GEOSPATIAL DIGITAL ASSET MANAGEMENT – A SOLUTION INTEGRATING IMAGERY AND GIS
WHERE WILL ALL THE PIXELS GO?(AND HOW WILL WE EVER FIND THEM?)

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ABSTRACT:

The era of widely available high resolution remotely sensed data has arrived. With the advent of numerous commercial satellite systems, data sets of a quality and size previously restricted to government use are now readily available to a broad range of customers. But the data is only the beginning; the continued growth and health of the remote sensing industry depend on broad adoption of this technology. To achieve success, systems to derive information from imagery are essential. Utility of the high resolution data must be apparent to a broad community ranging from map makers to agricultural analysts to intelligence staff. Data utility depends critically on intelligent, useable systems for data storage, management, and exploitation. Digital asset management systems for storing and maintaining high resolution imagery data must be capable of integration with GIS layers and other metadata in order to move beyond GIS to spatial decision support systems. In this paper we describe an image-based geospatial data management system which meets these requirements and addresses issues crucial to the user including efficient data ingest and retrieval, cataloging, data security, data integrity, intellectual property and others. The system incorporates extensive retrieval strategies including geographic search techniques. The open architecture of the system ensures easy integration of multi-functional software to meet the needs of the individual user. For example, the system as currently configured integrates third party viewing and imagery manipulation software. The technical specifications and heritage of the system will be described as well as typical applications.

1. INTRODUCTION

Commercial high resolution and multispectral satellite and airborne systems are delivering an unprecedented quantity of earth observation data in a very short time after acquisition. The ready availability of the data and the short time line together open up exciting new application areas including disaster management, urban planning, homeland security and many others. The demand for the data is growing and more and more imagery-derived products and applications are being developed.

There is an increasing recognition, in both public and private sectors, of the importance of managing all of this digital imagery and associated derived products. A very successful and highly visible conference, GeoIntel, late in 2003 appears to herald a new era in the US in which the importance of geospatial information will be more widely recognized as an crucial element of the marketplace. Dr. Stephen Cambone, Under Secretary of Defense for Intelligence and a keynote speaker, discussed the need to transform the use of geospatial assets in the military and intelligence establishment – in the current environment we must "know something about everything all the time" rather than know everything about a few things (as in the Cold War era). At the same time, more and more commercial enterprises are using geospatial information as an essential element of their business strategy. And, of course, the concern with Homeland Security has led to a critical need for geospatial databases which can be accessed effectively and efficiently in the event of an emergency. These major paradigm shifts in how government and commercial enterprises do business imply a critical need for intelligent management of digital assets of all kinds but, particularly of geospatial digital assets. Extensive (and expensive) data gathering efforts, in government and industry, will be in vain if the

information is not easily retrieved, carefully preserved and secured for use by the intended audience only.

A major driver in the geospatial digital asset management market place is the growth of so-called location enabled solutions, i.e. the use of geospatial information in industries where there is no fundamental geographical content. An example would be the insurance industry where location, including imagery of the surroundings, may be used to identify risk exposures.

The satellite collection capability has in many ways outstripped the ability to handle the data effectively on the ground. Tools to convert imagery to information play a crucial role in the commercial marketplace. Equally important is the ability to store and distribute the data and the products in a timely manner. Digital asset management systems are crucial to handling the petabytes of data and associated information products. These systems provide integrated solutions for the cataloging, storage, distribution and preservation of original imagery and products.

