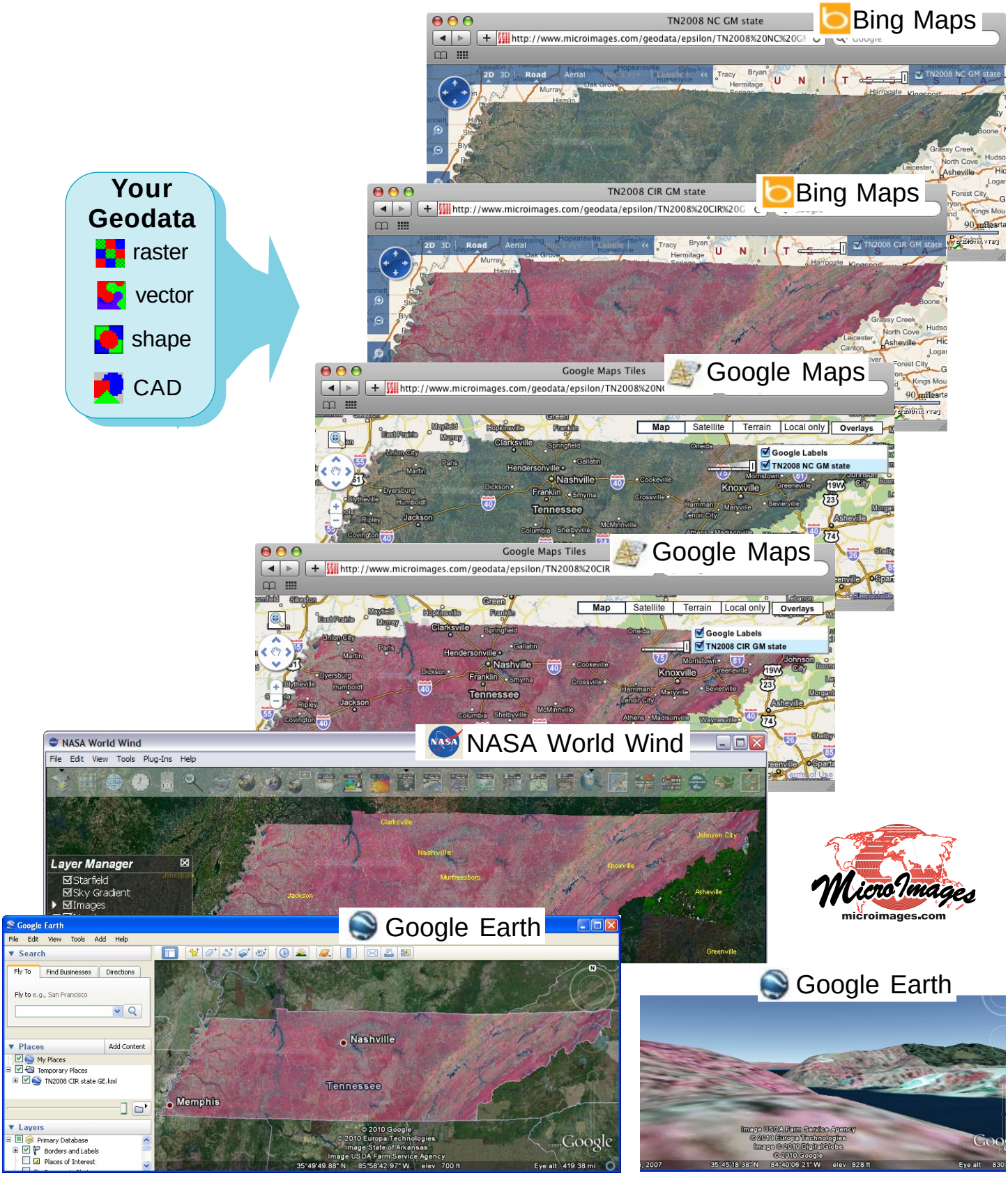
Tileset Concepts and Terminology



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Tileset Concepts and Terminology

Terms and concepts related to the use of tilesets for publishing map and image materials for use in Google Maps, Bing Maps, Google Earth, World Wind, and the TNT products.

TNTmips provides a suite of processes that create tilesets for use in various popular products. Tilesets and the mashups assembled from them are simple to use in popular geoviewers provided by Google and Microsoft and in the TNT products. However, the terminology used to describe a tileset, its structure, and content is not widely understood or standardized. This document provides descriptions of the tileset-related terminology used by MicroImages.

A tileset is a collection of small image files, called tiles, in a predefined file size, format, and directory structure. It is designed for efficient viewing of very large images or maps over the Internet. Labels and geometric features such as roads, polygons, … are rendered into these small files in a tileset with appropriate styles and transparency for each zoom level at which they will be viewed.

Use the web link for more information on each topic.

Mashup

http://en.wikipedia.org/wiki/Mashup_(web_application_hybrid)

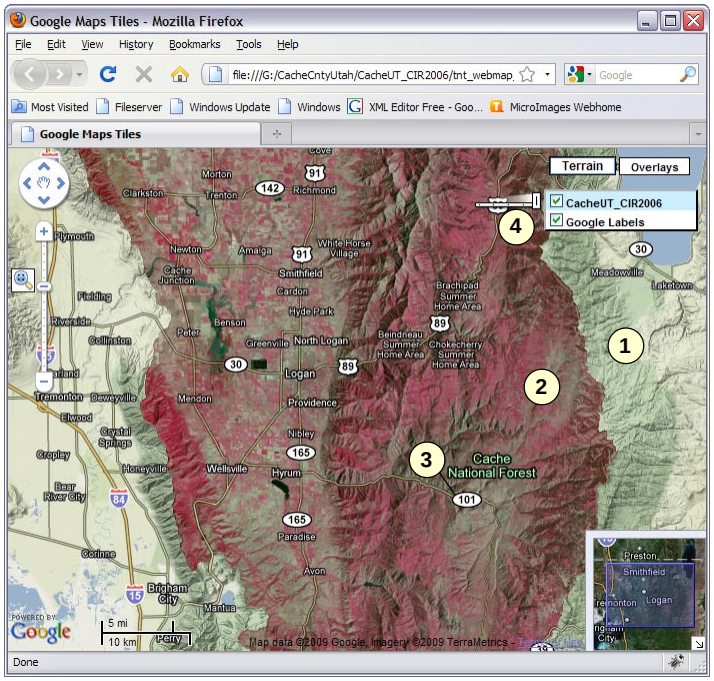
A *mashup* is a web page or application that combines data or functionality from two or more Internet sources to create a new service. The term mashup implies easy, fast integration and frequently uses open APIs and data sources to produce results that were not the original reason for producing the source data. An example of a mashup is the use of cartographic data to add location information to real estate data, thereby creating a new and distinct web API that was not originally provided by either source.

Geomashup

www.microimages.com/documentation/TechGuides/76IntroGeomashup.pdf

A *mashup* is a web page or application that combines data and/or functionality from two or more Internet sources to create a new service. A *geomashup* is a combination of geospatial data (such as maps, images, plans, point locations, ...) from multiple sources into a single, interactive web page. Geomashups commonly show geodata for a particular geographic area or theme and overlay it on a global reference layer, such as the proprietary map and/or satellite layers offered by Google Maps and Bing Maps. The Application Programming Interface (API) for Google Maps, Google Earth, Bing Maps, or Open Layers provides the geomashup with familiar controls for panning the view and browsing through different zoom levels (i.e., levels of detail).

A tileset structure is the most efficient way to store each image for use in a geomashup. Its hierarchical directory structure and small compressed tiles, precomputed for each available zoom level, permit an image of any size to be efficiently viewed in a geomashup. Viewing or adding any part of a tileset into a Google Maps or Bing Maps view requires reading only a few small tiles for the area of interest and zoom level from the Internet source that is hosting the tileset.



Preview of a Google Maps geomashup assembled in the Publish Geomashup process. This geomashup includes:

1. **Base Map**: Google Maps Terrain layer.
2. **Overlay**: Local tileset (Google Maps Tile Overlay) of color-infrared orthoimage Cache County, Utah, which can be zoomed to a resolution of 1 meter.
3. **Overlay**: Google Maps Labels layer (which includes roads, highway route symbols, and place name labels).
4. **Tools**: Custom zoom box, controls for toggling overlays and changing their opacity, and others.

