IEC 13522, *Coding of multimedia and hypermedia information* (MHEG), will provide the coded representation of final form multimedia and hypermedia information objects, to be interchanged within or across open applications and services, by any means of interchange. The objective of this standard is to ease the development of multimedia applications in open environments by ensuring the cross platform compatibility of elementary units of information called multimedia and hypermedia objects (MHEG Objects). In the present context, generic techniques (such as compression techniques) and object-oriented techniques (as used in MHEG) are gaining prominence in various areas that used to live separately, such as telecommunications, computer industry, television, and consumer electronics. In many respects, the MHEG technology proves to be at the crossing point of these sectors. The ability to provide an interchange format for digital media such as image, audio, text, graphics; the ability to interchange information objects between systems; and the ability to re-use this information in further applications, are features of paramount importance in many services such as office information systems and engineering documentation; training and education; electronic publishing; computer supported cooperative work; and on-line multimedia information broadcasting for navigation support in a digital television system.

The two SC 29 standards of particular relevance for raster data in ISO/TC 211 are the standards known informally as JBIG and JPEG. The MPEG and MHEG standards are only of indirect relevance to ISO/TC 211. They may be of use in situations where mapping information is included in multimedia applications.

3.1.1.3 ISO/IEC JTC 1/SC 32/WG 3 SQL/MM – Structure – Database Languages

ISO/IEC JTC 1/SC 32/WG 3 on data base languages is currently completing version 3 of the SQL language. SQL is the query and definition language for relational databases. Developed in parallel with this version of SQL is a separate standard called SQL/MM (Multi-Media). SC 32/WG 4 is responsible for SQL/MM (Multi-Media) and application package. One aspect of SQL/MM is Part 5 – Still image, which relates to image data.

ISO/IEC 9075 SQL is a major standard that is widely implemented. The companion standard ISO/IEC 13249 SQL/MM defines application specific data types for multi-media applications and the associated definition and query routines using the user defined features of ISO/IEC 9075 version 3 SQL3. The SQL/MM standard is structured as a multi-part standard consisting of the following parts:

— Part 1: Framework

— Part 2: Full-text

— Part 3: Spatial

— Part 4: General purpose facilities

— Part 5: Still image

The current version of the SQL/MM standard is at the final DIS (FDIS) stage in ISO/IEC JTC 1. It is closely related to the revision of ISO 9075:1998 SQL3 and will not progress to be a final standard until SQL3 is complete.

SQL/MM Part 3 – Spatial relates to vector data. It defines application specific data types and the associated definition and query routines for that data. There has been a significant level of harmonization between SQL/MM Part 3 and ISO/TC 211 projects 19107 and 19111 and the OGC Simple Feature Model. SQL/MM effectively defines in data base terms the basic elements used in vector data models. A similar coordination has been proposed for alignment of SQL/MM Part 5 with the work in ISO/TC 211 on image and gridded data and the work in OGC on "coverage)"[2)] data. However, in the field of image and gridded data there exist a number of other standards efforts (as described in this report) that would also need to be harmonized.

The ISO/IEC 13249-5 Still Image standard defines data types for simple still images and associated text comments. A special data type is defined for an ISO/IEC DIS 10918-4 JPEG image as a binary large object. Functions are also defined for returning specific values that are imbedded in the JPEG image definition.

3.1.2 ISO/TC 130 – Graphic technology

The ISO Technical Committee 130 on graphic technology has developed the standard ISO 12639, *Graphic technology — Prepress digital data exchange — Tag image file format for image technology (TIFF/IT)*. This is a second-generation format, developed in a public standards body, intended to replace the private TIFF format in the field of graphics technology. It is intended to be upward compatible to TIFF 6.0.

This draft International Standard specifies a media-independent means for prepress electronic data exchange. It defines image files formats for encoding colour continuous tone picture images, colour line art images, high resolution continuous tone images, monochrome continuous tone picture images, binary picture images, and binary line art images.

The Standard has two levels of conformance: TIFF/IT (also referred to as full TIFF/IT) conformance and TIFF/IT-P1 conformance. Both conformance levels are intended to support a media-independent means for the exchange of various images used in the prepress, printing, graphic arts, and information processing fields. TIFF/IT-P1 conformance provides a minimized set of options to permit simpler implementation and compatibility, where possible, with commonly available TIFF 6.0 readers and writers. TIFF/IT-P1 is intended for use where the full set of TIFF/IT options is not required.

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2) Definition of term coverage, image, raster, matrix, and gridded data has not yet been determined by ISO/TC 211 and is deferred to the new stage 0 work item – NP 17754; the Coverage Schema work item – NP 17753; and the terminology team.

3.2 DIGEST (DIgital Geographic Exchange STandard)

The DGIWG DIGEST standard has included the capability to handle (raster) image and gridded data sets for many years. It includes a number of product formats that share some common metadata and a common pixel encoding structure. A significant amount of data exists using this standard.

The DIGEST version 2.0 standard was released June 1997. In addition to geospatial vector data, this standard also supports image and gridded data in alignment with the ISO/IEC JTC 1/SC 24 BIIF standard. DIGEST Annex D, known as the Image Interchange Format, is an encapsulation of the NATO Secondary Imagery Format (NSIF) NATO STANAG 4545. Systems using geo-referenced imagery, matrix, or raster map data formatted according to NSIF should be designed to extract the needed data as specified in DIGEST Annex D. ISO/IEC JTC 1/SC 24 is developing an ISP of the BIIF based on NITFS and NATO STANAG 4545, which will be known as the interNational Standard Imagery Format (NSIF). The current version of BIIF has pointers to DIGEST Annex D until such time as corresponding components exist within ISO/TC 211.

NSIF allows for the standard exchange of image (ISO 10918 Joint Photographics Experts Group and Vector Quantization compressions are proposed within the NSIF), graphic (ISO/IEC 8632 Computer Graphics Metafile), and text data. For the NSIF, the image data encompasses multispectral imagery and images intended to be displayed as monochrome (shades of grey), colour-mapped (pseudocolour), or true colour. It encompasses also grid or matrix data intended to provide geographic or geo-referencing information. The following are some of the categories of images supported by NSIF and the Image Interchange Format described in the DIGEST Annex D.

Table 1 — Categories of Images Supported by DIGEST

Image Category	Definition	Image Category	Definition
VIS	Visible Imagery	SAR	Synthetic Aperture Radar
SL	Side-Looking Radar	SARIQ	SAR Radio Hologram
TI	Thermal Infrared	IR	Infrared
FL	Forward Looking Infrared	MS	Multispectral
RD	Radar	MAP	Raster Maps
EO	Electro-optical	LEG	Legends
OP	Optical	PAT	Colour Patch
HR	High Resolution Radar	DTEM	Matrix Data (elevations)
HS	Hyperspectral	MATR	Matrix Data (other)
CP	Colour Photography	LOCG	Location Grid
BP	Black/White Photography		

Flexibility to add support for the types of data and data characteristics not explicitly defined in the NSIF standard is provided within the format through a standard extension mechanism. A set of Standard Geospatial Support Data Extensions of NSIF are defined in the DIGEST Annex D. They are used within NSIF to convey standard geographic metadata such as geographic reference description, source description and quality description. Here are brief descriptions of these standard extensions:

GEOPS for geo-referencing parameters including datums, ellipsoids, and projections;

GRDPS for non-rectified image, raster, or matrix data that is positioned using a location grid;

GEOLO for image, raster, or matrix data rectified consistently with geographic (lat/long) coordinate systems;

MAPLO for image, raster, or matrix data rectified consistently with cartographic (E,N) coordinate system;

REGPT for registration points in either geographic or cartographic systems;

ACCPO for horizontal and vertical accuracy over regions for which the definitions are constant;

ACCHZ for horizontal accuracy when the vertical accuracy varies across the region for which horizontal accuracy is constant;

ACCVT for vertical accuracy when the horizontal accuracy varies across the region for which vertical accuracy is constant;

SNSPS for sensor parameters;

SOURC for map source information.

3.3 Spatial Data Transfer Standard: Part 5: Raster Profile

The Spatial Data Transfer Standard (SDTS) is a multi-nation standard used by the United States, Australia, New Zealand, and South Korea. On June 9, 1998, the American National Standards Institute (ANSI) formally adopted the Spatial Data Transfer Standard as an American National Standard. The official designation of the standard is ANSI NCITS 320:1998. Currently much work is ongoing in the development of various profiles to implement SDTS.

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 (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 (e.g., topological vector, point, grid, and image). 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. Currently SDTS Part 4: Topological Vector Profile is a component of ANSI NCITS 320:1998. Of interest to readers of this report is the development of SDTS Part 5: Raster Profile.

