

Solving the problem of serving large image mosaics

Using ECW Connector™ and Image Web Server™ with ArcIMS®

A White Paper from Earth Resource Mapping



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Executive Summary

This White Paper provides detailed technical information on proven solutions to enable and accelerate serving large amounts of imagery for ArcIMS based GIS web servers.

The challenge – serving large image mosaics

Imagery forms an essential and well-understood part of GIS applications. There are unique challenges associated with making effective use of imagery, especially when providing Internet or Intranet GIS web mapping solutions.

Application requirement	Type of imagery used	Uncompressed imagery size
City wide coverage	High resolution color airphotos	300GB to 1.5TB
County or shire wide coverage	Medium resolution airphotos	500GB to 2TB
State or country wide coverage	Satellite imagery	300GB to 40TB

The above table shows the approximate size of imagery required to cover the needs for a typical GIS web mapping application covering a city, county, state or entire country.

As can be seen, a GIS web server needs to be able to easily serve 300GB to 40TB of imagery. The problem gets worse when users wish to monitor changes over time between imagery covering different years.

Where as 10GB of data might represent a huge amount of information stored as vector and attribute information, 10GB of imagery is quite small.

Yet the benefits from using imagery are compelling (for example, vector GIS and CAD data is often created from imagery as a starting point), and it provides an intuitive, accurate and up to date view of the real world for users.

This White Paper discusses different solutions that enable ArcIMS based GIS web servers to effectively prepare, manage and serve the large image mosaics in common use today.

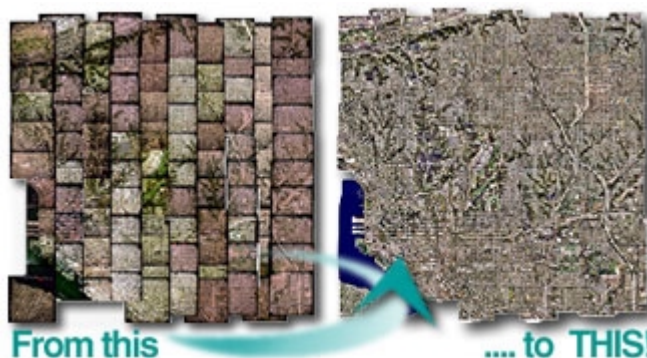


The solutions: ECW Connector and Image Web Server

Earth Resource Mapping (ERM) is an international company with 14 years of expertise in enabling GIS, CAD, Office and imagery users to prepare, use and serve imagery.

Four core ERM product technologies are directly useful to organizations wishing to deploy large amounts of imagery within an ArcIMS GIS web server environment. These are:

1. **ER Mapper** (not discussed in this White Paper) creates seamless ECW image mosaics by geocoding, mosaicking, color-balancing and compressing thousands of raw images using a simple wizard-based GUI.



Color-balancing is essential to ensure quality image mosaics

2. **ECW** is a proven wavelet based technology specifically designed to handle very large geospatial images. ECW enables images to be quickly viewed from any level from overviews right down to a pixel level. ECW also enables images to be compressed, typically 1TB (1,000GB) of imagery can be compressed to just 50GB, at a much better quality than JPEG DCT compression.
3. **ECW Connector** for ArcIMS enables large ECW images to be integrated and served directly from ArcIMS. Free ECW plugins are also available for other ESRI® products such as ArcInfo® and ArcView®.
4. **Image Web Server** accelerates serving of images. Instead of doing server-side image decompression and serving from within ArcIMS, the Image Web Server directly streams compressed imagery to the client web browser, resulting in significant reductions in server CPU, disk and network loads. The free companion I-Wizard product for Image Web Server enables Image Web Server served ECW images to be easily added to existing ArcIMS web pages.



About Enhanced Compressed Wavelet (ECW) images

The ECW image format is a popular image format within the GIS and CAD geospatial markets. All major GIS and CAD vendors – except ESRI - offer native ECW support within their applications.

Free ECW plugins can be downloaded from www.ermapper.com/downloads for ESRI desktop applications such as ArcView, ArcGIS and so forth.

