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## TerraServer Scale

TerraServer Resolution Examples

The three images above are the same size but contain varying amounts of land area and detail. The left image shows a large area of San Francisco with very little detail. The middle image shows less area and more detail. The right image shows a very small area of the Bay Bridge with a lot of detail. The contrast between land area and image detail is known as the image's resolution. The left image is considered to be a "lower resolution image". Each pixel covers 32 meters on a side, whereas the right most "high resolution image" covers 1 meter per pixel.

The resolution, or ground area, of a satellite or aerial image is measured by the amount of area covered by each pixel in the digital image. For example, if you are viewing a TerraServer image at 16 meters, each side of a pixel or dot represents the length of 16 meters on the ground. (By the way, if you click the meter "Detail" line on the image display page, you will be able to see information on the size and resolution of the image you are viewing.)

To visualize the resolution levels of an image, imagine a pyramid. TerraServer supports seven levels for each image pyramid, ranging from 1-meter resolution (showing more detail) to 64-meter resolution (showing more ground area). The source imagery is up or down sampled (added to or substracted from) as necessary to an appropriate Microsoft TerraServer resolution. Sampling basically means drawing a "sample" from a tile and adding or substracting to it to get different levels of resolution.

To compute all these resolutions, TerraServer uses its TerraScale program. TerraScale is the second load program in the Load Management Schema used to import images into TerraServer's imagery database. It re-samples the tiles created by TerraCutter to create the lower resolution tiles in the image pyramid. To create a lower resolution tile, TerraScale takes four tiles from the next higher resolution and averages four pixel values into one pixel value. TerraScale repeats this process at every resolution level until it tiles the lowest resolution tile for a given image.
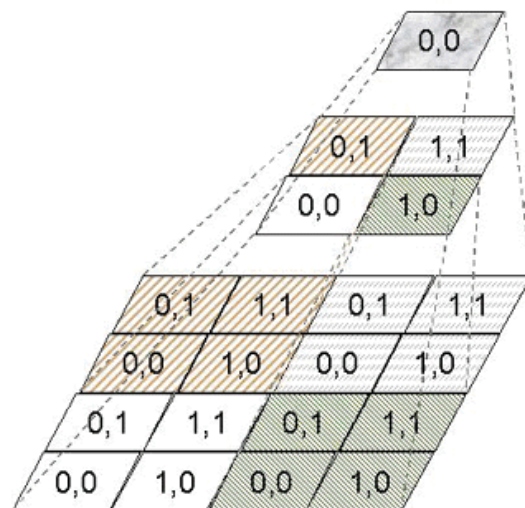
The diagram above depicts how the highest resolution tiles loaded by TerraCutter contribute to the pixels at lower resolution. We refer to the tiles loaded by the TerraCutter program as the "base scale" or "base tiles".

The number of lower resolution tile levels created by the TerraScale program is theme dependent. The USGS DOQ base scale is 1 meter. The SPIN-2 base scale is 2 meters. TerraScale creates 2-meter resolution through 64-meter resolution - a total of seven levels.

USGS DRG data is a special case. Original DRG input images are available at 2.5-meter resolution, 10-meter resolution, and 25-meter resolution. TerraCutter re-samples the 2.5-meter resolution image into the 2-meter tile table, the 10-meter input image into the 16-meter tile table and the 25-meter image into the 64-meter tile table. TerraScale re-samples the 2-meter tiles into the 4- and 8-meter tables. The 16-meter tiles are re-sampled into to the 32-meter table. The 64-meter tiles are re-sampled into the 128-meter table.

The TerraScale program takes into account the ever-changing landscape in the base tile table. It handles the case where lower resolution tiles must be padded with blank space because not all of the lower resolution tiles yet exist. It determines that a lower resolution tile must be re-sampled based on the insert dates maintained in each tile table.

Each time the TerraCutter program completes an input file found in the source path, it inserts a row into the **ScaleJob** table. This is the signal to the TerraScale program that a block of image tiles is ready to have its image pyramid created. The TerraScale program updates the **ScaleJob** table with its progress information, and again a set of Active Server Pages are used to monitor the progress of the image pyramid creation.

The TerraScale program continuously scans the **ScaleJob** table for new work to do. If it finds a row with a "job queued" status for the theme and zone it is assigned to, then it reads the job characteristics and updates the **ScaleJob** row to indicate that the TerraScale program is handling the job.

The **ScaleJob** fields identify the minimum and maximum X and Y values inserted into the base tile table by the TerraCutter for a single SceneID value. TerraScale computes the range of X and Y values for the lowest resolution scale that it must generate for the theme type. This constrains the size of the image pyramid the TerraScale program will attempt to create during this **ScaleJob** run.

TerraScale begins a loop to create the tiles at the lowest resolution. This is the top of the image pyramid. It fetches the current tile's insert date and image pixels. Then it fetches the four tiles and insert dates at the next higher resolution level. It recurses down the image pyramid (higher resolution levels) until it fetches the four base tiles and the insert date. If any of the insert dates along the way are after the insert date found in the **ScaleJob** table, the TerraScale program will resample the imagery along the line of descent. If the dates of the higher resolution images are on or before the insert date found in the

The TerraScale program continues to walk up-and-down the image pyramid underneath the lowest resolution tile it is generating. It finally completes and moves on to the next X,Y value to process for the **ScaleJob** and repeats the process.

TerraScale is told which resolution levels are to represent the image pyramid in the search system. As a last step in building an image pyramid for a particular low resolution X,Y value, TerraScale inserts the appropriate rows into the **ImagePlace** and **ImageSearch** tables. A tile is not visible in the TerraServer application until a row is inserted into these two tables.

When all the X, Y pairs are completed for the lowest resolution tiles, TerraScale updates the **ScaleJob** to indicate that it has completed the job.

Both TerraCutter and TerraScale continously do their jobs in the background while you browse imagery on TerraServer. The table design and load program insertion order ensures that all the required meta data and imagery is in place prior to new imagery being made visible to the web application.

Now the image files have been received from TerraServer's data sources, loaded into the database, and "sliced and diced" into millions of image tiles. How does TerraServer access all these stored image tiles to display an image on the screen as you browse? Move on to the next section, "TerraServer Interface", to find out what happens when you click an image link.

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