Significant effort has gone on to harmonize SDTS with other standards, particularly the EOSDIS Satellite Imagery and the DIGEST suite of standards. The US Raster Convergence Group using the US Federal Geographic Data Committee FGDC standards development process is endeavouring to merge existing raster standards by means of extensions to the original formats in order to move away from the special-use standards as much as possible. Some of the standards being addressed are the Spatial Data Transfer Standard (SDTS) Raster Profile, the Basic Image Interchange Format (BIIF), the Tagged Image File Format (TIFF), and the US National Image Transmission Format (NITF). The result of this effort is a new version of the SDTS Raster profile, titled Part 5: Raster Profile and Extensions (SRPE). The SRPE will incorporate an extension based on the NSIF described in subclause 3.2. The US FGDC accepted SDTS Part 5: Raster Profile and Extensions, as an FGDC Standard on 24 February 1999.

A key concept implemented in the SRPE is the use, where appropriate, of an existing image transfer standard, such as BIIF, TIFF or JFIF (JPEG File Interchange Format), to encode the actual image data. SDTS modules supply the means to register the image data geographically as well as supply any other metadata necessary for its use in a geographic information or analysis setting.

The following table illustrates the basic modules of an SDTS Raster Profile transfer as defined in the SDTS Part 1: Logical Specifications. Note that Part 1 of SDTS allows many more possible encodings of raster and N-dimensional data than are allowed in the SRPE. Another profile (or an annex to the existing SRPE) could be developed to take advantage of these additional capabilities.

Table 2 — Basic modules of an SDTS raster profile

SDTS Standard Module Names Used in the SRPE	
IDEN (Identification),	CATD (Catalogue/Directory),
CATX (Catalogue/Cross Reference),	CATS (Catalogue/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 (Colour Index)	
RSDF (Raster Definition)	LDEF (Layer Definition)
Cell (Cell)	Attp (Attribute Primary)
Bttp (Attribute Secondary)	

SRPE data transfers are composed of instances of these modules. There must be one Raster Definition module, one Layer Definition module, at least one Cell module (or adjunct image file), 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. Optionally, instead of (or in addition to) the Cell module(s), one or more adjunct image files conforming to the BIIF, TIFF or JFIF (JPEG) standard may contain the raster data cell values. The Internal Spatial Reference module describes the resolution for the spatial dimension.

3.4 IHO S-57 – International Hydrographic Organization – Transfer Standard for Digital Hydrographic Data

The International Hydrographic Organization is currently beginning the study of the inclusion of Raster and Matrix data within the S-57 standard. Currently there exist three national formats for the distribution of scanned paper navigational charts, which have been presented to The IHO Transfer Standard Maintenance and Development (TSMAD) committee. IHO is considering these as distribution formats, and is developing a generic exchange format compatible with these distribution formats and with the structure of the existing S-57. Among the issues that are being addressed in IHO are the support of insets, plans and marginalia on raster scanned paper charts.

IHO is also developing a method for supporting matrix data. Of particular importance is the support for sounding data derived from sonar. The enormous volume of this matrix data requires methods such as Helical Hyperspatial coding with non-uniform pixel sizes.

The current IHO standard S-57 edition 3 includes the support of raster and matrix (image and gridded) data within its data model. The IHO plans to extend this support for several types of image and gridded (matrix) data in a manner compatible with external raster standards.

Two distinct types of image data have been recognized in the IHO context. The first type is synthetic raster data, which corresponds to scanned paper chart products. Raster Nautical Chart (RNC) products are currently being made by several nations. It was also recognized that the situation for RNC's is different than that for vector chart data and that there is no need or desire to disrupt the existing distribution of such raster charts encoded using national formats.

The fundamental difference between a RNC product and a vector based Electronic Nautical Chart (ENC), is that, except for some minor metadata about the chart, the content of the raster chart product is defined by the paper product which was scanned. In the case of the vector ENC the content is defined by the ENC product specification.

The IHO TSMAD Working Group decided that it was appropriate to develop a RNC product specification as a minimum functional specification. This functional specification should be defined so as to have no impact on how Hydrographic Offices currently produce paper charts.

The second type of raster and matrix information is natural image data or other measured data such as the output of side scan sonar surveys or satellite images of ice. The TSMAD recommended that a generic raster extension should be prepared for S-57 and issued along with Edition 4.0 of that standard. This raster extension must be capable of handling ice data and other continuous tone imagery. An existing or emerging raster standard should be invoked if possible as an upward compatible extension to the existing S-57.

TSMAD indicated that "S-57 currently contains a place holder for the extension of the S-57 data model to handle raster as a spatial element within its object content. This could be extended to handle raster elements in context and/or a link could be made to an external raster standard. Both would make use of S-57 metadata." It also recognized that "there may be side effects of using a pre-existing raster standard" and that these side effects should be minimized.

The support of scanned sonar sensor data is of great importance. This data can be represented as an image, but is essentially gridded or matrix data. The data consists of position, depth, time, and other sensor parameters and is inherently multi-dimensional. The Helical Hyperspatial matrix structure and coding technique is currently under study in IHO as a likely candidate for the support of sonar data. This makes use of the Non-equal cell size pixel organization described in annex A.

IHO has indicated a desire to cooperate with ISO/TC 211 through WG 5 on this and related matters.

3.5 CEOS – Committee on Earth Observation Satellites

The Committee on Earth Observation Satellites (CEOS) is an organization that aims to achieve international coordination in the planning of satellite missions for Earth observation and to maximise the utilisation of data from these missions world-wide. CEOS defines and develops interoperability concepts.

The earth observation satellite industry has spawned a number of different standards for image data due to the different characteristics of unprocessed satellite imagery. These include raw satellite sensor image data from optical, radar and other sources and processed Earth Observation data. The majority of these satellite or sensor specific standards have been developed as derivatives of the CEOS standard.

3.5.1 CEOS Superstructure

The CEOS Superstructure is an international family of formats used by various space agencies. The CEOS Working Group on Data (CEOS-WGD) adopted the Landsat format, which was developed by the Landsat Technical Working Group (LTWG) for the purpose of exchange of Landsat data, as the family of formats to be recommended for exchange of Earth observation data. Landsat data has been received at over a dozen ground stations located in different parts of the world. Since each station produced a different Landsat product from the same basic raw data, the Landsat Ground Station Operators Working Group (LGSOWG) decided to have a common family of formats for Landsat data distribution. Since then, the CEOS-WGD has approved and recommended many implementations of the superstructure, and has also developed a specific CEOS Synthetic Aperture Radar (SAR) format, as a specific implementation of the CEOS superstructure concept. The CEOS WGD intends to continue using and recommending the CEOS superstructure family of formats as a general purpose formatting concept which can be implemented on any data set. The principal use of CEOS remains for data exchange.

3.5.2 CEOS Superstructure and the Catalogue Interoperability Protocol (CIP)

The CEOS Superstructure is a family of related standards for satellite data. The CIP specifies the services for interacting with a catalogue.

The CEOS Protocol Task Team (PTT), who produces, ratifies, and publishes the CIP specification, is comprised of the representatives of the space and remote sensing agencies of a number of countries.

3.5.3 Overview of CIP Architecture

The Catalogue Interoperability Protocol (CIP) standardizes the services needed for interaction between users and catalogues. The Interoperable Catalogue System (ICS) is a reference design which uses CIP as the common protocol between data providers and users.

The main objectives of CIP are to provide transparent distributed search, retrieval, browse, order and other services against Earth Observation catalogues; provide such access in a catalogue independent way; enable clients to dynamically learn about services and features; and allow creation of and access to collections of data organized thematically, independently of the physical location of the data.

3.5.4 CIP Features

CEOS has established the following CIP and ICS standards:

- Search Standardization
- Retrieval Standardization
- Attribute Standardization
- Dynamic Client Configuration Standardization
- Order Procedures Standardization
- Security

Based on the CEOS Interoperable Catalogue System (ICS) user requirements as defined by the PTT, the Z39.50-1995 standard, Information Retrieval (Z39.50): Application Service Definition and Protocol Specification, was selected as the base protocol for CIP. CIP is a profile of Z39.50, i.e., it uses a well-defined subset of the "out of the box" functionality defined by Z39.50. CIP has defined attributes and tag sets, and uses Explain and Extended Services, and several externally defined messages for search control, ordering, and authentication. Other Z39.50 profiles from which CIP derived some of its features include GILS, GEO, and the Digital Collections Profile.

CIP is currently being implemented by several CEOS member agencies. Implementations of CIP components are expected to be available as freeware.

3.6 EOSDIS/HDF

As a part of the U.S. Global Change Research Program, the National Aeronautics and Space Administration (NASA) is developing and implementing its Mission to Planet Earth (MTPE) Program. The foundation of MTPE is the Earth Observation System (EOS), which provides the next generation of satellite remote-sensing instruments and platform hardware, a community of funded scientists, and the infrastructure to consolidate data and information from surface campaigns and remote-sensing satellites. It is planned that the EOS program will observe the Earth continuously for the next 15 years (Asrar and Greenstone, 1995). In order to process, distribute, and archive data from the EOS satellites and to facilitate interdisciplinary research of the Earth system, NASA is developing the EOS Data Information System (EOSDIS) Core System (ECS). It also facilitates the interaction and communications among EOSDIS users (Asrar and Dozier, 1994).

