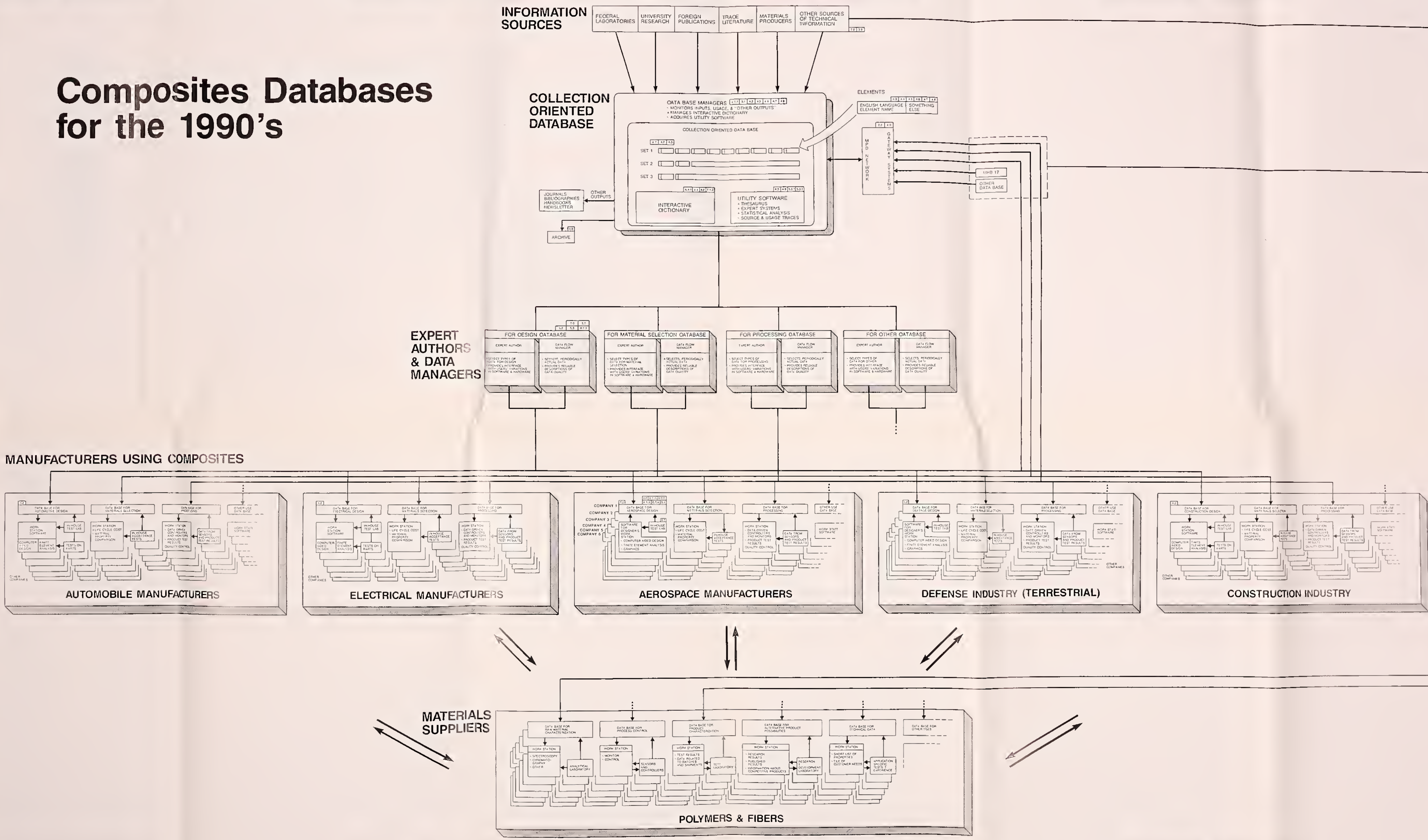
Composites Databases for the 1990's



NISTIR 88-4017

Standards for the Interchange of Large Format Tiled Raster Documents

Frankie E. Spielman, Editor

U.S. DEPARTMENT OF COMMERCE
National Institute of Standards and Technology
(Formerly National Bureau of Standards)
Gaithersburg, MD 20899

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National Bureau of Standards became the
National Institute of Standards and Technology
on August 23, 1988, when the Omnibus Trade and
Competitiveness Act was signed. NIST retains
all NBS functions. Its new programs will encourage
improved use of technology by U.S. industry.

U.S. DEPARTMENT OF COMMERCE
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Ernest Ambler, Director

PREFACE

This document is a compilation of separately prepared, but interrelated, reports which discuss aspects of raster image processing, primarily as they relate to a standard tiling scheme being developed to support the interchange of large raster images.

This document was prepared in support of the Department of Defense (DoD) Computer Aided Logistic Support (CALS) Program under an Interagency Agreement between the National Institute of Standards and Technology (NIST) and DoD. The objective of the CALS Program, a multi-year effort, is to integrate the design, manufacturing, and logistic functions through the efficient application of new and emerging technologies. A critical step toward achieving this objective is the development and use of standards and specifications for the interchange of digital data. NIST's role in this effort is to assist DoD in the development of military specifications and to help expedite the development and enhancement of national and international hardware, software, and data interchange standards.

A number of reports relating to raster graphics were developed in support of the DoD CALS effort. The reports were prepared by members of an ad hoc Tiling Task Group (TTG) composed of government and industry representatives and chaired by NIST. The TTG with the aid of ANSI/X3V1 members has developed and submitted to ISO an addendum to part 7 of ISO 8613, Office Document Architecture (ODA) and Interchange Format. This addendum will allow vendors to deliver, and the government to accept, digital technical data in lieu of paper and film. Upon approval of the addendum, the Document Application Profile for the Interchange of Large Format Tiled Raster Documents, described in this document, will be considered for publication as a Federal Information Processing Standard (FIPS).

Raster graphics or image processing allows the user to capture, maintain, manipulate and distribute pictorial information in a digital format. Such digitized images include engineering and architectural drawings, diagrams, photographs, pictures, fingerprints, and other pictorial material. The first report of this document describes existing standards that support raster graphics within office document processing environments. The remaining reports in this document concentrate on the development of standards required to support the interchange of large format images. Their focus is on a standard tiling scheme to be used for applications supporting the interchange of large format engineering drawings. This scheme provides a method for subdividing a large raster graphics image into subelements called tiles.

The five reports composing this document describe specific areas of raster graphics. Each is intended for a different audience. The first report provides the reader with a brief introduction to raster graphics and the current standards used to support raster graphics applications. The second provides the reader with a non-technical overview of the tiling scheme. The third report describes the user's requirements for tiling that were identified by the TTG. The fourth report, a Document Application Profile, presents information about all the attributes pertaining to a tiling application. The fifth report is a proposed addendum to an ANSI standard which is required to support the tiling scheme.

ACKNOWLEDGMENTS

We would like to gratefully acknowledge all the members of the TTG who have contributed towards the development of the proposed tiling standard. The TTG membership list is included in Appendix A. We don't mean to imply that all those named on the list were active contributors or even that they are all in agreement on the current rendition of these documents. Many, however, gave greatly of their time, energy, and ideas and ensured the success of the TTG's work. We would especially like to acknowledge the contributing editors: Louis H. Sharpe, II and Eric Von Dollen. We are also grateful to Jim Gilbert and Michael Ott who were editors of earlier TTG documents and to Marcel Rivard for his significant contribution to the development and review of all the documents. We would also like to acknowledge the assistance of the ANSI/X3V1.3/5 subcommittee members in developing the proposed addendum to ISO 8613/7. All have aided immeasurably in the development of this document.

CONTENTS

RASTER GRAPHICS:
BASIC CONCEPTS AND STANDARDS

Frankie E. Spielman

Section I

RASTER GRAPHICS:
BASIC CONCEPTS AND STANDARDS

Raster graphics provides the capability to process, store, and exchange images in a digital format. This technology will play a significant role in future systems development as we move toward the elusive goal of the paperless office and work environment.

Raster graphics has been used for several years to exchange documents by facsimile. More recently, elements of the Department of Defense (DoD), specifically the Army and Air Force, have started using this technology to store engineering documents. The Navy and Defense Logistics Agency (DLA) are also in the process of procuring systems using raster graphics to store engineering documents. Additionally, DoD future plans call for the exchange of engineering documents using raster graphics technology. Similarly, the Patent Trademark Office has started digitizing and storing a portion of their patents using raster graphics, thus making them available for on-line review. Raster graphics technology is absolutely necessary for applications that interchange and store pictorial data such as photographs and logos.

Raster graphics is a method of representing a two-dimensional image by dividing it into a rectangular two-dimensional array of picture elements (pels). Each element of the pel array comprises data indicating the color and the brightness of the corresponding picture element of the image. To produce a raster image from an existing document, the hard copy paper or microfilm media must be processed through a raster scanning device.

The data which determines the image of a pel specifies one of two states, named "set" and "unset." The set state is used to identify the foreground color and the unset to identify the background color. In black and white images, the foreground is represented by a "1" and background by a "0." For reproduction on paper, the background color will normally be white and the foreground color black. The array is often referred to as the bit-map image.

In the electronic data capture and conversion of existing images to digital form by an optical scan process, the scanner superimposes an imaginary grid or raster over the image to be scanned. Each of the grid squares represents an individual pel in the pel-array. Scanning is performed from left to right along each line beginning at the top of the page. The scanner evaluates each pel and assigns a corresponding binary value of "0" for mostly white or "1" for mostly black.

The dimensions of the array or bit-map are determined by the size of the document or image being represented. The image detail that can be illustrated is dependent upon the resolution density of the raster grid. The resolution density is the specific number of pels per inch which is normally the same for both directions of the image dimensions. Image detail can be improved by increasing the grid density but this also increases the storage and data processing requirements. Consequently, there is a trade-off between the image detail required for the application and the costs associated with the higher density requirements.

One of the costlier aspects of raster graphics processing is the large amount of data generated by the process. For example, the actual letters "Me," as illustrated in figure 1, require only 16 bits, or two bytes, to represent using ASCII character coding. The bit-map image, as shown in figure 2, requires a total of 1260 bits, or 158 bytes, to represent these same two letters in a raster image format. To help reduce the storage requirements, there have been several encoding schemes developed to compress raster data. In the world of facsimile transmission, the International Consultative Committee on Telegraphy and Telephony (CCITT) Recommendation T.4 (Group 3) is currently used for compressing the documents during transmission [CCITT84a]. It is anticipated that future systems will use the CCITT Recommendation T.6 Group 4 compression algorithm [CCITT84b]. DoD Military Standard 1840A stipulates the use of CCITT Recommendation T.6 Group 4 as the DoD standard to be used for the interchange of raster data between DoD installations and their vendors [MILSTD87]. Compression ratios can typically range from 10:1 to 50:1 depending upon the complexity of the image. In a report completed for DoD, the average compression ratio using a <u>modified</u> Group 4 compression algorithm on 40 DoD images from Army and Air Force data repositories was 22:1 [AITI87].

