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Information technology — Computer graphics and image processing — Image Processing and Interchange (IPI) — Functional specification — Part 3: Image Interchange Facility (IIF)

Technologies de l'information — Infographie et traitement de l'image — Traitement de l'image et échange (IPI) — Spécification fonctionnelle —

Partie 3: Accessoires pour l'échange d'images (IIF)

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Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees, established by the respective organization, to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work.

In the field of international technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

International Standard ISO/IEC 12087-3 was prepared by the Joint Technical Committee ISO/IEC JTC 1, *Information technology*.

ISO/IEC 12087 initially consists of three parts, under the general title *Information technology — Computer graphics and image processing — Image Processing and Interchange (IPI) — Functional specification*:

- *Part 1: Common architecture for imaging*
- *Part 2: Programmer's imaging kernel system application program interface*
- *Part 3: Image Interchange Facility (IIF)*

Annex A forms an integral part of this part of ISO/IEC 12087. Annexes B to G are for information only.

Introduction

ISO/IEC 12087-1 establishes the conceptual and architectural framework for ISO/IEC 12087. In particular, it defines the types of all image data objects, image-related data objects, and attributes that may be interchanged by means of the IPI-IIF.

ISO/IEC 12087-2 establishes the specification of the Programmer's Imaging Kernel System (IPI-PIKS).

ISO/IEC 12087-3 provides a data format specification and an application program interface specification. The IIF data format may be used for image data interchange in open, heterogeneous environments. It may also serve as a local file format for imaging applications, especially in conjunction with ISO/IEC 12087-2. In future, the IIF data format could be used by telecommunication standards. Examples are future versions of File Transfer, Access, and Management (FTAM), ISO/IEC 8571; the Message Oriented Text Interchange Systems (MOTIS), ISO/IEC 10021 (also known as Message Handling System (MHS), CCITT Recommendation X.400). Thus the IIF data format could become part of application-oriented OSI communications protocols.

Within the IIF data format (IIF-DF), compressed images may be specified and interchanged. For this purpose, the following standards are referenced:

- CCITT Recs. T.4 and T.6 (Facsimile)
- ISO/IEC 11544 (JBIG)
- ISO/IEC 10918 (JPEG)
- ISO/IEC 11172 (MPEG-1)

Image data streams that conform to the encoded representation of compressed image data specified by these standards may be included in the IIF-DF. For instance, a time series image can be represented as an array of time slices, each of which is encoded according to the JPEG Standard. Furthermore, the IIF-DF allows images to be represented through the combination of compressed parts with uncompressed parts. It is also possible to use multiple compression methods within a single IIF-DF-conformant image. For instance, a colour image can be represented as tiled images whereby some tiles are encoded according to the lossy mode of the JPEG Standard and others according to the lossless mode. For detailed information concerning compressed data streams and compression/decompression functionality, refer to 5.3.3 and 7.1.6, respectively.

There are various possibilities for interaction and data exchange between the IPI-PIKS domain and the IPI-IIF domain. Both domains are controlled by the application via application program interfaces (APIs). For a detailed description of the interworking between the IPI-PIKS and the IPI-IIF refer to clause 4 (the IPI-IIF architecture) and clause 7 (the IPI-IIF Gateway functionality). For a description of the relation between the types of objects that may be interchanged by means of the IPI-IIF and those types of objects that may be processed by the IPI-PIKS, refer to clause 6 (the profiles for the IIF data format). Refer also to ISO/IEC 12087-1.

Information technology — Computer graphics and image processing — Image Processing and Interchange (IPI) — Functional specification — Part 3: Image Interchange Facility (IIF)

1 Scope

This part of ISO/IEC 12087 facilitates the interchange of digital images. For this purpose, conceptual, architectural, and functional definitions of the Image Interchange Facility (IPI-IIF) are established. ISO/IEC 12087-3 consists of two major parts, the:

a) IIF data format (IIF-DF) definition (by means of a formal syntax, described according to the Abstract Syntax Notation One (ASN.1) -- refer to clause 5), and the

b) IIF Gateway definition (by means of a manual page description of the functionality of an Application Program Interface (API) -- refer to clause 7).

An IPI-IIF-conformant implementation has to fulfill the functionality specification of the IIF Gateway, as outlined in clause 7. Besides the IIF Gateway, there may be information processing systems (software such as parsers, generators, etc.) which read and/or write the IIF-DF.