3.6.1 Conceptual Data Models

Because EOSDIS will process the data from field campaigns, aircraft and ship observations, satellite remote sensing, and the output of scientific models, the data are in various forms. Therefore, common conceptual data models have been established so that EOSDIS data products can be mapped into a limited number of data form groups. Then, encoding standards and software interface can be developed for the limited number of data groups. In EOSDIS, data are grouped into three generalized models: grid, swath, and point:

— Grid: rectangular arrays or data structures for geocoded data.

— Swath: simple or complex remote-sensing swath data.

— Point: simple or indexed data of geo-located and/or time-tagged point observations or event data.

Each conceptual data model defines the data object (i.e., Swath, Grid, and Point), the components of the object, and the relationship between the components. In the swath and grid models, there are two required components; data and geolocation. The description of how to relate the geolocation component to the data components has to be packaged with these two components. In the point data model, the data collected at a point on earth can be a record in a table and the geolocation information for the record is either as fields in the record or attached to the record through a pointer.

Three basic data types are needed for describing the EOSDIS data models:

— ASCII Text--plain and formatted text for labels, descriptions or documents;

— Tables--standard tables for record-like data; and index tables for indices and variable length counters for ragged arrays;

— n-dimensional Array--array of records or array of scalars for heterogeneous or homogeneous multi-dimensional data.

For Swath and Grid data models, all three basic data types are needed. For the point data model, only the table and the ASCII text are needed.

The EOSDIS data models are in the process of becoming US Federal Geographic Data Committee (FGDC) content standards for remote sensing data. It is expected the swath standard will become an FGDC standard in 1999.

3.6.2 Hierarchical Data Format (HDF)

To implement the conceptual data models in EOSDIS, one or several physical data formats have to be selected as the standard format to host the data models. Through detailed study, NASA has selected the Hierarchical Data Format (HDF) as the basis for developing the standard format for EOSDIS. The main reasons for selecting HDF include the following:

1) Multiple data type support – All data types in EOSDIS can be supported by HDF.

2) Portability – Data in HDF can be ported to many different platforms.

3) Easy to use and implement – HDF provides a software library and good documentation.

4) HDF software and documents are free and available on anonymous FTP.

5) Availability of software tools for manipulating and visualising data in HDF. Most of the tools are free.

3.6.3 HDF-EOS – The HDF Implementation of the EOSDIS Conceptual Models

The EOSDIS data models are implemented in HDF by mapping the EOSDIS conceptual models to HDF internal data models and structures. HDF has six internal data models. Using the standard HDF data models as a basis, EOSDIS has developed three additional internal data models - the swath, point, and grid – corresponding to the three conceptual models of EOSDIS. These models use combinations of the standard HDF internal models to provide both the data and the georeferencing information in a form that can be accessed as easily as standard HDF data. The three new data models are collectively known as HDF-EOS.

HDF-EOS stores metadata by encoding it in text format using Object Description Language and storing it as global attributes in HDF-EOS files. The content standard for structure metadata, which defines the relationship between data components, is defined in the EOSDIS conceptual data models. The HDF-EOS software library automatically generates, encodes, and stores structure metadata when an HDF-EOS data object is created. For product metadata, which describes the data product, EOSDIS has developed its own metadata model and standard (Heller, 1994).

3.7 International Telegraphic Union – Telecommunications ITU-T SG VIII - T.4 and T.6

The U.N. based International Telegraphic Union (ITU-T) has developed the T.4 and T.6 recommendations for the encoding of facsimile images. These formats use a differential line to line coding that is very efficient on synthetic images such as printed text and line drawings. Colour algorithms are included using T.43. The facsimile algorithms are very efficient for encoding particular types of synthetic image data that includes a lot of "white space" or areas of constant colour. This may be suited for raster images of REPMAT (printing master separates) and for scanned paper maps.

The T.4 and T.6 formats should be considered as basic data encodings for particular classes of image data. They work by encoding runlengths in one and two dimensions using Huffman probabilistic encoding.

3.8 Open GIS Consortium (OGC) – Coverages

The Open GIS Consortium (OGC) is developing industry-consensus object classes and interface specifications that support frequently encountered requirements in GIS systems. The object model includes "Geospatial Features" whose spatial extent are modelled with vector geometry as well as Features whose spatial extent are modelled as Coverage functions. A coverage function distributes a set of values over a spatial domain. A spatial domain is a collection of objects (typically points or other geometries) which may be placed into correspondence with Earth locations. Images and gridded data are types of coverage functions.

The OGC technology development process is based on the gathering of consensus on an Abstract Specification. Currently, the Abstract Specification is held in 14 volumes, organized by topics. For example, the "OGC Feature" is topic volume 5, the "Coverage Subtype" is Topic 6, and the "Earth Image" is topic volume 7. As these volumes mature, and fully describe the relationships and behaviours of the objects in their domains, they form the "requirements" statement in the RFP process. The proposals that result from this process nominate implementation-level specifications for the interfaces that provide access to the desired behaviours. A recent version of the complete set of Abstract Specifications is available from OGC.

The OGC develops consensus technology through the Request For Proposal (RFP) process. The OGC has a number of Working Groups and Special Interest Groups developing requirements and administering the RFP processes. Two of them are of interest from the perspective of objects and interfaces that support images, and gridded and raster objects.

The Coverage WG is responsible for RFP 5, "Access to OpenGIS Coverages" issued in April 1998. In this RFP, consensus object classes and interfaces are being sought to support the discovery, access, retrieval, display, and simple manipulation of gridded "coverage" objects such as orthophotos, elevation matrices, raster maps, and similar objects. The purpose of the Earth Imaging SIG is to refine the Open GIS Abstract Specification toward defining future standard interfaces for image use services.

The OGC "Coverage" is a subtype of the OGC "Feature" and inherits its interfaces. Another OGC object is "Earth Image", a subtype of "Coverage". In the Coverage Subtype topic volume, for example, several types of earth images are identified and distinguished.

The Abstract Specification includes a taxonomy of images based on the level of processing they have undergone.

The OGC is a Class A Liaison with ISO/TC 211, and a Class C Liaison with ISO/IEC JTC 1/SC 32/WG 4 on SQL/MM Spatial Extensions. OGC has expressed the commitment to the development and implementation of profiles of ISO standards that enable and support a vigorous and healthy marketplace for geospatial information and geoprocessing.

3.9 Private formats

A number of industry sponsored private formats are in wide use for picture coding. Some of these formats are based on patented technology such as GIF. Others such as TIFF are freely available, but are loosely controlled and are implemented inconsistently. Several of these are briefly mentioned below.

3.9.1 Fractal Transform Coding

Fractal Transform Coding is a patented image coding technique used by Microsoft in its multimedia products. The algorithm is based on the reconstruction of attractors in chaos theory and can achieve lossy compressions of up to 10,000 to 1,000,000:1.

3.9.2 The Graphic Interchange Format (GIF)

The Graphic Interchange Format (GIF) is a proprietary format developed by CompuServe that makes use of the patented LZW compression algorithm. Once broadly in use, its use has been limited since Unisys has begun to enforce its patent.

3.9.3 Photo Compact Disk

Photo Compact Disk is a proprietary format developed by Eastman Kodak Ltd. to store high quality continuous tone photographic images on a CD-ROM.

3.9.4 Portable Network Graphics (PNG)

Portable Network Graphics (PNG) is a public domain format developed by the World Wide Web Consortium (W3C) to counter the enforcement of the GIF patents. It is expected to replace both GIF and TIFF. It supports both colour mapped and true colour (RGB) images. It supports both gamma and chromaticity information to ensure proper colour rendering. This feature may be important for the proper rendering of Colours and Symbols according to IHO S-52. It provides lossless compression comparable to GIF.

3.9.5 Tag Image File Format (TIFF)

The Tag Image File Format (TIFF) is a proprietary format by Aldus Corporation. It defines Tags to identify several different types of coding and allows "private" tags for extension. Standard tags allow for LZW, Fax T.4 and T.6 and JPEG compression for monochrome, grey-scale, colour palette or true colour (RGB). The use of private tags and the number of optional coding types have lead to incompatible partial implementations.

The tag image file format (TIFF) is routinely used in electronic publishing for interchange of clip art, logotypes and scanned documents. Increasingly the TIFF format is used for the storage, interchange and display of geographic raster data. There are many optional TIFF tags available in the TIFF6.0 baseline which may be used for in-file image annotation. See subclause 3.1.2 for a related discussion on the internationally standarized TIFF/IT.

