Understanding and Implementing ArcGIS® Image Server

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An ESRI White Paper

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Executive Summary

Geospatial imagery is the foundation of most mapping and geographic information system (GIS) technology. Many organizations need to manage rapidly expanding catalogs of imagery from various sources such as scanned maps and aerial films, digital cameras, satellite imagery, and digital terrain models. Such huge quantities of imagery pose difficulties in managing, processing, and distributing data to users.

The value of imagery is greatest when large numbers of users have quick access to it. When using conventional solutions, the steps in managing, processing, and distributing imagery are time-consuming, and users have difficulty accessing and utilizing the imagery within familiar applications. When new source imagery is captured, users must wait until it is processed and loaded into a data storage and distribution system before they can request the data from an imagery server. Processed source imagery grows to multiple datasets that administrators must maintain and store individually. Even when directly using preprocessed imagery, there is often a substantial cost in time and storage required to convert or load it for use in a server environment.

ArcGIS® Image Server is an enterprise-wide image distribution platform from ESRI, the world leader in GIS. It provides a new approach for managing, processing, and distributing imagery that immediately reduces costs and improves workflows.

ArcGIS Image Server provides fast access and visualization of large quantities of imagery, processed on the fly and on demand. Image processing is performed by the server, eliminating the need to preprocess the imagery after capture. This gives users immediate access to the imagery once it is acquired. Imagery that is preprocessed can similarly be very quickly served. When a client makes a request, ArcGIS Image Server processes the imagery and delivers it along with important metadata to the client almost instantaneously.

ArcGIS Image Server handles image processing on the fly for each client request; therefore, only the source imagery needs to be stored, which eliminates the need to maintain multiple datasets. As new imagery is added or updates are made to the processing requirements, changes are immediately reflected in the processed imagery delivered to clients, thereby reducing maintenance costs. Additionally, with only a single set of imagery to maintain, storage requirements are substantially reduced.

ArcGIS Image Server provides a wide range of processing options that gives users all of the benefits of processed imagery without the normally higher costs. By supporting leading third-party client applications—including applications from ESRI, Autodesk®, and Bentley—ArcGIS Image Server allows users to leverage imagery within familiar applications.

Unlike other image server solutions that serve only static, preprocessed imagery, ArcGIS Image Server is an enterprise product that meets all image management, processing, and

distribution needs. In turn, this simplifies integration with existing systems and workflows.

The Growing Need for Better Access to Imagery

Importance of Imagery

Imagery is important for many applications and can be used in several ways including the following:

- As a natural background in many GIS applications, where it is often used to assist navigation. The popularity of sites such as Google Earth™ has increased the demand by users to see imagery as a backdrop to their applications.
- For direct interpretation, it is used to identify features such as new roads, housing developments, and other aspects of a changing landscape.
- As the source for digitizing most vector maps, it is the basis of most GIS systems.
- For the verification of vector data. Questions often arise about the reliability of vector data used in an analysis, and frequently more up-to-date imagery is available that can be used to verify the vector data.

Not all uses of imagery are the same. Different applications require imagery optimized to different criteria. For some applications, timeliness of the imagery is especially important; for others, quality or resolution; while for some others, it is the sun's angle; and so on. For some applications, specific new imagery will be acquired, while for others, existing imagery will be utilized but may need to be enhanced or ordered to ensure the optimum imagery is displayed.

Growth of Imagery

Huge quantities of imagery already exist and are growing exponentially. Not only are the volumes of imagery increasing but also the depth of imagery in terms of the following factors:

- **Resolution—**The resolution of the sensors is increasing, resulting in finer visible details and much larger dataset file sizes covering the same area.
- **Dynamic range—**The bit depth, or spectral resolution, is increasing from 8 bits to 12 bits and higher per channel. This higher dynamic range in the sensors provides better spectral detail, which, for example, enables one to see details within shadows.
- **Spectral bands—**Many new sensors have more spectral bands. Many aerial cameras capture the near-infrared band in parallel with red, green, and blue. Satellites with higher numbers of bands are being launched, some with hyperspectral sensors that have hundreds of bands.
- **Overlap—**The overlap of imagery is increasing. The same areas are being acquired repeatedly by satellites, thereby providing temporal data. In aerial photography, it is standard practice to acquire imagery with a high overlap for stereo coverage.

Imagery is becoming increasingly inexpensive, and many datasets are available for free. Currently, one key issue with geospatial imagery is accessibility. There is plenty of imagery available, but only a small fraction of it is actually accessed and used. If imagery is made quickly accessible to larger numbers of users, the value of the imagery increases significantly.