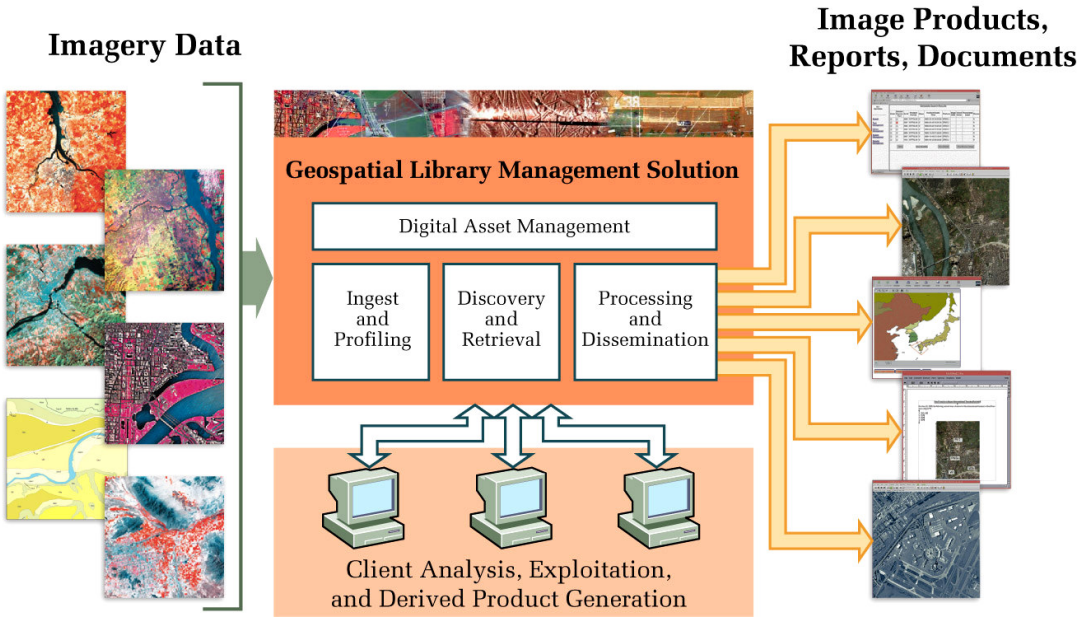

Figure 1 – Illustrating the functionality of a G-DAM – Geospatial Digital Asset Management System

The era of widely available high resolution remotely sensed data has arrived. With the advent of numerous commercial satellite systems, data sets of a quality and size previously restricted to government use are now readily available to a broad range of customers. But the data is only the beginning; the continued growth and health of the remote sensing industry and related geospatial enterprises depend on broad adoption of this technology. To achieve widespread adoption of remotely sensed imagery, systems to derive information from the imagery are essential. Equally important is the ability to store and retrieve both data and derived information. Utility of the high resolution data must be apparent to a broad community ranging from map makers to agricultural analysts to intelligence staff. A farmer wants information on how to fertilize his fields delivered to him in a timely manner; he does not want reams of imagery on his floor. First responders, in a crisis, likewise require near real time access to route data and do not need pixels on their patrol car floors. Figure 1 illustrates G-DAM functionality for a general system which may be customized for any of the applications mentioned here.

Data utility depends critically on intelligent, useable systems for data storage, management, and exploitation. Digital asset management systems for storing and maintaining high resolution imagery data must be capable of integration with exploitation tools, GIS layers and other metadata in order to move beyond GIS to spatial decision support systems.

Geospatial digital asset management systems must meet the challenges of archiving, retrieval, distribution and analysis of geospatial imagery and associated reports. In the words of an engineer in the G-DAM development business, the objective of a G-DAM is to "accelerate the geospatial information processing chain through advanced automation techniques" In this paper we present a highly modular and scaleable geospatial digital asset management system. Scaleability is essential as typical geospatial enterprises will have rapidly growing storage requirements. For example, a satellite receiving station may receive dozens of multi-megabyte images per day. This system is an image-based geospatial data management system which addresses issues crucial to the user including efficient data ingest and retrieval,

cataloging, data security, data integrity, intellectual property protection and others. The system incorporates extensive retrieval strategies including geographic search techniques. The open architecture of the system ensures easy integration of multi-functional software to meet the needs of the individual user. For example, the system as currently configured integrates third party viewing and imagery manipulation software.

Effective geospatial asset management solutions go beyond incorporating software and hardware for automated asset processing, management, retrieval and preservation. They provide optional integrated software solutions for imagery analysis and a specialized "joystick" for smooth imagery manipulation.

2- G-DAM – A CUSTOMIZED ASSET MANAGEMENT SYSTEM FOR THE GEOSPATIAL INDUSTRY

Digital asset management is a broadly used concept; it means very different things in different application areas. Geospatial Digital Asset Management systems (G-DAM's), the subject of this paper, are an essential element of success in the geospatial industry. This industry spans many fields from the traditional (e.g. map-makers and ground station operators) to new participants of which the most important current example is homeland security. All players in the business require a system which meets their needs and concerns.

In the geospatial context, a DAM (or G-DAM) will ingest the imagery, will store the imagery intelligently, will preserve it and will incorporate interfaces to a broad variety of image manipulation tools. The G-DAM system will provide searchable, secure archives and address all aspects of the digital media processing chain. In order to generate products, in many application areas, there will also be a built in interface to a Geographical Information System or GIS. Table 1 summarizes the needs of the DATA USER, the DATA Collector and the Developer.