3.9.6 GeoTIFF

The GeoTIFF data interchange standard for raster geographic images is an extension of the TIFF format to support a geodetically sound raster data georeferencing capability. The use of private tags in TIFF has lead to the extension GeoTIFF, where private tags are introduced to support some geo-metadata and geo-referencing. The GeoTIFF format is quite common since people that have access to software that can view TIFF images can at least view the pixels from a GeoTIFF file ignoring metadata, registration, etc. The geographic content supported in GeoTIFF tag structure includes its cartographic projection, datum, ground pixel dimension, and other geographic variables. The aim of GeoTIFF is to allow means for tying a raster image to a known model space or map projection, and for describing those projections.

GeoTIFF is the product of collaboration among a number of imagery data users and suppliers. The work was initiated in the early 1990's by Intergraph and the Jet Propulsion Laboratory (JPL), and enhanced in 1994 by SPOT Image Corp. It is currently maintained by a mailing list of over 140 subscribers.

GeoTIFF is not intended to become a replacement for existing geographic data interchange or metadata standards, such as FGDC, USGS or ISO standards. Rather, it aims to augment an existing popular raster-data format to support georeferencing and encoding information which is compatible, in principle, with these standards, the National Spatial Data Infrastructure (NSDI) and other emerging international standards.

The GeoTIFF data structure is designed to meet the requirement of public domain, open, platform interoperable data standards for the transfer and storage of geographic raster imagery. While the baseline implementation is oriented toward ortho-imagery, the specification is extensible to encompass vastly more complex project or distorted imagery if so required by clients and users.

The format implements a cartographic and geodetic hierarchy which serves the purpose of ease of use and extensibility. It provides the ability of users to define private and customised projection spaces in addition to built in projected coordinate systems.

GeoTIFF is a simple format that essentially adds several geo-referencing tags to the popular, commercial TIFF format. The establishment of TIFF/IT as an ISO Standard for printing applications has strengthened GeoTIFF. However, if TIFF becomes a general JTC 1 Information technology standard this would be a further strengthening.

3.10 Mapping of existing imagery and gridded data standards to geographic information standards

In this section each of the existing imagery and gridded data standards is described with respect to the ISO/TC 211 work items, and the elements of those external standards that should be considered by the ISO/TC 211 project teams are identified. Based on input from experts on the various existing related standards, a cross-reference table identifying a number of characteristics that apply to each of these standards was developed. The table is a summary for informative purposes. It is not intended to be a complete description.

Table 3 — Cross-reference of characteristics of standards

Name	Liaison	Geo Content	Metadata	Encoding NOTE 3	Compression NOTE 3	Services	Data Model (object/entity relationship)	Interchange Format	Impact on ISO/TC 211
1	2	3	4	5	6	7	8	9	10
DIGEST	Y	Y	Y	E	R	N	N (not Raster)	Y	Y
IHO	Y	Y	Y	S	S	N	Y	Y	Y
IP-IIF	Y	N	SOME	S	R	N	N	Y	Y
BIIF	Y	Y NOTE 6	Y	S	R NOTE 7	N	N	Y	Y
NITF	Y	Y	Y	S	R NOTE 7	N	N	Y	Y
SQL/MM Image	Y	Y	N	N	N	Y	Y	N	Y
OGC	Y	Y	Y	E	NOTE 8	Y	Y	NOTE 9	Y
SC29 JBIG	N	N	Y	S	S	N	N	Y	Y
SC29 JPEG	N	N	Y	S	S	N	N	Y	Y
SC29 MPEG-2	N	N	Y	S	S	N	N	Y	Y
T4&T6	N	N	N	S	S	N	N	PART	N
TC130 TIFF	N	N	N	S	R	N	N	PART	N
GeoTIFF	N	Y	Y	S	R	N	N		Y
SDTS raster	N	Y	Y	R	R	N	Y	Y	Y
CEOS CIP	Y NOTE 10	Y	Y	R NOTE 11	N	Y	Y NOTE 11	Y NOTE 11	Y
CEOS Super Structure	Y NOTE 10	Y	Y	S	N	SOME	Y	Y	Y
HDF	N	N NOTE 12	Y	S	Y	Y	Y	Y	Y
HDF-EOS	N	Y	Y	S	Y	Y	Y	Y	Y

NOTE 1 “Impact” means that ISO/TC 211 should consider the standard identified as a source of requirements for ISO/TC 211 development. The standard may be referenced in the ISO/TC 211 development or effort may be expended to harmonize with it.

NOTE 2 There has been no effort to assess the level of authority of the various standards identified in the table. There is a range from proprietary standards and standards managed by a single government agency to ISO/IEC standards.

NOTE 3 Some of the Encoding and Compression methods identified in column 5 and 6 indicate that a standard specifies an encoding or compression method. Others simply reference external standards for the methods used. These are broken down into the following : R – references specification, S – contains specification, N – none, and E – provides instructions on how to apply external specifications.

NOTE 4 Column 7 indicates that the referenced standard specifies services. The DIGEST standard doesn’t directly specify services, but the DGIWG committee responsible for DIGEST has developed a suite of services to support DIGEST.

NOTE 5 Column 8 indicates that the standard is supported by a conceptual schema written in a conceptual schema language.

NOTE 6 BIFF uses the Geo Content from DIGEST Annex D

NOTE 7 This standard allows many formats, including JPEG and VQ.

NOTE 8 OGC has not yet specified any particular compression service, but such specifications are expected as progress is made in the Image Exploitation Working Group of OGC.

NOTE 9 The focus of OGC, relative to exchange formats, has been upon structures that support the dynamic exchange of feature information between client and (a potentially remote and heterogeneous) server during an interactive session.

NOTE 10 CEOS WGISS is in the process of developing a Class Liaison

NOTE 11 Metadata only

NOTE 12 The format allows users to put in the Geo Contents.

4 Components of image and gridded data

Unlike vector data a raster exchange format is very simple. It consists of the following basic parts:

- Picture Elements (PIXELS) or Cells;
- Metadata about the Raster data sets (including Source and Quality information);
- Spatial Registration information;
- A method of Encapsulation and Coding.

Certain basic parameters or a small choice of parameters can be standardized for each of these elements, except perhaps the encapsulation and coding. There currently exists a strong similarity between the various existing formats on most of these points. Each of the following sub-sections presents the components that should be supported by the ISO 19100 series of geographic information standards.

4.1 Picture elements of cells

The coverage function maps from a spatial domain to an attribute domain. There are different types of coverage function distributions. A regular array of picture elements in a rectangular area is the simplest. Others are a set of irregularly spaced points, a set of lines, a Triangulated Irregular Network (TIN) etc. The coverage distribution function is a tessellation of a space.

A raster is a distribution of an attribute over a geometry in the spatial domain and is a simple type of coverage function. The geometry may be a simple rectangular area, or it may be an area of more complex shape, such as an irregular polygon.

Each position of a raster coverage function is assigned an attribute value. The value may be at the point corresponding to the position in the geometry (for instance DEM), or it may be the value representing the area surrounding the point (for instance census data). These two types of data have both common character and different character.

Attribute values distributed over the space may contain information as collected by an imaging or other sensor, and as such form an image. Attribute values may also contain other calculated or measured information such as elevation data, tidal harmonic parameters etc. When the elements of a coverage function correspond to the elements of an image, they are termed pixels. More generally, all of the elements of a tessellation are called cells.

Some of the basic parameters of a raster are the number and size of cells. The number of cells (or pixels) is dependent on the resolution of the tessellation. For an image, the number of pixels is dependent on the size of the area covered and the resolution of the scanner or sensor.

Another basic parameter is the domain of the attribute distributed by the coverage function. For an image this is the "depth" of the pixel values as determined by the set of values that each pixel can take. Parameters of both the same dimension (shape and size of the coverage functional area) and depth types exist for synthetic images, as for scanned images. The difference is that synthetic images tend to have less "depth".

There are two fundamentally different ways in which pixels can represent image colours (or grey scales). These are "direct colours" where each pixel takes on a Red, Green and Blue value and "indirect colours" where a colour palette is used. For direct colours, often there are 8 bits of red, 8 bits of green and 8 bits of blue, which allows for over 16 million possible colour grey scale combinations. Adjacent pixels may take on subtly different colours, and "soft" gradations are possible from one solid colour to another. Colour palettes are typically limited to a small maximum number of colours such as 64. "Soft" gradations from one colour to another are difficult to achieve when using a colour palette because one soon runs out of intermediate colour values.

The coverage distribution function defines the spatial organization or arrangement of the tessellation cells, which is essentially a discrete coordinate system that may be mapped to an underlying continuous coordinate system. A traversal mechanism maps data values to cells. The most common organization is for equal size cells structured in terms of rows and columns; however, there are many other possible organizations. A space-filling curve traverses a cell organization. Some even traverse non-uniform sized cells (or pixels). See annex A.

4.2 Metadata

Metadata is the information that describes data. It is as important as the image or gridded data itself, since it is nearly impossible to interpret an image or gridded data set without knowing what it is and what the attributes mean.