Raster graphics images can be integrated into office documents through the use of International Standard ISO 8613, Office Document Architecture (ODA) and Interchange Format [ISO88]. ODA provides for open interchange of structured compound documents containing text, vector graphics and raster graphics. It provides the rules for partitioning and organizing (structuring) the document and the encodings for this structure using Abstract Syntax Notation One (ASN.1). ASN.1 is specified in ISO 8824 and ISO 8825 [ISO87a, ISO87b].

A standard is being developed which provides a scheme for subdividing a large raster graphics image into non-overlapping regions called tiles. This scheme provides a format that supports operations on portions of a large image without requiring other portions of the image to be accessed. It also allows parallel compression and decompression of the individual tiles. DoD has specified the use of tiled raster graphics in MIL-R-28002, the DoD standard for the delivery to the Government of raster graphics data in digital form by contractors [MILSTD88]. The remainder of this document describes the requirements for the evolving tiling raster graphics standard, which will be an addendum to ISO 8613, ODA/ODIF, Part 7.

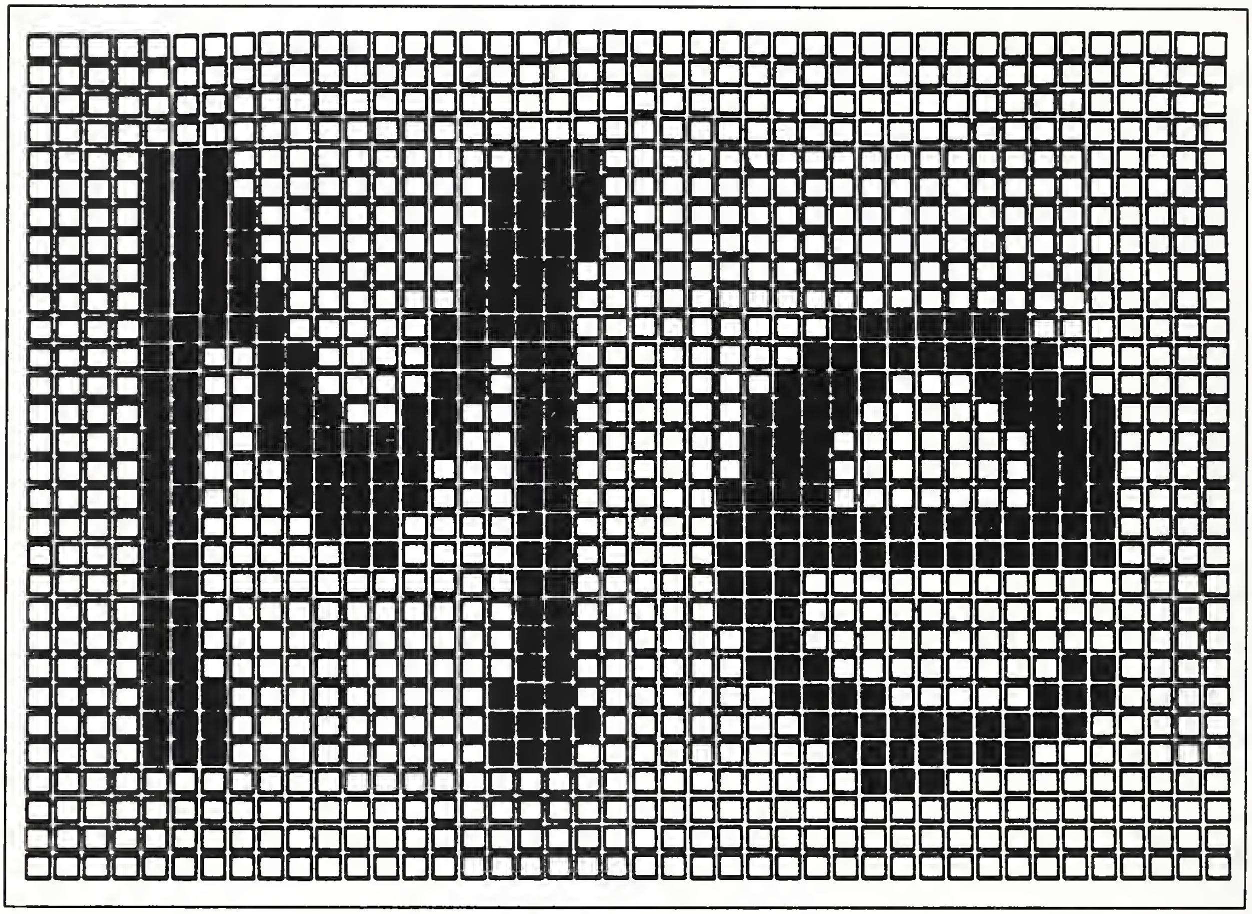

Figure 1 - The Raster Scan Process

NOTE: The boundary of each pel is directly adjacent to its neighboring pel without any space between them.

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Figure 2 - Raster Data

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Tiling in Large-Format Raster Documents

Louis H. Sharpe II

VIDAR Systems Corporation

Section II

Tiling in Large-Format Raster Documents

INTRODUCTION

When ancient builders looked for ways to build their residences or their tombs permanently and colorfully, they turned to ceramic tiles. A tile was a manageably-sized chunk of technology with all the right properties. In the emerging large document raster field, some rather daunting systems problems can similarly be managed by the divide and conquer strategy of tiling. In this case the chunks are pieces of an electronic image rather than baked clay, but the principle is the same: dissect the problem, reduce it to manageable elements and all manner of advantages follow.

WHAT IS TILING ?

The Latin word for tile comes from the verb "to cover." Tiling is a means of breaking an electronic image into pieces by completely covering the image plane with many identically shaped, perfectly interlocking regions. Rectangles or squares are the most obvious and useful such regions, though an entire branch of mathematics has arisen to identify others.

Tiling allows a large, seamless bit-mapped image to be cut up, manipulated in some fashion, and then sewn back together. It essentially only affects the storage order of pels. Normally all the pels of an image follow one another in a left to right, top to bottom, raster fashion. Tiling results in the storage of one tile after another; only within a given tile does the raster ordering of pels occur.

WHY TILE ?

Craftsmen called upon by their ruler to ornament his palace 12,000 to 18,000 years ago used ceramic tiles. Why? They were small enough to be easily manufactured, handled, and applied.

When building a raster image handling system, what are some of the things we want to do with an image? How can tiling help?

Storing the image is the most immediate problem. Today's high-speed scanners can produce data at a rate and of a quantity well beyond the abilities of the average mass storage architecture. Compression is clearly needed to alleviate both storage bandwidth and storage size difficulties.

The existing compression standard for facsimile, known as CCITT Group 4 or (more precisely) T.6 encoding, is well suited to binary images. While some other schemes are being evaluated, this method still holds the central role in all binary image standards work and will dominate the raster image products of the 1990's.

It is a statistically-based technique, however. This means it (a) is not guaranteed to produce a result smaller than the original, and (b) is going to have wild variations in processing speed. Systems designers are fond of more predictable elements: worst-case design assumptions will result in high cost, but design to the average case will result in systems that fail. Can tiling help with these two problems? Yes, indeed, and in much the same way that ceramic tile makes a building problem easier.

Tiling helps with the storage size. The fact that T.6 compression <u>on average</u> produces data sets 10 to 20 times smaller is beneficial but covers up a rather nasty fact. For significant portions of a busy image, it can actually <u>negatively compress</u> (i.e. enlarge) the image. Well, someone might say, why not simply take the entire uncompressed image in place of such a poorly compressed image? We could, but then we lose the benefit of the high compression achieved in the border or non-busy areas. If we tile, we can decide on a tile-by-tile basis whether to use the compressor's result or to stay with the original bit-map image of that tile.

This also cures a more subtle difficulty with the untiled case: even if the overall image would have come out reduced in size, the momentary flood of data from a busy region could overwhelm busses or storage devices and cause a scan or print to abort. The only way around this is to have a full image buffer before the compression module. Even worse, this would have to be a dual buffer for systems which are <u>pipelined</u> to allow scanning and compression to go on in parallel. This buffer is in addition to the full-image buffer required by both methods after the compressor (for those documents which compress very poorly). Tiling permits us to substitute the bit-map of the tile in place of any tile which would overwhelm our system with a temporary flood of data. This cures the storage bandwidth problem without introducing additional expensive full-image buffers.

Tiling also helps with the processing speed problem. The bandwidth problem just discussed is a case where the local variations in the non-redundant data content of the image cause momentary difficulties. What if systems considerations require a minimum instantaneous compression or expansion <u>rate</u> (e.g., averaged over the time required to handle a small buffer)? For example, a scanner or laser printer moving too fast to do line-on-demand would need this. We need either a very fast engine or many moderate speed engines to share this "deadline burden." Since the T.6 algorithm operates by reference to the line above the current line, it is not possible to break an image into multiple pieces, parcelling out the work. Tiling essentially makes many smaller, distinct images (at some small penalty in overall compression) from one large one. The appropriate level of parallel processing can then be applied to tackle the throughput need.

Tiling makes it easier to build high-performance integrated circuits for large documents. Just as it would be difficult indeed to spread an entire wall with clay and fire it as one unit, so it is hard to design a chip for any width image. Significant speed advantages accrue if an on-chip reference line memory is used, but some assumptions must be made about its size. Competitive pressure and market realities dictate that this memory will be sized with small documents in mind. Tiles allow such integrated circuits to be used on arbitrarily wide images.

HOW TO TILE

What shape tiles should we choose? Rectangular shapes are the most sensible from an implementation point of view. If 90 degree rotation is considered, square tiles make even more sense.

To tile, we need to create a grid of the appropriate number of square tiles. We then take our large-document image and lay it on this grid. We can position it any way we like over the grid as long as we keep it orthogonal and within the outer grid boundary. We then define the area within the tile grid which actually contains image data; it will likely be smaller than the enclosing set of tiles it touches. Some portion of each of the tiles on the outer "ring" of tiles may in fact be unused. The portion of this image we are <u>truly</u> interested in may in fact be smaller still due to overscan.

What size tiles should we choose?

At first sight, the size of ceramic tiles seems to have been fixed by artistic evolution or convention to be (let us say) 4 by 4 inches. However, analysis shows instead that material and process limitations (e.g. firing temperatures, vulnerability to breakage, etc.) were really the key factors.

Similar considerations govern the choice of a size for an electronic tile. We do not wish to exceed the limits of available technology or even to be pushed up to the (expensive) frontier.

"Cooking" an electronic tile requires it to be stored in a fast static RAM memory buffer. The largest of these with a modest price is 32K bytes or 256K binary pels. This corresponds to a tile of 512 by 512 pels.

The "cutting up" of tiles during scanning or the "stitching together" of tiles during printing requires buffering up an entire row's worth of tiles before playing the data out in a new raster order. With the line widths encountered in some large-format raster images, a full row of 512 line high tiles will take a megabyte or two of dynamic RAM, again available at a modest price.

A quick look at available and planned compression/expansion chips shows them all capable of handling a 512 pel wide tile. Rotation of that size tile is straightforward both in hardware and in software. The branch of commercial image processing that grew up around television camera and frame grabber technology also often uses 512 by 512 as its image size.

Once a tile shape and size have been set, what other elements are needed for a tiling scheme?