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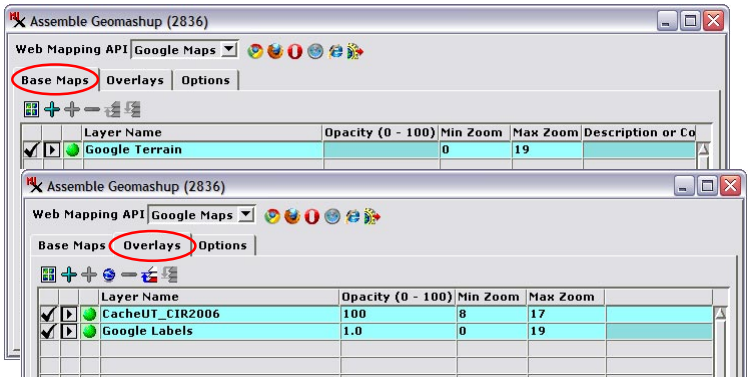
Assembling a Geomashup

www.microimages.com/documentation/TechGuides/76IntroGeomashup.pdf

The Geomashup process in TNTmips (Main/Assemble/Geomashup) allows you to mashup your own local tilesets and/or geodata layers from remote sources for viewing in the Google Maps, Bing Maps, or Google Earth web applications. A Google Earth geomashup can also be viewed in the downloaded and installed version of Google Earth without any Internet connection as long as all the tilesets used are local on your hard drive, DVD, or network.

In this interactive tool you choose base map and overlay tileset layers, the web mapping API to use, and the map controls to be included. At any time during the assembly of your geomashup you can immediately preview it in Google Maps, Bing Maps, or Google Earth in any popular Windows or Mac browser (Firefox, Safari, Internet Explorer, Chrome, or Opera). You can also choose to launch your current geomashup design in your local, installed Google Earth.

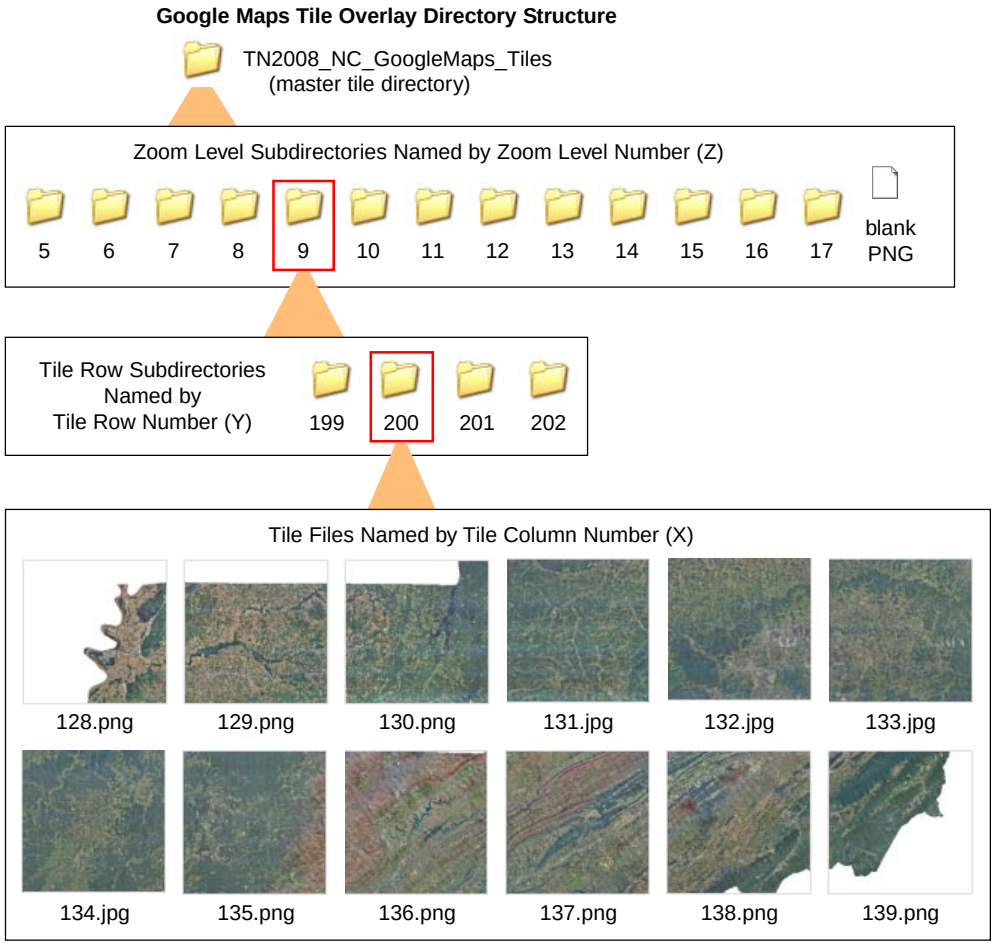


The Assemble Geomashups window lets you choose base layers, overlays, and the type and style of map controls to use. In the example above, the base map and overlays have been selected for the geomashup shown in the preceding illustration.

Each time you preview your design, the Geomashup process assembles the complete HTML and JavaScript geomashup file in seconds and launches your browser and Google Maps, Bing Maps, or Google Earth to view it. When you are satisfied with the design of your geomashup file, you can save the ready-to-go HTML/JavaScript file in the desired location. You also have the option to assemble a zip archive including the HTML/JavaScript file, your local tilesets, and any other referenced geodata. Your geomashup can then be easily copied to any web site and installed by unzipping. The geomashup file can then be linked to directly or linked to another page in your web space for public viewing by anyone using their web browser.

Tileset

When used in connection with geospatial applications, a tileset is a directory structure of small files that represent an image, map, plan, or other geodata layer. It is the inverse of a mosaic. Similar to an image file format, its structure and other characteristics are fixed and are designed to optimize its use in a specific application. A tileset can have a “flat” structure, with all tile files in a single directory (e.g., as prescribed by Microsoft for use as Custom Overlays in Bing Maps 3D) or use a



Directory structure for a Google Maps Tile Overlay created in TNTmips using the Automatic option for Tile Format, which creates JPEG files for interior tiles and PNG files for edge tiles to provide transparency for non-image areas. This tile overlay includes zoom levels 5 through 17. Tiles are stored in nested subdirectories, first by zoom level number and then by tile row number. Individual tile files are named by tile column number.

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scale-pyramided or hierarchical directory structure of tile files (e.g., as prescribed by Google for use as a Tile Overlay in Google Maps or for use as a Bing Maps 2D Custom Overlay). MicroImages' tileset raster objects are also a hierarchical tileset structure that can be used in any TNT product.

The time to access a tileset in the geoviewer that has specified its structure is independent of the size of the tileset or the scale at which it is being viewed.