There is a significant amount of metadata information already included in the ISO 19115, *Geographic information — Metadata*, addressing image and gridded data sets. In addition each of the referenced external standards also addresses metadata to varying degrees.

Certain aspects of metadata are specific to image and gridded data. With respect to remote sensing, image data are more often acquired by instruments that make physical measurements (as opposed to photographic systems) with spectral, radiometric, and geometric characteristics, as well as polarimetric characteristics in some cases. Information specifying accuracy and uncertainty in these image products is essential. The most fundamental image characteristics requiring product standards in remote sensing are radiometric calibration uncertainty and geolocation accuracy. In other words, how uncertain is the intensity attributed to a given pixel and how well known is the three-dimensional location of that pixel on the surface of the earth.

Depending on the imaging system and product application, other important image benchmarks include spatial resolution, spatial sampling, modulation transfer function, contrast, sensitivity, signal-to-noise ratio, spectral response, spectral resolution, spectral sampling, and general image quality performance criteria. Related processing considerations as applicable include fidelity of data dissemination; processing algorithm and software correctness; output device considerations (e.g., artifacts and test patterns); and operating environment (e.g., electronic interference and moisture conditions).

Annex B of this report contains a table of metadata elements extracted from ISO CD 19115. This is intended to be a representative list for review, and not a comprehensive list. It is important that metadata elements for raster and gridded data be included in the ISO/TC 211 metadata list. Certain aspects of metadata are very specific to particular sensors. Data describing a sensor model can be included as metadata using the extension mechanism defined in ISO 19115.

4.3 Spatial registration

One of the most important aspects of an image or gridded data set is the information that describes precisely the real location of the image. There are many factors involved, ranging from lens or other distortions in the sensors, to the geometry of the position of the scanner, to the geodetic parameters used to describe the earth. All of these items may be represented as metadata, but they deserve separate consideration due to their importance with respect to image and gridded data sets. Registration is also important for scanned paper and REPMAT image files since there are inherent errors, such as skew, in scanners.

A sensor model is very specific to a particular class of sensors. Often these are unique and are sometimes confidential. The distortions inherent in the sensor model must be described as part of the pixel registration.

A geometry model is needed to describe how the sensor, (camera, scanner, etc.) views the world. It is very unusual for a sensor to be looking straight down on its target. Oblique angles and other geometric factors must be compensated. There are a number of ways that this is accomplished. The OGC Topic 7 Report 98-107 describes "The Earth Imagery Case".

Georeferencing parameters must also be included, to "identify where the earth is". The ISO/IEC DIS 12087-5 BIFF standard makes use of the georeferencing components defined in the DIGEST STANAG 7074. Similar predefined lists of geodetic parameters, such as grids, ellipsoids, datums, and projections are required as part of the ISO 19100 series of geographic information standards or as registered profiles.

4.4 Encapsulation and coding

The current work on the 19118, *Geographic information — Encoding* is developing a neutral exchange format based on the instantiation of models using the eXtensible Markup Language (XML). This provides a universal base for exchange of all geographic information. This technique can be applied to imagery and gridded data, however many other encoding schemes may also need to be considered. One of the principle characteristics of imagery and gridded data is that there is a large number of similar "picture elements" or "grid elements". Some efficiency is needed in handling these elements to avoid enormously large data sets. There exist several ISO standards in JTC 1 for picture coding and the support of imagery for different classes of images (see subclause 3.1.1).

The rationale for using different ISO standardized encodings is to provide efficient exchange in different situations. An encapsulation standard designed for efficient communications is quite different from the one that is used for archival purposes or the ones that are designed to be directly human readable. The main principal that needs to be followed with respect to encapsulation and coding is the seperation of « carrier and content ». The content is the information or data, and the carrier is the method by which it is delimited and encoded. Different encapsulation and coding techniques may be used to carry the same data as long the encapsulation and encoding method is robust enough to support the data. The format effects the message , but it is not the message.

The stage 0 preparatory work should investigate the use of Extensible Markup Language (XML) as a neutral encoding for imagery and gridded data information. It should also identify how other encoding techniques can be used to handle attributed picture or grid elements using JTC 1 picture coding standards within a XML environment.

ISO/TC 211 should also investigate the support of multiple equivalent encodings of image and gridded data for use in different situations in alignment with the work on imagery and gridded data in other standard committees. The principal encoding standards are identified as potential sub-components in the next section of this report.

5 Interaction with other standards

Some of the external standards, such as the work of ISO/IEC JTC 1/SC 29 on picture coding, largely support the work of ISO/TC 211; that is, the standards are being developed for a wider community and they also satisfy requirements of the geographic community in relation to imagery and gridded data. These standards should be incorporated as normative references in the work of ISO/TC 211. Other external standards, such as the work of DGIWG and IHO will influence the work of ISO/TC 211, so that existing data products such as the DIGEST raster data products can be described in terms of ISO 19100 series elements. These standards should be considered as sources of requirements for the work of ISO/TC 211. Other work of external standard bodies partially or substantially overlaps the work of ISO/TC 211. In these cases it is necessary to cooperate with the external agency to ensure that there is harmonization. The major external influence of this type is ISO/IEC JTC 1/SC 24 Computer graphics and image processing.

The work of ISO/TC 211 on imagery will fit within the scope of this other ISO group on general image interchange. This group has already harmonized its standard with DIGEST, and similar harmonization work is needed with ISO/TC 211. The ISO/IEC JTC 1/SC 32 group on SQL/MM is nearly finished the development of a standard for image retrieval from databases. This work is also of great importance to ISO/TC 211 and will need to be harmonized. The work of the OGC on its Coverages model is of significant importance to part of the work of ISO/TC 211. The development of schemas for raster data in WG 2 should make use of the OGC specification along with other external influences. This should be done in cooperation with OGC. The influence from the satellite community is significant. Standards such as CEOS are in broad use in the satellite community. The issues of common interests need to be discussed.

5.1 Subcomponents

The ISO 19100 series of geographic information standards will define components that can be assembled in the form of profiles to create specific exchange formats. All of the standards listed below are, or include, methods for encoding imagery and gridded data. They should be included as references in ISO 19118, *Geographic information — Encoding* so that they can be used as components for profiles.

— ISO/IEC 12087-5 BIFF provides an encoding for image exchange.

— ISO/IEC 10918-4 JPEG, ISO/IEC 11544 JBIG and potentially ISO/IEC 13522 MPEG and ISO/IEC 13522 MHEG are purely image encoding standards that can be referenced as sub-components.

— ISO 12639 TIFF/IT is a coding standard for image data. It is intended for prepress digital data for printing, which is of direct interest for the printing of maps. It is also a partial establishment of the commercial TIFF specification as an ISO standard and is therefore of great significance.

— STANAG 7074 DIGEST provides, among other information, several encodings for image exchange. Product specifications under DIGEST select one of the encoding methods.

— The EOSDIS extension of the Hierarchical Data Format (HDF-EOS) has an encoding model for image data.

— ITU-T T.4 and T.6 are bit level encoding formats for synthetic image data that have been defined for use in facsimile. They are especially useful for line drawing map images.

— Several of the private encoding formats, Fractal Coding, GIF, Photo Compact Disk, PNG, and TIFF can be used as sub-components for encoding.

— The GeoTIFF is an extension of TIFF, that can be used to encode image data, but it also includes other information.

5.2 Profiles

Several of the external image and gridded data standards are more specific or product oriented than ISO/TC 211, and can be represented as profiles of the ISO 19100 series components. Elements of the ISO/TC 211 family of standards need to be specified in such a way as not to preclude the future development of these standards as profiles. These include:

— STANAG 4545 NSIF is being developed as a profile of the ISO 12087-5 BIFF standard. It can also be made a profile of the ISO 19100 series of geographic information standards.

— DIGEST is a product-oriented standard that contains detailed content information about image and gridded data, including georeferencing. The DGIWG has indicated that they intend to develop the next version of DIGEST using ISO 19100 series components.

— IHO-S57 is also a product oriented standard that can be developed as a profile of ISO 19100 series components. The IHO-S57 raster and matrix data section is currently under development. This should be done cooperatively with ISO/TC 211 to ensure commonality.

— The CEOS set of standards defines detailed content information about image and sensor data (metadata) that must be supported in the ISO 19100 series components.

— The EOSDIS format contains detailed content information about image and sensor data (metadata) that must be supported in the ISO 19100 series components.

— The SDTS Raster profile and the general SDTS standard is largely comparable to the ISO 19100 series of geographic information standards. As such there is a significant need for review and alignment between these standards. The ISO 19100 series of geographic information standards can be thought of as a more generalized SDTS. The SDTS Raster profile can be framed as an ISO/TC 211 profile.