1. A description of the number of tiles present lets a program reading a tiled file reserve a frugal amount of memory for that purpose. Whether it occurs explicitly or implicitly, an absolute limit to that number lets the programmer make further simplifying assumptions. A limit of 4096 tiles is more than sufficient to handle a K size (40" by 143") image at 400 dots per inch (dpi) with one inch overscan.

2. A tile index, which would be much like the index in the back of a book, only more likely to be modified. An index allows a specific tile to be found directly, without having to sift down through a long chain of tiles each time. An index allows one to change the ordering of tiles by simply changing the pointer to where a tile is located within the file. A tile index can be included within a file format as an <u>application comment</u>, or can be built up upon the first encounter with the file. Such an index would have, for each tile, a <u>content offset</u>. The offset is a the distance in bytes from the beginning of the index to the beginning of the tile, allowing a program to go directly to get a given tile.

3. An indication of where the actual image is located within the tile grid. This can be accomplished by a <u>tiling offset</u>. The offset would be the coordinates within the first tile of the starting corner of the actual image. The true image size will in general be smaller than the outer dimensions of the tile grid. Because most images will not be exact multiples of the tile size, so-called "runt tiles" along some of the edges of the tile grid will result. These partially-

used tiles will exist in a ring around the periphery of the other, fully-used tiles. This ring will be at most one tile wide.

4. A pair of points marking the diagonal corners of a rectangle indicating the so-called clipping. This is handy for after-the-fact trimming of an over-scanned image to indicate which portion of the image is truly of interest. This is necessary in addition to the tiling offset discussed above.

A tiling standard for large-format documents would of course have to support all the common and anticipated resolutions (100 to 1200 dots per inch) and sizes (A through K and A4 through A0) of images.

Two additional pieces of information are necessary to process the actual tile content. Those pieces are:

Tile type. The tile type lets the application program know how to treat the tile it finds there: whether to expand it or leave it as a bit-map. The tile type may also be null foreground or null background. When the tile is of one of these two types, no actual tile content will follow because it is unnecessary.

Tile position. The tile position tells a program where to "paint" or render the tile on the page. Given a tiling offset (position of the start of the pel array in the first tile) and the tile dimensions, the position of each tile can be calculated if not explicitly stored.

SYSTEM ARCHITECTURE

Within the limits of the available technology, ceramic tiles evolved to become a reliable and convenient building block. They set a size scale below which attention was not required, allowing a focus on a grander scale.

In our present context, that grander scale is called systems design, and the systems of immediate interest are those for the management of electronic images. In large-document image management systems, scanning, compression, quality assurance inspection, transmission, storage, editing, expansion, and printing are all essential. Tiling can be enormously helpful in these areas, as the following demonstrates:

* Viewing an image during both editing and inspection can be either done faster or performed on a lower-cost workstation if tiling is used. If a zoomed-back view of the document is separately stored, there is no need to ever expand the entire image into a full-image buffer.

Since 8 megabytes is rather expensive (E size at 200 dots per inch) and 32 megabytes more so (400 dpi), a systems design which allows expansion of only the portion of the document which is actually being displayed can save a lot of money. Current generation displays can present a full-resolution view of about six 512 by 512 tiles. The new generation of faster compressor/expanders can easily keep up with real-time panning on the screen, i.e. they can compress the recently modified tiles as they pass off the screen, and expand the new ones sliding into view.

* Raster editor software can be written to take advantage of tiling techniques. For example, in an editing station only the modified tiles need be written back to the file. They can be tagged onto the end of the other tiles and the tile index changed, without having to re-order everything. If an aperture card scanner produces an image with a different orientation than that desired by the editor and user, the tile index takes care of describing the proper left-to-right, top-to-bottom ordering of the tiles even though their physical ordering in storage will still be that which was convenient for quick handling during the scan. Then, only as the editor "touches" tiles do they need to be actually rotated 90 degrees. At the time of interchange, however, all the remaining tiles would have to be rotated and placed in the proper order. The editor can ship tiles off to hardware modules to have rotation and other tasks such as despeckling or scaling performed.

* Tiling can reduce a network's transmission capacity needs by lowering peak demands. When a user requests a drawing, the storage server and network need not provide the entire image at once. If a separately-stored overview is available (which would have a small file size), it would likely be sent first along with the index of the full-resolution, tiled image. When the user identifies a region of interest, the first view's worth of tiles would then be requested and sent. Then, if and when the user begins panning, the appropriate tiles (perhaps with some degree of anticipation) can be requested incrementally.

* In a low-cost environment, tiling could allow all compression and expansion to be performed by a central, multitasked server. This is possible because tiles represent well-defined, distinct tasks. The server could, for instance, compress a tile for a raster editor which just experienced a panning event, expand a tile to send to a laser printer, and expand a new tile for display, all "simultaneously." If the server were located over a network, this would result in rather low

performance, since half of all the data would be uncompressed. If, on the other hand, the server were located on a workstation bus or the Small Computer Systems Interface (SCSI) bus, the performance would be very good. In either case, the cost advantage of sharing the compression/expansion function among several peripherals is clear.

* The quality assurance (QA) function is an important one, particularly when the electronic image will replace its paper or aperture card equivalent. The clipped pel array feature can be used at a QA workstation to indicate via an outline the area out of a full aperture scan where the document is suppose to be located. In the likely event that the card was out of specification, the operator need only move the outline to a more appropriate position. If the document had been pre-tiled and compressed by the scanner (and tagged with a guess at the active area outline), all that need be done is to modify the field in the file describing the clipped area. Later automated processing can "white out" and recompress partial tiles, discard unused tiles, etc. to achieve a smaller size or the file can simply be left as-is. If the scanner had not compressed or tiled the image, the QA workstation would do these things as the operator signs off on the scan.

STANDARDIZATION OF TILING

The Tiling Task Group was formed to put forward a standard allowing industry-wide interchange of data, lower systems costs, and growth of the large-document raster market. The hard work of many people made that a success.

The standardization activity has produced documents which fit into the scheme defined by Office Document Architecture (ODA) and Interchange Format. ODA, ISO 8613, is designed for the interchange of intelligent, multi-media documents. To slip the tiling scheme into this mainstream effort, three documents had to be produced: User Requirements, Content Architecture, and Application Profile. These three documents were derived from the Tiled Raster Interchange Format (TRIF) working documents created by the Tiling Task Group.

The first is the <u>User Requirements</u> document. This, quite logically, answers the following: Why do people need tiling? What are the unique requirements of this class of user? Why can't they use what already exists? What are the motivating principles in the ensuing documents?

The second document is a <u>Content Architecture</u> for the tiled raster graphics content to be included in a document. A content architecture is the "vocabulary" of concepts used to express a given type of content within a document. Fortunately, ISO 8613, Part 7, Raster Graphics Content Architecture, already exists to deal with raster images. The new concepts required for tiled raster graphics have been included in a proposed addendum to ISO 8613 Part 7. This puts all large-document raster work squarely into the smaller-document and facsimile mainstream, assuring compatibility and making workstations and peripherals capable of handling both needs more easily.

The third document is an Application Profile. This takes the needs identified in the User Requirements and tools defined in the Content Architecture together to describe a subset which is sufficient to the application. In the absence of the application profile, we would be faced with a standards problem, i.e. guidelines so broad and all encompassing that no given vendor would choose exactly the same subset to implement as any other vendor.

Tiled raster graphics has been specified for use by the Department of Defense (DoD) in MIL-R-28002, the DoD standard for the delivery to the Government of raster graphics data in digital form by contractors.

User Requirements for Tiled Raster Graphics

Tiling Task Group

Section III

Requirements for Tiled Raster Graphics

Tiling Task Group

Introduction

This document outlines the user requirements for tiled raster graphics that were identified by the Tiling Task Group (TTG). The TTG, in addressing these requirements, has sought to establish a conventional way for implementing tiling in large-format raster images. This document describes the considerations and reasoning which led to the TTG proposals. These proposals are being implemented in other documents including an addendum to the ISO 8613 Part 7 content architecture and an application profile.

Background

Interest in an industry-supported tiling scheme was first expressed at a meeting with the Department of Defense on April 15, 1987. A number of large-document raster equipment and software vendors were present to discuss the issue of image encoding of engineering drawings for delivery to the government. While it was clear that the majority supported encoding schemes consistent with the ODA/ODIF work, a remarkable consensus was spontaneously expressed that an additional feature was needed: tiling.

As a result of that meeting, a task group composed of industry representatives including system integrators, peripheral manufacturers, and users, as well as government representatives, assembled in an open forum to exchange views on tiling. This ad hoc group (TTG) concluded that development of an interchange format using tiling was desirable. Subsequently, a number of meetings and reviews were held by the TTG in order to develop this proposal.

Purpose

The need for an interchange format using a tiling scheme arose from a number of considerations associated with handling large-format engineering drawings in raster format. In developing the tiling format, issues were raised and evaluated concerning the usefulness and efficiency of tiling as a technique for handling large-format raster images between and within a wide range of systems. It was generally agreed that a tiling scheme could be developed that would receive broad, industry-wide support.

Therefore, it was the intent of the TTG to recommend a well-defined scheme to foster industry adoption. The TTG felt that adoption would be facilitated by fixing most parameters, thereby simplifying implementation. These parameters are set or narrowed in the proposed application profile.

The tiling scheme developed provides a format that supports operation on a subset of an image without requiring other portions of the image to be accessed. For large-format documents, this provides a way to interchange images between systems of various capabilities.

System efficiencies were a primary consideration in development of the tiling scheme and interchange format. Concerns associated with processing, system cost, real-time access, and archival storage were discussed and considered. A tile format was developed for interchange that could also reasonably be used for storage and retrieval without necessarily requiring translation.

Methodology

It was the intent of the TTG to develop a proposal that used existing and emerging standards as a basis wherever possible. This strategy assured that efforts were within the mainstream of raster imaging standards and promoted interoperability with other raster graphics formats utilized in the office document standards. It was the TTG's intent to create new mechanisms or objects only where existing work could not reasonably accommodate the needs of tiling.

This work is primarily intended to produce an interchange format for simple exchange of large-document images between systems. Such a format needs to have its range of features intentionally minimized.

A number of potential capabilities were identified which could have an impact on the interchange format. These were all evaluated and considered. Where appropriate, some of these capabilities were incorporated, others were reserved for future consideration, and still others were intentionally excluded.

Features

This section discusses features of the proposal. It also discusses restrictions which were made in the scope of the interchange format to ease user implementation.

This interchange format deals only with bi-tonal (black and white) data. Picture elements (pels) are assumed to be square.

A tile is a rectangular region in a page in which all regions have the same dimensions (are regular) and no part of any region overlaps any other region. There may not be more than one tile imaged to a given tile location. Every tile that exists is imaged to a single, unique tile location.

For the purposes of this interchange format, the application profile restricts the dimensions for all tiles to be square. Square tiles have the desirable attribute of being easily rotated. Tiles are allowed to be absent, i.e. to be specified as composed of all foreground or all background pels, thereby removing the need for including a content portion for the tile in question.