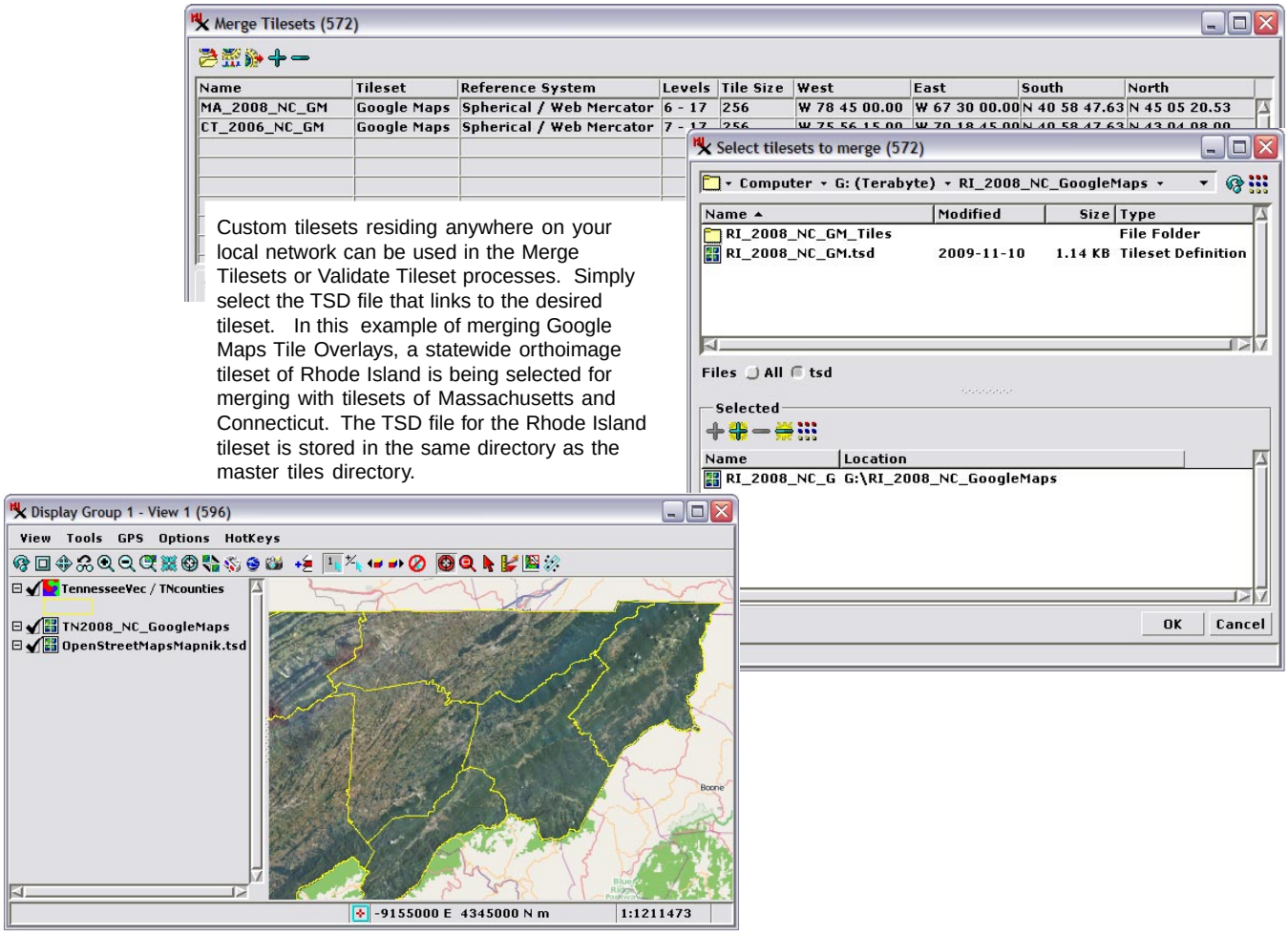
A tileset can range from a few tiles covering a local project to 100s of millions of tiles covering a continent or the globe. The actual speed of accessing and adding a specific tileset layer of any size to a view will depend on the current size of the view, where the tileset is located (hard drive, DVD, tile cache, … even drive fragmentation), how it is brought to the view (Internet bandwidth, local network, bus speed, …), the tile file formats required in the structure, and the geoviewer (e.g., Google Earth 3D views are rendered more slowly than Google Maps 2D views).

Tileset Use

http://www.microimages.com/documentation/TechGuides/76UsingTSD.pdf

As Reference Layers in a View

It is important to keep in mind that a tileset defined by Google (Maps and Earth), Microsoft (Bing), and NASA (World Wind) is a precomputed, optimized structure of any total size designed for the frequent viewing of a few small local "pictures" read and assembled into the current view by the viewing software. This precomputed, standardized structure maximizes the speed of access to and viewing of the map or image stored in the tileset. However, a tileset no longer has many of the properties that may have been part of the original geodata from which it was assembled. For example, creating a particular tileset structure requires reprojection to a required Coordinate Reference System that may not match that of the original image and resampling to a set of fixed-resolution zoom levels that may not include an exact match to the spatial resolution of the original image. A tileset also does not provide access to the individual band values of a multiband image and, thus, is not suitable for spectral image analysis procedures. Tileset structures allow a limited range of image file formats that do not support the efficient JPEG2000 compression that you can use for your internal TNT raster objects. A tileset is a very simple and efficient but rigid structure for very fast viewing of images or maps!



As Geodata

TNTmips raster object tilesets can represent geodata without any of these restrictions, i.e., they are fast, size independent, and efficiently viewed by the TNT products. They can have larger tile sizes that keep the geodata in a file suitable for further analysis, use better compression (e.g., lossy or lossless JPEG2000), support GeoTIFF and other tile formats, allow more than 3 bands, any CRS, any resolution, and so on. However, they are only useful in the TNT products and processes! Any of the other standard tileset structures built in TNTmips can also be viewed from local or Internet locations as reference layers in any TNT view.

Crossover Uses

There are some exceptions whereby geodata not in the standard, prescribed structure can be used in other geoviewers. For example, Google Earth has some flexibility in the tile size and format it will read and use as a temporary layer (e.g., GeoTIFF). The Google Maps API will permit sending it a small, non-tiled georeferenced image and it will build the tiles and use them as a mashup. Using small georeferenced files directly in these web and local applications is useful but will slow down the addition of the layer to the view as a function of their size.

Tile

A tile is the individual image file in a tileset structure. A tile file's characteristics are dictated by, and optimized for, the application(s) that will use them. The files are usually small, square, and with dimensions that are a multiple of 2. A single tileset may contain millions or 100s of millions of tile files depending upon the geographic area covered and most detailed zoom level (i.e., scale, resolution, level-of-detail) it contains. Tile file formats are usually JPEG for tiles that are completely within the image they portray and lossless, compressed PNG for areas that contain an edge or if the entire tileset is to be rendered as transparent. TNTmips' tileset raster objects are not limited to square, uniform tiles; tiles can be larger, and can use additional georeferenced formats, such as GeoJP2.

33767.jpg

Illustrated to the left is a single 256 by 256-pixel tile from zoom level 17 of an orthoimage tileset with hierarchical structure. The ground extent of a single pixel at level 17 at this latitude is 0.996 meter. The Bing Maps tile coordinates for this tile are: tile row or Y = 51,209, tile column or X = 33,767. The JavaScript code in the sample HTML file created with this tileset constructs the URL to this tile file (shown below) using the numeric zoom level directory name, tile column directory name, and tile file name.

[path to tileset] \ TN2008_NC_BingMaps_Tiles \ 17 \ 51209 \ 33767.jpg

Names of Popular Tileset Structures

Google Maps' Tile Overlays

http://www.microimages.com/documentation/TechGuides/76googleMapsStruc.pdf

A "Tile Overlay" is how Google identifies the structure of the tileset that is optimized for its web API to use as an overlay. It conceptually emulates the way in which Google stores its proprietary satellite, terrain, roads, and other proprietary base layers accessible over the Internet. Details can be found at http://code.google.com/apis/maps/documentation/overlays.html.

Bing Maps' Custom Tile Layers

http://www.microimages.com/documentation/TechGuides/76BingStructure.pdf

A "Custom Tile Layer" is how Microsoft identifies the structure of the tileset that is optimized for its web API to use as an overlay. It conceptually emulates the way in which Microsoft stores its proprietary road and aerial layers accessible over the Internet. Details can be found at http://msdn.microsoft.com/en-us/library/bb259689.aspx.

Google Earth's Super-Overlays

http://www.microimages.com/documentation/TechGuides/76googleEarthStruc.pdf

A "Super-Overlay" is how Google identifies the structure of the tileset that is optimized for use as an overlay in its browser plug-in or in its executable version as an overlay or independent base layer. It conceptually emulates the way in which Google stores its proprietary image base layer on the Internet. A description can be found at http://code.google.com/apis/kml/documentation/kml_21tutorial.html#superoverlays.

World Wind's Tile Layers

http://www.microimages.com/documentation/TechGuides/76worldwind.pdf

A "Tile Layer" is how the community using NASA's World Wind application commonly refers to a tileset that is optimized for use as a base image or overlay in this application. This structure is described at http://issues.worldwind.arc.nasa.gov/confluence/download/attachments/394/world+wind+tile+systemt.gif.

MicroImages' Tileset Raster Objects

A "tileset raster object" identifies a proprietary tileset object created in MicroImages' TNTmips and used for viewing and for multiband data analysis within the TNT products. All the other standard tilesets created by TNTmips are 3-band color composites designed only for viewing. A "tileset raster object" is the term that identifies these raster objects stored in a Project File and linked to external files in an image format, such as GeoTIFF, GeoJP2, TIFF, JPEG, etc.

