FlashPix™ *format*

and Architecture

White Paper

Kodak

The *FlashPix*™ format will be defined in a specification and a test suite, developed and published by Eastman Kodak Company in collaboration with Hewlett-Packard Company, Live Picture Inc. and Microsoft Corporation. Only products that meet the specification and pass the test suite may use the *FlashPix* file format name.

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Introduction

Starting Christmas 1996, people will find it easier and more fun to use and share pictures on their current home computers. They'll discover ways to take pictures further, using "smart" applications and peripherals that make digital imaging irresistible for everyday computer users and more productive for experienced image users. The new capabilities are the result of a completely new philosophy of digital imaging introduced on June 3, 1996.

The purpose of this White Paper is to provide an overview of the FlashPix™ *architecture for software developers, analysts, business managers, product marketing managers and other people who track important developments in imaging technology. It is organized into two parts:*

- *An* **executive summary** *(pp. 4-15) describes the initiative, the needs it addresses, how it developed and the marketing opportunities it creates.*
- *A* **ten-minute technical tour** *(pp. 16-27) provides a technology overview of the* FlashPix *imaging model and the features of the format.*

The Philosophy of *FlashPix* technology
–Executive Summary

FlashPix technology is based on a new philosophy of what digital imaging should be. For everyday computer users, it will make using digital pictures practical and fun, easy and straightforward, without requiring expensive computer hardware upgrades for hard drives or processors, or increases in RAM. For existing digital imaging users, it will mean higher productivity and new capabilities for collaborating with colleagues and customers on-line. In fact, the *FlashPix* architecture represents the first unified approach to serving a full spectrum of digital imaging applications.

This new approach will drive the development of "smart" products and services that take the frustration and guesswork out of digital imaging. Images in *FlashPix*-optimized applications will burst on-screen, transform instantly when edited, move rapidly over phone lines and look great coming off the printer. Users won't need high-powered computers, or esoteric software applications that require a degree in graphics and computer science, or lots of time to wait as their images slowly paint on screen.

Eastman Kodak Company collaborated with **Hewlett-Packard Company**, **Live Picture, Inc.** and **Microsoft Corporation** to develop the *FlashPix* architecture and the new image format that serves as its centerpiece. All four companies contributed key technologies. In addition, companies such as **Apple**, **Canon**, **IBM** and **Intel** provided valuable technical feedback. Kodak owns the *FlashPix* format specification, reference implementation and interoperability test suite. Only products that meet the specification and pass the test suite to be published by Kodak may use the *FlashPix* file format name. The *FlashPix* format specification will be open and available to all developers, with tools to help them incorporate its features to meet the needs of their customers.

The *FlashPix* architecture doesn't change the fact that representing high-quality color images electronically generates large data files compared to text. But it recognizes that most users don't need most of that data most of the time. Just as smart travelers don't load a moving van for a weekend at the beach, *FlashPix*-optimized applications will automatically process only the data each activity needs. *FlashPix* images offer multiple resolution levels, and edits are applied only to the specific areas of an image being changed.

The *FlashPix* architecture also lets people use the same image any number of ways, without processing or storing large files each time. Multiple views of an image can be stored without copying the image data. The new file stores the data that defines the unique view and is then linked to the file containing the original image data — so the image data file need not be duplicated, and the full-resolution image file is only processed when it's needed, usually for high-quality output. This capability takes the *FlashPix* architecture beyond software and hardware products, and opens up new possibilities for on-line image sharing, network image services and "while-you-wait" imaging kiosks.

FlashPix technology creates a new kind of digital imaging.

- ***It's easy***. The *FlashPix* experience is intuitive, so users don't need to learn complex imaging technology and terms.
- ***It's fast***. Users can work with large image files easily — opening, displaying and editing them rapidly, and seeing results immediately.
- ***No upgrades required.*** The CPU power and memory of a standard multimedia PC is all users need to get the full benefit of *FlashPix*-optimized applications.
- ***It plays well***. The *FlashPix* format provides exceptional interoperability, functioning as a universal link between computers, software and peripherals.
- ***It prints accurately***. People get the results they expect when printing, with no surprises in image quality or color.
- ***It's more fun***. Developers will use *FlashPix* technology to create products that combine the fun of pictures with the convenience of today's word-processing and e-mail applications.
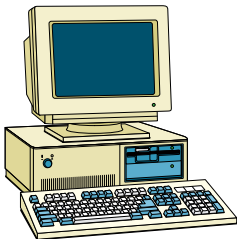
Market opportunity

The *FlashPix* architecture overcomes the barriers that have confined digital imaging exclusively to the desktops of professionals and "power users" until now. It will create business opportunities for the computer, photographic and telecommunications industries, as content providers and output service companies realize its benefits.