The IPI-IIF is based on the definitions described in ISO/IEC 12087-1, the "Common Architecture for Imaging". The IPI-IIF, as a whole, may be characterized briefly as follows:

c) By means of the IIF data format and Gateway, image data objects and image-related data objects are transported to and from application environments.

d) By means of the full PIKS profile of the IPI-IIF data format (i.e., a format for data interchange between IPI-IIF and IPI-PIKS), image data objects and image-related data objects are imported to and exported from the Programmer's Imaging Kernel System (IPI-PIKS), defined in ISO/IEC 12087-2.

e) The IPI-IIF facilitates the storage of image data objects and image-related data objects in a variety of pre-defined storage modalities, including different periodicity organizations, such as pixel-interleaving or band-interleaving.

f) This part of ISO/IEC 12087 defines syntax of image data (and image-related data) streams. The encoding of IIF data types is defined in ISO/IEC 12089. See also 5.3.3.

g) The IPI-IIF supports a concept of standardized conformance profiles. Initially, three conformance profiles are defined within ISO/IEC 12087.

h) An IIF data stream may be stored in devices such as file systems. An IIF data stream may be interchanged and communicated in data networks (e.g., LANs and WANs) or in other data communication facilities. All low-level data storage and transfer is delegated, for instance, to the operating system of the target hardware.

i) The IIF Gateway performs compression and decompression of image data objects using standardized compression and decompression techniques. These techniques are referenced in this part of ISO/IEC 12087. See 1.4.5 and 5.3.3 and 7.5 for further definition.

j) The IIF Gateway is accessible via an API to perform image interchange functions. See clause 7 for a definition of IIF Gateway functionality.

Reference shall be made to this part of ISO/IEC 12087, and its definitions shall be employed, whenever images are interchanged, according to the IPI-IIF, among different imaging applications environments or among imaging devices. The IPI-IIF is applicable to scenarios requiring the interchange of digital images, as outlined in Annex C.

The use of the IIF data format as a superset of the functionality of most of the existing image interchange formats solves the problem of application-independent syntactical and semantical interpretation and understanding of image data.

The IPI-IIF is applicable to image interchange in and among different application domains. The following application areas have been considered:

- Medical imaging
- Remote sensing
- Publishing
- Industrial vision
- Computer graphics arts
- Computer animation
- Scientific visualization
- Mission planning
- Document processing
- Outdoor scene surveillance

The limiting of the IPI-IIF scope to certain application domains is a matter of profiling. This is treated in clause 6.

NOTE - Whether an image interchange format may also be regarded as a device format, depends on the (local) processing power of the device itself. Thus a conceptually "high-level" format which has become an industrial standard page description language for desktop electronic publishing, can be regarded as a device format. The IPI-IIF may well be considered a device format if, for instance, there is an IPI-IIF-compatible printer which is able to receive, process, and hardcopy an image according to the IPI-IIF. In the same sense, it is reasonable to design IPI-IIF-compatible image sources, e.g. IPI-IIF camera systems.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO/IEC 12087. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO/IEC 12087 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 2022:1986, *Information processing - ISO 7-bit and 8-bit coded character sets - Code extension techniques.*

ISO/IEC 8613:1994, *Information processing systems - Text and office systems - Open Document Architecture (ODA) and Interchange Format (ODIF).*

ISO/IEC 8632:1992, *Information processing systems - Computer graphics - Metafile for the storage and transfer of picture description information.*

ISO/IEC 8824:1990, *Information technology - Open Systems Interconnection - Specification of Abstract Syntax Notation One (ASN.1).*

ISO/IEC 8825:1990, *Information technology - Open Systems Interconnection - Specification of Basic Encoding Rules for Abstract Syntax Notation One (ASN.1).*

ISO/IEC 8879:1986, *Information processing systems - Text and office systems - Standard Generalized Markup Language (SGML).*

ISO/IEC 9069:1988, *Information processing systems - SGML support facilities - SGML Document Interchange Format (SDIF).*

ISO/IEC TR 10000-1:1990, *Information technology - Framework and taxonomy of International Standardized Profiles - Part 1: Framework.*

ISO/IEC TR 10000-2:1994, *Information technology - Framework and taxonomy of International Standardized Profiles - Part 2: Principles and taxonomy for OSI Profiles.*