A single tile size is desirable to limit the burden on implementors of the interchange standard. The tile size is specifically 512 by 512 pels. This size was chosen as a compromise between the line buffer memory requirements of larger tiles and the storage overhead burden of smaller tiles. While it was recognized that system implementations exist that use 256 pel or 1024 pel square tiles, all vendors present agreed that a migration to 512 pel square tiles was acceptable for interchange.

Ease of implementation was a primary consideration. Restrictions deemed to ease implementation were: only one page (one single raster image) is allowed per document; the page is an integral number of tiles in each dimension; and transparency is not used.

An interchange format should include a minimal but sufficient set of allowable parameters, such as resolution. These parameters are defined as attributes in the application profile.

Any given tile is to be encoded as CCITT T.6 compressed data, as bit-map data, or is specified as all foreground or all background. Each T.6 compressed tile ends in a EOFB (end of facsimile block) as specified in T.6. Where T.6 encoding is used, the uncompressed escape option defined there is not supported. This is done because it places an unreasonable burden on implementors, is not used by any known vendors, and is not supported by existing or planned integrated circuits. This escape option is rendered unnecessary by the ability to insert bit-map encoded data on a tile-by-tile basis.

The ability to intersperse compressed and uncompressed tiles meets several crucial user requirements. A system or peripheral which must meet a given throughput requirement without failure can selectively choose to leave uncompressed those tiles which do not compress in a specified amount of time. Similarly, when a given storage requirement must be met, this ability permits an upper bound to storage needs by using bit-map encoding for those tiles which would have reverse compression. Both of these requirements arise from the need to predict the behavior of an essentially statistical encoding technique.

An upper limit is set on the number of tiles allowed in an image. A limit of some sort allows vendors to put a bound on system memory requirements.

Pragma is a term introduced from software terminology to describe non-required information which can be used to some advantage by a system implementation, but also can be safely ignored. An example is an attribute which specifies the starting location (index) of a tile within the file. A system could use this information to increase efficiency or could safely ignore it and correctly image the file by processing each tile in sequentially.

Alternatives

In an effort to keep the interchange as simple as possible, a number of features were excluded or considered beyond the scope of the TTG.

Issues that were considered but specifically excluded were variable tile sizes, rectangular (non-square) tiles, overlapping tiles, tiles of variable transparency, and multiple images per document. These and other items could be addressed in a later, separate application profile, but there were strong feelings that they do not belong in a limited, basic interchange format.

This proposal defines raster file format only and not issues related to media or database management such as document information, aperture card Hollerith code, document and page relationships, sheets, revisions, and multiple aperture card frames. These issues are outside the scope of the TTG and are being dealt with by other organizations.

Summary

This document outlines the user requirements for tiled raster graphics that were proposed by the TTG. The TTG proposals are being implemented through the development of an application profile and an addendum to the ISO 8613 Part 7 content architecture.

A DOCUMENT APPLICATION PROFILE
FOR THE INTERCHANGE OF
LARGE FORMAT TILED RASTER DOCUMENTS

Tiling Task Group
TTG/88-27

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Frankie E. Spielman
Editor

Section IV

CONTENTS

1. INTRODUCTION

This document application profile defines the Tiling Task Group's Agreement on the format to be used for the interchange of large format documents. It is based on the Office Document Architecture (ODA) and Interchange Format, as defined in International Standard (IS) 8613 and the Tiled Raster Graphics Addendum to ISO 8613, Part 7.

2. SCOPE

2.1. This document application profile specifies an interchange format suitable for interchanging large format documents, such as engineering drawings, that contain raster graphics implemented with a tiling scheme.

2.2. The features of a document which can be interchanged using this document application profile fall into the following categories:

> Page format features - these concern how the layout of each page of a document will appear when reproduced;
>
> Raster graphics layout and imaging features - these concern how the document content will appear within pages of the reproduced document; and
>
> Raster graphics coding - these concern the raster graphics representations and control functions that make up the document raster graphics content.

3. FIELD OF APPLICATION

3.1. This document defines a document application profile that allows large format tiled raster documents to be interchanged in a formatted form or formatted processable form in accordance with ISO 8613.

3.2. This document application profile is designed to be independent of the means used to create or to interchange the encoded documents.

3.3. It is assumed that, when negotiation is performed by the service using this document application profile, all non-basic features are subject to negotiation.

4. REFERENCES

The following references are required in order to implement this document application profile:

ISO 8613/1 - Information processing: Text and Office Systems; Office Document Architecture (ODA) and Interchange Format Part 1: Introduction and General Principles

ISO 8613/2 - Information processing: Text and Office Systems; Office Document Architecture (ODA) and Interchange Format Part 2: Document Structures

ISO 8613/4 - Information processing: Text and Office Systems; Office Document Architecture (ODA) and Interchange Format Part 4: Document Profile

ISO 8613/5 - Information processing: Text and Office Systems; Office Document Architecture (ODA) and Interchange Format Part 5: Office Document Interchange Format

ISO 8613/7 - Information processing: Text and Office Systems; Office Document Architecture (ODA) and Interchange Format Part 7: Raster Graphics Content Architectures

IS 8613, Part 7 "Addendum" (draft): Tiled Raster Graphics Addendum to ISO 8613, Part 7

ISO 8824 - Information Processing Systems - Open Systems Interconnection - Specification of Abstract Syntax Notation One (ASN.1)

ISO 8825 - Information Processing Systems - Open Systems Interconnection - Specification of Basic Encoding Rules for Abstract Syntax Notation One (ASN.1)

FIPS PUB 150 - Facsimile Coding Schemes and Coding Control Functions for Group 4 Facsimile Apparatus (FED-STD 1065) (EIA-538-1988) (CCITT Recommendation T.6)

5. CONFORMANCE

5.1. Introduction

In order to ensure that implementations conform to this application profile, it is necessary to define suitable conformance tests that implementations must pass before they may be classified as conformant. This section defines conformance requirements and provides definitions for the interpretation of results from conformance testing.

5.2. Conformance Requirements

Conformance to this document application profile is defined in terms of an implementation's ability to act as an originator and/or recipient of data streams conformant to the syntax and semantics of ISO 8613 and the "Addendum" as well as meet all the requirements listed below:

IF THE IMPLEMENTATION IS AN ORIGINATOR :

1) generate data streams, for formatted document architecture (FDA)

2) generate data streams that include only constituents specified in the relevant sections of this document.

3) for each constituent, generate data streams that include only those attributes and combinations of attributes permitted by the relevant sections of this document.

4) either

   a) for each attribute of each constituent, generate data streams that contain only basic attribute values as specified by the relevant sections of this document.

   or

   b) for each attribute of each constituent, generate data streams that contain both basic and non-basic attribute values as specified in the relevant sections of this document.

IF THE IMPLEMENTATION IS A RECIPIENT :

5) receive data streams, for formatted document architecture (FDA)

6) receive data streams that include any of the constituents specified in the relevant sections of this document.

7) for each constituent, receive data streams that include any of the attributes or any combination of attributes permitted by the relevant sections of this document.

8) either

a) for each attribute of each constituent, receive data streams that contain only basic attribute values as specified by the relevant sections of this document.

or

b) for each attribute of each constituent, receive data streams that contain either basic or non-basic attribute values as specified in the relevant sections of this document.

5.3. Conformance Testing Definitions

Any implementation that can correctly generate data streams in accordance with the conformance requirements listed above in section 5.2, paragraphs 1), 2), 3) and 4)a), is defined as a "minimal conforming originator."

Any implementation that can correctly receive data streams in accordance with the conformance requirements listed above in section 5.2, paragraphs 5), 6), 7), and 8)a), is defined as a "minimal conforming recipient."

6. DEFINITIONS

The definitions in ISO 8613 and the "Addendum" apply to this document application profile.

7. CHARACTERISTICS SUPPORTED BY THIS DOCUMENT APPLICATION PROFILE

7.1. Overview

A large format tiled raster document is the result of a formatting process and therefore the purpose of this document application profile is to allow transfer of the complete layout of the interchange document.

Only one category of content is allowed within the same page, namely, a tiled raster graphics content.

This section describes the layout features that can be represented in documents conforming to this document application profile. The features are described in terms that are typical of the user-perceived capabilities and semantics found in current document processors.

7.2. Document profile

Every document interchanged in accordance with this document application profile must include a document profile containing information which relates to the document as a whole. The document profile used in this document application profile must identify the contents as tiled raster graphics data. Every non-basic attribute value used in a document must be indicated in the document profile.

7.3. Logical Characteristics

A logical structure of the document conforming to this application profile consists of a two level hierarchy of a logical document root and tiled raster graphics content.

7.4. Layout Characteristics

7.4.1. Document layout structure

A document layout structure contains a page of tiled raster graphics contents.

7.4.2. Document

A document consists of only a single page.

7.4.3. Page layout

This document application profile supports various page dimensions including the nominal page sizes of the North American A-K and ISO A4-A0 formats. The standard default is the nominal page size of the North American A format since this is the most common size.

A page layout contains only tiled raster graphics contents consisting of as many tiles as is necessary to represent the image in digital form.

7.5. Content Characteristics

7.5.1. The content characteristics of this document application profile will contain only large format tiled raster data. Only the CCITT Recommendation T.6 Group 4 compression algorithm will be used except where it is more efficient to retain a tile image in bit-map format or to have no encoded tile content (null).

7.5.2. The contents of a page consisting of tiled raster graphics is defined by the type of coding and the dimensions of the array of picture elements (pels). The attributes to define the contents are specified in ISO 8613-7 and the "Addendum."

7.5.3. The presentation of the tiled raster graphics content block is controlled by the presentation attributes specified in ISO 8613-7 and the "Addendum".

8. TECHNICAL SPECIFICATION

8.1. Summary of Technical Specification

8.1.1. Overview

This section contains the technical specification of the document application profile for large format tiled raster documents.

This document application profile allows documents to be represented in the following forms:

- formatted form, which allows a recipient to reproduce the document as intended by the originator; or

- formatted processable form, which facilitates the reproduction of a document as intended by the originator or facilitates the revision of a document.

8.1.2. Specification of Constituents

This section specifies the required constituents used for the representation of documents that conform to this application profile. Also, it specifies the content architectures that may be present in these documents. There are no optional constituents.

Constituents specified as "required" must occur in any document that conforms with this application profile. Constituents listed as "optional" may or may not be present in the document depending upon the requirements of a particular application.

8.1.2.1. Constituents for formatted form documents

The required constituents include:

- a document profile, and

- layout object descriptions representing a specific layout structure.

There are no optional constituents.

8.1.2.2. <u>Constituents for formatted processable form documents</u>

The required constituents include:

- a document profile,
- logical object descriptions representing a specific logical structure, and
- layout object descriptions representing a specific layout structure.

The optional constituents include:

- layout styles, and
- presentation styles.

8.1.3. <u>Notation and Constraints</u>

This section presents the notation used to define the permissible structures and attribute values for this document application profile.

Attributes in the tables specifying values for the tiled raster graphics format specify BASIC, NON-BASIC, and DEFAULT values. For example,

Line-Progression	BASIC	{90,270 }
	NON-BASIC	{NONE }
	DEFAULT	{270 }

specifies that the Line-Progression attribute may be one of the two possible directions of either 90 or 270; that no values other than basic values are allowed; and that the default is 270.

