

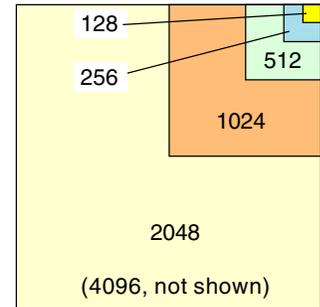
Google Earth Structure

You can convert very large images or image collections into tilesets for use in Google Earth using the Auto Mosaic and Export Raster Tilesets processes in TNTmips. A Google Earth tileset created in these processes conforms to the Super-Overlay structure, Google's term for a tiled, multi-resolution image that provides the most efficient and responsive 3D perspective viewing of your very large images in Google Earth. The Super-Overlay includes the tileset, which is partitioned into a nested set of directories by level of detail (zoom level) and tile row, and a master KML file that references the tileset. Each tile in the hierarchical structure is accompanied by an individual KML file that references the relative path to the tile file and specifies its geographic extents, appropriate level of detail, and the corresponding tiles in the next higher resolution level. This structure is optimized for use in Google Earth's 3D perspective view, in which higher-resolution tiles are shown in the foreground and lower-resolution tiles in more distant parts of the view. The Super-Overlay structure allows Google Earth to rapidly identify and load only those tiles that are currently in the

view and to determine the appropriate resolution level to show for each tile area.

Reference System and Tile Sizes

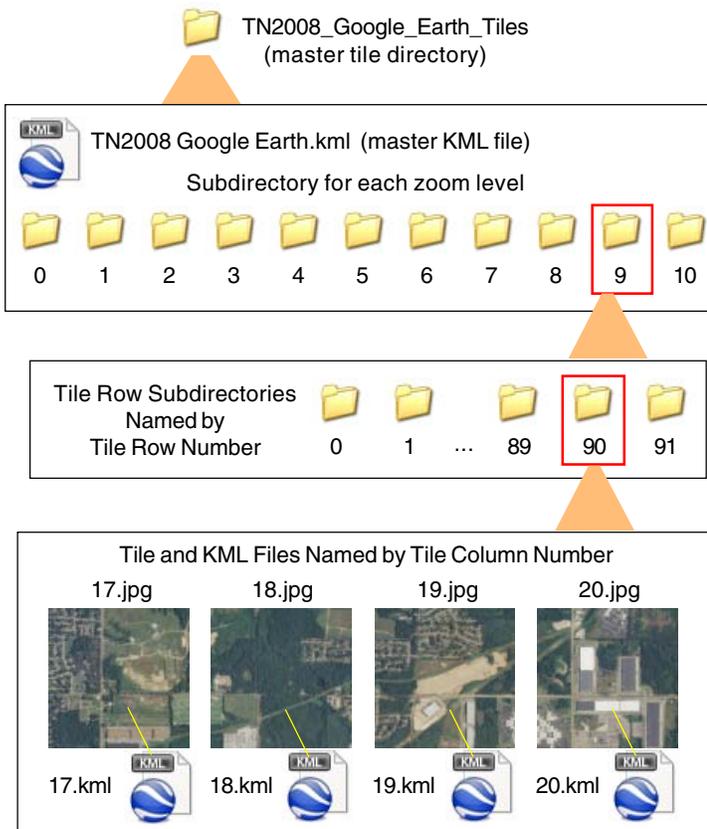
Tiles in a Super-Overlay are aligned to the WGS84 / Geographic coordinate reference system required by Google Earth to allow tiles to be draped on their global 3D terrain model. Google Earth does not require a specific tile size, but the linear dimension of square tiles must be an integer power of 2 between 256 and 2048 pixels. Google recommends a tile size of 256 or 512 pixels, but MicroImages has found that a tile size of 1024 for large tilesets provides excellent performance in Google Earth while reducing the number of tiles by a factor of 16 compared to a 256-pixel tile size.



Allowed Tile Sizes (linear dimension in pixels) for a Google Earth Super-Overlay.

Google does not require that tile boundaries in a Super-Overlay coincide with any predefined global grid. However, the Export Raster Tilesets and Auto Mosaic processes automatically set tile boundaries consistent with those in the Google Maps global grid. This procedure creates Google Earth tilesets with consistent tile boundaries than can later be merged using the Merge Tilesets process.

Google Earth Super Overlay Directory Structure



Levels of Detail (Zoom Levels)

A Google Earth Super-Overlay contains a hierarchy of pre-rendered tiles of different spatial resolution, or levels-of-detail (to use Google's term). The size of the ground area represented by a single tile pixel is reduced by a factor of two for each integer increase in level-of-detail, providing increasing visual detail for screen areas that are closer to the viewer in Google Earth's 3D view. For convenient file management TNTmips creates a numbered directory to contain the tiles for each level-of-detail. Unlike Google Maps tilesets, levels-of-detail in a Google Earth Super-Overlay are not required to conform to a global, predefined numerical system of fixed-resolution "zoom levels". Rather, the number of levels-of-detail and the ground pixel size at any particular level varies depending on the resolution and geographic extents of your source image(s) and the tile size used to partition the image. The maximum detail level in a Super-Overlay contains tiles that match the full detail of the source image, while the minimum detail level (numbered 0) includes the entire extents of the tileset image in a single tile.

Tile Naming and Formats

Because the path and filename for each tile file is stored explicitly in an accompanying KML file, Google Earth does not require any particular naming convention for tile files. TNT organizes the tiles for each detail level in numbered subdirectories by tile row number and names tile files by tile column number.