With conventional solutions, image processing and distribution has been time-consuming, and end users have had difficulty accessing and utilizing the imagery within familiar applications. When new source imagery is captured, users must wait a long time until it is processed and loaded on a server before it can be accessed. During image processing, datasets grow into multiple versions that administrators must then maintain, which further adds to costs. Even with the subsequent compression of the imagery, which typically reduces image quality, these datasets can become difficult to maintain and manage.

Uniqueness of Imagery

The solutions required to manage, process, and distribute imagery often need to be different from other geospatial data. Imagery distinguishes itself from other data by the following aspects:

- **Volume—**The volumes of imagery are generally larger than other geospatial datasets. Imagery datasets can often be in the multiterabyte range or greater. Traditionally, their storage, management, and distribution have been challenging.

- **Value—**The value of imagery changes quickly. For most applications, imagery has its highest value when it is new, and the value decreases over time. In some applications, the value can be reduced substantially in hours or days; for other applications, it can be reduced in weeks or months. For most applications, the latency between image acquisition and exploitation needs to be reduced to maximize the value of imagery. There are some applications, such as change detection, where the value increases again over longer time periods.

- **Fixed—**An image is actually a snapshot of the earth acquired at an instant of time. Unlike a road or utility network dataset, imagery is not edited and the image does not change. What does change over time is how the image is processed to create different products to be visualized or analyzed.

Different States of Imagery

Organizations that acquire imagery normally receive the data in one of the following states:

- **Tiled or mosaicked images—**These are generally the products of traditional mapping programs where the imagery is processed, mosaicked, and cut into tiles similar to map sheets. Large volumes of such imagery exist such as digital orthophoto quadrangles (DOQ), National Aerial Imagery Program (NAIP), and Controlled Image Base (CIB) formats. In many cases, such image products are further mosaicked and compressed into formats such as MrSID® or JPEG 2000. Tiles, or mosaicked imagery, should be delivered with both georeferencing data and metadata defining its source and accuracy. These datasets are primarily used for viewing as a background data source. Due to preprocessing, some of the original data content may be lost, thereby limiting the type of analysis that can be performed.

- **Rectified scenes—**These are images delivered as individual scenes, generally from satellites. Each scene is acquired at a specified time from a specific sensor. Scenes are rectified to the ground using a spatial reference system and should come with metadata defining the source and accuracy. They are typically multispectral and are often not radiometrically adjusted for visualization, so they can be used for different analyses. For visualization of large areas, the multiple scenes need to be enhanced and mosaicked together.

- **Nonrectified scenes—**These are images acquired using digital cameras or satellites or from scanning of film or existing mapping. They have limited preprocessing applied to them and need to be georeferenced before they can be used within a GIS application. Most modern sensors include the approximate georeferencing information, and their accuracy can be enhanced with access to ground control and a terrain elevation model. These images have the most data content but require more data processing.

Requirements

The demand for imagery solutions in the past few years has moved away from pure image analysis applications to those that enable users to manage, process, and serve huge volumes of imagery within an enterprise environment.

User Requirements

Users of imagery range from general users who only view imagery as a background to assist in visualization to advanced users who wish to perform analysis of the pixel values. Therefore, there is a wide range of different requirements. The following list enumerates various user requirements and is roughly ordered from those of the general user to the advanced user:

- **Access to large expanse at high resolution—**Users should be able to view very large areas at both small and large scales and in different projections without needing to select specific images or tiles.

- **Use in multiple applications—**Users need access to the same imagery in different Web and workstation applications.

- **Fast performance—**Imagery should be accessible nearly instantaneously at any scale.

- **Timeliness—**Users often demand the most current imagery available. For some applications, such as emergency response, this is critical.

- **Metadata—**Access to metadata about imagery or each individual image (in cases of mosaicked images), such as date/time of the imagery, producer, and sensor parameters, is important to many applications and provides users with confidence in the source.

- **Image quality—**Superior resolution and sharpness of each pixel provides good, crisp imagery, which is important for better analysis.

- **Geometric accuracy—**As imagery is utilized in more professional applications, its geometric accuracy becomes increasingly important. Both the relative accuracy for distance measurement and the absolute accuracy required to overlay different imagery are invaluable.

- **Radiometric accuracy—**The actual pixel values within the imagery are important for more advanced users. Therefore, the pixel values should not be affected by sampling or lossy compression.

- **Ability to export or print—**Users often need to export clips of imagery to their local machines or mobile devices for access when they are not connected to the source, such as a database or server, or to print the data. The size of such image requests can be very large.