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Tile Formats

http://www.microimages.com/documentation/cplates/76TileFormats.pdf

The formats that can be used in each type of tileset structure are dictated by the application that will use the tileset and the specific uses within that application. Although the allowed formats vary, Google, Bing Maps, and World Wind tilesets all support the use of JPEG and PNG tile file formats, which have the following characteristics and limitations:

JPEG format

Small file size using lossy image compression that is most appropriate for continuous-color images. Compression artifacts may be noticeable if used for tilesets created from map data. No support for transparent tile areas, so non-image areas of a JPEG tile appear black.

PNG format

Lossless compression produces file sizes larger than for JPEG format, but map data can be rendered to PNG without compression artifacts. PNG supports transparency, so non-image areas of a tile can be designated transparent.

Automatic format

TNT processes that create tilesets for Google Maps, Bing Maps, Google Earth, and World Wind provide a default Automatic format option. This format option uses JPEG format for any tile that is 100% covered by the source image to minimize the stored size and PNG format for any tile that overlaps the regular or irregular outer edge of the source image (or an inner edge for missing internal areas) to render non-image areas transparent.

Table 1. Image formats and tile sizes available for different tileset structures.

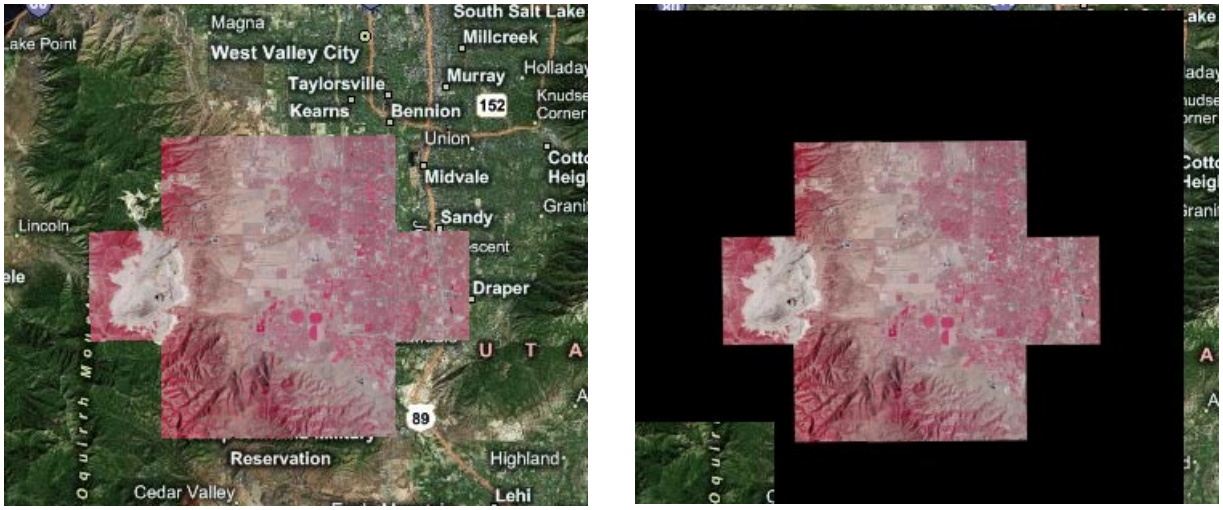
Tileset Structure	Tile Image Format				Tile Sizes (width & height in cells)
	JPEG	PNG	GeoTIFF	GeoJP2	
Google Maps Tile Overlay	Yes	Yes			256, 128*
Bing Maps Custom Tile Layer	Yes	Yes			256, 128*
NASA World Wind Tile Layer	Yes	Yes			512
Google Earth Super Overlay	Yes	Yes	Yes		256, 512, 1024, 2048
TNT tileset raster object		Yes	Yes	Yes	256, 512, 1024, 2048, 4096, 8192

* option for tileset display on cell phones

Table 2. Characteristics of different tile file image formats.

Format Characteristics	JPEG	PNG	TIFF	GeoTIFF	GeoJP2
Compression	Lossy	Lossless	Lossless	Lossless	Lossless or Lossy
Transparency	No	Yes	No	Yes†	Yes†

† TNT tileset transparency in the TNT products via null mask



Microsoft Bing Maps Custom Tile Layers created from a TNT mosaic layout. The tile overlay on the left was created using the Automatic format option in the Mosaic process, which uses JPEG format for complete image tiles and automatically switches to PNG format for tiles that cross the edge of the image, providing transparency for null areas. The tile overlay on the right was created with the JPEG Best Quality format option. Non-image pixels around the edges of the image in the tile overlay are black. In zoomed-out views these marginal black areas may extend far beyond the edges of the image because Bing Maps tiles have a fixed size of 256 by 256 cells at all zoom levels and are aligned on a predetermined grid for faster display.

Google Maps Tile Overlay *http://www.microimages.com/documentation/TechGuides/76googleMapsStruc.pdf*

Tiles that are 100% covered by the source image and require no cells that are transparent are usually JPEG. Tiles are PNG where the area covered by the tile overlaps the regular or irregular outer edge of the source image or an inner edge for missing internal areas. The tile overlay can also be 100% JPEG or 100% PNG tiles depending upon the desired appearance of the source image in the application.

Bing Maps Custom Tile Layers *http://www.microimages.com/documentation/TechGuides/76BingStructure.pdf*

Tiles that are 100% covered by the source image and require no cells that are transparent are usually JPEG. Tiles are PNG where the area covered by the tile overlaps the regular or irregular outer edge of the source image or an inner edge for missing internal areas. The custom overlay can also be 100% JPEG or 100% PNG tiles depending upon the desired appearance of the source image in the application.

Google Earth Super-Overlays ***http://www.microimages.com/documentation/TechGuides/76googleEarthStruc.pdf***

A variety of file formats and sizes can be used in used in this structure. The TNT tileset processes can assemble these tilesets using JPEG, PNG, or TIFF files or automatic mixtures of these as appropriate. The sizes of these tiles can also be larger. The TNT tileset processes support selection of tile file sizes from 256 by 256 cells to 8096 by 8096 cells. Smaller tile sizes (e.g., 1024 by 1024) are more appropriate if the layer will be accessed via the Internet. Larger tile sizes work well if the tileset is located locally. Some display boards will not support the use of larger tile sizes in this application.

World Wind Tile Layers *http://www.microimages.com/documentation/TechGuides/76worldwind.pdf*

Tiles that are 100% covered by the source image and require no cells that are transparent are usually JPEG. Tiles are PNG where the area covered by the tile overlaps the regular or irregular outer edge of the source image or an inner edge for missing internal areas. The tile overlay can also be 100% *JPEG or 100% PNG tiles depending upon the desired appearance of the source image in the application.

MicroImages Tileset Raster Object

Tiles can be in one of several formats.

GeoJP2

Best compression and viewing quality can be achieved in the TNT products using lossy compressed JPEG2000 tiles (choose any desired compression ratio). If the tileset is to be used for data analysis, lossless compressed JPEG2000 tiles are recommended. Each tile can contain binary, 8-bit, or other data types for 1, 3, or many bands of multispectral imagery or other kinds of raster data.

GeoTIFF

Tiles can be in the TIFF georeferenced format of 1, 3, or many bands. TNT raster object tiles that use this format can also be used directly by other software packages that support this common format.

PNG

Tiles can be PNG files with or without an alpha band. All PNG files are compressed.

Other Options

TNT raster object tilesets can also be collections of irregularly-sized files of a uniform CRS, format, and data type. These are simply linked up in TNTmips without alteration and function as a single object. This type of tile file can be in any georeferenced format supported by the TNT products including, in addition to those noted above, MrSID, JPEG, and others whose georeference is provided using a world file or other auxiliary file.

Tileset Size *http://www.microimages.com/documentation/TechGuides/76Sizes.pdf*

The time it takes to view or refresh a view of a tileset is independent of its size! This is the fundamental property that governed tileset design. Any view always directly accesses and reads the few tiles that are required at the view's scale or zoom level. The tileset's directory hierarchy means that any individual tile can be directly located. The small tiles, made even smaller by lossy compression, insure that they can be rapidly read even when they are read over the Internet or a local network or even from a DVD.

A single tileset can contain a few thousand or 100s of millions of tiles in a single directory structure. For example, a single tileset prepared in TNTmips covering the globe with a false color image (bands 7, 4, and 2) with a 10-meter nominal pixel size can be viewed as an overlay in Google Maps or Bing Maps or added directly to any TNT view from microimages.com. This tileset has approximately 60,500,000 tiles in approximately 13,700 directories and a total size

of approximately 1.2 terabytes—yet any global location up to the maximum 10-meter resolution can be viewed equally fast.