There is only one non-basic value, 12 SMU, allowed for attribute the Pel-Transmission-Density in the layout object descriptions. The respective default values, when different from ISO 8613 and the "Addendum," are specified in the document profile attribute "document application profile defaults." For example,

```
dimensions  {#horizontal{#fixed{10200}}
            {#vertical{#fixed{13200}}}
```

specifies for the document profile attribute dimensions that the default values for the horizontal and vertical are equal to the common nominal page size of North American Letter.

The keywords used in this document are defined as follows:

AS_8613 - Used to denote that any value may be specified that is both consistent with the rules of this document application profile and is permitted in ISO 8613; however, for the convenience of using this document, the attribute values may be listed instead of using AS_8613

AS_8613Adden - Used to denote that any value may be specified that is both consistent with the rules of this document application profile and is permitted in the ISO 8613-7 "Addendum"

NONE - Used to indicate that there are no valid values for this attribute or parameter

/* */ - These characters used in this combination are used to enclose comments about the constituent and attribute specifications.

OBJECT_CLASS_ID_OF
Used to specify any object call identifier from the set of instances of a particular constituent constraint.

STYLE_OF
Used to specify any style identifier from the set of instances of a particular style constraint.

8.2. Logical Structure

This section defines all of the logical structure constituent constraints. Each constituent constraint has three parts: a list of required (mandatory) attributes; and a list of permitted (optional) attributes; and an optional list of relationships with other constituent constraints.

The number of hierarchical levels allowed is 2, namely:

- document logical root; and

- basic logical component.

These levels are all mandatory. A single content portion is associated with the basic logical component.

8.2.1. Logical Document

REQUIRED

Object-Type	{document-logical-root}
Object-Class-Identifier	{AS_8613}
Object-Identifier	{AS_8613}
Object-Class	{OBJECT_CLASS_ID_OF(Logdoc)}

PERMITTED

User-Readable-Comments	{AS_8613}
User-Visible-Name	{AS_8613}
Default-Value-Lists	{AS_8613}
Protection	{AS_8613}

8.2.2. Basic Logical Component, Raster

REQUIRED

Object-Type	{basic-logical-object}
Object-Class-Identifier	{AS_8613}
Object-Identifier	{AS_8613}
Object-Class	{OBJECT_CLASS_ID_OF(Raster)}

PERMITTED

Content-Portions	{AS_8613}
Content-Architecture-Class	{2 8 2 7 2} /* rfp */
Presentation-Style	{STYLE_OF(P-Style3)}
User-Readable-Comments	{AS_8613}
User-Visible-Name	{AS_8613}
Protection	{AS_8613}
Layout-Style	{STYLE_OF(L-Style6)}
Application-Comments	{Tile-Content-Offset}

8.2.3. Presentation Styles for Raster, P-Style3

REQUIRED

Presentation-Style-Identifier	{AS_8613}
Content-Architecture-Class	{2 8 2 7 2} /* rfp */

PERMITTED

Colour	{AS_8613}
Raster-Graphic-Presentation-Attributes	/* see section on raster graphics content */
User-Readable-Comments	{AS_8613}
User-Visible-Name	{AS_8613}

8.2.4. Layout Styles for Raster, L-Style6

REQUIRED

Layout-Style-Identifier	{AS_8613}

PERMITTED

Indivisibility	{AS_8613}
Layout-Category	{AS_8613}
Layout-Object-Class	{AS_8613}
New-Layout-Object	{AS_8613}
Offset	{AS_8613}
Same-Layout-Object	{AS_8613}
Separation	{AS_8613}
User-Readable-Comments	{AS_8613}
User-Visible-Name	{AS_8613}

8.3. Layout Structure

This section defines all of the layout structure constituent constraints. Each constituent constraint has three parts: a list of required (mandatory) attributes; and a list of permitted (optional) attributes; and an optional list of relationships with other constituent constraints.

8.3.1. Generic layout structure

Not Applicable

8.3.2. Specific layout structure

The number of hierarchical levels allowed is 2, namely:

- document layout root; and

- page.

These levels are all mandatory. A single content portion is associated with each page.

8.3.2.1. Document layout

REQUIRED

Object-Type	{document-layout-root}
Object-Identifier	{AS_8613}

8.3.2.2. Page

REQUIRED

Object-Type	{page}
Object-Identifier	{AS_8613}

PERMITTED

Application-Comments	{Tile-Content-Offset} /* This is a structured attribute for tile indexing, see paragraph 8.4.4 */
Dimensions	{NA-A,NA-L,NA-B,NA-C,NA-D,NA-E,NA-F, NA-G,NA-H,NA-J,NA-K,ISO-A0,ISO-A1, ISO-A2,ISO-A3,ISO-A4} /* See table 1, para 8.3.2.4 */
Content-Portions	{AS_8613Adden} /* The contents must be Tiled Raster Format 0 (trf-0). */

8.3.2.3. Dimensions for Page Sizes

The horizontal and vertical dimensions will be the nominal page sizes measured in Basic Measurement Units (BMU) for the various page sizes ISO A0-A4 and North American (NA) A-K. The value of the BMU is equal to 1/1200 of 25.4mm (see ISO 8613/2, paragraph 3.3.4). The allowable BASIC BMU values are identified in the following table.

PAGE SIZE	NOMINAL PAGE SIZE WID x LEN	BMU HORIZONTAL	BMU VERTICAL
- Metric	(mm)		
ISO-A4	210X297	9920	14030
ISO-A3	297X420	14030	19840
ISO-A2	420X594	19840	28060
ISO-A1	594X840	28060	39680
ISO-A0	840X1188	39680	56120
- North American	(inches)		
NA-A	8.5X11	10200	13200
NA-L	8.5X14	10200	16800
NA-B	11X17	13200	20400
NA-C	17X22	20400	26400
NA-D	22X34	26400	40800
NA-E	34X44	40800	52800
NA-F	28X40	33600	48000
NA-G	11X90	13200	108000
NA-H	28X143	33600	171600
NA-J	34X176	40800	211200
NA-K	40X143	48000	171600

TABLE 1. Dimensions for Various Page Sizes

8.4. Tiled Raster Graphics Content Architecture

The Tiled Raster Graphics Content Architecture permits the inclusion in documents of content portions containing tiled raster graphics. Tiled raster graphics represent a two-dimensional pictorial image in the form of a rectangular two-dimensional array of picture elements (pels) divided into non-overlapping regions called tiles. The content architecture is as specified in part 7 of ISO 8613 and its "Addendum."

The Tiled Raster Graphics Content Architecture defines a formatted or formatted processable content architecture. This content architecture class supports Presentation Attributes and Content Portion Attributes. Each attribute comprising this content architecture is specified in subsequent sections in a form that has been defined previously. For each attribute, permissible values are differentiated as BASIC, NON-BASIC and DEFAULT.

8.4.1. <u>Presentation Attributes</u>

These attributes specify constraints and initial conditions relating to the layout and imaging of a tiled raster graphics content portion.

Pel-Path	BASIC	{0 90 180 270}
	NON-BASIC	{NONE}
	DEFAULT	{0}
	/* Direction of the progression of successive pels along a line, relative to the horizontal axis of the basic layout object. */	
Line-Progression	BASIC	{90 270}
	NON-BASIC	{NONE}
	DEFAULT	{270}
	/* Direction of the progression of successive lines, relative to the pel path. */	
Pel-Transmission-Density	BASIC	{1, /* 1200 */ 2, /* 600 */ 3, /* 400 */ 4, /* 300 */ 5, /* 240 */ 6} /* 200 */
	NON-BASIC	{12} /* 100 */
	DEFAULT	{6} /* 200 */
	/* Attribute values are SMU values representing the Pels per 25.4 mm density */	
Initial-Offset	BASIC	{Horizontal offset = any integer, Vertical offset = any integer}
	NON-BASIC	{NONE}
	DEFAULT	{see table 2, 8613/7}

```
Clipping                  {
                  {First-Pair-X-Coordinate
                       BASIC      {AS_8613}
                       NON-BASIC {NONE}
                       DEFAULT    {AS_8613}}
                  {First-Pair-Y-Coordinate
                       BASIC      {AS_8613}
                       NON-BASIC {NONE}
                       DEFAULT    {AS_8613}}
                  {Second-Pair-X-Coordinate
                       BASIC      {AS_8613}
                       NON-BASIC {NONE}
                       DEFAULT    {AS_8613}}
                  {Second-Pair-Y-Coordinate
                       BASIC      {AS_8613}
                       NON-BASIC {NONE}
                       DEFAULT    {AS_8613}}
                            }
                  /* Used to identify the useful portion of an
                  image, say, within an over-scanned image */

Pel-Spacing          {
             {Length          BASIC      {AS_8613}
                              NON-BASIC {NONE}
                              DEFAULT    {4}}
             {Pel-Spaces      BASIC      {AS_8613}
                              NON-BASIC {NONE}
                              DEFAULT    {1}}
                          }

Spacing-Ratio        {
             {Line-Spacing-Value
                              BASIC      {AS_8613}
                              NON-BASIC {NONE}
                              DEFAULT    {1}}
             {Pel-Spacing-Value
                              BASIC      {AS_8613}
                              NON-BASIC {NONE}
                              DEFAULT    {1}}
                          }
```

```
Image-Dimensions
                              BASIC       {CHOICE-OF
     {Width-Controlled        {SEQUENCE-OF
          {Minimum-Width BASIC       {AS_8613}
                              NON-BASIC {NONE}
                              DEFAULT     {NO-DEFAULT}}
          {Preferred-Width
                              BASIC       {AS_8613}
                              NON-BASIC {NONE}
                              DEFAULT     {NO-DEFAULT}}
     }}
     {Height-Controlled       {SEQUENCE-OF
          {Minimum-Height
                              BASIC       {AS_8613}
                              NON-BASIC {NONE}
                              DEFAULT     {NO-DEFAULT}}
          {Preferred-Height
                              BASIC       {AS_8613}
                              NON-BASIC {NONE}
                              DEFAULT     {NO-DEFAULT}}
     }}
     {Area-Controlled         {SEQUENCE-OF
          {Minimum-Width BASIC       {AS_8613}
                              NON-BASIC {NONE}
                              DEFAULT     {NO-DEFAULT}}
          {Preferred-Width
                              BASIC       {AS_8613}
                              NON-BASIC {NONE}
                              DEFAULT     {NO-DEFAULT}}
          {Minimum-Height
                              BASIC       {AS_8613}
                              NON-BASIC {NONE}
                              DEFAULT     {NO-DEFAULT}}
          {Preferred-Height
                              BASIC       {AS_8613}
                              NON-BASIC {NONE}
                              DEFAULT     {NO-DEFAULT}}
          {Aspect-Ratio-Flag
                              BASIC       {variable|fixed}
                              NON-BASIC {NONE}
                              DEFAULT     {NO-DEFAULT}}
          }}
     {Automatic               BASIC       {NO-PARAMETERS}
                              NON-BASIC {N/A}
                              DEFAULT     {N/A}}
          }
                              NON-BASIC {NONE}
                              DEFAULT     {AUTOMATIC}
```