- **Controllable properties—**More advanced users not only want to view imagery as static images but also want to interact with and change how it is processed or mosaicked.

- **Ability to handle overlapping imagery—**There is a lot of information in the overlap of imagery that comes from image captures of the same area being taken at different dates or from different locations.

- **Analysis—**More advanced users utilize imagery for analysis and automated feature extraction. Capabilities for integration with specialized analysis applications are important.

Administrator Requirements

From an administrator's perspective, the requirements are different from that of the user. The following are typical requirements:

- **Easy installation—**Administrators often need to work on multiple systems; therefore, solutions should be easy to install and run.

- **Simple workflows—**To simplify training and reduce setup times, workflows to add (or load) and disseminate (or serve) imagery need to be easy and quick to perform. Different datasets from various sources and in diverse projections often need to be provided together.

- **Reduced storage space—**Storage space is an important issue for most administrators due to the large size of imagery. However, today's lower costs of disk space have made this less of a concern.

- **Stability—**Stability of a solution is often critical.

- **Backup—**Ability for systemwide backups is important for mitigating system failures. With such large data volumes, special consideration may need to be taken.

- **Scalability—**Systems should be scalable to provide consistent, nondeclining performance when more users are added.

- **Maintainability—**Maintenance becomes a significant factor soon after imagery is served. Users expect images to be kept up-to-date as new ones become available. It must be possible to quickly add or change data without delaying accessibility.

- **Integration—**Integration of imagery into multiple systems is key. As usage increases, the demand to use imagery from different sources and provide data to more applications increases.

ArcGIS Image Server—Fast, Dynamic Image Processing and Distribution

Traditionally, image processing and distribution have been considered two separate stages in image exploitation. This separation causes data redundancy, radically expands volumes of data, and hinders efficient data management. With ArcGIS Image Server, these two stages are combined, enabling administrators to maintain only the primary imagery with multiple image products created on the fly as required by users. This is a significant and unique paradigm shift in how imagery is managed, processed, and distributed, which resolves many issues pertaining to imagery.

Provided by ESRI, ArcGIS Image Server is a complete enterprise imaging solution that caters to all imagery requirements. Unlike other image server solutions that serve only static, preprocessed images, ArcGIS Image Server is an enterprise product that uniquely combines image distribution and on-the-fly, server-based image processing. It provides enterprise-wide access to very large image datasets within GIS, CAD, imaging, and Web applications, allowing users to manage, process, and quickly serve large quantities of raster data for visualization and analysis to a variety of clients. Bottlenecks in conventional image-processing workflows can be resolved since the raster datasets can remain as files on servers in their original form, then processed and distributed at once without extensive preprocessing or loading into a database.

On-the-fly processing enables high-resolution, georeferenced imagery to be distributed and made available to end users in a timely manner upon acquisition. Imagery can be quickly published using the best available processing parameters; then, over time, the grade of the product can be increased as better georeferencing or enhancement parameters become available. When applied to imagery, this methodology reduces the latency between image capture and usage, thereby maximizing the value of the imagery and making it easier to maintain. Even backup is substantially simplified, as large volumes of imagery only need to be backed up once. The parameters that define the processing to be performed are small and can be backed up very easily.

The Value of ArcGIS Image Server

ArcGIS Image Server provides value to any organization involved in image storage, processing, and distribution. By reducing the data storage costs and manpower required for data processing and maintenance, ArcGIS Image Server gives users an immediate return on their investment. In addition, by significantly increasing accessibility to imagery, the value of the imagery is increased.

The immediate value of ArcGIS Image Server is derived from the following:

- **Fast access to geospatial imagery—**ArcGIS Image Server provides access to source imagery without requiring any preprocessing, eliminating data redundancy and making imagery available to clients quickly. Plus, clients can access the imagery they need almost instantaneously, without lengthy load times.

- **On-the-fly image processing—**ArcGIS Image Server processes source data on the fly, minimizing storage requirements and reducing the latency between data capture and use by staff.

- **Data and client interoperability—**ArcGIS Image Server provides access to multiple image file formats from multiple clients, eliminating the need to convert source data into proprietary formats.

- **Full scalability—**ArcGIS Image Server can scale to meet users' current and future technical and functional requirements.

ArcGIS Image Server is able to generate multiple image products from a single source, each with different radiometric processing, geometric processing, and compression options. This on-the-fly processing maximizes the information content that can be obtained from the imagery without the need for costly preprocessing. ArcGIS Image Server thereby enables users to eliminate management problems associated with multiple preprocessed datasets and can substantially reduce data storage requirements. Server-side processing also allows access to raster data from thin-client applications, reducing requirements for workstations to access and process the imagery.