ISO/IEC 10031-1:1991, *Information technology - Text and office systems - Distributed office application model - Part 1: General model.*

ISO/IEC 10031-2:1991, *Information technology - Text and office systems - Distributed office application model - Part 2: Distinguished object reference and associated procedures.*

ISO/IEC 10918-1:1994, *Information technology - Digital compression and coding of continuous-tone still images - Part 1: Requirements and guidelines.*

ISO/IEC 10918-2: To be published., *Information technology - Digital compression and coding of continuous-tone still images - Part 2: Compliance testing.*

ISO/IEC 11172-1:1993, *Information technology - Coding of moving pictures and associated audio for digital storage media up to about 1,5 Mbit/s - Part 1: Systems.*

ISO/IEC 11172-2:1993, *Information technology - Coding of moving pictures and associated audio for digital storage media up to about 1,5 Mbit/s - Part 2: Video.*

ISO/IEC 11172-3:1993, *Information technology - Coding of moving pictures and associated audio for digital storage media up to about 1,5 Mbit/s - Part 3: Audio.*

ISO/IEC 11544:1993, *Information technology - Coded representation of picture and audio information - Progressive bi-level image compression.*

ISO/IEC 12087-1:1995, *Information technology - Computer graphics and image processing - Image Processing and Interchange (IPI) - Functional specification - Part 1: Common architecture for imaging.*

ISO/IEC 12089:—[1], *Information technology - Computer graphics and image processing - Encoding for the Image Processing and Interchange Standard (IPI) - Encoding for the Image Interchange Facility (IIF).*

CCITT Rec. G.711(1984), *Coding of analogue signals by pulse code modulation.*

CCITT Rec. G.721(1984), *32 Kbit/s Adaptive Differential Pulse Code Modulation (ADPCM).*

CCITT Rec. T.4(1988), *Standardization of Group 3 Facsimile Apparatus for Document Transmission.*

CCITT Rec. T.6(1988), *Facsimile Coding Schemes and Coding Control Functions for Group 4 Facsimile Apparatus.*

CCITT Rec. T.30(1988), *Procedures for Document Facsimile Transmission in the General Switched Telephone Network.*

NOTES

1 All normative references which are common to Parts 1 to 3 of ISO/IEC 12087 are included in ISO/IEC 12087-1. In ISO/IEC 12087-3, only the IIF-specific references are listed.

2 References to documents which are neither ISO/IEC Standards nor CCITT Recommendations are given in Annex G.

3 Some ISO Standards are technically aligned with CCITT Recommendations, in particular the ASN.1 Standard (ISO Standards 8824/8825 and CCITT Recs. X.208/X.209). The differences between the International Standard definitions and the CCITT definitions are quite small, and should not affect interoperability between implementations written against either document. Within this part of ISO/IEC 12087, the ISO Standards are referenced whenever possible.

1) To be published.

3 Definitions and Abbreviations

3.1. Definitions

For the purpose of this part of ISO/IEC 12087, the definitions given in ISO/IEC 12087-1 apply.

3.2. Abbreviations

API	Application Program Interface
ASN.1	Abstract Syntax Notation One
BER	Basic Encoding Rules
CCITT	Comité Consultatif International Télégraphique et Téléphonique
CGM	Computer Graphics Metafile
DCT	Discrete Cosine Transform
DOAM	Distributed Office Application Model
DOR	Distinguished Object Reference
FOD	Interchange Format and Representation Profile of Office Documents
FTAM	File Transfer, Access and Management
IIF-DF	Image Interchange Facility - Data Format
IPI	Image Processing and Interchange
IPI-CAI	IPI - Common Architecture for Imaging
IPI-IIF	IPI - Image Interchange Facility
IPI-PIKS	IPI - Programmer's Imaging Kernel System
JBIG	Joint Bi-level Image Experts Group
JPEG	Joint Photographic Experts Group
LAN	Local Area Network
MHS	Message Handling System
MOTIS	Message-Oriented Text Interchange Systems
MPEG	Moving Pictures Experts Group
ODA	Open Document Architecture
OSI	Open Systems Interconnection
PER	Packed Encoding Rules
SDIF	SGML Document Interchange Format
SGML	Standard Generalized Markup Language
WAN	Wide Area Network

4 The IPI-IIF Architecture

4.1 The IPI-IIF Data Format and the IPI-IIF Gateway

As outlined in clause 1, the IPI-IIF consists of the specification of a data format and the specification of functionality. The data format is called Image Interchange Facility Data Format (IIF-DF). It is described in clause 5. Clause 6 describes conformance profiles for the IIF-DF.

