

# MrSID Technology Primer

NOVEMBER 2004

LIZARDTECH, INC.

## OVERVIEW

LizardTech's GeoExpress products are powered by MrSID<sup>®</sup>, a powerful wavelet-based image encoder, optimizer, viewer and file format designed specifically for GIS professionals for true portability of massive images. The name MrSID stands for Multiresolution Seamless Image Database.

The MrSID technology enables instant viewing and manipulation of imagery both locally and over networks without sacrificing image quality. MrSID also enables unprecedented compression ratios, true multiple resolutions, selective decompression, seamless mosaicking, and improved image browsing and manipulation.



The benefits enumerated above are made possible by MrSID's planar architecture. A plane, or "bitplane", is an efficiently encoded representation of a subset of the image data corresponding to a degree of image quality and a level of resolution. It is not necessary to fully understand bitplanes to appreciate these benefits, though bitplanes are described in detail further below. The following three statements summarize what is necessary to know about MrSID from a technology standpoint:

- A MrSID image is a set of bitplanes.
- All bitplanes are essentially optional. A high-quality image is still achievable even when not all bitplanes are retained.
- A transaction of MrSID image data is simply the extraction and delivery of exactly and only those bitplanes necessary to construct a view according to desired scene, scale, or image quality, independent of bandwidth constraints.

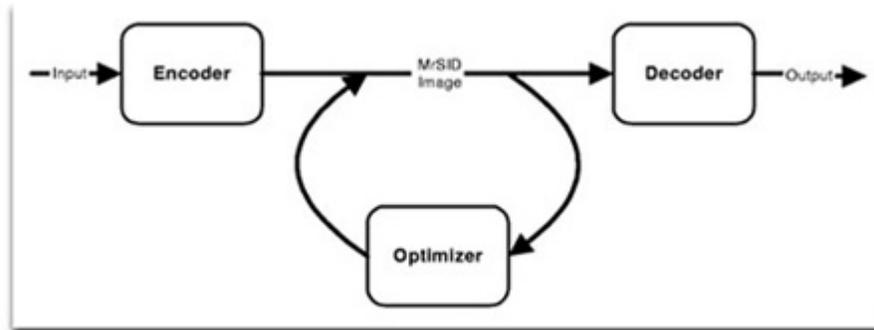
The discussion that follows describes encoding, optimizing and decoding MrSID images in more detail. While it most often occurs after encoding, we discuss optimization first because it involves more general processes, and because optimization can be performed at the time of encoding.

## MRSID OPTIMIZATION

Instead of the common, two-phase architecture in which an image is encoded once into a lossy compressed file of a particular size, then decoded for viewing, MrSID is built around three phases: (1) an initial lossless encoding process, (2) an optional and repeatable optimizing process and (3) a selective decoding process, or “selective decompression”.

With the two-phase architecture, decisions about how an image is to be optimized have to be made “up front”. These are decisions that affect how an image can and cannot be used; for instance, whether an image is encoded *losslessly* or *lossily*.

Lossless encoding retains all image data – even with some compression – and results in a file that can be decoded back to the original image with pixel-for-pixel fidelity. Lossy encoding discards some data – usually for further compression, cropping, or some other optimization.



The three-phase architecture means images can be encoded once – either losslessly or lossily – and then optimized as many times as the user wishes for as many purposes and workflows as the user wishes the image to serve.

For example, a large satellite image in TIFF format may be encoded and stored as a lossless MrSID image. A copy of that image might later be cropped for analysis of a particular scene within the image, while another copy might be optimized for thumbnail creation or low resolution browsing or panning within the image.

The lossless image remains intact as a “single-source” MrSID image and serves an infinite number of workflows. It can also be retrieved entirely and decoded as the original TIFF image.

## MRSID ENCODING

To further illuminate the optimization process, it is necessary to describe the encode process and how bitplanes work. In the Encoder, image data undergo a wavelet transform, a color transform and lossless compression through a binary arithmetic encoder (BAC). At the same time, the Encoder divides an image into zoom levels, subbands, subblocks and bitplanes.

### Zoom Levels

For every image a certain number of resolutions or “zoom levels” is created, depending on the size of the original and number of levels the user desires.



**Zoom Level Zero** is the image at original size, represented as number of pixels high by number of pixels wide (h x w).

Each smaller zoom level has dimensions half the size of the previous (for example **Zoom Level One** has the dimensions  $h/2 \times w/2$ ) and is thus one fourth as large. It has one fourth the resolution of the next higher level.