The distribution and processing capabilities of ArcGIS Image Server include

- Fully scalable enterprise client/server architecture
- Fast access to large amounts of imagery
- Direct support of multiple file formats and compressions
- Multiplatform GIS, CAD, imaging, and Web access
- Extensive service and image metadata support
- Access to information from overlapping imagery
- Independence from third-party software or DBMS
- Data security and access logging

Benefits of using ArcGIS Image Server over traditional methods of image data management include the following:

- **Quick updates—**New imagery or processing parameters can be quickly added or changed in existing image services without interrupting the services.

- **Extensive coordinate transformation capability—**This capability resolves many issues that occur with imagery in different spatial reference systems.

- **Handles disparate datasets—**Imagery is often not in well-defined rectangular blocks but is spread among different areas of interests such as along roads. Traditional systems that require a single image format or size cannot handle such cases.

- **Scalable to massive amounts of imagery and large numbers of users—**This capability makes it easy to get the system up and running as well as expand as the imagery or number of users increases.

- **Integration—**Imagery can be integrated into existing infrastructures by leveraging the plug-ins to other applications and using the Web standards' support of ArcGIS Server to deliver the imagery.

Who and What Applications Use ArcGIS Image Server?

ArcGIS Image Server enables the user to exploit the value of new raster datasets for a range of applications such as the following:

- Emergency response and planning for security and military operations require fast access to huge raster datasets after acquisition. In emergency situations, people need to access information quickly. ArcGIS Image Server allows users to take the acquired imagery and make it available online in a timely manner. Additionally, users can update the service with new imagery as it becomes available or update the georeferencing or radiometric processing as parameters are more clearly determined.

- Municipalities and utilities with large numbers of users need access to different imagery from different applications. Many municipalities often provide public access to their imagery as orthorectified datasets while also requiring higher-resolution versions for use in their own planning departments. With ArcGIS Image Server, the same imagery can be accessed at a higher resolution by planning departments and public access restricted to a coarser resolution.

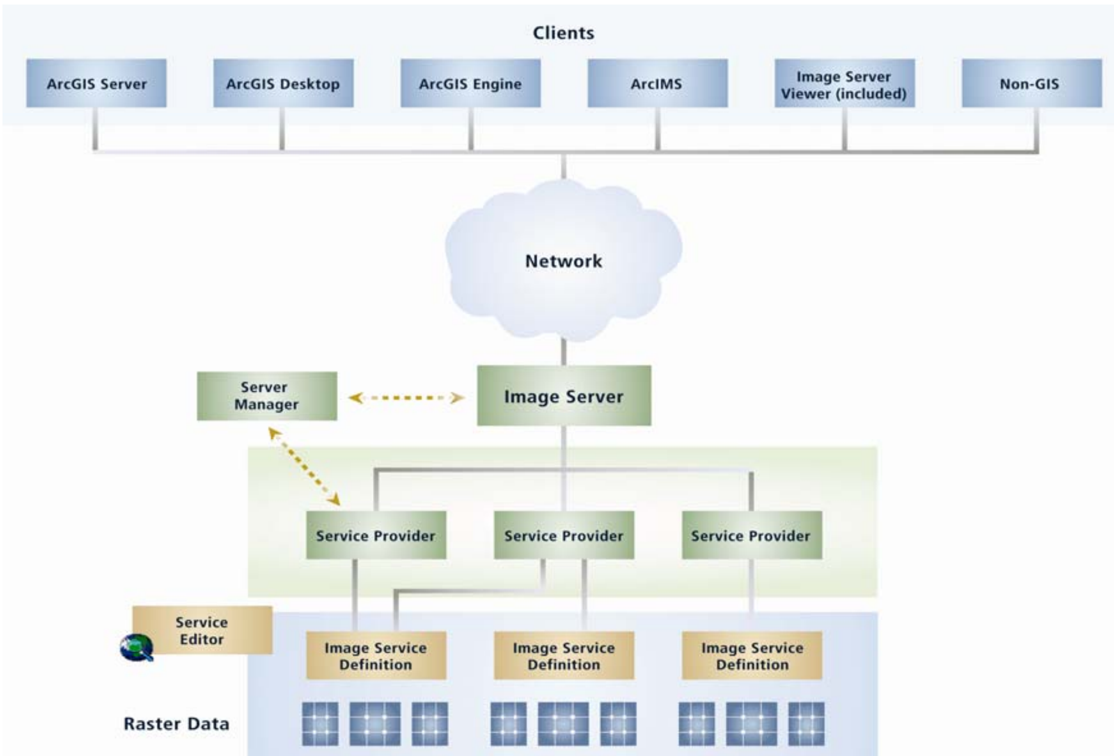
- Data acquisition and provisioning organizations manage, process, and distribute huge quantities of imagery. Such organizations may need to keep catalogs of a huge number of images, provide access to subsets of the images as services, and quickly create products for distribution. With ArcGIS Image Server, not only can the user easily manage large quantities of imagery and its attributes, but the required products can also be defined as dynamic services available for timely access or processed for conventional distribution.