5.3 Alignment with overlapping standards

Several of the existing and external standards are at the same level or partially at the same level as the ISO 19100 series of geographic information standards, and provide important influences for the development of these standards. In some cases only a part of the external standard may be at the same level as a ISO 19100 series component standard and only some of the ISO 19100 series components may be influenced.

- ISO 12087-5 BIFF provides structures for image data that should influence ISO/TC 211 development. The STANAG 4545 NSIF provides detailed content information that must be accommodated in ISO/TC 211; i.e., it must be able to carry this information via ISO 19100 series components.

- ISO 13249 SQL/MM-Part 5 Still Image defines a mechanism for the storage and retrieval of image data in databases. The content of that data can be defined in terms of ISO 19100 series components; the form can be defined in terms of SQL/MM data types and functions. A particular application could be represented as a profile of ISO 19100 series components and utilizeSQL/MM data types and functions.

- The "Coverages" and "Image Exploitation Services" topics of the OGC Abstract Specification are closely related to the work proposed for ISO/TC 211. Although the end goal of the OGC work is to publish implementation specifications, OGC intends to base these on abstract models that are tightly aligned with ISO/TC 211 standards.

6 Plan to address imagery and gridded data in ISO/TC 211 work items

The plan developed in this report identifies additional work to be done to address imagery and gridded data. Rather than delaying the progress of the other work items in ISO/TC 211 it is proposed to produce a New Work Item at the Preparatory Stage 0 which will prepare the details for the various aspects of imagery and gridded data. These elements may be added to existing ISO 19100 series of geographic information standards through the route of Technical Amendment or in some cases new standards may be developed.

As part of a survey of the project leaders of the current Work Items in ISO/TC 211 it was found that all work items are influenced to some extent by Imagery and Gridded data; however, for some the effect is minor. Other work items may require the development of entire new sections for their standards. In some cases new standards may be required.

It is proposed to add references to image and gridded data to ISO 19101, *Geographic information — Reference model* and 19102*, Geographic information — Overview* within the current scope and time frame of work on these geographic information standards. Some additional terms will be contributed to 19104, *Geographic information — Terminology* within the current scope and time frame for this work item; however, additional terms will be added, possibly as part of a Technical Amendment, when the work on imagery and gridded data is nearly finalized.

In all cases – the development of a Technical Corrigenda to an existing standard, the development of a Technical Amendment, or the development of a new standard – a New Work Item proposal is required. This New Work Item proposal would include as part of the preparatory work identified in the proposal an extract from the appropriate sections of the Preparatory Stage 0 document for imagery and gridded data.

With respect to the spatial schema required for imagery and gridded data, this will require a new work item proposal to develop a new standard within geographic information. The OGC has already issued a Request For Proposals (RFP) for the development of an industrial specification based on material currently in the OGC Abstract Specification for raster and grid "coverages". This work is of high priority with respect to the support of imagery and gridded data. A new work item is required for spatiotemporal geometry. It will define constructs that will be useful for describing the structure of imagery and gridded data.

6.1 Impact on existing work items

The following list identifies which of the existing geographic information standards are impacted and identifies where additional work is required to address imagery and gridded data.

19101:	Reference model	add to work program within its current scope and time frame
19102:	Overview	add to work program within its current scope and time frame
19103:	Conceptual schema language	no impact
19104:	Terminology	add to work program within its current scope and time frame
19105:	Conformance and testing	no impact

19106:	Profiles	no impact
19107:	Spatial schema	propose a New Work Item to address additional work
19108:	Temporal schema	propose a New Work Item to address additional work
19109:	Rules for application schema	develop elements as part of Stage 0 preparatory document
19110:	Feature cataloguing methodology	refer to Stage 0 work item for determination
19111:	Spatial referencing by coordinates	refer to Stage 0 work item for determination
19112:	Spatial referencing by geographic identifiers	no impact
19113:	Quality principles	develop elements as part of Stage 0 preparatory document
19114:	Quality evaluation procedures	develop elements as part of Stage 0 preparatory document
19115:	Metadata	develop elements as part of Stage 0 preparatory document
19116:	Positioning services	refer to Stage 0 work item for determination
19117:	Portrayal	develop elements as part of Stage 0 preparatory document
19118:	Encoding	develop elements as part of Stage 0 preparatory document
19119:	Services	develop elements as part of Stage 0 preparatory document
19120	Functional standards	contribute to maintenance of functional standards report including new information on imagery and gridded data

6.2 New work required

The new work on imagery and gridded data will require input from experts from each of the ISO/TC 211 Working Groups as well as additional input from new experts familiar with the practise in handling imagery and gridded data. The following table (Table 4) illustrates where this new input is needed.

Table 4 — Proposed new areas of work

New area of work	**WG**	**New area of work**
(closest existing current standard)		
19107	2	Schema for coverage geometry and functions
19108	2	Spatiotemporal geometry
19109	2	Rules for application schema for coverage functions
19110	3	Cataloguing for image and gridded data
19111	3	Spatial referencing for imagery and gridded data
19113 & 19114	3	Quality & quality evaluation for imagery and gridded data
19115	3	Metadata elements for imagery and gridded data
19116	4	Position services for imagery and gridded data
19117	4	Visualisation of imagery and gridded data
19118	4	Encoding elements for imagery and gridded data
19119	4	Image exploitation services

NOTE 1 The work on Schema for coverage geometry and functions and Spatiotemporal geometry will be handled by New Work Item Proposals developed in WG 2.

NOTE 2 The other areas of new work will be handled in a Stage 0 preparatory document developed by the Raster and gridded data project team with input from other project teams.

NOTE 3 There may also be a need for a new area of work on Reference System Transformation Services for Imagery. This would also be handled as part of the Stage 0 preparatory document.

The New Work Item (NWI) on Schema for coverage geometry and functions, to be handled by Working Group 2, will address the requirements of imagery and gridded data, as well as other requirements for different types of coverage function data, such as Triangular Irregular Networks (TINs), etc. This will be done in cooperation with the OGC.

Annex C provides additional information regarding the new work required.

Annex A
(informative)

Cell organization

Mathematics provides us with a number of space filling curves, some simple and some complex. The properties of these space filling curves should define the constraints on a raster/matrix coverage function. If a simple rectilinear scan is used to fill a space (the common case), then the raster/matrix coverage function will, by necessity, be built out of evenly sized raster cells of the same size and shape enclosed in a rectangular array. If other more complex space filling curves are used then irregular spaced areas and/or variable sized raster cells may be used.

The following are examples of space filling curves that can generate a raster:

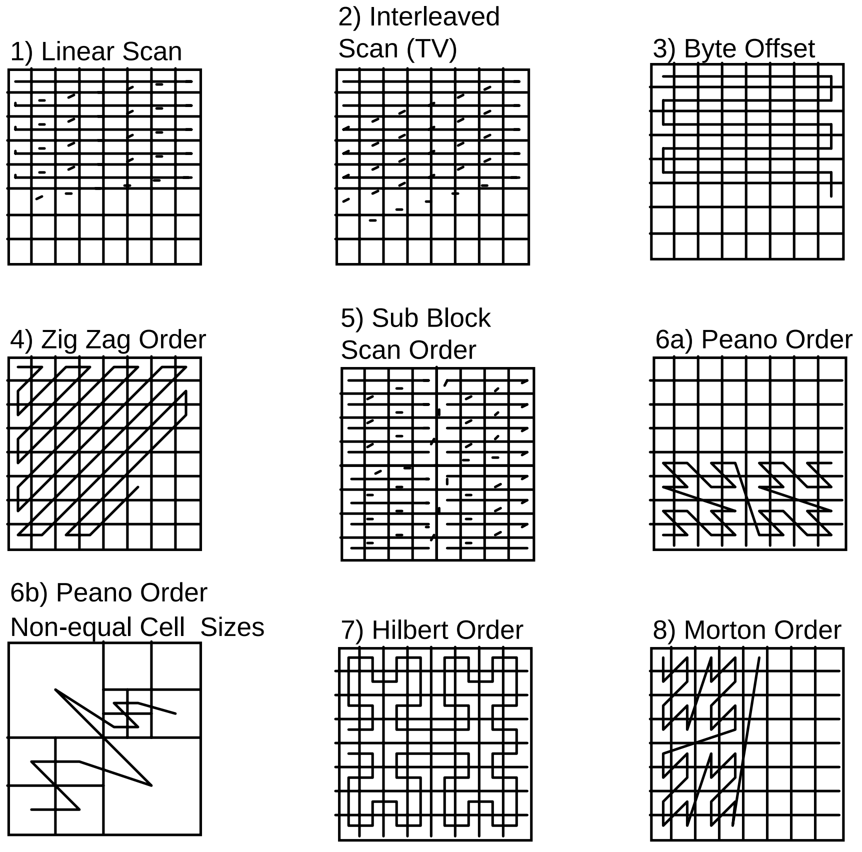
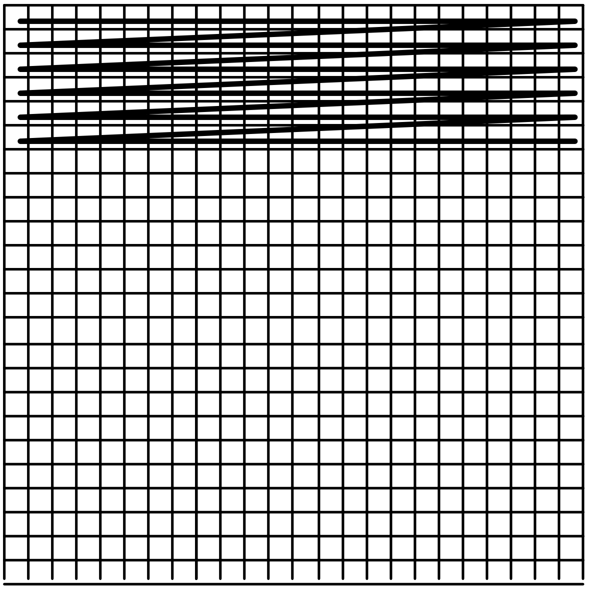