For digital imaging professionals *FlashPix* technology combined with the *Photo CD* format, will in time, mean expanded productivity and capabilities, including on-line collaboration with colleagues and customers.

People love pictures. People love computers

People take and use billions of pictures each year to communicate information and emotions — from the photos we send to Grandma, to the real estate sheets that help sell houses, to the newspapers and magazines that tell us about our world.

Computer technology also has gained enormous popularity as a source of home entertainment and as a business tool. More than 200 million personal computers (IBM compatibles and Apple *Macintosh* computers) have been sold to consumers and businesses since 1990 — and last year, US consumers purchased more home computers than television sets. Color monitors have become standard with most home computers. Although many industry observers predict flattening growth in PC sales in homes and offices, the *FlashPix* architecture has the potential to generate renewed interest in, and utilization of, computer products.

More than 200 million personal computers sold since 1990.

Today, computers also provide an efficient way to share and obtain information. There were more than 10 million subscribers to commercial on-line services in early 1996, and tens of millions more worldwide are surfing the Internet. In 1995, the number of e-mail transactions in the US surpassed the number of pieces of mail delivered by the US Postal Service.

But few people love using pictures on computers

With today's technology, using images on computers should be as natural as apple pie and ice cream. Processors are more powerful, and a variety of color printers provide good-looking output at an affordable price. What's more, digital images are easier to get — through image databases, businesses that provide *Photo CD* discs or pictures on floppy disks, or through affordable desktop peripherals. Desktop scanners cost as little as $100, and digital camera prices also are dropping dramatically.

When shown prototypes of software products and photography services that create composite pictures, and sample prints, over 60 percent of the average computer users surveyed said they would be willing to buy such products. The explosion of interest in the Internet generated by pictures on the World Wide Web is another indication of the potential power of digital imaging.

But for most people, their love of pictures has not yet been married with their growing affection for computers. In fact, most people haven't even tried using pictures on computers. For example: The installed base of *Windows*-system home computers will be more than 100 million by the end of 1996; just over 1 million units of photo editing software will be installed on those computers. Only four percent of PC owners use digital photographs; 85 percent have never even viewed a personal digital image on the desktop.

Why isn't digital imaging popular?

Although today's technology makes it *possible* for average computer users to work with pictures, current imaging paradigms make it difficult. And the absence of compelling products and services hasn't made it desirable enough.

I. *It's expensive.*

Cost is one reason most computer users don't work with pictures.

Although getting images into computers is affordable, the hardware and software for working with high-quality images isn't. Today's image users make significant investments in high-powered hardware and imaging software that typical computer users aren't willing to make.

II. *The performance is disappointing.*

Reading and displaying multi-megabyte image files is a computation-intensive process — no problem for a high-powered graphics workstation, but slow and cumbersome on a standard desktop computer with 8 or 16 MB of RAM. First-time image users are often disappointed when their applications become sluggish as they add images — screen refreshing takes several seconds, and processing takes several minutes even after a minor edit.

Printing images tends to be another disappointing experience for average computer users. The process can be painfully slow. Low-resolution images work fast, but image quality and color are inconsistent at best, and often completely unacceptable.

III. *It's not rocket science, but it's tough.*

The learning curve is another difficult challenge facing non-professionals who want to use digital images.

When average computer users first try digital imaging, a dizzying alphabet soup of technical terms and buzz words bombard and confuse them. What's an aspect ratio? How many lines per millimeter, or dots per inch are needed to make the picture look right? And when a new scanner or application offers a choice of resolutions, which one is best?

People who try to print their digital images face another confusing set of issues. How many pixels does it take to print a 5 x 7-inch picture? I have a picture of my son's softball team — is that a portrait or a landscape? And what are these color rendering options all about? Few first-timers know how to determine the appropriate picture resolution, color matching and calibration to get the desired output.

An opportunity missed

These barriers explain the low penetration of digital imaging products among consumers, small businesses and other typical computer users. In fact, imaging customers can be divided into three broad categories.

- *The Power Users:* Professionals and other imaging veterans have the knowledge, high-powered hardware and software they need to navigate current imaging technology, but they represent a small minority.