The functional component of the IPI-IIF is called IPI-IIF Gateway. It is described in clause 7. The IPI-IIF Gateway functions are called by an application program via a specific API (Application Program Interface). Concerning data interchange, it provides functionality for

a) the import of image data to and export of image data from application, as well as

b) the import of image data to and export of image data from the IPI-PIKS.

Part of the IPI-IIF Gateway functionality deals with the differing complexity of the IPI-IIF data types (clause 6 of ISO/IEC 12087-1) and the IPI-PIKS data types (clause 5 of ISO/IEC 12087-1). The IPI-IIF data types are defined according to the (generic) IPI data types that are introduced in clause 4 and form a superset of the IPI-PIKS data types. The IPI-IIF data types support compound and heterogeneous image structures of arbitrary hierarchical organization whereas the IPI-PIKS data types support five-dimensional images with limited heterogeneity. The IPI-IIF Gateway provides a general mechanism - called attach/detach functionality - to combine simpler IIF structures into more complex ones, and extract simpler structures from more complex ones. Hence, this functionality represents the interface between the IPI-IIF data types (that are interchangeable by means of the IPI-IIF) and the IPI-PIKS data types (that can be processed by the IPI-PIKS, but also interchanged by the IPI-IIF).

The IPI-IIF Gateway function classes are:

c) Gateway control functionality: These functions are used to open and close the IPI-IIF Gateway, to inquire about its status, and to handle errors.

d) Import and export functionality: These functions allow for the import and export of image and image-related data to and from the IPI-IIF Gateway via the application program.

e) Parse and generate functionality: These functions allow for the translation between IPI-IIF data streams (according to the IPI-IIF data format) and IPI-IIF gateway-internal data structures that are accessible and manipulable via IPI-IIF Gateway functions of category f) and g), respectively.

f) Data structure access functionality: These functions allow for the access of parsed image data structures. This includes tree traverse, inquiry, put value, and get value functions.

g) Data structure manipulation functionality: These functions allow for the manipulation of image structures. Create, delete, attach, and detach functions are provided.

h) Compression and decompression functionality: Functions are provided for the compression and decompression of pixel fields according to the standards listed in section 1.4.3.

i) Application-oriented functionality: This category encompasses functions which perform at the same time multiple functional steps according to categories c) to h). Seen from the application, these functions are located on a higher (and thus more application-oriented) level.

The specification of the functions is given in clause 7.

4.2 Interworking between IPI-IIF Gateway and IPI-PIKS

The interworking (i.e. data flow and function calls) of the IIF Gateway and the IPI-PIKS for image data interchange is depicted in Figure 1. The diagram shows three domains, called the "application domain," the "IIF Gateway domain," and the "IPI-PIKS domain." These "domains" indicate whether a certain function or data structure is part of the IPI-PIKS, the IIF Gateway, or the application program, respectively. The arrows between (squeezed) ovals indicate the data flow. Possible interworking situations include:

a) The imaging application program uses only an IIF Gateway, but no IPI-PIKS: The application program may import and export image data which is interchanged using the IIF data stream. On the other hand, the application program has the capability to process image data by means of application-private imaging functions.

b) The imaging application program uses a non-IIF-capable IPI-PIKS and no IIF Gateway: In this case, the IPI-PIKS conformance profiles defined in ISO/IEC 12087-2 describe the import and export functionality of the IPI-PIKS.

c) The imaging application program uses an IIF-capable IPI-PIKS and no IIF Gateway: In this case, the standardized import and export functions of the IPI-PIKS, if called by the application program, produce image data according to the full PIKS profile or the foundation profile of the IPI-IIF data format. The application program will be able to read data streams that conform to the profile of the IPI-IIF data format. The application program, as well as the import and export function of the IPI-PIKS implementation, will have a parser and a generator for the IPI-IIF data format.

d) The imaging application program uses both an IPI-IIF Gateway and an IPI-PIKS: The import/export, parse/generate and data structure access and manipulation functions work according to a) and b), above. Further details are provided by the manual pages for these function descriptions (see clause 7).