Tennessee Orthoimage Google Maps Tile Overlay

Image clipped to Tennessee state boundary

Folders, Tiles, and File Size by Zoom Level

Zoom Level	Pixel Size at Equator	Pixel Size in TN**	Number of Folders	Number of Tiles	Size on Disk
5*	4.9 km	4.0 km	1	2	32 KB
6	2.4 km	2.0 km	2	5	92 KB
7	1.2 km	1.0 km	2	7	308 KB
8	611 m	496 m	3	18	0.98 MB
9	306 m	248 m	4	43	2.86 MB
10	153 m	124 m	7	143	6.96 MB
11	76 m	62 m	13	516	17.1 MB
12	39 m	31 m	25	1,871	58.8 MB
13	19 m	15 m	49	7,236	201 MB
14	10 m	7.7 m	96	28,388	750 MB
15	5 m	3.9 m	192	112,485	2.88 GB
16	2.4 m	1.9 m	382	447,836	10.6 GB
17†	1.2 m	1.0 m	762	1,786,429	40.5 GB

Google Maps Zoom Levels: 5 to 17
Tile Size: 256 x 256 Pixels (required)
Tile Formats: JPEG with PNG for edge tiles
Image area: 109,185 square kilometers
Coordinate Reference System:
WGS84 / Spherical Web Mercator (required)

** computed at the latitude of the center of the state

* minimum zoom level: lowest level requiring more than one tile to cover the image area

† maximum zoom level: pixel size equal to or less than the spatial resolution of the input image.

Total Number of Folders: 1,551
Total Number of Tiles: 2,384,979
Total Size on Disk: 55.1 GB

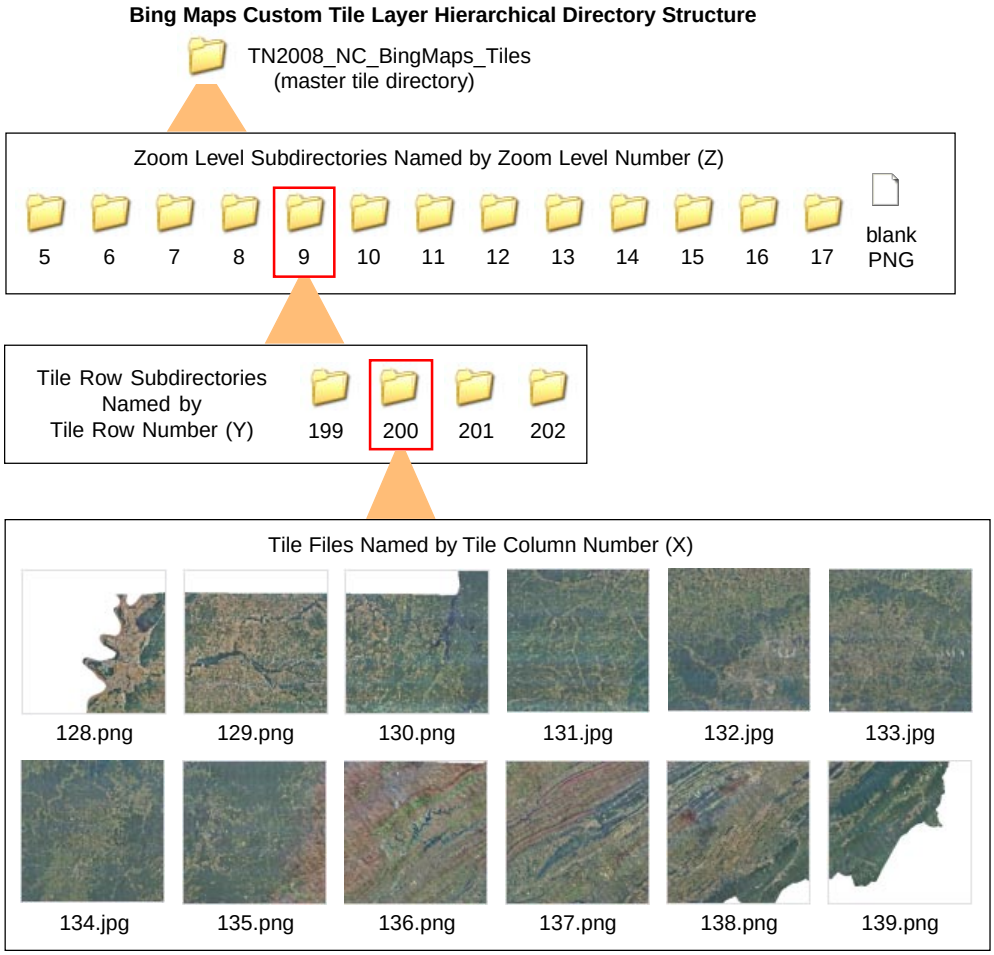
Prerendered

All tilesets are rendered, exported, or created as they are computed and are stored *prerendered* in a standard directory structure for later use in a specific web or local application.

Tileset Structure

http://www.microimages.com/documentation/TechGuides/76BingStructure.pdf

A tileset can be flat, with all tile files in a single directory (e.g., as prescribed by Microsoft for use as a Custom 3D Overlay in Bing Maps) or use a scale-pyramided hierarchical directory structure of tile files (e.g., as prescribed by



Directory structure for a Bing Maps Custom Tile Layer created in TNTmips using the Automatic option for Tile Format, which creates JPEG files for interior tiles and PNG files for edge tiles to provide transparency for non-image areas. This tile layer includes zoom levels 5 through 17. Tiles are stored in nested subdirectories, first by zoom level number and then by tile row number. Individual tile files are named by tile column number.

Google for use as a Tile Overlay in Google Maps) in one or mixed formats. MicroImages' tileset raster objects are also hierarchical tileset structures.

A tileset is selected, displayed, used, and functions like a file in TNTmips and other popular local or Internet applications. Image file formats have pixels while tilesets have small image files in a predetermined structure that behave similar to pixels. A tileset is not a single file so its type can not be identified by referring to it by its format. For example, one can not say or write that "this is the Google Maps tileset format." The concept and use of a tileset is clear if it is referred to as a structure and not as a format. Thus it is clear what is meant if one says or writes that "this is the Google Maps tileset structure." Thus "select a tileset structure" clarifies to nontechnical readers and users that the item selected is not a single file but a special collection of files and formats.

Flat Tileset

A flat tileset is one that has no directory hierarchy. All the tiles are placed in a single directory that might contain millions of tiles required to cover the area of the source images or maps for all the zoom levels available. The naming structure of each tile defines where it occurs on the ground (i.e., its georeference) and its zoom level or scale.

Operating systems have limits on the number of files that can be in a directory. Vista and Windows 7 limit a FAT32 directory to 65,536 files. There is a Microsoft format tool available for both of these operating systems that uses the exFAT (aka FAT64) drive format to permit 2,796,202 files in a directory. Using the standard FAT32 places a limit on the area that can be covered by the standard, flat Bing Custom Tile Layer for any given resolution. For example, a Bing Maps Custom Tile Layer with global extent prepared as a flat tileset (e.g., a 3D tileset) would be limited to 1.2-km resolution requiring 21,844 tiles in a single directory; adding the next higher zoom level (611-m resolution) would add 65,532 files and exceed the number of files allowed in a directory. Tilesets covering a smaller area could preserve higher resolutions.