- *The Frazzled Few:* Some average users have tried digital imaging only to be frustrated by a complex array of image formats, resolutions, slow performance, inconsistent color output and inadequate storage. A fraction of them invest the time and money to become "Power Users," but most simply give up on using digital images.

- *The Unsold Masses:* The vast majority of computer users haven't even tried to use pictures. They think of computers as tools for word processing, producing spread sheets, sending e-mail and playing games.

Enter the *FlashPix* architecture

The potential market for digital imaging convinced four industry leaders to pool their talents to transform imaging from a specialized activity for "Power Users" into a practical and popular activity for the "Frazzled Few" and the "Unsold Masses." In early 1995, Eastman Kodak Company, Hewlett-Packard Company and Live Picture, Inc., Microsoft Corporation joined together to develop a standard that achieves this goal. All four companies share a vision that digital imaging can be as common on standard PCs as word processing, and as popular as the games and educational products that prompt families to purchase PCs today.

They realized that to reach this untapped market, it's not enough simply to remove the technical barriers to digital imaging. There must be compelling products that inspire people to try digital imaging — products that would let the "Frazzled Few" and the "Unsold Masses" have fun with their pictures as easily as they type e-mail messages and annihilate the villains of Doom. Kids could create their own posters and party invitations, parents could send family pictures electronically and small businesses could advertise more creatively. Beyond what people could do at their desktop with their own hardware peripherals and software, people could take advantage of innovative photo and output services, from walk-up kiosks to on-line networks.

With these capabilities available on today's PCs, digital imaging could take off in the next decade the way word processing did in the past 10 years with the advent of scaleable fonts and laser printers. The result of the originating companies' work is the *FlashPix* architecture.

An open opportunity for developers

The initiative to establish the *FlashPix* format as an industry standard will be expanded over time to embrace even more collaborators to establish broad support and the capabilities of the platform. Already many leading solution providers have announced their support for establishing this new digital imaging paradigm. *(See the Kodak World Wide Web site for a press release quoting supporting companies.)*

The *FlashPix* architecture provides the foundation for generations of compelling products and services that interact smoothly with each other and with end-users.

Industry Support

$+$

Open, available specifications

$+$

Clearly defined licensing terms

$+$

Robust developer kits

Supporters of the *FlashPix* technology are committed to making the *FlashPix* format an open and available industry standard. Many of these companies will introduce *FlashPix*-optimized products and services by the end of 1996.

Product developers will find the information and tools they need to take advantage of the *FlashPix* format readily available. The new format specifications will be freely available on the Internet in the fall of 1996, with availability of robust developer toolkits at the same time. Implementation tools and an interoperability test suite also will be available through developer channels.

Users of these tools will find clear, explicitly defined licensing terms and full access to all of the technical information required to support the *FlashPix* format. Developers can take advantage of *FlashPix* technology in one of two ways:

- The tools will make it easy for developers to provide the full "*FlashPix* experience" to their customers, by taking complete advantage of the technology. Kodak will encourage the development of optimized products that more fully take advantage of the format's features and offer a robust set of end-user benefits, such as those described above.

- Developers can add *FlashPix* -format read/write capabilities, or provide a partial "*FlashPix* experience" using a proxy image approach.

Any product that reads or writes images in the *FlashPix* format as defined in Kodak's specification and test suite will be able to use the *FlashPix* format name and carry the format logo.

This high level of industry support will jump-start interest in the new format — facilitating widespread awareness and a significant number of *FlashPix*-optimized products and services. Consumers will associate the *FlashPix* format name with high-quality products and services that make it easy to work with pictures.

Average computer users will get the *FlashPix* experience — a completely new way to work with pictures that's easy, fun and practical. Solutions that take full advantage of *FlashPix* technology will transform the "Frazzled Few" and "Unsold Masses" into new customers for digital imaging software, peripherals and services.

People will find that using pictures is as easy as working with text, and a lot more fun. They will have reasons to combine their love of pictures with the enjoyment and convenience of computer technology.

The new format will serve as a framework for long-term growth in the digital imaging industry. The *FlashPix* architecture will bring the benefits of digital imaging to a new group of uninitiated users. As it unleashes the creativity of developers and their customers, it will help to spawn new products and capabilities for taking pictures further on computers.

Before *FlashPix* technology

Another way to understand the benefits and potential of *FlashPix* technology is to compare the experience of working with *FlashPix*-optimized products with the imaging experience end-users have today.