GEOSPATIAL DATA USER

The user needs efficient search and retrieval and an easy to handle catalogue system. G-DAM solutions must incorporate a variety of techniques to search and retrieve imagery from the facility archive. The archive should be searchable by location, by date and by subject matter. Search algorithms should be implementable by drawing on an onscreen map or entering parameters. To achieve this full range of search capability requires a system which incorporates "intelligent storage".

What is intelligent storage?

- If a system has stored data intelligently, it is easy and quick to search and retrieve by date, by location (especially critical in the geospatial context) and by other parameters relevant to the application at hand. For example, in an agricultural application, both time of day and season of the year may be important parameters for searches. In cases where multiple sets of data, acquired in different ways, exist for the same area, it is important to be able to search using meta data related to the cameras used for the various images.
- Data that is more immediate in some sense (whether temporal or otherwise) should be more readily accessible. If the application is time-critical (e.g. the news media) then it is essential that images acquired most recently be in the on-line storage areas.

The original archive will be enhanced with derived products. The search mechanism implemented in the DAM must allow for this – a user should be able to retrieve original imagery and associated derived product. This functionality is achieved by a combination of hardware and software architecture. The hardware architecture is typically a traditional three level archive – storage is on line, near line or off line.

The DATA Collector

The data collector (typically the owner of the data) has serious concerns about security of the data and its preservation.

- **SECURITY** - A capable asset management system incorporates comprehensive multi-level security schemes, which include control and monitoring of user privileges, workstation access, system administration, and product distribution. Access to the data should be controlled by password, i.e. users must be authenticated before gaining access. In addition, the system must be capable of supporting a hierarchy of users with more or less privileged access. The output of the system should also be controlled - various products may be viewable by different sets of users. In other words, distribution of products generated by the system is controlled by rules limiting export of files according to predetermined categories of recipients. A multi-level security algorithm is essential in geospatial DAMs. In addition to the measures outlined above, the administrative controls include security logs that track and permanently record each and every transaction, file retrieval or distribution.

	Geospatial Data Users	**Data Collectors or "Owners"-**	**Developers**
Ingest and Profiling (ingests imagery and generates catalog information)	- "User friendly" catalog entries	- Secure ingest and storage - Asset preservation - Scalability	- Catalog update - Modular system
Discovery and Retrieval	- Search including map-based techniques - Retrieval - Efficient catalog update as products and imagery are added	- Security controlled access to system and data - Efficient access to preserved data	- Search including map-based techniques - Retrieval - Efficient catalog update as products and imagery are added
Processing and Dissemination	- Automated workflow	- Filtered secure distribution	- Automated workflow - Access to exploitation tools - Interface to GIS

Table 1 – G-DAM Requirements as seen by the customers – the user, the "owner" and the developer. The requirements fall into three categories as indicated by the labels on the left of the table.