- Environmental organizations need to process, manage, and compare many different types of imagery. In environmental applications, there are often requirements to handle many different image sources with different dates, spectral characteristics, and resolutions. With ArcGIS Image Server, such imagery can be accessed as multiple services for viewing in a GIS or other applications.

Note: See how ArcGIS Image Server makes life easier for customers and read their comments at http://www.esri.com/news/arcwatch/1007/arcgis-image-server.html and http://www.esri.com/news/releases/07_2qtr/usda-forest-service.html.

ArcGIS Image Server Architecture

The ArcGIS Image Server architecture is similar to the ArcGIS Server architecture and is composed of several components as outlined in the diagram below:



The ArcGIS Image Server components can be organized into three main parts: authoring, serving, and use.

Authoring

The authoring part of ArcGIS Image Server comprises the Service Editor, which is used to

- Create a new image service definition and define its properties.
- Add or remove raster data.
- Define any processing that is to be applied to all the images in the image service or to individual rasters.
- Construct and validate selected parts of the image service to derive parameters such as the pixel size ranges, metadata fields, and boundary of the image service.
- Review and edit the image footprints and any seamlines.
- Preview the image service prior to publishing.
- Validate the processes and data in the image service.

- Optimize the image service by creating derived tiles and service overviews.
- Generate the compiled image service definition file (.ISCDef) used by service providers.

Serving The serving part of ArcGIS Image Server comprises the Server Manager, server, and service provider:

- Server Manager enables the administrator to configure and manage the server and service providers.
    - Manages servers by associating image service definitions with one or more service providers
    - Logs and records requests that can be analyzed if needed
- The server acts as an image service request broker to which a client application initially connects.
    - Publishes and maintains the list of available image services
    - Authenticates clients and provides access control to the image service
    - Identifies the service provider with which the client will further communicate
    - Provides access authentication and load balancing when an image service is available on multiple service providers
    - Maintains a log of all connections
- The service provider is the workhorse of the ArcGIS Image Server system.
    - Receives requests for an area of interest in a specific image service from the client applications
    - Reads the required pixels from the source and performs processing outlined in the image service definition
    - Transmits the required data to the client application optionally by first compressing the imagery
    - Enables multiple service providers to run in parallel, enabling the system to be scalable and fault tolerant should a service provider fail

Use The use part of ArcGIS Image Server is usually the client applications, where users view the image service and its associated information and perform the following:

- Request the server to provide information and metadata on available image services.
- Open a connection to an image service and make imagery requests.

- View and extract both imagery and associated image metadata.
- Interact with and modify image service properties. These properties include the mosaic method that controls the order of overlapping images as well as the spatial reference system, resampling method, transmission compression, and background color.
- Save the imagery to disk by specifying the extents, pixel size, and file format in which it should be saved (such as TIFF, JPEG, JPEG 2000, and PNG). The maximum volume (and extent) of exported imagery is controlled by the administrator of the image service.

There are a number of different clients that can connect to ArcGIS Image Server. They are categorized into two main client types:

- **Direct clients—**These include all ESRI and third-party applications that can connect directly to ArcGIS Image Server using the remote procedure call (RPC) protocol that works over the LAN or Internet. The third-party applications for which plug-ins exist to make direct connections include AutoCAD versions 2000 to 2008, MicroStation® version 8.5, MapInfo® 8.0, and GeoMedia® version 6. An application programming interface (API), which is part of the software developer kit, enables developers to quickly add the ArcGIS Image Server client to other applications.
- **Web clients—**These connect to ArcGIS Image Server using the Internet HTTP protocol via ArcGIS Server or ArcIMS®. By accessing ArcGIS Image Server image services through ArcGIS Server, Web clients that support Web Map Service (WMS) or KML capabilities can access imagery from ArcGIS Image Server. SOAP is also supported for use in enterprise integration.

Server-Based Image Processing

A key feature of ArcGIS Image Server is its ability to perform server-based image processing and thereby create multiple imagery products for different applications from a single source without the redundancy of multiple datasets or long preprocessing times.