Janice, a real estate rental agent with creative flair, is not a graphic artist or an imaging professional. Although she's competent and enjoys using her IBM compatible computer, she faces a formidable challenge when trying to create a striking sales document with color pictures and text.

She selects a 1024- x 2048-pixel (6 MB) TIFF image to import into her word processing program, because it looks good on screen. The image takes two or three minutes to load, and the software application becomes sluggish as she tries to add text. When using drawing software to crop the image and adjust the horizon and color, Janice experiences further delays; processing time for each edit is three-to-five minutes.

It takes another ten minutes for Janice to save the file, place it back into her word processing document, then print the page on her color inkjet printer. Once saved in a randomly selected format, the file consumes 6 MB of her hard disk.

Janice spends almost an hour to bring two photos into her document. In the end, she's unhappy because the color of the final output is inconsistent with her on-screen version, and the only explanation she can imagine is that her printer might be malfunctioning.

After *FlashPix* technology
A new world of images for end-users

Janice has heard how new *FlashPix*-optimized products and services make working with images on computers as easy as working with text. Despite her previous experience, she decides to try digital imaging again with a similar document.

Janice has her images digitized and stored on a Writable CD in the *FlashPix* format. She uses *FlashPix*-optimized software specially designed with ready-made templates for business and consumer users. The easy-to-use software loads the first image within seconds; Janice is not required to select a resolution level. The picture is automatically sized to fit the frame selected in the document. Janice discovers she can enter text as fast as she can type.

As she works, Janice decides she would like to make some minor edits to her picture. The software presents simple editing tools when Janice double-clicks on the picture, enabling her to crop, edit and adjust the color. The image is updated in seconds. With the *FlashPix* format and software, the file saves in a matter of seconds, writing only 2 KB of disk space, and Janice realizes she can easily use more images than in her previous document.

This time when Janice prints, the color is correct and the resolution is ideal for her printer. Printing takes several minutes, but is performed in the background, so Janice can continue using her computer. The entire activity — from launching the software to output — takes less than a half hour, and it's both fun and rewarding.

The future of *FlashPix* technology

Kodak is committed to making the *FlashPix* architecture a universally accepted industry standard by maintaining the purity of the new format. The originating companies will ensure that the format is openly available and changed only through a process of fair industry participation and collaboration. Kodak intends to establish an advisory process to create and review future enhancements to the *FlashPix* format standard.

Developers can add proprietary information in the Structured Storage container without damaging a *FlashPix* file's compatibility with any *FlashPix*-enabled reader. Kodak will enable public extensions for popular additional features, such as audio, to promote and maintain *FlashPix* format standards.

How *FlashPix* technology works — the 10-minute technical tour
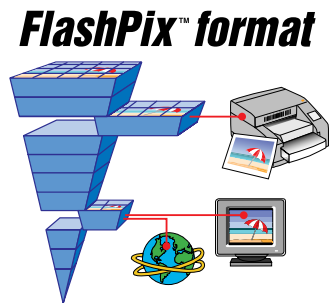
FlashPix™ format

FlashPix technology provides a new imaging architecture that will make using pictures on computers faster, easier and more intuitive. It incorporates many features from existing architectures or image formats, and adds new technology to optimize the *FlashPix* format for a full spectrum of imaging needs.

FlashPix technology will support images of any size, captured at any resolution. Images in *FlashPix* files are stored at multiple independent resolutions, and each resolution is sub-divided into square tiles. These features allow applications to select the appropriate resolution a user needs for a selected procedure, and to access directly the specific areas of an image needed for the operation being performed. No longer do applications have to process the entire image in order to view a small section, nor process a high-resolution image to produce a low-resolution display. Edits are applied to high-resolution images only when necessary — usually when users want high-quality output, have clicked the print button and are done interacting with their image.

An edit, layout choice or other use of an image, called an image view, is stored as a small script separate from the image data itself. The script and image data are wrapped inside a structured storage "container." Microsoft's *OLE* Structured Storage enables software to store a variety of information types easily — such as scripts, image data, ownership information, color management data, etc. — all in one convenient single file. This file is interoperable with existing structured storage architectures, such as *OLE* II and *OpenDoc*, as well as *JAVA* and Netscape *Navigator* plug-ins. To display or print the edited version, a *FlashPix*-optimized application applies the changes described in the image view script to the appropriate resolution of the original image data.