All ECW plugins can read ECW images of any size (subject to any application imposed image size restrictions). Many plugins also offer free ECW compression capabilities for images smaller than 500MB uncompressed size. Free ECW compression plugins and applications include ECW Compressor and the ECW plugin for ArcGIS.

The ER Mapper product is used to create larger ECW images. ER Mapper provides image geocoding, mosaicking, color-balancing and compression capabilities. It is designed and tuned to easily create image mosaics from 100GB to TB amounts of source imagery, and is routinely used for this purposes by many organizations around the world.

ECW features include:

- Widespread Geospatial industry support and free ECW SDKs.
- No 2GB file size limit (many formats, such as TIFF and older wavelet based compression technologies, have a 2GB file size limit).
- Designed – and proven – to handle terabyte (TB) size images.
- Significant reduction in disk space requirements. Color airphotos are typically compressed at 20:1, so 1TB (1,000GB) of uncompressed imagery reduces down to 50B in compressed size.
- Quick image views from overview right down to pixel level views.
- Very high spatial accuracy of imagery, even when compressed.
- Streaming ECWP support. In addition to directly reading ECW files from a local or network file directory, many applications have full ECWP:// support which enables ECW images to be streamed into the application from an Image Web Server.



About ECW Connector

ECW Connector enables ArcIMS to directly read and use ECW images.

In addition to adding important capabilities (such as the ability to serve complete image mosaics very quickly) the ECW Connector removes the need to store and manage individual images in ArcSDE.

The ECW Connector technology is heavily tuned for multiple client access into the same image mosaic with different views. Caching is fast and efficient. ECW does not have the overhead of accessing imagery through a database engine. ECW's multi-level wavelet based ECW image structure is specifically designed to enable very fast access.

We encourage performance testing and comparison of multi user access into a ECW file compared to multiuser acces into an ArcSDE based image mosaic.

ECW Connector provides the following features to ArcIMS based GIS web sites:

- Install and start serving images immediately.
- Direct access to ECW images, which can be any size. 100GB or even a TB image mosaic can be used and accessed as a simple single image.
- Fast access to imagery at any resolution or level.
- ECW image preparation can be done offline using ER Mapper on desktop PCs.
- Images can be enhanced using powerful ER Mapper techniques. For example, an airphoto mosaic can be merged with a shaded topographic map to provide an integrated image view of both types of data.

About Image Web Server

Image Web Server acceleration of ArcIMS adds the following capabilities:

- Streaming imagery support into client browsers
- Streaming imagery into ESRI desktop applications including ArcView and ArcGIS with the free ECW plugin for those products.
- Streaming imagery into non-ESRI products, such as Microsoft Word®, MapInfo® and CAD applications, enabling full imagery deployment through the organization.
- Much lower disk, CPU and network loads.
- Faster ArcIMS response by offloading imagery into the imagery specific Image Web Server product.
- Reduced ArcIMS load as client-size real time roam/zoom can actually *reduce* the number of server requests because more views are being generated client side rather than server side.

A White Paper providing details about accelerating ArcIMS with the Image Web Server is available and can be found at: http://ermapper.com/document/doc.aspx?doc_id=33