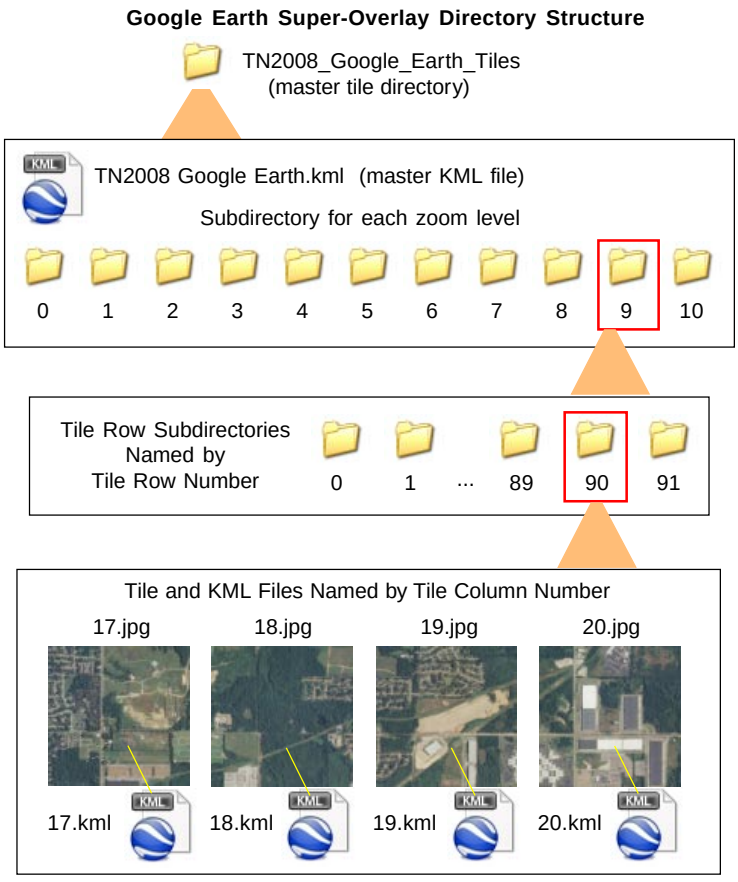
Google Maps Tile Overlays have a hierarchical structure. It is designed so that no directory's file count will exceed 65,536 files and thus no limit is placed on the global resolution (i.e., image resolution) it can preserve. As an option the Bing Maps 2D API will support the efficient use of exactly the same Google Maps Tile Overlay structure. As a result all TNT processes produce a Google Maps Tile Overlay tileset structure that can also be used, *without alteration*, as a Bing Maps Custom Tile Layer in 2D. An option is available to choose to output the required flat Bing Maps Custom Tile Layer if the final use is for viewing in 3D.

Hierarchical Tileset

The common, popular web geoviewers use hierarchical tilesets where a collection of subdirectories in each directory contain all the tile files for one prerendered zoom level. These directories are all arranged pyramid-style where each directory at a given level represents a portion of the image at that level's scale or zoom. MicroImages' internal tileset raster objects use a hybrid approach combining both flat and hierarchical structures. which exploits the best features of both.

Tile Column and Row Number

Tiles in Google Maps, Bing Maps, and World Wind tileset structures are aligned to a predetermined global grid at each zoom level. The position of each tile within the grid is indicated by its tile column number (east-west position) and tile row number (north-south position). Tile rows are numbered from top to bottom and tile columns from left to right, each beginning with 0 in the upper left cor-



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.

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ner of the global grid. In tilesets using the Bing Maps flat quadkey structure and the World Wind structure, tile column and row numbers are encoded into the file name for each tile file. In the hierarchical tileset structures created for use in Google Maps and Bing Maps, tile files are named by their tile column number and grouped in directories named for their tile row number.

Tileset CRS (Coordinate Reference System)

The web geoviewer or viewing application dictates the global Coordinate Reference System that each tile must use. This insures that no time is lost in changing CRS during the display of a tileset or in matching it with the proprietary layers they provide in their standard CRS. Google Maps and Bing Maps use Spherical Web Mercator while Google Earth and World Wind use Plate Carrée (Equirectangular).

The tiles in a TNT tileset raster object can be in any of the 1000s of CRSs supported by the TNT products. This has significance since the TNT tileset structure can be used for data analysis as well as for simple viewing.

Spherical Web Mercator

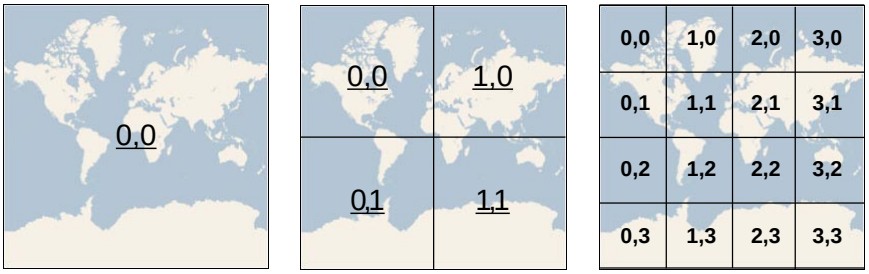
Google and Microsoft tileset structures were designed for global coverage using a spherical adaptation of the Mercator projection called Spherical Web Mercator (EPSG code 3785). Google Earth and NASA World Wind tilesets use Plate Carrée (Equirectangular). TNTmips tilesets can use any projection and datum defined by EPSG and projections defined by other sources.

Minimum Zoom Level

http://www.microimages.com/documentation/TechGuides/76TilesetZoom.pdf

The minimum zoom level, or least detailed zoom level, contains the tiles that provide the most synoptic or most overall view of the area covered by the tileset. It is the lowest resolution at which the area covered by the tileset can be viewed.

Every tileset covers a range of image and map detail or resolution. Global tilesets contain 1, 4, or more tiles (number depends on geoviewer used) to represent the minimum zoom level covering the entire globe. Tilesets that cover only a local area, such as a state, province, or city, may omit many gross or synoptic zoom levels. The minimum zoom levels in these local tilesets are determined by the extent covered by the tileset and the usefulness of viewing the content at progressively lower detail. Often a local tileset first appears as a viewable layer when the view is zoomed to the scale of the minimum zoom level.



Global tile grids at the three lowest Google Maps zoom levels. Google Maps uses a Spherical Web Mercator projection representing the globe as a square shape. Tiles at each zoom level are indexed by tile row and tile column number (beginning with 0) from the upper left corner of the global map. The number pairs on each tile grid show the tile column and tile row (X,Y) for each tile.

Maximum Zoom Level

http://www.microimages.com/documentation/TechGuides/76TilesetZoom.pdf

The maximum zoom level, or most detailed zoom level, contains the tiles that provide the maximum detail in content that is available in the source image or map. It sets the maximum resolution at which the area covered by the tileset can be viewed. A tileset must use predetermined zoom levels and, thus, the source image or map is unlikely to match any of these zoom levels in detail or resolution. Thus the maximum zoom level is usually set to be the zoom level that is the closest match at a higher resolution, or detail, to the resolution of the source image or map.

Precomputed Zoom Levels

Tilesets are computed and stored in advance of their end use in an optimal hierarchical structure of small tiles. Each zoom-level, or level-of-detail, in the structure contains complete coverage of the source image at a specific scale.

Tilesets are optimized for viewing large images and image representations of maps and other graphical materials at very fast response rates even over wireless or cell phone connections. This is accomplished by computing and storing all the possible views of the source materials or layers at each zoom level at which it will be allowed to be viewed. All zoom levels in a particular tileset structure consist of tiles of the same dimensions in pixels, but the area covered by one tile at any zoom level is covered by 4 tiles at the next higher zoom level. Lower-resolution zoom levels therefore can be easily constructed by resampling from the next higher-resolution level. The fixed zoom levels in Bing Maps Custom Tile Layers, Google Maps Tile Overlays, and World Wind Tile Layers can only be viewed at these fixed

scales in their native applications. However, any of these tilesets can be viewed in the TNT products at any intermediate zoom level or scale.

Zoom Levels

Fixed Zoom Levels

Web geoviewers and the related viewing applications dictate that all tiles must be in a specific zoom level and structure. Each available zoom level is set by the structure defined for that application. For example, both Google Maps and Bing Maps have a zoom level 17 that has a cell size of 1.2 meters and a level 18 for 60 cm at the equator. Note that these applications display data at these fixed zoom levels as you zoom in and out. For a list of the zoom levels required for each supported tileset structure see the Technical Guide entitled *Tilesets: Setting Zoom Levels* www.microimages.com/documentation/TechGuides/76TilesetZoom.pdf.

A TNT tileset raster object does not have predetermined tile zoom levels. The maximum zoom level of the tiles can be set to be appropriate to the source material and CRS it uses. The TNT display process automatically resamples and reprojects the tiles from any tileset structure in real time. It adds any tileset layer, local or remote, to the current view at the scale of the other layers it contains, not in discrete zoom steps.

Maximum Zoom Level

The maximum zoom level is the most detailed or resolved representation of the image in the specific tileset. The source data used to produce the tileset has some inherent resolution level. Each tileset structure has discrete, specified zoom levels. TNTmips determines the zoom levels that bracket the source's resolution and uses the higher zoom level to produce the maximum zoom level.