In the *FlashPix* architecture, people can use and modify an image in any number of ways, but store the original high-resolution image data in only one place. Computers won't process the complete file to display an image and will employ only the resolution level required for the selected view and monitor size. Software applications won't have to convert between "interchange formats" (such as TIFF) used outside the application and proprietary "representation formats" used within. They can use the *FlashPix* format exclusively as the application workspace as well as the

interchange format. And changes to images will take place faster, because only affected tiles have to be adjusted before processing.

The vehicle for delivering on the technology's promise — and for bringing digital imaging to the consumer market — will be a new generation of "smart" imaging products and an extensible file format that enables the products to interoperate easily. This "10-minute tour" describes the *FlashPix* technology on which those products will be based, including technical benefits and features of the *FlashPix* file format.

Technical benefits of *FlashPix* technology

For most end-users, the key benefit of *FlashPix*-optimized applications will be the technology they *don't* see. They'll have fun editing, e-mailing, printing and playing with their images — without worrying about how it all works, using their current home and office computers.

For the developers who provide those benefits, the *FlashPix* architecture offers a number of advantages over today's imaging options. By providing the "*FlashPix* experience," developers can dramatically improve the capabilities they provide today's customers ... and reach a mass market of new customers by making digital imaging convenient, fun and fast.

Many of the technical benefits assist all users of *FlashPix*-optimized products, regardless of their individual needs.
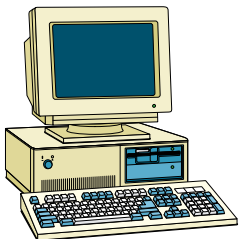
- *It's not power-hungry.* End-users can get the *FlashPix* experience with a standard multimedia PC — a 486 or *Pentium* processor (or *Macintosh* 68030 or *PowerMac* computer) with 8 or, preferably, 16 MB of RAM, 200 to 500 MB hard disk storage and a CD-ROM drive. For developers, that translates to new potential customers in the tens of millions.

- *The image connects the workflow.* Each *FlashPix* file is a transportable image object that can be used by digital cameras, scanners, scanning services, applications, printers, printing services, on-line services and databases. The technology is

designed to provide a universal standard that can connect the entire imaging workflow. It eliminates the need to convert from interchange formats to proprietary image formats, reducing application memory requirements by up to 95 percent.

Printing is predictable

- ***Printing is predictable.*** Users will get the results they expect when printing *FlashPix* files from *FlashPix*-enabled applications, with no unpleasant color surprises. All the source and color information present at capture can be stored in the *FlashPix* file, and is maintained throughout image manipulation and printing.

- ***Using pictures takes less RAM and disk space.*** Users will realize significant storage savings when they work with *FlashPix* images. Applications can save multiple uses of the same image as image view scripts or store low-resolution/ screen-resolution versions along with a link to the original image file. This allows direct access to the low-resolution image for sharing and viewing, without being hindered by the high-resolution data of the original image. Either of these can be linked to the original image data, so that edits can be applied when needed to any available resolution.

- ***Multiple images display easily.*** Users can work with many images on-screen without overloading their computer memory or slowing performance substantially. *FlashPix*-optimized applications will automatically grab the minimum resolution needed for the selected image size and screen. No matter how many images appear at once, memory requirements will never exceed the amount of data needed to fill the screen — usually 1-3 MB. (Many applications today require hundreds of megabytes of memory and/or application workspace on the hard drive to display several high-quality images at once.)

Other *FlashPix* benefits apply to specific types of applications:

- ***Simple edits are a snap.*** Viewing parameters built into the *FlashPix* format allow applications to make simple, non-destructive edits that adjust the image — including rotation, scaling, color and brightness adjustments — without destroying the original image data.

- ***Images and related data are easy to find.*** Microsoft's *OLE* Structured Storage provides a container to keep information related to an image along with the image data itself. This benefit is ideal for database applications, providing a standard place for

storing image descriptors linked directly to the images they describe. It also benefits applications in which users work with many images, by making it easier to organize (and harder to lose) images and related data. *OLE* libraries are available for many platforms, making *FlashPix* technology supportable across different environments. Since the complete specification for the new format will be made public, many different methods for accessing information on *FlashPix* technology will be available — *OpenDoc*, *JAVA*, and Netscape *Navigator* plug-ins, for example.