8.4.2. Content Portions Attributes

```
Type-of-Coding              BASIC     { 2 8 3 7 4 }
                                 /*'tiled T6 encoding'*/
                                      { 2 8 3 7 7 }
                                 /*'tiled bitmap encoding'*/
                                      { 2 8 3 7 8 }
                                 /*'tiled T6 and bitmap
                                           encoding'*/
                                 /* ASN.1 object identifiers to
                                 process tiled raster graphics
                                 to be assigned */
                            NON-BASIC {NONE}
                            DEFAULT   { 2 8 3 7 8 }
                                 /*'tiled T6 and bitmap
                                 encoding'*/

Compression                 BASIC     {compressed}
                            NON-BASIC {NONE}
                            DEFAULT   {compressed}
                            /* Uncompressed escape option (extension
                            code) is not supported */

Number-Of-Pels-Per-Line     BASIC     {any positive
                                      integer less than
                                      211,200}
                                      /*see Notes 1 & 2 */
                            NON-BASIC {NONE}
                            DEFAULT   {NONE}

Number-Of-Lines             BASIC     {any positive
                                      integer less than
                                      211,200}
                                      /*see Notes 1 & 2 */
                            NON-BASIC {NONE}
                            DEFAULT   {NONE}

Number-Of-Pels-Per-Tile-Line
                            BASIC     {512}
                            NON-BASIC {NONE}
                            DEFAULT   {512}
                            /* see Note 2 */

Number-Of-Lines-Per-Tile    BASIC     {512}
                            NON-BASIC {NONE}
                            DEFAULT   {512}
                            /* see Note 2 */
```

Note 1: These values are restricted to be positive integers which correspond to an integral number of tiles in the respective dimension. Their values must be no larger than 211,200 which represents the maximum dimensions of a J size drawing at 1200 density.

Note 2: The four attributes Number-Of-Pels-Per-Line, Number-Of-Lines, Number-Of-Pels-Per-Tile-Line, & Number-Of-Lines-Per-Tile can be used to calculate the number of tiles in the image which should not exceed 4096. This provides for the representation of a K size drawing at a Pel-Transmission-Density of 3 SMU (400 dots/inch). The formula for computing the total number of tiles in the image is: (Number-Of-Pels-Per-Line / Number-Of-Pels-Per-Tile-Line) * (Number-Of-Lines / Number-Of-Lines-Per-Tile).

Tile-Type

```
BASIC     {null background,
           null foreground,
           bit map encoded,
           T.6 encoded}
NON-BASIC {NONE}
DEFAULT   {NONE}
```

/* This attribute is used to specify a sequence of integers, one per tile. Each integer specifies the type of coding of the corresponding tile in the content portion. Null indicates an absence of data on either a background color (null background) or a foreground color (null foreground). */

Tiling-Offset

```
{X { BASIC      {AS_8613Adden}
     NON-BASIC {NONE}
     DEFAULT   {0}},
{Y { BASIC     {AS_8613Adden}
     NON-BASIC {NONE}
     DEFAULT   {0}}}
```

/* This is a coordinate pair specifying the location of the pel array within the tile space by defining the offset of the first pel of the pel array from the first pel position of the first tile. */

8.4.3. Application Specific Attributes

Tile-Content-Offset	BASIC	{Sequence of positive integers}
	NON-BASIC	{NONE}
	DEFAULT	{NONE}

/* This attribute consists of a sequence of positive integers, one for each tile. Each integer value will be the distance in bytes from the beginning of the index to the respective tile. The integers will be sequenced in the same order as the tiles. The tiles will be sequenced primarily in the line progression direction and secondarily in the pel path direction as defined by the presentation attributes. */

8.4.4. Document profile attributes

8.4.4.1. Presence of document constituents

REQUIRED

Specific Layout Structure {AS_8613}

8.4.4.2. Document characteristics

REQUIRED

Document-Application-Profile	{ } /* ASN.1 object identifier to be supplied */
Document-Architecture-Class	{formatted}
Content-Architecture-Class	{ } /* ASN.1 object identifier to be supplied */
Interchange-Format-Class	{A}
ODA-Version	{ISO 8613, 1988-XX-XX}
Document-Reference	{AS_8613}
Document-Application-Profile-Defaults	{Dimensions {#horizontal {10200} #vertical {13200}}

NON-BASIC Document Characteristics

PERMITTED

Pel-Transmission-Density	{12} /* 100 SMU */
Dimensions	{NA-A,NA-L,NA-B,NA-C,NA-D, NA-E,NA-F,NA-G,NA-H,NA-J, NA-K,ISO-A0,ISO-A1,ISO-A2, ISO-A3,ISO-A4} /* See table 1, para 8.3.2.4 */

9. DOCUMENT INTERCHANGE FORMAT

The aspects of this document application profile are concerned with the interchange format of large raster graphics documents. These aspects include the data stream, the interchange data units, and ASN.1 encodings.

9.1. Data Stream

The data stream is in accordance with the Office Document Interchange Format Class A, as defined in ISO 8613-5.

The encoding is in accordance with the Basic Encoding Rules for Abstract Syntax Notation One (ASN.1), as defined in ISO 8825.

9.2. ASN.1 Generation and Parsing

This clause covers two distinct aspects of ASN.1 generation and parsing. The first aspect covers ASN.1 practices that are mandatory for an implementation to be conforming to this document. The second aspect covers ASN.1 practices that are recommended by this document. These recommended practices are not mandatory for conformance, but are recommended solely in the spirit of improving interoperability among different implementations.

9.2.1. ASN.1 Generation Requirements

There are no additional requirements, beyond ISO 8824 and ISO 8825, imposed on the ASN.1 generation.

9.2.2. ASN.1 Parsing Requirements

There are no additional requirements, beyond ISO 8824 and ISO 8825, imposed on the ASN.1 parsing.

9.2.3. <u>ASN.1 Generation Recommendations</u>

The focus of the ASN.1 generation recommendations is to generate ASN.1 encodings that will allow parsing by the most rudimentary of implementations. These recommendations are described in the following sub-clauses.

Segmenting Strings

ISO 8825 allows Bit Strings, Octet Strings, and Character Set Strings to be encoded in the Primitive form or in the Constructed form. The choice of which form to use is an option of the encoder. Using the constructed form allows a string to be segmented into a sequence of strings. This sequence of strings is then contained in the constructed form of the string. The constructed form is allowed the use of the indefinite form on content length.

This document recommends that implementations limit the encoding to one level of the constructed form for Bit Strings, Octet Strings, and Character Set Strings.

For example, if of type OCTET STRING, the value '432E436F6D6273'H can be encoded in the primitive form as:

Octet String	Length	Contents
04_{16}	07_{16}	$432E436F6D6273_{16}$

The same value may be encoded in the constructed from as:

Octet String	Length	Contents		
24_{16}	80_{16}			
		Octet String	Length	Contents
		04_{16}	02_{16}	$432E_{16}$
		04_{16}	05_{16}	$436F6D6273_{16}$
		EOC	Length	
		00_{16}	00_{16}	

The same value encoded using two levels of constructed form is not recommended by this Implementors Agreement. An example of an encoding containing two levels of construction is:

Octet String Length Contents
24_{16} 80_{16}

Octet String Length Contents
24_{16} 04_{16}

Octet String Length Contents

04_{16} 02_{16} $432E_{16}$

04_{16} 05_{16} $436F6D6273_{16}$

EOC Length
00_{16} 00_{16}

Length Expression

ISO 8825 allows the content length of an encoding that could be expressed using the short form to also be expressed using the long form. For example, a length of one could be expressed in the short form as 00000001_2 or in the long form as 10000001_2 00000001_2. CCITT Recommendations X.208 and X.209 are identical to ISO 8824 plus Addendum 1 and ISO 8825 plus Addendum 1.

This document recommends that implementations generate content lengths only in their most economical form.

Ordering of Set Members

ISO 8824 defines sets to be unordered lists of values. It is the generator's option to select an order for the values of the set. Since this ordering is unpredictable from one implementation to the next, it is recommended that generators order the values in a set according to the order in which the members appear in the definition of the set. The intent of this recommendation is to reduce the possible interoperability problems associated with the unpredictable ordering of members in a set.

9.2.4. ASN.1 Parsing Recommendations

The overall intent of these parsing recommendations is to allow a high tolerance in the representation of the ASN.1 syntax without jeopardizing the semantics of the information being conveyed. Each of these tolerances is described in a following sub-clause.

Segmented Strings

The ASN.1 generation restriction on segmenting strings is a recommendation of this Implementors Agreement and is not a requirement of ISO 8825. Therefore, it is recommended that implementations accept string encodings which have been segmented into more than one level of the constructed form.

ANNEX A

<u>Format of the values of the attributes "object identifier" and "subordinates".</u>

The object identifiers of the specific layout object descriptions are composed of sequences of numbers, each of these numbers representing a particular level of the specific layout structure.

The number assigned to the specific document layout root object description is "1." The subordinate pages have a second number which uniquely identifies a particular page. The delimiter between "1" and this second number is the "space" character.

Example:

"1 27" corresponding coding: '31 20 32 37'H

The subordinate block identifiers are composed of the identifier of the page to which they belong extended with an additional number which uniquely identifies a particular block. The delimiter between the prefix derived from the page identifier and this additional number is the "space" character.

Example:

"1 27 5" corresponding coding: '31 20 32 37 20 35'H

Content portion identifiers are composed of the identifier of the object to which the content portion belongs and an additional number which uniquely identifies a particular content portion.

Examples:

block description "1 27 5" coding: '312032372035'H
content portion "1 27 5 6" coding: '3120323720352036'H
associated with the block

The value of the attribute "content portion" consists of a sequence of numbers, each of which indicates a content portion of that object. Each of these numbers is equal to the last number in the content portion identifier.

TITLE:	First Working Draft of a Tiled Raster Graphics Addendum to International Standard 8613 Part 7
SOURCE:	ISO/IEC JTC1/SC18 WG5
STATUS OF DOCUMENT:	First Working Draft
PURPOSE OF CONTRIBUTION:	Text proposed as an addendum to International Standard 8613-7
DATE:	November 1988

TABLE OF ADDENDA

INFORMATION PROCESSING - TEXT AND OFFICE SYSTEMS

OFFICE DOCUMENT ARCHITECTURE (ODA) AND INTERCHANGE FORMAT

PART 7: RASTER GRAPHICS CONTENT ARCHITECTURES

TILED RASTER GRAPHICS ADDENDUM

Add the following definition to clause 3 (Definitions) of ISO 8613-7 and/or to the definitions of ISO 8613-1.

3.1 tile

One element of a two dimensional array of non-overlapping rectangular regions of a pel array.

Add the following paragraphs to clause 4.5 (Coding of content information) of ISO 8613-7.

The pel array may be subdivided into a two dimensional array of nonoverlapping rectangular regions called tiles. The content information of each tile is coded independently of the content information of the other tiles of the same pel array.

Tiling facilitates convenient access to, and/or processing of portions of the pel array independent of access to, and/or processing of other portions. It also provides data compression for tiles of uniform pel values.

> NOTE - Tiling provides an alternative method for coding of raster graphics content and therefore does not affect the positioning of the clipped pel array.