**Level Zero - Original Image: 512 x 512**



**LEVEL ONE**  
( $h/2 \times w/2$ )  
256 X 256



**LEVEL TWO**  
( $h/4 \times w/4$ )  
128 X 128



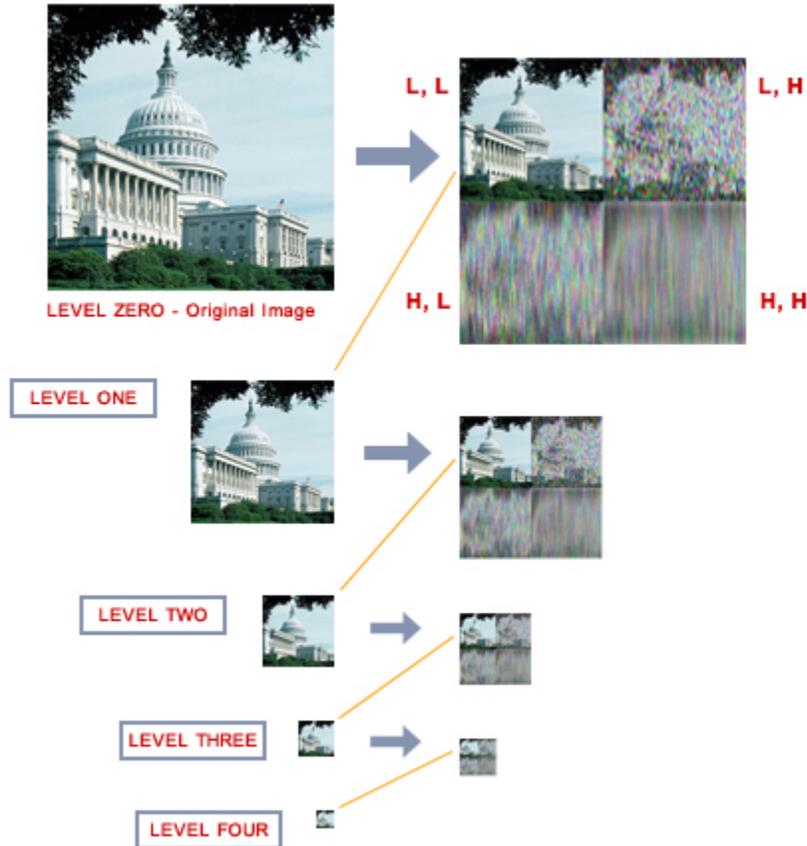
**LEVEL THREE**  
( $h/8 \times w/8$ )  
64 X 64



**LEVEL FOUR**  
( $h/16 \times w/16$ )  
32 X 32

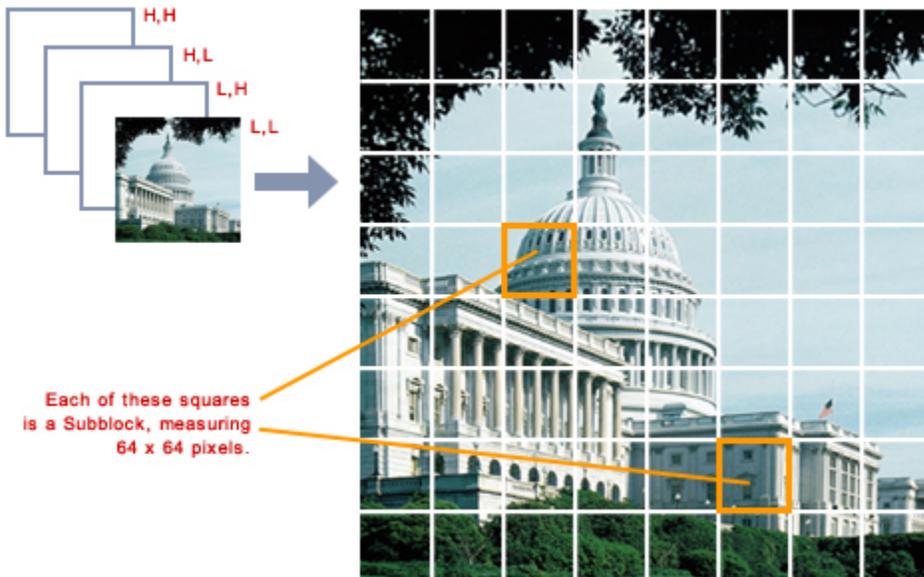
## Subbands

Each zoom level is divided into four subbands corresponding to the four frequency combinations (low-low, low-high, high-low, high-high). The next smaller zoom level is created from the low-low subband.



## Subblocks

Each subband is further divided into subblocks. Each subblock measures 64 x 64 pixels.