- *On-line users don't just view images, they interact.* The *FlashPix* format will enable interactive Web pages that provide rapid pans, zooms and access to images for display or high-resolution printing. *FlashPix* technology also expedites on-line picture editing: Remote users edit and send a small file, with edits later applied to the full-resolution file at the other end of the line. This capability opens the door both to new *FlashPix*-optimized products, and to new service businesses that produce image output using files created or edited by consumers on home computers and sent on-line.

- *The FlashPix format supports almost unlimited do/undo flexibility.* Valuable memory and disk space won't be consumed as the end-user experiments with multiple revisions. *FlashPix*-optimized applications maintain a list of user edits and apply the edits to the viewing parameters; the original image data is always preserved.

The *FlashPix* format at a glance
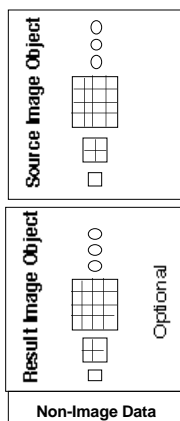
A *FlashPix* image file consists of a number of key components that provide flexibility, speed and ease of use to the end-user :

- **Source image object**
- **Viewing parameters**
- **Result image object**
- **Thumbnails**
- **File linking**
- **Extensions**

What's a source image object?

The Source image object is the digital representation of the image; either the original scene or a digitally synthesized picture.

The *FlashPix* architecture brings together some of the best concepts in digital imaging, color science and computer technologies. The six key features are:

1. **Multiple resolutions**
2. **Tiled sub-images**
3. **Structured storage**
4. **Optional JPEG compression**
5. **Multiple color space options**
6. **Descriptive information**

By combining these features in one architecture, the *FlashPix* file format can serve as a universal standard that meets the needs of a wide range of imaging applications. *FlashPix* files function like small files when people use them, on-screen or on-line, and like big files when people need them to be — usually for printing or storing. To understand *FlashPix* technology and its potential, it's helpful to understand how the features have been implemented.

1. Multiple resolutions
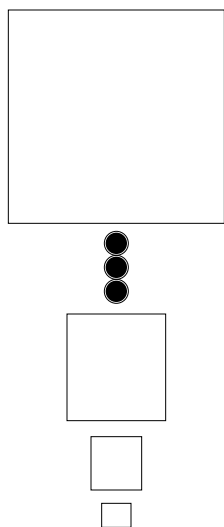
Instead of storing images at one resolution, the *FlashPix* format creates a hierarchy of multiple independent resolutions. This feature enables intelligent applications to select the best resolution level for the desired activity, with substitution virtually invisible to the end-user.

The hierarchy is created by starting with the highest resolution level, determined by the resolution level(s) of the capture device. To create each consecutive lower level in the hierarchy, *FlashPix*-optimized applications and peripherals decimate the image in half vertically and horizontally. The hierarchy stops when the image can be fully represented in a single tile, 64 pixels square.

The multiple-resolution hierarchy is a critical element in the *FlashPix* architecture. However, some products are constrained

by either the lack of processing power, or the shortage of available free storage, and cannot afford to create the hierarchy.

For these applications, it is possible to create a non-hierarchical *FlashPix* file that contains only the highest resolution.

The format accepts images of any aspect ratio. It prescribes no limit on resolution, below the system addressing constraint of 2^{32} pixels, so that digital images of virtually any size and shape can be stored as *FlashPix* files and used conveniently.

2. Tiled sub-images
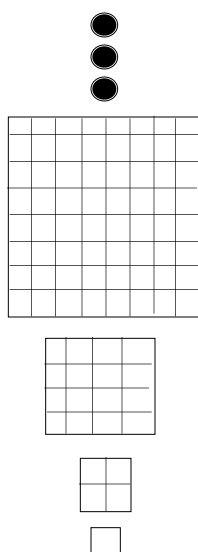
The *FlashPix* format divides the image into building blocks — equal-sized rectangles or "tiles" — instead of grouping the data in rows of contiguous pixels as most formats do. (The tile size is set to 64 pixels square.)

This feature enables optimized applications to reach any portion of the image quickly and conveniently, with consistent speed. They don't have to read all of the data between the starting point and a newly selected portion of the image; instead, smart *FlashPix*-optimized applications directly access the tile(s) that contain the selected image area.

Tiling allows *FlashPix*-optimized applications to work fast, with less I/O and processing demands than traditional imaging software. People can see their edits immediately, because only the displayed tiles have to be processed. Applications also can provide consistent zoom performance, because they're always processing the same amount of data to fill the same size window, regardless of the resolution level.