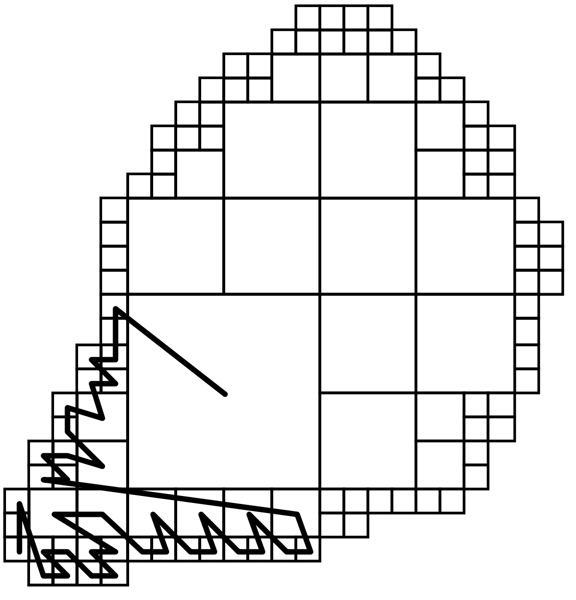
Figure A.1 — Examples of space filling curves

Other space filling curves may also be defined. The curves 1 to 4 generate raster patterns with raster cells that are the same size. The curve 5 defines a number of sub blocks each of which are scanned using a linear scan. If a sub block is of a constant pixel value it can be skipped and replaced by a single value representing the whole block. This technique is used in some DIGEST Functional Standard raster products. Curves 6 to 8 permit variable sized raster cells. This permits the representation of Quadtrees and Octtrees.

The shape of a raster/matrix coverage function may be rectangular or it may be some other arbitrary shape that may be covered by a particular space filling curve. For example, a conventional raster is a linear scan in a rectangular area. A Peano order scan permits a quad tree to cover an arbitrary shaped area. This is illustrated below.



Linear Scan on a Rectangular Area



Peano Order Scan on an Irregular Convex Area

Figure A.2 — Order of scan

The coordinate system for the raster/matrix coverage functional area is defined by the characteristics of the space filling curve. A linear scan in two dimensions generates a set of row, column coordinates. The coordinates for other space filling curves result from those curves.

Annex B
(informative)

Metadata

Table B.1 — Spatial data representation information definitions

	Name	**Identifier**	**Definition**	**Obligation/ Condition**	**Maximum occurrence**	**Data type**	**Domain**
1	Raster spatial representation information	40.03	Types and numbers of raster spatial objects in the dataset	C/ type equals raster ?	N	Metadata entity	Lines 8-27
2	Raster object type code	40.03.01	Raster spatial objects used to locate zero-, two-, or three-dimensional locations in the dataset	M	1	integer	1- matrix values 1- matrix coded 2- pixel RGB 3- pixel codes 4- pixel HIS
3	Origin of pixels	40.03.02	Location of pixel 1,1	O	1	string	free text (example NW corner)
4	Row count	40.03.03	Maximum number of raster objects along the ordinate (y) axis	O	1	integer	Row count > 0
5	Column count	40.03.04	Maximum number of raster objects along the abscissa (x) axis	O	1	integer	Column count > 0
6	Vertical count	40.03.05	Maximum number of raster objects along the vertical (z) axis	O	1	integer	Depth count > 0
7	Raster scan resolution x direction unit code	40.03.06	Units used to express data density along the X axis	C/ scan resolution x direction provided	1	integer	5- inch 6- millimetres
8	Raster scan resolution x direction	40.03.07	Data density along x axis expressed in pixel per unit Ex.: 400	O	1	integer	pixel/unit
9	Raster scan resolution y direction unit code	40.03.08	Units used to express data density along the Y axis	C/ scan resolution y direction provided	1	integer	1- inch 2- millimetres
10	Raster scan resolution y direction	40.03.09	Data density along y axis expressed in pixel per unit Ex.: 400	O	1	integer	pixel/unit
11	Raster object value units code	40.03.10	Unit of value of each cell/point in matrix	O	1	integer	1- feet 2- meters 3- RGB value 4- HIS value 5- enumerated code
12	Raster object code description	40.03.11	Description of the attribute described by the measurement value	O	1	string	free text
13	Raster pixel colour description	40.03.12	Description of the colour values of pixel	O	1	string	free text
14	Raster object ground spacing x direction units code	40.03.13	Units of measurement used to describe the distance	O	1	integer	1- feet 2- meters 3- minutes of arc 4- seconds of arc

Table B.1 *(continued)*

	Name	Identifier	Definition	Obligation/ Condition	Maximum occurrence	Data type	Domain
15	Raster object ground spacing x direction measurement	40.03.14	Distance between raster objects in ground space in the x direction	O	1	real	Real
16	Raster object ground spacing y direction units code	40.03.15	Units of measurement used to describe the distance	O	1	integer	5- feet 6- meters 7- minutes of arc 8- seconds of arc
17	Raster object ground spacing y direction measurement	40.03.16	Distance between raster objects in ground space in the y direction	O	1	real	Real
18	Raster object ground spacing z direction units code	40.03.17	Units of measurement used to describe the distance	O	1	integer	9- feet 10- meters 11- minutes of arc 12- seconds of arc
19	Raster object ground spacing z direction measurement	40.03.18	Distance of raster objects above ground space in the z direction	O	1	real	Real
20	Tone gradation	40.03.19	Number of colours or greyscales present in the image	O	1	Integer	Integer
21	Bits per pixel per band	40.03.20	Maximum number of significant bits for the value in each band of each pixel without compression	O	1	Integer	Integer
22	Image spatial representation information	40.04	Information about the image used to represent geographic information	C/ type equals image ?	N	Metadata entity	Lines 29-50
23	Image identifier	40.04.01	Unique Identifier for an image within a dataset	C/title defines a series of images?	1	string	free text
24	Image type	40.04.02	Identifies the general kind of image represented by the data	M	1	string	free text–Examples: visible, hyperspectral, multispectral, infrared, thermal infrared, radar
25	Focal length	40.04.03	Focal length of the lens in millimetres	O	1	real	Real
26	Sun elevation angle	40.04.04	Sun elevation measured in decimal degrees from the target plane at intersection of the optical line of sight with the earth's surface	O	1	real	0 – 90
27	Sun azimuth angle	40.04.05	Sun azimuth measured in decimal degrees clockwise from true north at the time the image is taken	O	1	real	0.00, 359.99
28	Obliquity angle	40.04.06	Angle off vertical of image in decimal degrees	O	1	real	Real
29	Image orientation angle	40.04.07	Angle from the first row of the IMAGE to true North in decimal degrees	O	1	real	0 – 360