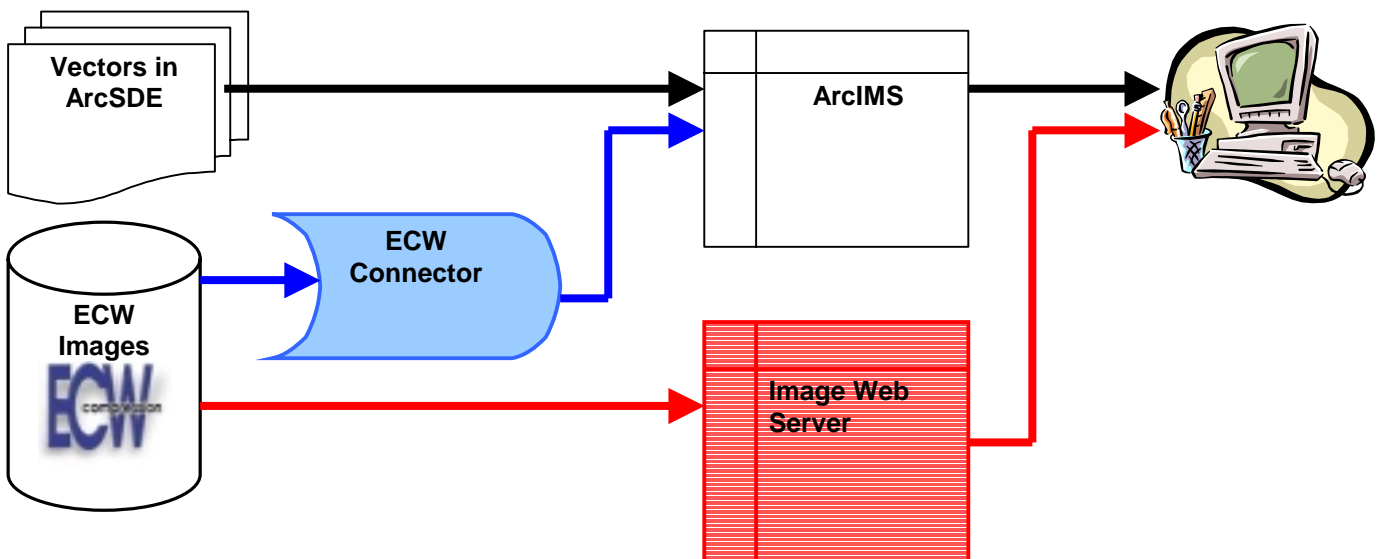


Selecting the right product to use

Both the ECW Connector and Image Web Server products enable ArcIMS based GIS web server environments to add large images to GIS maps served to client browsers. The two products address different issues dealing with large images.

The ECW Connector enables server side integration of ECW images with ArcIMS servers. The Image Web Server enables client-side integration of ECW images with ArcIMS based client browsers.

The following diagram demonstrates imagery integration using ECW Connector (in blue) or Image Web Server (in red) with ArcIMS:



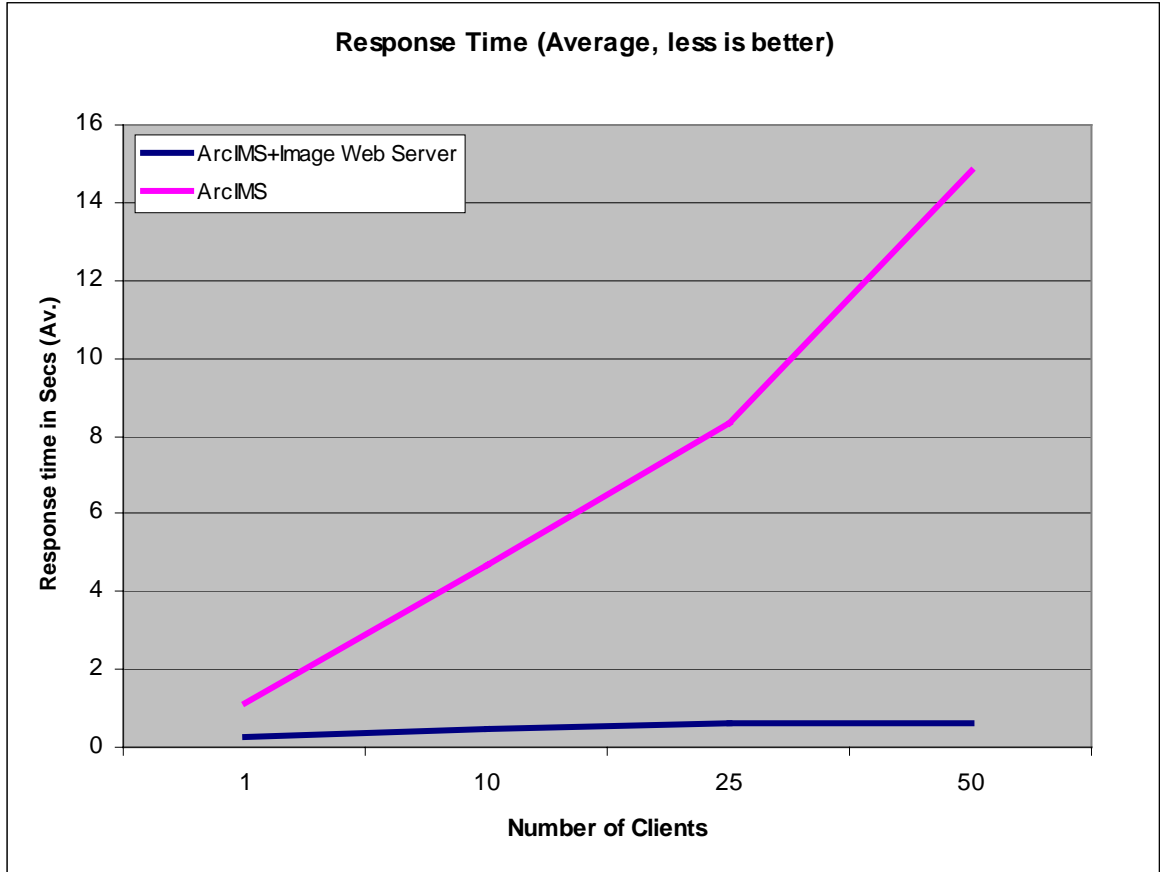
Using ECW Connector

ECW Connector is cheaper than the Image Web Server. Simply add ECW Connector to an ArcIMS site and ArcIMS can then access ECW images to be included in GIS maps served to clients. However, ArcIMS is doing server-side extraction of image views, merging it with vector data also rendered into an image, and then serving that to a client browser. This means that server CPU, disk and network loads remain high. As ECW Connector removes the imagery load completely from ArcSDE, you will still get good image access to very large images.

Using Image Web Server

Image Web Server dramatically reduces server CPU, disk, and network loads. It does this by using the two-way streaming ECWP image product (layered over HTTP) to directly serve imagery into the client browser.

The client browser also caches imagery, further reducing network loads. This completely eliminates ArcIMS CPU loads for imagery as the imagery never passes through ArcIMS, and the Image Web Server has a very light server CPU load. Disk and network traffic are also reduced because the ECWP protocol serves compressed wavelet imagery. Only information not already cached at the client is sent, further reducing traffic.



The Image Web Server also actually reduces CPU load on your ArcIMS server itself, because Image Web Server enabled client browser views can roam and zoom over an existing view with a corresponding reduction in requests to the ArcIMS server for new views.

Another significant advantage is “never wait” client browser interfaces – the end user can always roam and zoom the GIS map view, rather than the far slower approach of selecting a view, waiting for a server refresh, then selecting another view, and so on. Image Web Server accelerated ArcIMS sites serve imagery so quickly that they often serve the image view faster than the overlaid vector layers.

Visit the site <http://huron.damap.com/website/nassau83/viewer.htm> to see a typical Image Web Server accelerated ArcIMS site in action.

Note that you can easily choose to use both the ECW Connector *and* Image Web Server products, as each product offers different advantages.

A White Paper providing a detailed analysis of performance benefits when using Image Web Server to accelerate an ArcIMS based web site can be found at http://ermapper.com/document/doc.aspx?doc_id=33



Questions to ask ESRI about large image performance in ArcIMS

Question: How long does it take to load 200GB of imagery into ArcSDE from 800 images each 250MB?

ESRI Answer: 80MB per minute

ERM: At 80MB/minute, that means 2 days to load a 200GB image mosaic into ArcSDE.

According to ESRI's own Raster Data in ArcSDE 8.2 white paper, loading images into ArcSDE is a slow process at just 80MB/minute – and that is without creating the image pyramid need by ArcSDE to provide quite multi-resolution access.

ECW image mosaics can be prepared on a normal desktop PC using ER Mapper. Once the image mosaic is loaded onto the web server it is immediately ready to use. The process of color-balancing and mosaicking and compressing an ECW mosaic with ER Mapper is actually faster than just loading images into ArcSDE, ER Mapper ECW image preparation speed is about typically 300MB/minute for straight compression and about 180MB/minute for the more typical color balance/mosaic/compress process needed to create a quality image mosaic.