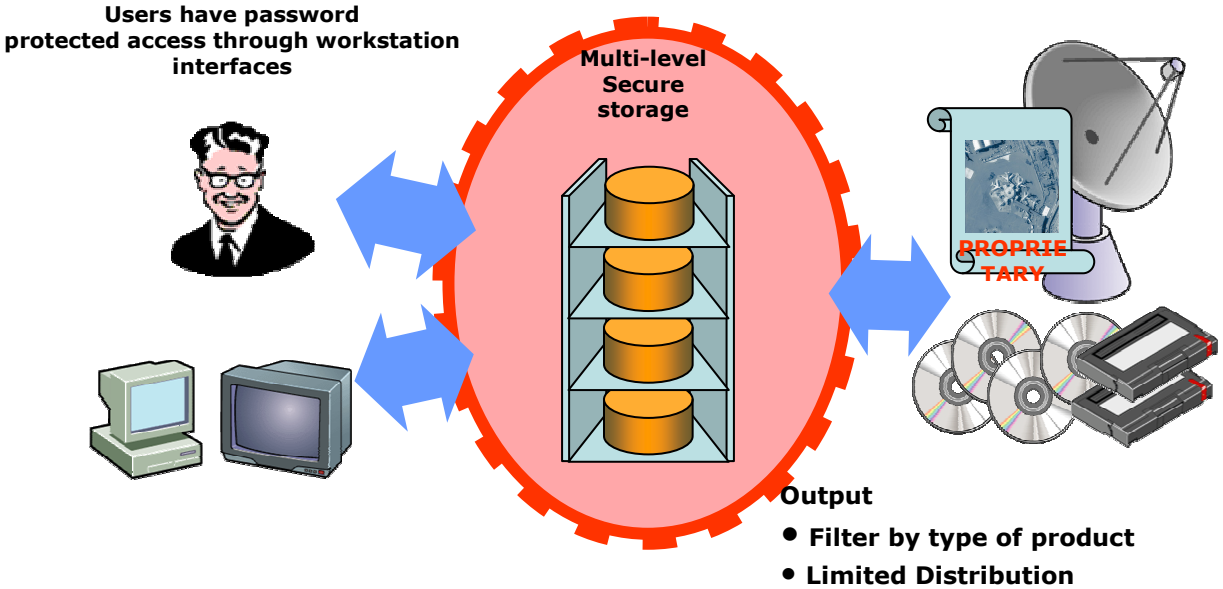

Figure 2 depicts a complete security solution.

- **ASSET Preservation** - Geospatial data is expensive and older data are irreplaceable. G-DAM systems should allow the user to indefinitely preserve digital assets, even if
- they are seldom or no longer used. Modern, sophisticated DAM systems automatically scan the archive periodically to determine the condition of the data. Figure 3 shows a multi-path approach to asset preservation. Automated immediate backup is just one element in the approach to asset preservation. In addition, the system carefully monitors both the age and utilization of all media, automating the performance of tape maintenance, for instance, or dictating the transfer to fresh media to ensure quality preservation. Coupled with the ability to accept future storage technologies and formats, this results in an unlimited life span for the system and its content.

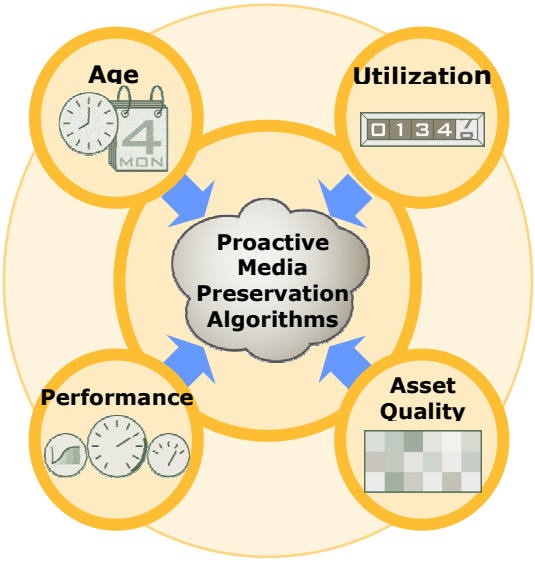

Figure 3 Illustrating a modern approach to digital asset preservation

DEVELOPER

The developer is involved in generating new and saleable products from the archive. His/her requirements for the G-DAM are similar to the USER requirements but, additionally, include the ability to interface to and integrate a variety of tools for image processing and manipulation and for GIS use. Many different image processing and GIS tools are commercially available. Software for applications as diverse as imagery analysis, demographic analysis, route planning, report writing or file editing and repurposing should be integrated and accessible through the user interface. The G-DAM system should have an easy interface to currently available tools and also be sufficiently customizable to change to other tools as they are developed. A related requirement is that the system be capable of ingesting a wide range of imagery formats.

To ensure efficient use of the system, automated workflow is another concern of the developer. A G-DAM should be capable of a high degree of automation in the installation's work flow. The developer can then customize the automation of distribution and assignment of tasks to speed tasks and data to the appropriate desktops. The automation of the distribution, assignment and approval processes permits tracking of work in progress, and enables ongoing prioritization adjustments among different projects or customers. Depending on the current and forecast workflow requirements of an organization, this type of automation can yield significant returns in efficiencies.

3- CONCLUSION

What is the current state of the art? How much automation is achievable and what are reasonable performance expectations?

By 2001, G-DAM systems were capable of capturing live satellite imagery at a rate of up to terabytes a day, eventually storing millions of images for easy and rapid retrieval. In a typical geospatial installation, data ingest and archive functions are integrated with imagery analysis software on dozens of workstations. Imagery analysts using modern G-DAM systems can call up a variety of applications, including GIS, from the same interface used to search and retrieve imagery. New software programs can typically be added to the suite of applications.

Current systems are highly automated but rely also on user interaction. Systems are scaleable and modular allowing for growth of an installation. Modern DAMs are capable of ingesting a wide variety of formats including motion imagery (MPEG) and various still image formats (JPEG and TIFF). They are designed with customizable browser-based graphical user interfaces and a modular architecture. DAM's can manage more than 10,000TB of digital assets in any combination of online, near-line and offline storage.