Add the following clause after clause 5.4.3 (Positioning rules for formatted processable content) of ISO 8613-7.

5.5 Positioning of tiled pels

Where the pel array is subdivided by tiles, the basic concepts, pel image model and positioning of pels in a basic layout object presented above continue to apply. Furthermore the attributes for pel array clipping continue to apply to the pel array.

The arbitrary location of the pel array in the tile set may result in some tiles being only partially filled with content. The location of pel array content relative to the tile content is specified by the "tiling offset" attribute. Figure 4 illustrates the location of the pel array in the tile set.

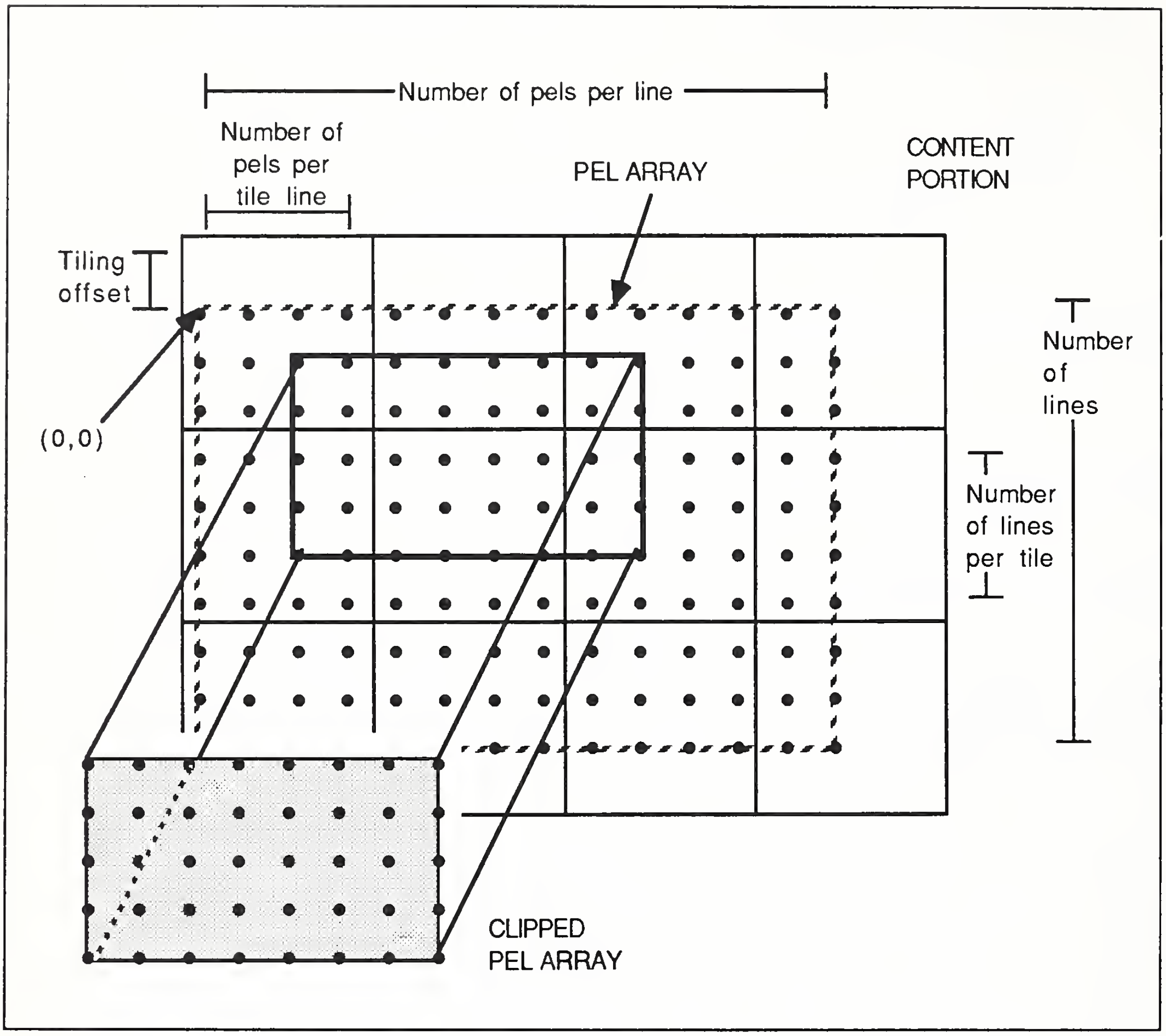

Figure 4 - Example of positioning of tiled pels within a basic layout object

A tile is defined by referencing either the pel positioning coordinate system or the pel identification coordinate system associated with the following values:

Abbreviation	Description
npl	number of pels per line
nl	number of lines
nptl	number of pels per tile line
nlt	number of lines per tile
ls	line spacing
ps	pel spacing
ntppd	number of tiles in the pel path direction
ntlpd	number of tiles in the line progression direction
toppd	tile offset in the pel path direction
tolpd	tile offset in the line progression direction

In the pel positioning coordinate system a tile is that part of the pel array consisting of all pels whose reference points have coordinates (x,y) such that:

$$xp+(i*nptl*ps) <= x < xp+((i+1)*nptl*ps)$$

and

$$yp+(j*nlt*ls) <= y < yp+((j+1)*nlt*ls)$$

where

- i and j are non-negative integers,
- xp and yp are the coordinates of the initial point
- all non-integer values arising in coordinate computations are rounded up to an integer number of SMUs.

In the pel identification coordinate system a part of the pel array consisting of all pels with coordinates (x,y) such that:

$$i*nptl <= x <= ((i+1)*nptl)-1$$

and

$$j*nlt <= y <= ((j+1)*nlt)-1$$

for some non-negative integers i and j.

These equations define a set of tiles as two dimensional array of non-overlapping rectangles of equal size. The tile set is superimposed on the pel array such that each tile overlays a portion of the pel array. Tiles at the periphery of the pel array are not required to completely overlay the pel array. The vertical and horizontal extent of the tile set may overlap the pel array consistent with the following equations:

$$ntppd = INT((npl+toppd)/nptl)+1$$

and

$$ntlpd = INT((nl+tolpd)/nlt)+1$$

where

- INT signifies numerical truncation yielding the unrounded integer portion of a real number.

Add the following to the end of the permissible value list in clause 7.1.1 (Type of coding) of ISO 8613-7.

{ 2 8 3 7 4 } for 'tiled T6 encoding',
{ 2 8 3 7 5 } for 'tiled T4 one dimensional encoding',
{ 2 8 3 7 6 } for 'tiled T4 two dimensional encoding',
{ 2 8 3 7 7 } for 'tiled bitmap encoding',
{ 2 8 3 7 8 } for 'tiled T4, T6 or bitmap encoding'

Add the following to the end of the list of dashed items in the definition area of clause 7.1.1 (Type of coding) of ISO 8613-7.

- 'tiled T6 encoding', according to the tiling scheme defined herein and the two dimensional encoding scheme defined in CCITT Recommendation T.6;

- 'tiled T4 one dimensional encoding', according to the tiling scheme defined herein and the one dimensional encoding scheme defined in CCITT Recommendation T.4;

- 'tiled T4 two dimensional encoding', according to the tiling scheme defined herein and the two dimensional encoding scheme defined in CCITT Recommendation T.4;

- 'tiled bitmap encoding', according to the tiling scheme defined in this standard and the bitmap encoding scheme;

- 'tiled T4, T6 or bitmap encoding' according to the tiling scheme defined herein, the bitmap encoding scheme, the two dimensional encoding scheme defined in CCITT Recommendation T.6, or the one or two dimensional encoding scheme defined in CCITT Recommendation T.4.

Add the following paragraphs after the line beginning "An explanation of these coding schemes ..." in clause 7.1.1 (Type of coding) of ISO 8613-7.

The value 'tiled T6 encoding' indicates that all tiles in the content portion are encoded per the two dimensional encoding scheme defined in CCITT Recommendation T.6.

The value 'tiled T4 one dimensional encoding' indicates that all tiles in the content portion are encoded per the one dimensional encoding scheme defined in CCITT Recommendation T.4.

The value 'tiled T4 two dimensional encoding' indicates that all tiles in the content portion are encoded per the two dimensional encoding scheme defined in CCITT Recommendation T.4.

The value 'tiled bitmap encoding' indicates that all tiles in the content portion are encoded per the bitmap encoding scheme defined in ISO 8613-7.

The value 'tiled T4, T6 or bitmap encoding' indicates that the tiles in the content portion are each encoded per the value of the associated "tile types" attribute as defined in 7.2.8.

Add the following paragraph to the REMARKS of clause 7.1.1 (Type of coding) of ISO 8613-7.

For bitmap and untiled and tiled T.4 and T.6 encoding the relationship between the order of pels, the order of encoded bits within an octet and the order of encoded octets shall be consistent with the pel array order specified in the document profile.

Add the following line to clause 7.2.1 (Compression) of ISO 8613-7.

This attribute is also applicable if the value of the attribute "type of coding" is 'tiled T6 encoding', 'tiled T4 one dimensional encoding', 'tiled T4 two dimensional encoding' or 'tiled T4, T6 or bitmap encoding'.

Add the following four clauses after clause 7.2.4 (Number of discarded pels) of ISO 8613-7.

7.2.5 Number of lines per tile

CLASSIFICATION: Defaultable

APPLICABILITY: Formatted processable content architecture class

PERMISSIBLE VALUE: Positive integer

DEFAULT VALUE: 512

DEFINITION:

This attribute specifies the tile dimension in units of "line spaces" in the direction of line progression.

REMARKS:

This attribute is only applicable if the value of the attribute "type of coding" is 'tiled T6 encoding', 'tiled T4 one dimensional encoding', 'tiled T4 two dimensional encoding' or 'tiled T4, T6 or bitmap encoding'.

7.2.6 Number of pels per tile line

CLASSIFICATION:	Defaultable
APPLICABILITY:	Formatted processable content architecture class
PERMISSIBLE VALUE:	Positive integer
DEFAULT VALUE:	512

DEFINITION:

This attribute specifies the tile dimension in units of "pel spaces" in the pel path direction.

REMARKS:

This attribute is only applicable if the value of the attribute "type of coding" is 'tiled T6 encoding', 'tiled T4 one dimensional encoding', 'tiled T4 two dimensional encoding' or 'tiled T4, T6 or bitmap encoding'.

7.2.7 Tiling Offset

CLASSIFICATION:	Defaultable	
APPLICABILITY:	Formatted processable content architecture class	
STRUCTURE:	Coordinate pair:	X coordinate, Y coordinate,
PERMISSIBLE VALUES:	Coordinate pair:	non-negative integer less than 'number of pels per tile line', non-negative integer less than 'number lines per tile',
DEFAULT VALUE:	(0,0)	

DEFINITION:

This attribute specifies the location of the pel array within the tile space by defining the offset of the first pel of the pel array from the first pel position of the first tile. The offset is specified in pel spaces in the direction of the pel path and line spaces in the direction of the line progression.

REMARKS:

All tiles cover a portion of the pel array. Portions of the tile space outside the pel array are artifacts of tiling and contain no information.