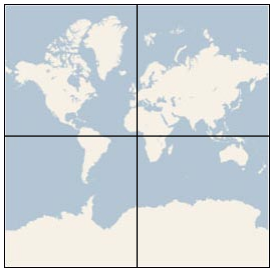
This best resolution level in the tileset can also be referred to as the maximum resolution level or maximum level-of-detail.

Zoom Level Range

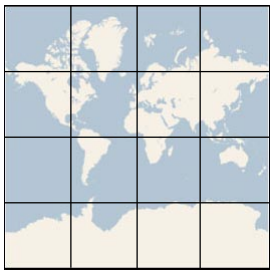
A tileset can have one or many zoom levels. The zoom level range indicates the number of zoom levels defined in the tileset's structure. Different tilesets can be used in an overlapping manner and, thus, an individual tileset may cover only a narrow zoom level range. A tileset that covers a small area may not have all of the allowed less-detailed zoom levels.

Google Maps and Bing Maps	
Zoom Level	**Pixel Size at Equator**
0	157 km
1	78 km
2	39 km
3	19.6 km
4	9.8 km
5	4.9 km
6	2.4 km
7	1.2 km
8	611 m
9	306 m
10	153 m
11	76 m
12	39 m
13	19 m
14	10 m
15	5 m
16	2.4 m
17	1.2 m
18	60 cm
19	30 cm
20	15 cm
21	7.5 cm
22	3.7 cm
23	1.9 cm
24	9.3 mm

Zoom Level 0: 1 tile
Google Maps Base Level



Zoom Level 1: 4 tiles
Bing Maps Base Level



Zoom Level 2: 16 tiles

Above, table showing range of possible pre-rendered, fixed zoom levels in a Google Maps tileset. The Bing Maps tiling scheme is identical except that it begins at Level 1 (a 2 x 2 array of tiles). Both schemes represent the globe with a spherical Mercator projection. The illustrations to the right of the table show the tile grids at the three lowest Google Maps zoom levels.

Bing Maps Zoom Level	Pixel Size at Equator	Bing Maps Zoom Level	Pixel Size at Equator
1	78 km	13	19 m
2	39 km	14	10 m
3	19.6 km	15	5 m
4	9.8 km	16	2.4 m
5	4.9 km	17	1.2 m
6	2.4 km	18	60 cm
7	1.2 km	19	30 cm
8	611 m	20	15 cm
9	306 m	21	7.5 cm
10	153 m	22	3.7 cm
11	76 m	23	1.9 cm
12	39 m	24	9.3 mm

Table of possible pre-rendered, fixed zoom levels in a Bing Maps Custom Tile Layer

TSD Link File (Tileset Definition file =*.tsd)

http://www.microimages.com/documentation/TechGuides/76UsingTSD.pdf

A tileset is a very simple structure of image files in common, non-georeferenced formats, such as JPEG and/or PNG. A tileset does not necessarily have any identification files or tags within its structure. The geographic location of each tile is coded into its name and/or directory path in the structure.

A tileset can only be used in a browser-based geoviewer or a stand-alone application that can identify and understand its structure. Its identity, properties, and potential use by the viewing program must be determined by scanning it at the time of its use, by direct links to it, or by other associated files. The Tileset Definition file is the link file that every TNTmips tileset process makes and maintains to identify and define the current location, properties, and use of a tileset.

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A TSD file defines the possible uses of the structure in the tileset (i.e., in Bing Maps, World Wind, …), the CRS, the zoom levels available, the path or URL to each tile, and so on. It permits all the TNT products to use a tileset as a reference layer in a display whether that tileset is located locally or on an Internet web site. It also permits the TNTmips Assemble Geomashup process or your own web applications, such as those built with OpenLayers, to define how to read the tileset from a local or Internet site.

Global and other tilesets are maintained at other web sources such as Google, Microsoft, NASA, and the OpenStreetMap project. Tilesets can also be prepared by other software although these often limit the size of the tileset. An effort has just been initiated to try to maintain an index to web sites that are providing tilesets suitable for use in Google Maps (http://groups.google.com/group/google-maps-api/web/map-indexing-faq). Any of these tilesets can be used in the TNT products if they are published in a standard tileset structure supported by TNTmips by creating a TSD file to link to them. This TSD link file can be located locally or at some web location where it would function as an web link for the tileset.

Since the TSD file is a simple, humanly-readable XML file, an existing TSD file can be edited to provide the link to any local or remote standard tileset that has not been prepared in TNTmips. TNTmips also provides a Link to Tileset process and a TSD editor (in the Tileset Manager) to assist in preparing a new TSD file for standard tilesets that are available locally or via the Internet.

A suitable web standard to define the contents of a tileset structure is not available. In the past the Open Source Geospatial Foundation (OSGeo) proposed one using a Tile Map Service Specification (see http://wiki.osgeo.org/wiki/Tile_Map_Service_Specification). Alas, this has not moved forward or been adopted as a standard. The MicroImages' TSD file is a simple, open, XML file that defines the content and structure of a tileset for all the TNT processes that can use a tileset. If the tileset was not created in a TNT product, a TSD link file to it can be created in TNTmips. The structure of the TSD file is documented and it can be freely adapted by others to define tilesets for use in their products (http://www.microimages.com/documentation/TechGuides/76TSDcomp.pdf).

Tileset Locations

http://www.microimages.com/documentation/TechGuides/76UsingTSD.pdf

Local Tileset

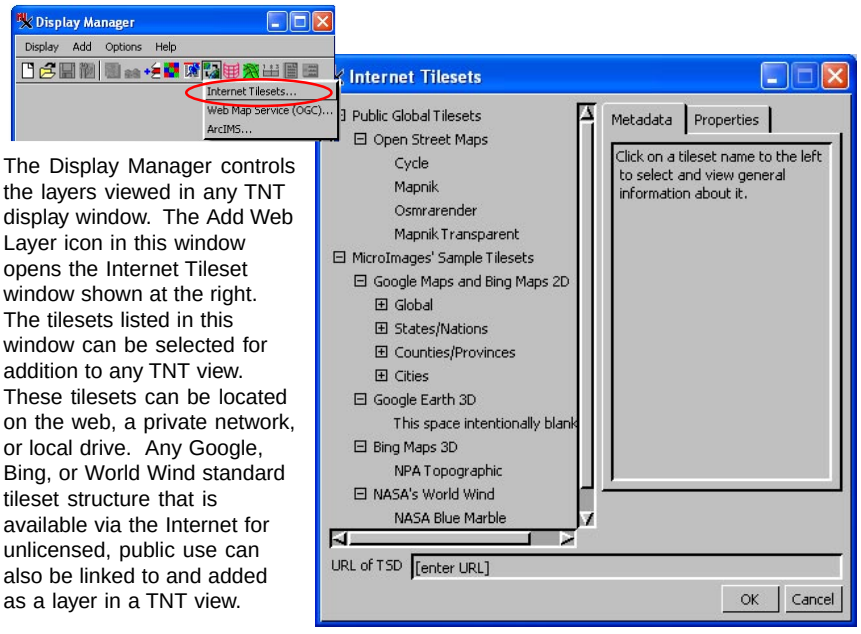
A local tileset is one that is located on an attached storage device or networked storage where it can be read using the path specification in the TSD link file. The TSD file can be selected and used in the TNT products from anywhere on this network as long as the paths to the tiles it defines are correct.