There is no need to lock up your ArcSDE and ArcIMS web servers loading imagery for days on end. Instead, prepare image mosaics using ER Mapper then just copy the file over to the web server.

Question: Does that load time include creating an image pyramid so the image mosaic can be quickly used?

ESRI Answer: That will add additional time

ERM: The 80MB/minute figure quoted by ESRI *did not include time to create an image pyramid.*

Also, note that if you wish to add an image to an image mosaic in ArcSDE, the pyramid will need to be recreated by ArcSDE.

ECW images are encoded into wavelet image space. This means that views into the image can be quickly extracted at any resolution, from an overview down to pixel level views.

There is no need to allocation additional storage on your web server just for image pyramids.

Question: Why is ESRI the only major GIS or CAD vendor that does not offer native ECW support?

ESRI Answer: ?

ERM: Free ECW plugins – created and supported by ERM not ESRI – are available for download for ESRI desktop products including ArcView 3 and the ArcGIS 8 family of products.

ESRI is the *only* major GIS or CAD vendor not to offer native ECW support.

AutoDesk, CadCorp, ENVI, GeoSQL, Intergraph, Manifold, MapInfo, PCI and SmallWorld are just some of the major vendors or products that offer native ECW support.

Question: How much extra will it cost in hardware, ArcSDE and database costs to add imagery?

ESRI Answer: ?

ERM: Very large image mosaics can be produced from a single copy of ER Mapper in under a day ready for copying to your web server. Disk IO is not a critical factor for ECW files, which are also compressed, so disk costs are low.

Question: How much additional disk space is taken up by having to build an ArcSDE image pyramid?

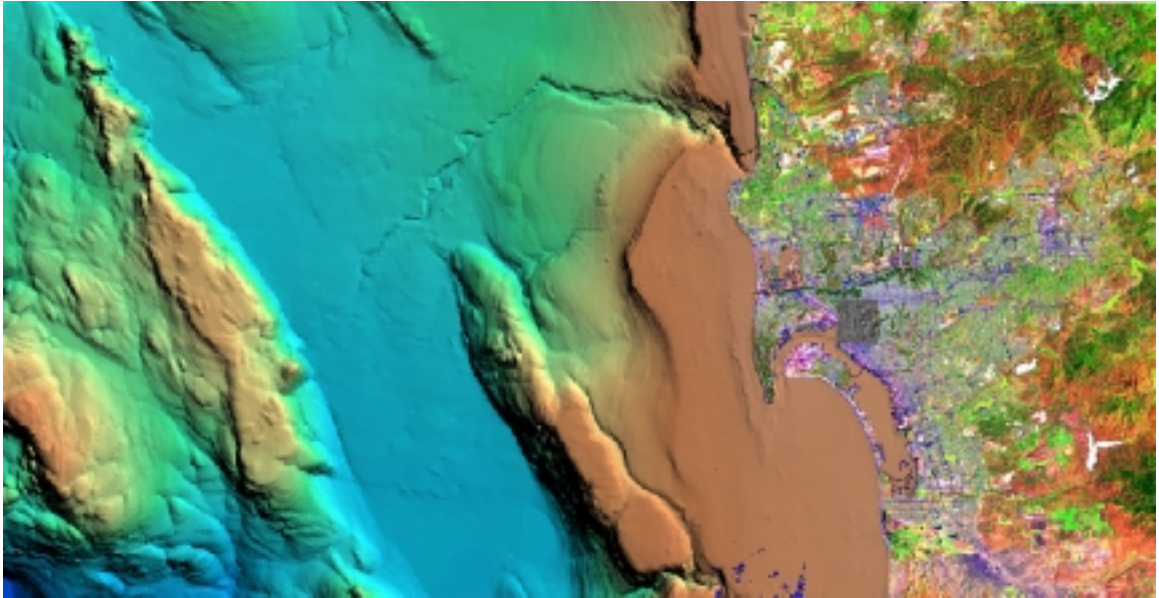
ESRI Answer: ?



Question: Are ArcSDE raster image mosaics limited to the same image cell size?