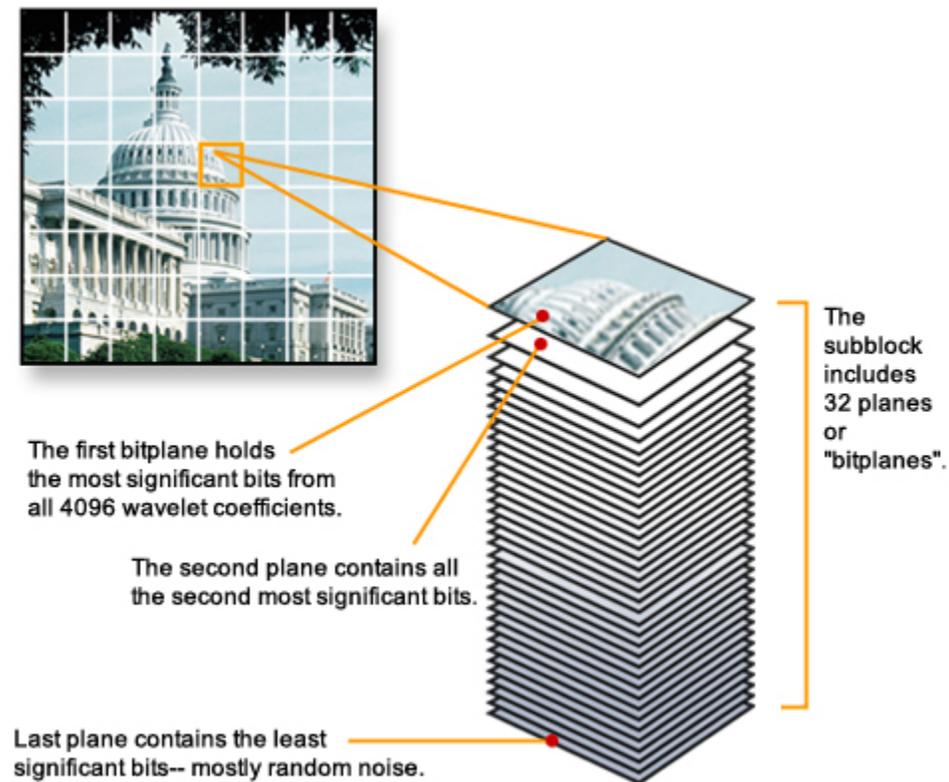


In the illustration above we're looking at the subblocks of the low-low (L,L) subband of Zoom Level 0. Smaller zoom levels would have fewer subblocks, because the subblocks are normally the same size (64 x 64) no matter what zoom level they're from.

You would only recognize an image in the low-low subband. But the other subbands contain important image data as well, and they too are divided into subblocks.

## Bitplanes

Finally, each subblock is made up of 32 bitplanes. As noted above, a subblock is an array of 64 x 64 pixels, which have by now been transformed into wavelet coefficients. Each subblock thus has 4096 wavelet coefficients. In turn, each wavelet coefficient is represented by a string of 32 bits. The bits are distributed among the bitplanes as shown below.



The first and thus most significant bits from all 4096 wavelet coefficients are represented together on the first bitplane. All the second bits (which are also the second most significant) are collected on the second bitplane. The third bitplane contains all the third bits, and so on to the last and least significant bit. As significance decreases toward the last bits in the bitplane, detail increases. (The last bit of a wavelet coefficient often represents random data or "noise" in the image, which can be imagined as "extreme detail".)

The last bitplane is meaningless without the first bitplane. In fact, within a given subblock each bitplane is dependent upon all the bitplanes before it.

## **Significance Versus Detail and the Selection of Bitplanes**

Ultimately, then, a MrSID image is a set of bitplanes. When a user requests an image or any portion of an image, those bitplanes and only those bitplanes are delivered that are necessary to render the desired quality, zoom level, or scene. If the user chooses another zoom level, pans left or picks a different scene, or requests a different degree of image quality, the additional bitplanes required for the new view are extracted from the “single-source” MrSID image and delivered.

## **MrSID DECODING**

MrSID’s selective decompression occurs in the Decoder. The MrSID Decoder runs all the encode steps in reverse. All selected bitplanes are run through the BAC, where the coplanar subblocks are reassembled and wavelet coefficients processed with an inverse wavelet transform.

Other formats require that the entire file be decoded before any of it can be used. Because it decodes only the required data, MrSID is more efficient in both memory and speed. Moreover, a MrSID viewer is a client that invokes the Decoder, so that viewing a MrSID image is merely an application of the decode process.

MrSID is a proven image optimization technology and dynamic image format that offers a flexible, cost-effective solution for maximizing storage, transfer, and workflow efficiency. Its planar architecture, lossless “file-size” reduction, selective decompression and other features solve the problems faced by image handlers today. Whether lossless or lossy, MrSID provides the foundation for advancing digital imaging to its next level.

## **FURTHER INFORMATION**

For more detailed technical information about MrSID, see downloadable white papers at [www.lizardtech.com/products/geo/techinfo.php](http://www.lizardtech.com/products/geo/techinfo.php).