Besides, it is possible that the application program does not use the standardized import and export functions, but explicitly ("manually") controls the interworking of the IPI-IIF Gateway and the IPI-PIKS by using only the import and export functions of the IPI-IIF Gateway and the IPI-PIKS utility functions. In this case, image data is transferred by the get_pixel and put_pixel functions from the IPI-PIKS to the application domain, and vice versa.

If both the IPI-IIF Gateway and the IPI-PIKS are developed and supplied as one software unit, the IPI-IIF Gateway and IPI-PIKS APIs may be linked together. In this case, the internal interworking between the IPI-IIF Gateway and the IPI-PIKS may be designed to be more efficient. In either case, private, non-standardized image data input and output may take place as shown by the dashed arrows in Figure 1. It is up to the application program to manage the reading and writing of private image file formats and convert the data into the IPI-IIF data format. See also 7.1.2 for the specification of low-level data exchange mechanisms of the IPI-IIF Gateway.

The IPI-PIKS functions relevant for the interworking of the IPI-PIKS with the IPI-IIF Gateway (defined in ISO/IEC 12087-2) are:

e) input_object: data transfer from the IPI-IIF Gateway to the IPI-PIKS.

f) output_object: data transfer from the IPI-PIKS to the IPI-IIF Gateway.

The IPI-PIKS can write and read image data streams only by means of the above-mentioned input_object/output_object functions. However, an application program may feed data to and from the IPI-PIKS with other utility functions, such as get_pixel, put_pixel, and import/export. For further details, see ISO/IEC 12087-2.

The functionality of both the IPI-IIF Gateway and the IPI-PIKS, as indicated above, is accessible via two separate APIs from the application program.