3. Structured storage

The *FlashPix* format's structured storage feature behaves much like a file system within a file. It serves as a container, holding both "storages" and "streams," which act as virtual directories and virtual files inside the framework of the complete image file. Even while they're being treated separately, these pieces of data remain part of the image file — making all of the information easy to manage.

The *FlashPix* format employs Microsoft's *OLE* Structured Storage as the standardized "wrapper" around *FlashPix* files, making them interoperable with *OLE* II as well as *OpenDoc* applications

Unlike today's public "interchange" formats, structured storage allows *FlashPix* files to serve as the native format within each application. Developers can put their own extensions in the structured storage container, adding proprietary features and functions. These extended files are interoperable with other *FlashPix*-enabled readers, while the extended data (containing the proprietary features) can be used by specially enabled products. As a result, the same *FlashPix* file can be used within an application and also used exactly as-is by other applications or peripherals.

The storage structure also builds in the ability to add new *FlashPix* format features over time. Besides the proprietary application extensions described above, extensions will be published that will add new features while maintaining core compatibility with original *FlashPix*-enabled readers and writers.

4. Optional JPEG compression

FlashPix format Version 1.0 allows three compression options — JPEG compression, uncompressed and single-color compression.

For tiles with image data that need to be compressed, the *FlashPix* format employs standard JPEG compression with storage optimization to reduce the file overhead generated by each tile. The uncompressed method is useful when storage space is plentiful, the storage device is fast and the processor speed is slow. For tiles in which all the pixels are the same color, single-color compression provides a 4096:1 compression ratio and a significant performance improvement in reading the file.

5. *Multiple color space options*

The *FlashPix* format supports multiple color spaces, so application and peripheral developers can adapt their products for different needs. They include:

- a calibrated RGB color space definition, NIFRGB, designed specifically for the format
- Photo YCC — a color encoding methodology employed by the Photo CD Image Pac format to represent color in a device-independent manner
- a calibrated monochrome option for grayscale images
- uncalibrated versions of each of the above allow existing, uncalibrated files to be converted to *FlashPix* files.

FlashPix files may easily be used on a color managed system using International Color Consortium (ICC) profiles to translate into the device independent Profile Connection Space (PCS). ICC profiles for both NIFRGB and YCC are provided.

Because color space options are built directly into the new file format, developers will be able to provide their customers accurate color automatically. As long as a *FlashPix* file uses one of the reference color spaces, products, services and systems can depend on the image data to be represented in a specific, accurate manner. In the case of uncalibrated images, applications will still process the data as though it were calibrated, and the results may or may not be acceptable. The uncalibrated images should only be used when the data cannot be represented in one of the reference color spaces. When using calibrated color spaces, the developer can provide accurate and predictable color results and use the standard ICC profiles supplied with the Toolkit.

6. *Descriptive Information*

The *FlashPix* architecture lets people store descriptive data along with the image data in each *FlashPix* file. Descriptive information aids in developing image databases and describing the image source to applications and devices that will use the file.

Developers familiar with the Advanced Photo System, for example, know that the system's information exchange (IX) feature can record picture-taking data (such as light source) magnetically on each frame of film, along with the film type and unique cassette number. In the future, when Advanced Photo System images are scanned as *FlashPix* files, this information may be recorded as part of each file's descriptive information.

The *FlashPix* format supports non-image data areas including: file source, intellectual property, content description, camera information, per-picture camera settings, digital camera characterization, film description, original document scan description and scan device.

Viewing parameters

The *FlashPix* format records edits — such as spatial transformations or image adjustments — to an image as viewing parameters called "image views." The *FlashPix* format supports the following manipulations in the image view: rectangle of interest, filtering, spatial orientation for rotation, scaling and shearing, colortwist matrix for color correction, contrast adjustment and result aspect ratio.

The use of viewing parameters reduces the amount of processing power and storage space needed to interactively manipulate images. Consider a simple operation like an image crop, for example. Most applications today rewrite the complete image file and display the selected portion at full resolution. In *FlashPix*-optimized applications, the crop requires applying a viewing parameter that defines the rectangle of interest, and processing the selected pixel data through it. Users can work quickly with high-quality images, because only a very small portion of the image data is processed to display the crop on-screen.

Viewing parameters also reduce storage requirements for users who want to keep their original image file intact, along with the edited version. Today, the user has to store two full-resolution image files. In the *FlashPix* architecture, the original image data and the edit are part of the same file; all the application needs to add are the viewing parameters.