Table B.1 *(continued)*

	Name	Identifier	Definition	Obligation/ Condition	Maximum occurrence	Data type	Domain
30	Imaging condition code	40.04.08	Indicates conditions which affect the quality of the image	O	1	integer	13- blurred image 14- heavy smoke or dust 15- night 16- degrading obliquity 17- rain 18- semi-darkness 19- shadow 20- snow 21- terrain masking 22- cloud 23- fog
31	Image quality rating system	40.04.09	Rating system on which the Image Quality Code is based	O	1	string	free text
32	Image quality code	40.04.10	Specifies the image quality	O	1	string	free text
33	Radiometric data availability code	40.04.11	Indicates whether or not Standard Radiometric Product data is available	O	1	integer	24- no 25- yes
34	Image exploitation support data availability code	40.04.12	Indicates whether or not Image Exploitation Support Data (ESD) is available such as position and attitude information	O	1	integer	0-no 1-yes
35	Cloud cover percentage	40.04.13	Area of a dataset obscured by clouds, expressed as a percentage of the spatial extent	O	1	real	0.0 <= cloud cover <= 100, unknown
36	Pre-processing type code	40.04.14	Image distributor's code that identifies the level of radiometric and geometric processing applied against the image	O	1	string	free text–Examples: "LEVEL1A", "LEVEL1B", "SPOTVIEWORTHO", "SPOTVIEWPRECISIO"
37	Mean ground sample distance (gsd)	40.04.15	Geometric mean of the across and along scan center-to-center distance between continuous ground samples in meters	O	1	real	Real
38	Compression generation quantity	40.04.16	Counts the number of lossy compression cycles performed on the image	O	1	Integer	Integer
39	Triangulation indicator code	40.04.17	Indicates whether triangulation has been performed upon the image	O	1	integer	26- no 27- yes
40	Ground-to-image coefficient availability code	40.04.18	Indicates if Ground-to-Image coefficients are available and contained within the product data	O	1	integer	0-no 1-yes
41	Image sensor time	40.04.19	The precise time image was captured in the sensor's time system	O	1	real	Real
42	Sensor name	40.04.20	Identifies the name of the SENSOR used in capturing the image	O	1	string	free text
43	Sensor category	40.04.21	Identifies the specific category of imagery	O	1	string	free text

Table B.1 *(continued)*

	Name	Identifier	Definition	Obligation/ Condition	Maximum occurrence	Data type	Domain
44	Sensor mode	40.04.22	Identifies the sensor mode used in capturing the image	O	1	integer	free text–Examples: FRAMING PUSHBROOM SPOT SWATH WHISKBROOM
45	Sensor band information	40.05	Set of adjacent wavelengths in the electro-magnetic spectrum with a common characteristic, such as the visible band	O	N	Metadata entity	Lines 52-57
46	Sensor band sequence identifier	40.05.01	Number that uniquely identifies instances of bands of wavelengths on which a sensor operates	O	1	string	free text
47	Sensor band high wavelength	40.05.02	Highest wavelength that the sensor is capable of collecting within a designated band in meters	O	1	real	Real
48	Sensor band low wavelength	40.05.03	Lowest wavelength that the sensor is capable of collecting within a designated band in meters	O	1	real	Real
49	Camera calibration information availability code	40.05.04	Are constants available which allow for camera calibration corrections	O	1	integer	28- no 29- yes
50	Film distortion information availability code	40.05.05	Is Calibration Reseau Information Available	O	1	integer	0-no 1-yes
51	Lens distortion information availability code	40.05.06	Is Lens Aberration Correction Information Available	O	1	integer	0-no 1-yes

Annex C
(informative)

New areas of work supporting imagery and gridded data

1. **Schema for coverage geometry and functions** – New Work Item for development of a new standard by ISO/TC 211.

Define the schemas related to coverage function geometry that support the establishment of data standards for geographic information image and gridded data. Provide the definition of the principles for describing raster geometry schemas (i.e., pixel, raster band, and grid) for defining imagery and gridded data requirements that influence or support the establishment of standards for geographic information.

2. **Spatiotemporal geometry (including Spatiotemporal for Coverage function geometry)** – New Work Item for development of a new standard by ISO/TC 211.

Define a schema for describing the geometry of geographic features and coverage functions using coordinates in both space and time.

3. **Rules for application schema for coverage function data** – To be handled in Stage 0 Preparatory document

Define the rules for creating an application schema, including the principles for classification of geographic objects and their relationships to an application schema, for coverage data. These rules influence or support the establishment of raster and matrix data standards for describing the spatial characteristics of geographic information in terms of coverage functions.

4. **Aspects of cataloguing for imagery and gridded data** – To be handled in Stage 0 Preparatory document

Determine whether there are any requirements on cataloguing derived from the introduction of imagery and gridded data types.

5. **Spatial referencing for imagery and gridded data** – To be handled in Stage 0 Preparatory document

Develop conceptual schemas for describing imagery and raster coordinate reference systems, particularly those related to orbital parameters and satellite frames of reference.

6. **Quality and quality evaluation procedures for imagery and gridded data** – To be handled in Stage 0 Preparatory document

Define the schema for the description of image quality and gridded data quality, and develop guidelines for the methods of specifying/evaluating quality that influence or support the establishment of imagery and gridded data standards for geographic information.

7. **Metadata elements for imagery and gridded data** – To be handled in Stage 0 Preparatory document

Define additional metadata elements, as required, to address imagery and gridded data.

8. **Coordinate transformation services for imagery and gridded data** – To be handled in Stage 0 Preparatory document

Define the conceptual schema and guidelines for describing transformations of raster and grid coordinates into geodetic reference system co-ordinates for imagery and gridded data.

9. **Visualisation for imagery and gridded data** – To be handled in Stage 0 Preparatory document

Define a schema for the portrayal of raster data in a form understandable by humans that influence or support the establishment of imagery and gridded data standards for geographic information.

10. **Encoding for imagery and gridded data** – To be handled in Stage 0 Preparatory document

Identify the encoding techniques available for handling imagery and gridded data with particular emphasis on the use of image and picture coding standards developed in other parts of ISO.

11. **Image exploitation services** – To be handled in Stage 0 Preparatory document

Identify and define the service interfaces used for image data and gridded data and definition of the relationship to the Open Systems Environment model that influence or support the establishment of imagery and gridded data standards for geographic information.

Annex D
(informative)

Acronyms

ANSI	American National Standards Institute
API	Application Programming Interface
ARCS	Admiralty Raster Chart Standard
ASCII	American Standard Code for Information Interchange
BIIF	Basic Image Interchange Format
BNSC	British National Space Center
CCRS	Canada Centre for Remote Sensing
CEO	Center of Earth Observation
CEOS	Committee on Earth Observation Satellites
CEOS-WGD	Committee on Earth Observation Satellites – Working Group on Data
CGM	Computer Graphic Metafile
CIP	Catalogue Interoperability Protocol
DEM	Digital Elevation Models
DGIWG	Digital Geographic Information Working Group
DIGEST	Digital Geographic Information Exchange Standard
DIS	Draft International Standard
DLR	Deutsche Forschungsanstalt fur Luft-und Raumfahrt
ECS	EOSDIS Core System
ENC	Electronic Nautical Chart
EOS	Earth Observation System
EOSDIS	EOS Data Information System
ERS	European Remote Sensing Satellite
ESA	European Space Agency
FDIS	Final Draft International Standard
FGDC	(US) Federal Geographic Data Committee

FTP	File Transfer Protocol
GIF	Graphic Interchange Format
GILS	Government Information Locator Service
GIS	Geographic Information System
HDF	Hierarchical Data Format
ICS	Interoperable Catalogue System
IEC	International Electrotechnical Commission
IHO	International Hydrographic Organization
IIF	Image Interchange Facility
IPI	Image Processing and Interchange
ISO	International Organization for Standardization ("iso" = Greek for "same")
ISP	International Standardized Profile
IT	Image Technology
ITU	International Telegraphic Union
JBIG	Joint Binary Images Group
JERS	Japanese Earth Resources Satellite
JFIF	JPEG File Interchange Format
JPEG	Joint Photographic Experts Group
JTC	Joint Technical Committee
LANDSAT	Land Satellite (US)
LTWG	Landsat Technical Working Group
LGSOWG	Landsat Ground Station Operators Working Group
MHEG	Multimedia/Hypermedia information Coding Experts Group
MOS	Marine Observation Satellite (Japan)
MPEG	Moving Pictures Expert Group
MTPE	Mission To Planet Earth
NASA	(US) National Aeronautics and Space Administration
NASDA	National Space And Development Agency of Japan
NATO	North Atlantic Treaty Organisation
NOAA	National Oceanic and Atmospheric Administration (US)

NSDI	(US) National Spatial Data Infrastructure
NITF	(US) National Imagery Transmission Format
NSIF	NATO Secondary Imagery Format
OGC	Open GIS Consortium
OSI	Open Systems Interconnection
PIKS	Programmer’s Imaging Kernel System
PIXELS	Picture Elements
PNG	Portable Network Graphics
PTT	Protocol Task Team
RADARSAT	Radar Satellite (Canada)
RGB	red, green, blue
REPMAT	Reproduction Material
RFP	Request For Proposal
RNCP	RasterNautical Chart Products
RNCPS	RasterNautical Chart Product Specification
SAR	Synthetic Aperture Radar
SC	Sub-Committee
SDTS	Spatial Data Transfer Standard
SPOT	Satellite Pour l’Observation de la Terre (France)
SQL	Structured Query Language
SQL/MM	SQL/ Multi-Media
SRPE	SDTS Raster Profile and Extension
STANAG	(NATO) Standardization Agreement
TC	Technical Committee
TIFF	Tag Image File Format
TIFF/IT	Tag Image File Format for Image Technology
TSMAD	Transfer Standard Maintenance And Development
UK	United Kingdom
US	United States
XML	eXtensible Markup Language

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