ESRI Answer: Yes. Images are also restricted to having the same bit depth and pixel offset

ERM: ESRI's [Raster Data in ArcSDE 8.2](#) white paper states that in order to add images to an ArcSDE based raster mosaic, the images must have the same bit depth, the same cell size, the same number of bands and the same pixel registration.



The above ECW 25GB image mosaic combines bathymetry, satellite imagery and airphotos all into a single view. ER Mapper can create ECW mosaics from images of different resolutions, different bit depths, different types of processing, and different pixel offsets.

After installing the ECW plugin for ArcView or ArcGIS, you can directly view the above 25GB ECW image mosaic from within your GIS application by specifying the following URL, which uses the Image Web Server to stream the image into your application.

`ecwp://www.earthetc.com/images/usa/sandiegomosaic.ecw`

Question: Can ESRI point to any public web sites with a TB image mosaic served by ArcSDE and ArcIMS?

ESRI Answer: ?

ERM: Many Earth Resource Mapping clients have created ECW image mosaics covering 100GB, 500GB and even 1TB of uncompressed imagery and are serving these images on a routine basis. Visit www.EarthEtc.com to see these sites in operation yourself.



Question: How much fast SCSI server storage will I need to serve a TB of imagery?

ESRI Answer: ?

ERM: ESRI's [Raster Data in ArcSDE 8.2](#) white paper states that ArcSDE provides LZW lossless or JPEG lossy compression.

LZW compression provides poor compression for airphoto imagery. If 50% compression is achieved, then 500GB of disk storage is required. Imagery stored in a typical SCSI based storage system used to achieve good database performance is expensive. The JPEG DCT compression technologies is quite old and can't compete with modern wavelet based compression technologies such as ECW. Using JPEG requires using a low compression rate to achieve acceptable quality.

ECW mosaics are typically compressed at 20:1 and still outperform both radiometric and spatial accuracy of JPEG DCT compression at much lower compression rates. Furthermore, the ECW format organizes data so that views for any area at any resolution can be very quickly retrieved. You see this yourself by asking ERM for the ECW Airphoto Mosaic sample CD-ROM (which has 25GB of airphoto imagery compressed onto a single CD-ROM) and see how quickly you can roam and zoom over the imagery *directly from the CD-ROM*.

Evaluating ECW image performance

Recently in the industry there have been a great many claims and counter claims made with respect to solving the problem of serving large images.

ERM encourages open benchmarks and information. When considering claims made by vendors, it is worth looking at the following factors:

1. What are the claims being made by a vendor?
2. Can those claims be backed up with public examples?
3. Can any claims made be independently verified?

We encourage you to perform your own tests comparing ECW performance with serving images via ArcIMS alone or via ArcIMS and ArcSDE.

Ask for a free evaluation copy of ER Mapper which will enable you to mosaic and compress your own seamless and colorbalanced mosaics. Alternatively, ask ERM for a free copy of the "ECW Airphoto Mosaic CD-ROM" which contains 25GB of airphotos.

Use the free ECW plugins to add ECW support to your ESRI desktop applications such as ArcGIS, and compare the roam and zoom speed over the 25GB imagery with database image solutions. The ECW Connector for ArcIMS uses the same underlying ECW technology as the plugins for ArcGIS et al.

Installing ECW Connector on your ArcIMS based web server

ECW Connector is licensed on a per CPU basis and installed on the server running ArcIMS. So if your ArcIMS web server hardware is a 2 CPU machine, you will need a 2 CPU license of ECW Connector. HyperThread capable CPUs are counted as a single CPU, not as two CPUs.

There are no limits (other than physical server hardware limitations) on the size of images or number of images or number of client connections.

ECW Connector is installed based on the unique system ID of your server. You can not move it to another machine. If you feel you may need to do move the license, please ask for a time limited license instead. ERM will then allow the license to be moved to another system.

Once ECW Connector is installed, ECW images become available just like any image supported by ArcIMS.



Conclusions

- Workable, real world imagery mosaic solutions are available today to enable ArcIMS based GIS web servers to add large image mosaics to GIS maps.
- Several solutions enable tuning to best suite organization deployment requirements.
- Demonstrations are publicly available online (visit www.EarthEtc.com)