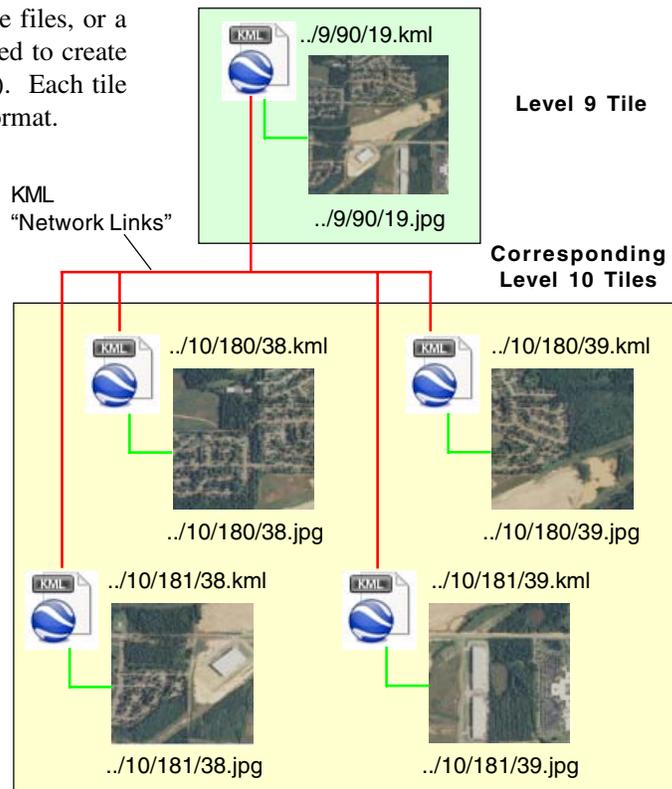
Directory structure for a Google Earth Super-Overlay created in TNTmips in the Auto Mosaic process. A Super-Overlay includes a master KML file and a subdirectory for each zoom level (level-of-detail, 11 in this example). Each level-of-detail directory contains a subdirectory for each tile row containing tile files named by column number. Each image tile is paired with a KML file of the same name.

(over)

A Google Earth Super-Overlay can contain JPEG, TIFF, or PNG tile files, or a mixture of JPEG and PNG files if the default format option was used to create the tileset (see the TechGuide entitled *Tilesets: Tile Image Formats*). Each tile row subdirectory contains all tiles for that row regardless of file format.

How Google Earth Loads the Tiles: Ground Overlays and Network Links

The KML file accompanying each image tile in the Super-Overlay uses the KML Ground Overlay structure to identify the path and filename of the accompanying tile, its geographic extents, and a minimum size in screen pixels at which the tile should be displayed. These settings allow Google Earth to drape the tile on its global 3D terrain in the correct location. If there are tiles covering the same area at the next-higher level of detail, this KML file also includes a Network Link structure for each higher-resolution tile (see illustration to the right). Each Network Link includes the path and name of the KML file for the higher-resolution tile as well as those tile extents and minimum screen size settings. Google Earth determines the projected size of each candidate tile on screen and compares that to the minimum screen size setting for the tile to quickly identify and load the tiles of the correct level-of-detail for each part of the 3D view.



Each KML file references its accompanying image tile as a Ground Overlay (green lines above) and includes the geographic extents of that tile, enabling Google Earth to display each tile draped onto the terrain in its correct location. If there are tiles covering the same area at the next higher level of detail, the KML file uses a network link structure to reference each of these higher-resolution tiles (red lines). The network link for each higher-resolution tile includes its geographic extents and level-of-detail settings.

Folders, Tiles, and File Size by Detail Level for a Sample Google Earth Super-Overlay (1-m Orthoimage Mosaic of a US State)

(see Technical Guide entitled
Tilesets: Understanding Sizes)

Source image size: 352 GB (uncompressed)

Image area: 109,185 square kilometers

Tile Size: 1024 x 1024 Pixels

Tile Formats: JPEG + PNG for edge tiles

Coordinate Reference System:

WGS84 / Geographic (mandatory)

Detail Level	Number of Folders	Number of Tiles	Size on Disk
0*	1	1	318 KB
1	1	2	1.2 MB
2	1	4	4.9 MB
3	2	14	19 MB
4	3	39	58 MB
5	6	150	119 MB
6	12	569	273 MB
7	23	2,121	895 MB
8	46	8,291	2.7 GB
9	92	32,650	7.9 GB
10†	184	129,179	22.2 GB

* minimum detail level: level requiring only one tile to cover the image area

† maximum detail level: pixel size equal to or less than the spatial resolution of the input image; 1 meter in this example for Tennessee

Total Number of Folders: 382

Total Number of Tiles: 173,022

Total Size on Disk: 34 GB

Using the Google Earth Super-Overlay

A local copy of a Super-Overlay can be viewed in the Google Earth desktop application by double-clicking on the KML file in the master tile files directory. This KML file and the image tileset it references can also be distributed on a DVD or other media for local use, or posted on your website for remote access by anyone in their desktop Google Earth (this application requires that you post a downloadable KML file with a Network Link pointing to the Super-Overlay's master KML file). TNTmips processes also create a sample HTML file along with each Google Earth Super-Overlay that you can add to your web pages to allow anyone to view the tileset in their browser with the Google Earth plug-in.

Size of Google Earth Super-Overlay Structures

The table to the left shows the number of tiles and stored size by detail level for a Google Earth tileset created in TNTmips from statewide, 1-meter color orthoimage coverage of the state of Tennessee. As each higher level-of-detail requires up to 4 times the number of fixed-size tiles than the previous level, high-resolution Google Earth tilesets can include millions of tile files and require tens of gigabytes of drive space (see the TechGuide entitled *Tilesets: Understanding Sizes*). Since Google Earth allows you to choose from a range of allowed tile sizes, you can minimize the number of files required by using a larger tile size. You should take these factors into account as you plan your processing activities.