The processing can be broken down into three key types:

- Radiometric processes, which define how the pixel values are displayed, such as band combinations or enhancements
- Geometric processes, which define the location of the pixels
- Mosaic methods, which define how the overlapping images are handled

A large range of processing options are implemented with user-definable process chains.

Radiometric Processes

Radiometric processes are used to define how the pixel values are displayed. Radiometric processes include the following:

- **Extract bands and stack bands—**Either extract-selected bands from a multispectral file or stack bands from different files. These are used to enable different band combinations for viewing. For example, with Landsat imagery, users can produce a 3, 2, 1 true-color band combination; a 4, 3, 2 near-infrared band combination; or a 7, 4, 2 false-color band combination.

- **Image algebra and NDVI—**Enables different bands of imagery to be processed together, often for better feature definition. A typical example is the Normalized Difference Vegetation Index (NDVI), which indicates biomass (greenness).

- **Stretch—**Enables imagery to be enhanced for optimum contrast and color, especially when imagery with higher bit depths from digital cameras is used. This operation maximizes the dynamic range, for example, to see into details in areas of shadow.

- **Gray scale—**Converts color imagery to gray scale. This is often used for background vector data, such as utilities, that is to be displayed in different colors.

- **Spectral matrix—**Transforms the color space of imagery. It can be used, for example, to convert false-color imagery, such as SPOT, that does not have a blue band into a pseudocolor image that looks more natural.

- **Convolution filter—**Used mainly for sharpening images. Most digital imagery can be made to look sharper. In ArcGIS Image Server, sharpening can be performed prior to any sampling, thereby producing superior results.

- **Pan sharpen—**Fuses lower-resolution, multispectral imagery with higher-resolution, panchromatic imagery. Typically, this is performed on most lower-resolution, multispectral satellite imagery. ArcGIS Image Server not only supports the standard Brovey and intensity, hue, saturation (IHS) methods but also includes the ESRI pan-sharpening algorithm that provides superior results.

- **Trend—**Changes the radiometry of an image based on a correction surface, which can be used as a simple method to remove brightness trends in images. Such brightness trends are often seen in aerial and satellite imaging where one side of the image is brighter than the other.

- **Classify—**Applies a simple classification of pixels to the rasters used in the image service for feature discrimination. Pixels can be classified based on the different ranges of their values. Generally, classify is applied in conjunction with another process that involves computations such as NDVI and image algebra.

- **Color map—**Transforms pixel values to display raster data as either a gray scale or red, green, and blue (RGB) image, based on a color map. This process can be used to display rasters representing analyzed data, such as a classified image, or to render a topographic map.

- **Elevation visualization—**This operation renders (displays) elevation data using various methods of visualization such as hillshade or shaded relief.

- **Histogram—**This process extracts a histogram and histogram statistics based on the image, which will be included with the image service as part of the process metadata.

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Geometric Processes

Geometric processes are used to define the ground location of the pixels. There are many different models that can be used to georeference imagery.

- **Affine—**A simple, six-parameter transform that is used to map most mosaicked or rectified imagery to a specific projection. It can be specified by the six parameters of a list of at least three points in the image and ground space.
- **Projective—**A nine-parameter transform that is often used to map the four corners of an image to a defined footprint. It can be specified by the nine parameters of a list of at least four points in the image and ground space.
- **Second- and third-order polynomials—**These are standard formulas for representing higher-order distortions.
- **Warp grid—**This enables the modeling of a more complex transformation by defining a grid of points in both image and ground space.
- **Orthorectification—**Orthorectification of imagery is based on a sensor model and elevation model. Two main sensor models are supported: standard frames are used in most aerial photography, and rational polynomial coefficients are used with many satellite sensors. Other sensor models can also be added.

These georeferencing models define how to map the pixels to a specific projection for each image. ArcGIS Image Server allows different images to have different projections and uses the ESRI projection engine to transform all imagery to the client-specified projection.

Geometric processes result in resampling of the base image. ArcGIS Image Server concatenates these geometric transforms using a single sampling of the imagery from base pixels to the screen. This results in an improved image quality. As the sampling is performed only as the image is accessed, ArcGIS Image Server enables imagery with different resolutions to exist within the same service without any loss of information content or an explosion in data volumes.

The sampling method used to interpolate the pixel values after the transform is also user definable and often dependent on the application. For example, the nearest-neighbor method is better for maintaining radiometry, while bilinear and cubic convolution provide sharper details.

Mosaic Methods

Where there is overlapping imagery, there are multiple methods by which the imagery can be mosaicked. Therefore, which imagery should be at the top and how the imagery should be fused need to be determined.

