

The Power of Metadata Is Propelling Digital Imaging Beyond the Limitations of Conventional Photography

*By Combining Optimized Convenience and Flexibility with
Expanded Content and Embedded Intelligence*

An Overview of the Opportunities for Implementing Metadata Standards

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by
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Overview.....	2
What is Metadata?.....	2
Vision and Goals of the DIG35 Initiative.....	3
Balancing Standardization with Application Flexibility.....	3
Leveraging XML.....	4
Tracking Real-world Scenarios via Use-Case Modeling.....	5
Fostering Inter-Organizational Cooperation.....	6
Current DIG35 Status Summary and Future Directions.....	6

Overview

Digital imaging is currently experiencing a worldwide revolution of growth in both the number of users and the range of applications that are replacing traditional film photography and fostering entirely new opportunities for using digital techniques. This has resulted in an ever-increasing flood of new digital images, driven by a combination of high-performance, low-cost, image capture methods, such as mega-pixel digital cameras, scanners, etc., as well as by new film processing services, such as the option for taking traditional film images directly to CD-ROM. New non-PC offerings, such as direct printing from the camera, are also extending the digital imaging market beyond its initial focus on computer owners. In addition, the widespread use of digital images on the Internet has created a whole new set of issues in terms of photo sharing, editing, and on-line imaging services.

While the easy creation and availability of digital images is opening the door for an unprecedented expansion of application opportunities, the sheer volume being used brings with it a new set of challenges in the area of image management issues. These issues include critical challenges such as efficiently archiving, indexing, cataloging, reviewing, and retrieving the individual images, whenever and wherever they are required for use. From the consumers' standpoint, this means avoiding the digital equivalent of an "unorganized shoebox full of photos", and from the perspective of businesses it means maximizing the value and reusability of precious corporate assets in the form of well-organized and accessible image archives.

Fortunately, the inherent nature of digital data carries within it the potential for solving these challenges through the use of metadata structures that can be directly integrated with the image files to provide unique identifying information. The focus of this paper and of the Digital Imaging Group's DIG35 Initiative Group is on the critical issue of defining metadata standards to optimize the ease-of-use, flexibility and range of application results that can be achieved with metadata-enhanced digital imaging.

What is Metadata?

Essentially, metadata is defined as additional information about the data. In the context of digital imaging, the use of metadata allows image files to be linked with additional information beyond the pixels in the image itself. Metadata can be used in a variety of different ways, including:

- To provide in-depth information on the image and its creation, such as date, time of day, focus distance, light levels, use of flash, GPS location, etc;
- To allow for easy indexing, identification, categorization and usage-control according to any pre-determined schema, such as image type,

Example Image #1



Example metadata:

Photographer:	Jim Hunt
Date:	08/07/99
Location:	Kern River
Subject:	Golden Trout
Length:	14 inches
Focus Distance:	2 feet
Zoom:	2-to-1

- copyright conditions, originator, subject matter, location, etc; and,
- To enhance the intrinsic content of the image.

In addition to making it easier for individual users to search, sort and use their image archives, the ability to efficiently embed additional information directly into the image file also opens up a variety of new and powerful application scenarios. For instance, metadata could be used to automatically provide distributed Internet applications with human/machine-readable and understandable information, thereby efficiently conserving bandwidth, streamlining usage and simplifying requirements for user intervention. Ultimately, the use of standardized metadata structures will enable content creators, providers and publishers to freely exchange images while also expanding and enhancing their ability to pass along other vital information.

Vision and Goals of the DIG35 Initiative

As part of its charter to help evolve and enhance the overall ability to effectively use digital images, The Digital Imaging Group (DIG) has also taken on the role of coordinating the development and adoption of standards for metadata structures and usage. As an outgrowth of strategic discussions that originated with the DIG Board of Directors in February 1999, the DIG35 Initiative Group was formally established in March of 1999 to leverage the existence and importance of current metadata and to help guide the evolution of metadata standards.

Ultimately, the vision of the DIG35 Initiative Group is to “provide a standardized mechanism which allows end-users to see digital image use as being equally as easy, as convenient and as flexible as the traditional photographic methods while enabling additional benefits that are possible only with a digital format.”

With this overall vision in mind, the key focus areas of the DIG35 Initiative Group include:


- Defining a standard set of metadata for digital images that can be widely implemented across multiple image file formats;
- Providing a uniform underlying construct to support semantic interoperability of metadata between various digital imaging devices;
- Ensuring that the metadata structure provides both a common inter-application exchange format and a high-degree of extensibility for enhanced use by specific applications; and
- Educating the industry at large regarding the importance of metadata usage, preservation and exchangeability.

Balancing Standardization with Application Flexibility

One of the primary dilemmas involved with defining a metadata structure is the simultaneous need for both industry-wide standardization and the flexibility to tailor the metadata to specific applications or industry segments. Therefore, an extensible metadata methodology needs to blend the definition of standardized fields, such as “Location”,

with the flexibility to define industry-specific or application-specific value structures within those fields. For example, in a medical industry application, the field for “Location” might represent various parts of the body; in mapping or aerial photography “Location” might be defined by specific latitude and longitude coordinates; or, in astronomy “Location” could be represented by angles of declination, ascension, etc. In effect, the standardized metadata structure should have the flexibility to accommodate the full breadth of individual user requirements, as illustrated in the following examples.