Result images

The result image feature builds on the viewing parameters, adding to the flexibility of the format. Result images are *FlashPix* images with the viewing parameters applied for display up to an application-specified resolution. These pre-processed images let any users of *FlashPix* files see what a manipulated image looks like, without the application having to process any data from the original *FlashPix* image. This feature accelerates display of images up to a certain resolution level by pre-applying the viewing parameter edits.

The result image is stored directly in the *FlashPix* file.

Thumbnails

Each *FlashPix* file includes a 96- x 96-pixel NIFRGB color space thumbnail image, which contains the results of any viewing parameters for immediate display. This enables quick previewing and selection of images.
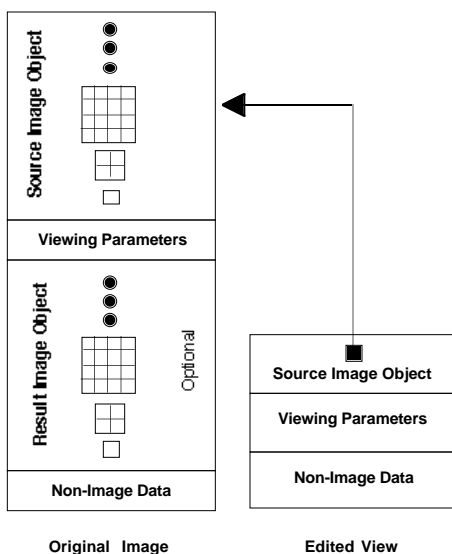
Linking

Image views can be stored as separate structured storage "container" files, and linked electronically to the original image data of a *FlashPix* file. The link lets optimized applications access the original image data whenever it's needed, without having to rewrite a full-resolution *FlashPix* image.

The components of the *FlashPix* file also can be separated across different devices or media. This powerful feature means a different version of an image can be very small by storing only an image view or a link to the original image.

For end-users, linking will mean using an image in any number of ways, while storing the high-resolution image data only in one place. Consider an application that lets people customize their photographs to create personalized prints. A user might customize a favorite picture 10 different ways, using a 20 MB scan of the image.

Source Image Object

Viewing Parameters

Result Image Object

Optional

Non-Image Data

Original Image

Source Image Object

Viewing Parameters

Non-Image Data

Edited View

Today's applications would write the complete file 10 times, and need more than 200 MB of storage for the full resolution clones of the original image file. A *FlashPix*-optimized application could write the original 20 MB file once, and link it to 10 different image views created by the user.

For image owners, such as professional photographers, linking will allow them to share low-resolution images freely. Users can edit them with the built-in viewing parameters, and the professional photographer can re-apply those edits to high-resolution files when fulfilling customer orders.

Extensions
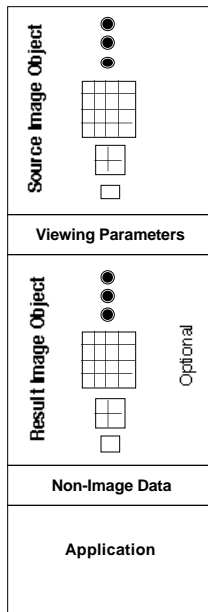
Due to structured storage, *FlashPix* files can be used to store application-specific data in addition to the core elements of *FlashPix* files, without adversely impacting interoperability. Applications must maintain an extension list indicating the extension is present in the file and the data elements associated with it. For some types of extensions, it may be necessary to create an intermediate result image of any extended manipulations in order for other *FlashPix*-enabled applications to correctly render the image.

Conclusion

The *FlashPix* architecture responds to a missed opportunity within the imaging industry: Research indicates that average computer users would use digital images if it was made more fun, easy and affordable than it is today. The *FlashPix* format was designed to give developers a tool to create products that do just that.

Clearly, the momentum behind the *FlashPix* format and experience is already building. The four originating companies announced the *FlashPix* format on June 3 at COMDEX, where it was recognized by Byte magazine as the best new technology at the show. More than a dozen other companies — including Apple, Corel, Fuji, IBM, Intel, Macromedia and Storm Primax — announced plans to support the *FlashPix* architecture, which will be openly available later this year. The real reason behind the excitement is a principle as old as any in business: The *FlashPix* architecture makes it easier to give customers what they want — an easy and fun way to work with pictures on computers. As a result, the *FlashPix* architecture presents a great opportunity to any developer willing to seize it.

The latest information on the *FlashPix* format is available on the Internet at http://www.kodak.com

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