When working with scenes or frames of imagery, it is important to be able to define what parts of the imagery are to be viewed and, when the images overlap, to control the order in which the images are displayed. With ArcGIS Image Server, each image has an associated footprint to which the pixels are clipped. This efficiently enables the exclusion of regions of NoData pixels or the removal of areas of the imagery that are not to be viewed such as clouds, camera frame data, or map borders.

When an area is covered by multiple images, the display order is specified by a user-definable mosaic method. These methods include the following:

- **Closest to center—**This is the default method that orders the imagery based on the distance between the image center and the screen center such that the closest image is on top.
- **By attribute—**Each image may have associated with it a set of attributes, such as acquisition date, view angle, or sun angle, extracted from the image metadata. A user can define the mosaic method as by attribute and specify how to order the imagery. This enables users to see topmost the imagery closest to a specific date.
- **Lock image—**An image can be locked to a specific scene or set of scenes on which analysis may be performed.
- **Most nadir—**This mode is similar to closest to center and often selected for large-scale aerial imagery that uses the nadir point of the image versus the image center.
- **Closest to viewpoint—**With this method, the location or direction from which the area should be displayed can be defined to allow users to see around occlusions as well as the sides of buildings. It is used primarily in utility and emergency response-type applications.
- **Most northwest—**This mode is similar to closest to center but keeps a fixed order based on the image that is most northwest being on top.
- **Seamline—**This method enables the blending of pixels along seamlines that are associated with each image. The blending can include feathering, which softens the transition from one image to the next. This method is most useful when creating seamless mosaics of rectified or nonrectified imagery, required typically for printing or when using elevation models of different resolutions.

Implementing ArcGIS Image Server

A key advantage of ArcGIS Image Server is that it can be set up quickly. Most users can install and have large image services running within half a day. Installation of the authoring component is added as an extension to ArcMap™.

The process of creating an image service can be performed step by step or by using a wizard. The location for storing the image service is first defined as well as the type of image service such as color, pan, or elevation. The user is prompted to specify the type and location of the raster to be added. The type defines how georeferencing and metadata about the rasters will be extracted. The location can be a set of individual files or a directory containing multiple subdirectories. The authoring component extracts all the properties and metadata about the rasters into the image service definition, which consists of a database table with a single record for each raster that is linked to a set of properties associated with each raster. Multiple rasters from different sources can be added to the same image service definition. If the rasters do not contain sufficient overviews, image service overviews can be defined that enable faster access to the image service at small scales. Properties of the image services, as well as processes to be applied to individual rasters or the complete image service, may be defined. A build process is available to compute properties that are derived from the rasters such as the boundary of the image service or creation of overviews. Prior to publishing, the image service definition is compiled. The compilation process converts the open data structures into a compact and optimized form for publishing. As the image service definition does not contain the actual pixel values, it is small in size. By working within ArcMap, the authoring component has access to all the extensive functionality including editing of the database and geometry such as footprints and seamlines.

The server component is small and easy to install. It does not require any third-party database or Web server. ArcGIS Image Server can utilize existing imagery on disks or networks, eliminating the need for long or costly data conversion. Most users can install and have large image services running within half a day.

To publish an image service, the Server Manager component is used. This provides the user interface to create a server as well as one or more service providers if required on multiple machines. By adding the compiled image service definition to the Server Manager, image services are published and immediately made available to client applications. The system is dynamic in that the compiled service definition may be updated at any time without affecting the image services. If a compiled image service definition is updated, the revised image service can become immediately available to users.

There are many ways to configure ArcGIS Image Server on different machines:

- **Single machine—**The server, service provider, and data are on a single machine. The media in this case is often just direct attached storage (DAS). This works very well and, depending on the server, imagery can be served to hundreds of users. This type of configuration allows ArcGIS Image Server to be used as a stand-alone server application.

- **Multiple machines—**The simplest method to increase capacity is to duplicate the server and link the second service provider to the first server. This doubles the performance in terms of the number of requests per hour that can be handled. This type of implementation is very effective, as a server with a DAS is often inexpensive.

- **Multiple service providers + NAS/SAN—**The truly scalable approach to increasing capacity is to use multiple service providers connected to a Network-Attached Storage (NAS) or storage area network (SAN). This can be implemented in the form of a blade server, where each blade server is an additional service provider. This approach has a single data source and can easily be scaled in terms of processing power and data storage.

When used with ArcGIS Server for serving to Web applications, ArcGIS Image Server can be installed on the same machine as ArcGIS Server, but for larger installations it is generally better to keep the two application servers on separate machines.