This attribute is only applicable if the value of the attribute "type of coding" is 'tiled T6 encoding', 'tiled T4 one dimensional encoding', 'tiled T4 two dimensional encoding' or 'tiled T4, T6 or bitmap encoding'.

7.2.8 Tile types

CLASSIFICATION:	Defaultable
APPLICABILITY:	Formatted processable content architecture class
PERMISSIBLE VALUES:	'null background', 'null foreground', 'bitmap encoded', 'T6 encoded', 'T4 one dimensional encoded', 'T4 two dimensional encoded'
DEFAULT VALUE:	All tiles have content and are encoded according to the value of the attribute "type of coding".

DEFINITION:

This attribute indicates the types of coding of tiles in the content portion. The value of this attribute is a sequence of integers. Each integer specifies the type of coding of the corresponding tile in the content portion. The possible values of each integer are:

- 'null background', indicating that all pels in the tile are known to be background and the tile has no encoded content,

- 'null foreground', indicating that all pels in the tile are known to be foreground and the tile has no encoded content,

- 'T6 encoded', indicating that the pels in the tile are encoded as a T.6 primitive octet string,

- 'T4 one dimensional encoded', indicating that the pels in the tile are encoded as a T.4 one dimensional primitive octet string,

- 'T4 two dimensional encoded', indicating that the pels in the tile are encoded as a T.4 two dimensional primitive octet string,

- 'bitmap encoded', indicating that the pels in the tile are encoded as a bitmap primitive octet string.

REMARKS:

If the attribute "tile types" takes its default value, then there are no null tiles and all tiles are encoded as either T.6, T.4 one dimensional, T.4 two dimensional or bitmap according to the value of the attribute "type of coding."

This attribute is only applicable if the value of the attribute "type of coding" is 'tiled T6 encoding', 'tiled T4 one dimensional encoding', 'tiled T4 two dimensional encoding' or 'tiled T4, T6 or bitmap encoding'.

Add the following to clause 7.3.1 (Content information) of ISO 8613-7.

Tiled raster graphics content information is a sequence of octet strings representing those portions of the pel array contained by non-null tiles. The sequence of tiles is ordered in the direction of the pel path and line progression as illustrated in Figure 7.1

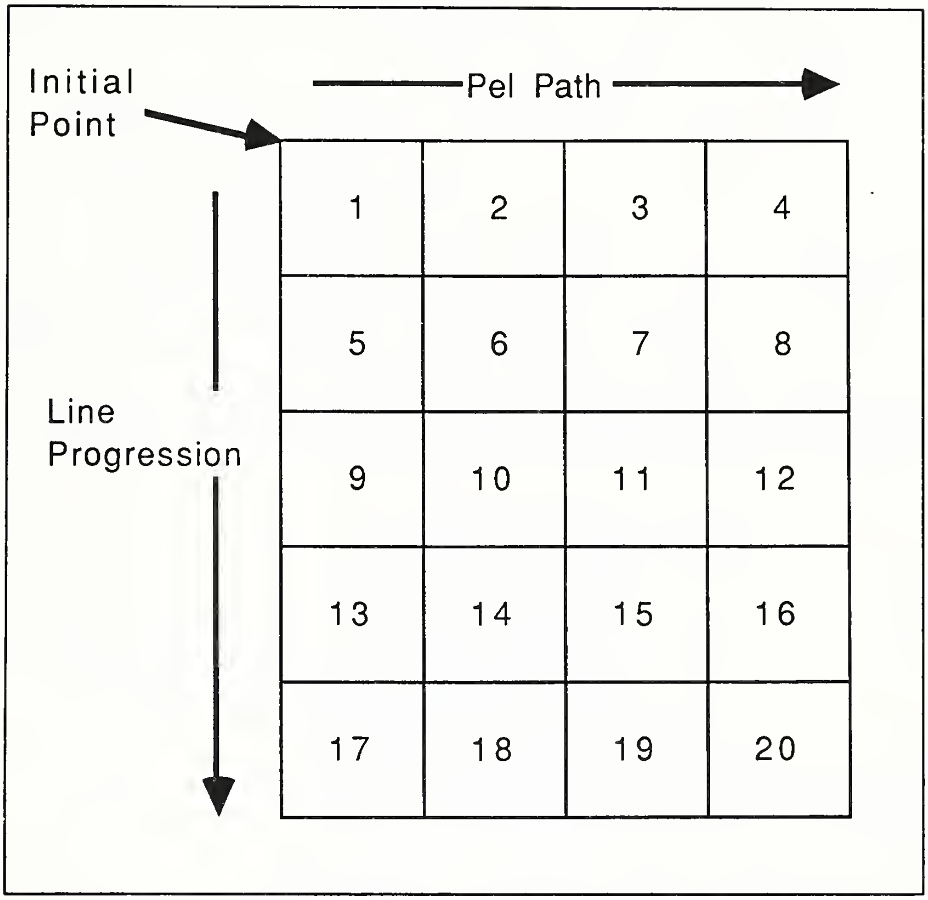

Figure 7.1 Tile Attribute and Content Ordering

The coding attributes describe the type of coding for each tile. The octet string describing the content portion of the tile may be T.4, T.6, bitmap or may be absent. If a null coding is specified then no content is associated with the tile.

Add the following to the list of EXPORTS in clause 8.3 (Representation of coding attributes) of ISO 8613-7.

Tile-type;

IMPORTS Measure-Pair

Add the following to "Raster-Gr-Coding-Attributes" in clause 8.3 (Representation of coding attributes) of ISO 8613-7.

```
number-of-pels-per-tile-line   [4] IMPLICIT INTEGER
                                          OPTIONAL,
number-of-lines-per-tile       [5] IMPLICIT INTEGER
                                          OPTIONAL,
tiling-offset                  [6] IMPLICIT Measure-Pair
                                          OPTIONAL,
tile-types                     [7] IMPLICIT SEQUENCE OF
                                      Tile-type OPTIONAL }
```

Add the following after the "Compression" definition in clause 8.3 (Representation of coding attributes) of ISO 8613-7.

```
Tile-type                 ::= INTEGER {
                          null background(0),
                          null foreground(1),
                          T.6 encoded(2),
                          T.4 one dimensional encoded(3),
                          T.4 two dimensional encoded(4),
                          bitmap encoded(5) }
```

Add the following after "pel array" in the first line of clause 9 (Coding schemes) of ISO 8613-7.

or tile

Add the following to Table 6 in clause 12 (Definition of raster graphics content architecture classes) of ISO 8613-7.

Number of pels per t'line	-	D3)
Number of lines per tile	-	D3)
Tiling offset	-	D3)
Tile types	-	D3)
NOTE 3-This attribute is only applicable if the value of the attribute "type of coding" is tiled encoding.		

Add the following to clause A.2.2 of the Annexes of ISO 8613-7.

[Type of coding]	Tiled T6 encoding Tiled T4 one dimensional encoding Tiled T4 two dimensional encoding Tiled bitmap encoding Tiled T4/T6/bitmap encoding	
Number of pels per tile line	Any non-negative integer	512
Number of lines per tile	Any non-negative integer	512
Tiling offset Coordinate Pair	(Any non-negative integer, less than 'number of pels per tile line', Any non-negative integer less than 'number of lines per tile')	(0,0)
Tile types	sequence of positive integers	According to the value of the attribute "type of coding".

NOTE 2 - The attribute "compression" is also applicable if the value of the attribute "type of coding" is 'tiled T6 encoding', 'tiled T4 two dimensional encoding', 'tiled T4 one dimensional encoding' or 'tiled T4, T6 or bitmap encoding'.

Add the following to the item list in Annex B of ISO 8613-7.

- RP-2 is an example of a content architecture level belonging to the formatted processable content architecture class utilizing tiling. Content pertaining to this level may be laid out using the fixed dimension layout method.

Add the following to the end of Annex B of ISO 8613-7.

B.5 Raster graphics content architecture level RP-2

RP-2 is a raster graphics content architecture level derived from the formatted processable content architecture class utilizing tiling; it is laid out using the fixed dimension method of the processable content layout process.

B.5.1 Presentation attributes

ATTRIBUTE	BASIC VALUES	NON-BASIC VALUES	DEFAULT VALUE
Pel path	0, 90, 180, 270 deg	None	Standard Default Value
Line progression	90, 270 deg	None	Standard Default Value
Pel spacing	(Any positive integer, any positive integer) SMU	None	Standard Default Value
Spacing ratio	(Any positive integer, any positive integer)	None	Standard Default Value
Clipping		None	Standard Default Value
First pair	(Any non-negative integer, any non-negative integer)		
Second pair	(Any non-negative integer, any non-negative integer)		

B.5.2 Content portion attributes

ATTRIBUTE	BASIC VALUES	NON-BASIC VALUES	DEFAULT VALUE
Number of pels per line	Any positive integer	None	None
Number of lines	Any positive integer	None	None
Type of coding	tiled T4, T6 or bitmap encoding	tiled T6 encoding tiled T4 encoding (one-dimensional) tiled T4 encoding (two-dimensional)	Standard Default Value
Compression see note 1	Compressed as in T.6	Uncompressed as in T.6	Standard Default Value
Number of pels per tile line	Any non-negative integer	None	Standard Default Value
Number of lines per tile	Any non-negative integer	None	Standard Default Value
Tiling offset	(Any non-negative integer, any non-negative integer)	None	Standard Default Value
Tile types	sequence of positive integers	None	Standard Default Value

NOTE 1 - The attribute "compression" is only applicable if the value of the attribute "type of coding" is 'tiled T6 encoding', 'tiled T4 two dimensional encoding', 'tiled T4 one dimensional encoding' or 'tiled T4, T6 or bitmap encoding'.

APPENDIX A

TILING TASK GROUP (TTG)
LIST OF MEMBERS
AS OF NOVEMBER 30, 1988

TILING TASK GROUP (TTG)
LIST OF MEMBERS
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Wallace, John F.	IBM - Federal Systems Division
Weisinger, Dick	ViewStar Corporation
Wilson, Charles	Qubix Graphic System
Witten, Neil	Delta Resources, Inc.
Young, Joyce	previously with Impell Computer Systems
Younger, Henry L	U.S. Army

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10. SUPPLEMENTARY NOTES

☐ Document describes a computer program; SF-185, FIPS Software Summary, is attached.

11. ABSTRACT *(A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here)*

This document is a compilation of five separately prepared, but interrelated, reports which discuss aspects of raster image processing, primarily as they relate to a standard tiling scheme being developed to support the interchange of large raster images. The first report provides the reader with a brief introduction to raster graphics and the current standards used to support raster graphics applications. The second provides the reader with a non-technical overview of the tiling scheme. The third report describes the user's requirements for tiling that were identified by an ad hoc Tiling Task Group (TTG). The fourth report, a Document Application Profile, presents information about all the attributes pertaining to a tiling application. The fifth report is a proposed addendum to an ANSI standard which is required to support the tiling scheme.

12. KEY WORDS *(Six to twelve entries; alphabetical order; capitalize only proper names; and separate key words by semicolons)*

application profile; digitized images; image processing; office document processing; raster graphics; standard tiling scheme; tiles.

13. AVAILABILITY

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