Example Image #2



Example metadata:

Photographer:	Kats Ishii
Date:	11/21/96
Location:	Honshu Japan
Subject:	Mt. Fuji
Height:	12,388 feet
Longitude:	138.45' E
Latitude:	35.21' N
Hyperlink to GPS Data	
Hyperlink to File Data	
Hyperlink to Camera Data	

Example Image #3



Example metadata:

Photographer:	Beverly Valdez
Title:	"50 Rose, Red"
Event:	Bloom date
	7/16/99 to 8/12/99
Date:	8/5/99
Place:	Lower Deck, Container Garden
Objects:	Two containers, 15 blooms remaining, red house siding, unfinished pine shelf

Leveraging XML

A key decision reached quickly by the DIG35 Initiative Group has been the choice of W3C’s XML (Extensible Markup Language) as the recommended reference-implementation structure for representing standardized metadata. While other implementation methods are certainly possible, the primary reasons for choosing XML are:

- XML is already being widely adopted as a cross-platform and Internet-enabled implementation language;
- Many applications within the imaging workflow can interface to XML structures;
- XML provides a highly extensible method for creating device-independent, language-independent, and application-independent interchange formats;
- XML is equally well-suited for handling relational or hierarchical data structures; and,

- XML provides a solid foundation for implementing human/machine readable and understandable metadata.

Because the industry has already developed a robust set of tools for both writing and reading XML, it offers a ready-made environment within which vendors of digital imaging applications and devices can rapidly incorporate the advantages of metadata structures. In addition, the widespread usage of XML within the Internet community provides for an inherently smooth meshing of metadata structures with underlying network transport mechanisms and Web-based communication methods.

Overall the use of XML supports the DIG35 commitment that the metadata implementation needs to be extensible and flexible, to be small enough for limited memory requirements and yet, maintain human readability/understandability of the information. For digital imaging product developers, XML provides a highly-adaptable, standardized method for interchanging data between any digital imaging device, application and/or database without having to continually write new device-drivers from scratch as the specific products and applications evolve and change.

Tracking Real-world Scenarios via Use-Case Modeling

One of the ways that the DIG35 Initiative Group process is ensuring the real-world viability of its metadata recommendations is through a process of “Use-Case” Modeling. In essence, each Use-Case describes, from the user’s perspective, all of the detailed steps involved in carrying out a specific digital imaging process. In addition, many of the Use-Case scenarios take into account the development and programming steps from the perspective of device designers or applications vendors.

Just a few examples of the specific Use-Case Scenarios that the DIG35 Initiative Group has considered thus far include:

- Relating multiple images into a “virtual roll” according to defined criteria;
- Describing objects within an image;
- Searching for images based on content;
- Linking derivative images to original “digital negatives”;
- Internet publishing and accessing of metadata-enhanced images;
- Uploading photos from a digital camera to a PC database;
- Sorting images by date, location or other attributes; and,
- Preserving copyright data across different applications.

For each Use-Case explored, the DIG35 participants outline all of the metadata implications with regard to how the user would need to perform the scenario as well as considering how device manufacturers and applications developers would likely need to implement the underlying structures. Any proposed metadata definition and decisions are then tested against the specific Use-Case requirements to guarantee that the final recommendations will mesh with and enhance achievement of the real-world Use-Case objectives.

Fostering Inter-Organizational Cooperation

In keeping with the DIG's overall objective to foster cross-organizational industry-wide collaboration, the DIG35 Initiative and other DIG Initiatives have also maintained close liaison and interaction with key standards-setting bodies throughout the industry. Primarily, these collaborations have included official liaisons with ISO's JPEG2000 (ISO/IEC JTC 1/SC29/WG1) and MPEG-7 (ISO/IEC JTC 1/SC29/WG11) committees that are involved in next-generation image compression technology and file format standardization for still images as well as multimedia content description. In addition, the DIG35 Initiative Group has closely tracked with the definition and development of XML and its related technologies, as well as other Internet standards.

Ultimately, the basic goals of the DIG's emphasis on cross-coordination are to foster the use of common technologies, to avoid over-laps, conflicts or gaps between different standards efforts and to develop a stronger foundation for effectively promulgating the finalized standards across the entire digital imaging industry.

Current DIG35 Status Summary and Future Directions

Since its formal kick-off in March 1999, the DIG35 Initiative Group has successfully fostered a growing industry understanding and consensus toward the development of a high level structure for the implementation of digital image metadata.

- Key objectives for the use of metadata have been defined along with the detailed definition of a wide variety of specific Use-Case scenarios;
- A reference implementation for describing metadata is being designed around the widely-adopted XML structure; and,
- Throughout the process, regular communication and collaboration has been sustained with other relevant standards-setting bodies.

Overall the DIG35 Initiative Group is on schedule against the objectives set by the DIG Board of Directors when it established the task of metadata definition as one of the most critical issues currently facing the digital imaging industry.

The next major milestones include:

- Publication of a draft document during the Fall of 1999;
- Promulgation by the end of 1999 of a final standard for extensible metadata that can support evolution of digital imaging technology over the next 5-10 years;
- Publication of a reference implementation to assist developers; and,
- Development of on-going education and informational programs to help further the optimization of digital imaging processes through the use of metadata.

As digital imaging moves into the next millennium, the DIG35 Initiative's efforts toward standardization of metadata definitions and usage are helping to lay the foundation for a whole new generation of intelligent and interoperable applications and devices. By

leveraging the inherent power of metadata, these new digital imaging products and services will routinely automate many underlying image-handling tasks while also simplifying user interfaces and putting more capabilities in the users' hands. Ultimately, the widespread usage of extensible metadata standards will be a key enabling force in making digital imaging as easy to use as traditional photography while simultaneously expanding the overall informational content and usability of the images.

For more information on the DIG35 Initiative and on other activities of the DIG:
Visit the Digital Imaging Group Web site at www.digitalimaging.org