Optimization Considerations for ArcGIS Image Server

ArcGIS Image Server is highly optimized and has been designed from the ground up for very fast access and processing of imagery. Service providers are multithreaded and a single machine can process tens of requests per second. The architecture that enables multiple service providers to be allocated to a single server provides ArcGIS Image Server with the capacity to scale up to large numbers of simultaneous requests. The speed at which image services are processed and returned to clients can be affected by a number of factors. These factors comprise the hardware configurations, the number of pixels for the source imagery that needs to be read, where or how imagery is stored, the number and types of image service processes, mosaicking methods used, compression of the source imagery, and compression used for transmission.

For more detailed information on this topic, read the article "Optimization Considerations for ArcGIS Image Server" located at http://webhelp.esri.com/arcgisdesktop/9.2/index.cfm?TopicName=Optimization_considerations_for_ArcGIS_Image_Server.

Integration and Customization

ArcGIS Image Server comes with a software developer kit that enables developers to

- Add new raster formats that define how pixels are read from a data source such as proprietary formats.
- Add raster types that define the various ways in which properties of rasters and their metadata are defined.
- Create processes that enable proprietary image-processing algorithms to be defined.
- Create geotransforms that define new sensor models or warping methods.
- Control different methods to store and display metadata for the services as well as individual rasters.

The client DLL can be used to integrate the client into other applications, so that imagery from ArcGIS Image Server can be accessed by any application.

Licensing

As part of the ArcGIS Server family, the ArcGIS Image Server licensing structure is similar to that of ArcGIS Server in that it is based on the number of cores being used on the server. There are no restrictions on the volumes of data or the number of clients.

System Requirements

ArcGIS Image Server is CPU intensive and optimized to minimize RAM requirements, so it has a relatively small RAM footprint. ArcGIS Image Server works on the Microsoft® operating systems listed below:

Server Manager

- Microsoft Windows® XP or Windows Server® 2003 (32 bit or 64 bit), installed with Microsoft .NET Framework 2.0
- Pentium 4 or higher processor, 512 MB of RAM minimum; 1 GB or higher recommended

Server

- Microsoft Windows XP or Windows Server 2003 (32 bit or 64 bit)
- Intel Pentium or Intel Xeon 1.0 GHz, 1 GB RAM

Service Provider

- Microsoft Windows XP or Windows Server 2003 (32 bit or 64 bit)

- Intel® Pentium® or Intel Xeon® processor, 2.0 GHz or higher recommended; 1 GB RAM per core minimum

Service Editor

- ArcGIS Desktop 9.2 (ArcView® minimum) installed with ArcGIS .NET support and Microsoft .NET Framework 2.0

- Hardware requirements as per ArcGIS Desktop 9.2

Image Server Clients

- Hardware requirements as per the application running the client

Support

In the United States, contact ESRI Technical Support from 6:00 a.m. to 5:00 p.m. (Pacific time), Monday through Friday.

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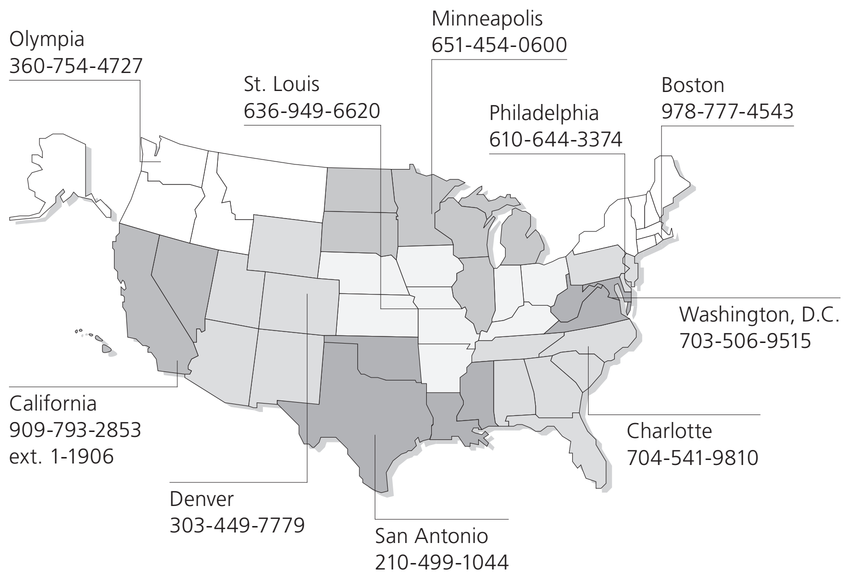

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