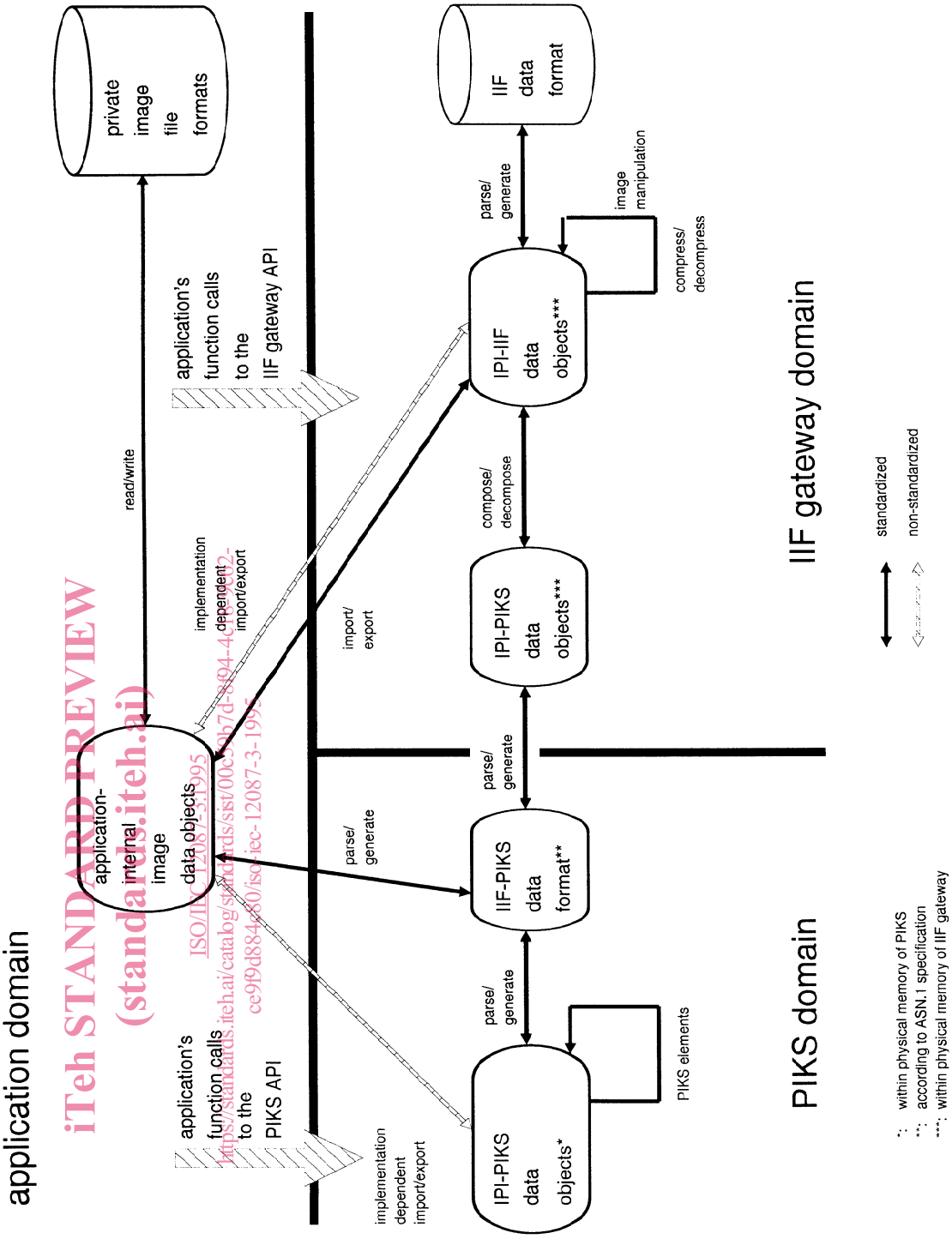

Figure 1 - Interworking of the IPI-IIF Gateway and the IPI-PIKS for image data interchange

5 The IIF data format (IIF-DF)

5.1 Basic features of the IIF-DF

This Clause gives an overview of:

- the kind of data objects which may be expressed by the IIF-DF,
- the kind of formal description method which has been chosen, and
- which encoding rules shall apply, in order to produce IIF-DF-conformant data streams.

Clause 5.3 defines the full IIF-DF syntax by giving the production rules for all data entities. Within this part of ISO/IEC 12087, the rules of the IIF-DF syntax are arranged in preorder traversal (depth-first) with the exception of image attributes, which are described after the non-image data types.

5.1.1 Objects that are expressed in the IIF-DF

The IIF-DF syntax allows description of a sequential format for all data objects that are structured according to the IPI-IIF data types, as defined in ISO/IEC 12087-1, clause 6. Since the IPI-PIKS data types (ISO/IEC 12087-1, clause 5) form a proper subset of the IPI-IIF data types, they are covered by the IIF-DF too. The names of the syntax entities correspond to the names of the data types of ISO/IEC 12087-1. The structure and semantics of these data entities are defined with reference to ISO/IEC 12087-1.

NOTE - ISO/IEC 12087-1 provides IPI-IIF data types and IPI-PIKS data types. Both are derived from the (generic) IPI data types. The IPI-IIF data types represent a very broad approach to image data modelling. The IPI-PIKS data types are oriented by the needs of image processing as defined in ISO/IEC 12087-1.

In addition to the data types defined in ISO/IEC 12087-1, the IIF-DF contains some data entities that specify the placement of pixel data, the ordering of elements of multi-dimensional arrays, and the coded representation of elementary data types, including compression algorithms.

5.1.2 Syntax notation

The syntax is expressed in ASN.1 (Abstract Syntax Notation One), according to ISO/IEC Standard 8824, "Specification of Abstract Syntax Notation One (ASN.1)." ASN.1 is a formal description language. It defines a set of primitive data types, such as `INTEGER`, `ENUMERATED`, and `REAL` and provides a facility to construct new elements with their own typing inherent in the structure using the constructors `SEQUENCE`, `SEQUENCE OF` and `CHOICE`. This allows for new data types to be defined which are uniquely recognizable within an application. To make these definitions more readable, textual labels may be associated with the elements in a constructor type. In order to distinguish different occurrences of the same type within one constructor, various types of tags are provided that may be associated with the constructor's elements.

Within the semantical description of the IPI-IIF data format, each element (which is either a primitive data type or a constructed type) is called *syntax entity*. According to ASN.1, the names of the syntax entities begin with capital letters. An example for a syntax entity is *BandRecord*. Syntax entities consist of a number of *component*s. According to ASN.1, the component labels begin with lower case letters. For example the *BandRecord* entity consists of the *number-of-bands* component, the *data-placement* component, and the *record-components* component. The type of each component is defined by reference to another syntax entity which is either described elsewhere in the IIF-DF syntax or within the ASN.1 standard. For example, the *data-placement* component is represented by the *DataPlacement* entity, which is described within the IIF-DF syntax. The *number-of-bands* component is represented by the *INTEGER* entity, which is an elementary syntax entity. For its definition, refer to ISO/IEC 8824. From the viewpoint