Remote Linked Tileset

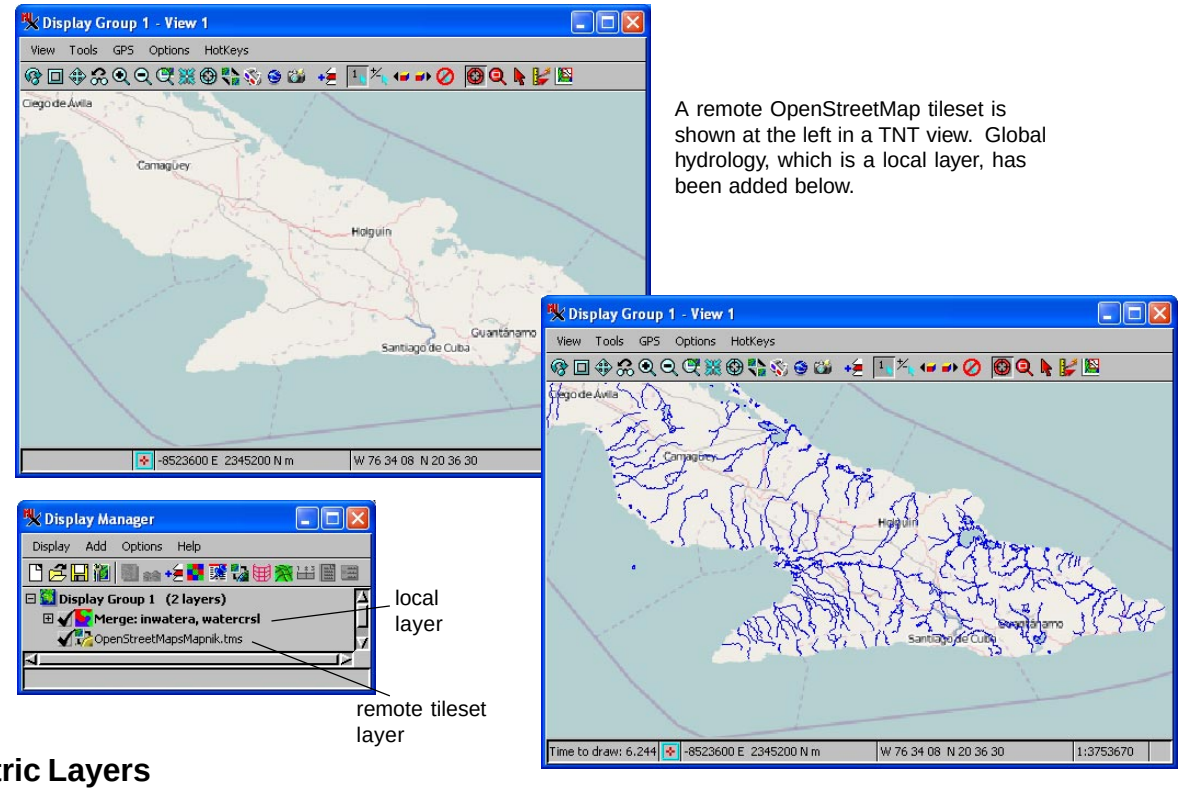
A tileset can be located anywhere in the world on a web site and used in any TNT view. The TSD file that references this remote tileset resides on a local drive or network. When this TSD file is selected for use in the TNT product, the remote tileset will then be read via the Internet from the URL links to each tile specified in the TSD file. This same TSD file can be provided to anyone or only to selected individuals or sites that you wish to allow to view this tileset.

Internet Tileset

A tileset and the TSD file that references it can be located anywhere on the Internet. The TNT products can then be used to load this tiny TSD file and use that remote, linked tileset. The Assemble Geomashup tool in TNTmips builds a web page with JavaScript that embeds the properties of this TSD file in the web page. Anyone using this geomashup web page from anywhere can also view and use this tileset via the web.



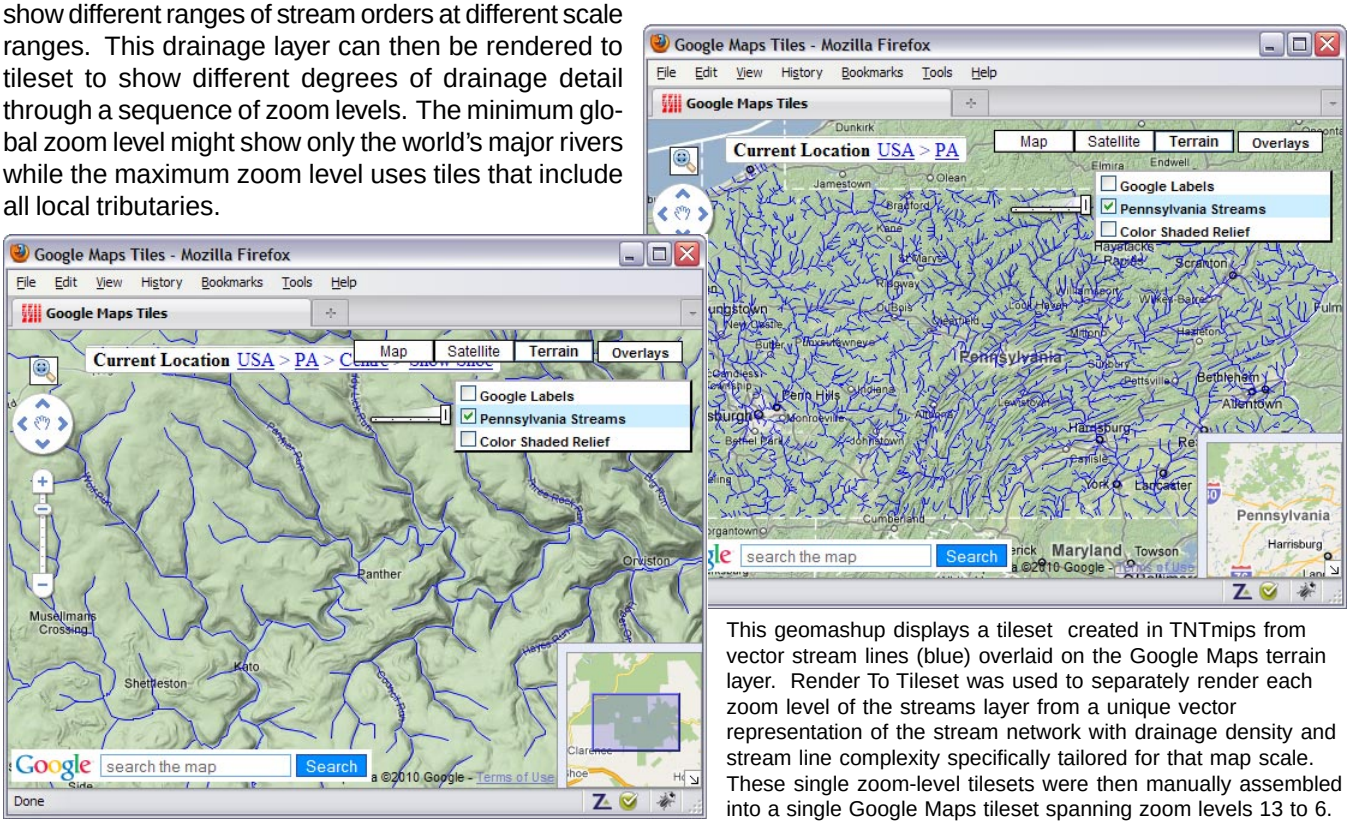
The Display Manager controls the layers viewed in any TNT display window. The Add Web Layer icon in this window opens the Internet Tileset window shown at the right. The tilesets listed in this window can be selected for addition to any TNT view. These tilesets can be located on the web, a private network, or local drive. Any Google, Bing, or World Wind standard tileset structure that is available via the Internet for unlicensed, public use can also be linked to and added as a layer in a TNT view.



A remote OpenStreetMap tileset is shown at the left in a TNT view. Global hydrology, which is a local layer, has been added below.

Geometric Layers

Any TNT geometric layer (CAD, vector, shape, or TIN) using any TNT selection procedure can be rendered into a tileset structure using the Render to Tileset procedure in the Display process. The lines, points, and other features are rendered into raster tiles in this process using their styles and symbols. Careful consideration must be given to select and render a specific selected set of appropriate geometric features into a given zoom level (or 2 or 3 contiguous levels). Render To can be used several times to build coextensive tilesets with different ranges of zoom levels from the same or different geometric objects. For example, a global drainage layer attributed with stream order can be set to show different ranges of stream orders at different scale ranges. This drainage layer can then be rendered to tileset to show different degrees of drainage detail through a sequence of zoom levels. The minimum global zoom level might show only the world's major rivers while the maximum zoom level uses tiles that include all local tributaries.



This geomashup displays a tileset created in TNTmips from vector stream lines (blue) overlaid on the Google Maps terrain layer. Render To Tileset was used to separately render each zoom level of the streams layer from a unique vector representation of the stream network with drainage density and stream line complexity specifically tailored for that map scale. These single zoom-level tilesets were then manually assembled into a single Google Maps tileset spanning zoom levels 13 to 6.

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Precomputed

A tileset is a precomputed structure optimized to work in a specific geoviewer/web browser. The size, format(s), CRS, and name and location of the tiles are all specified by the web application that will use the tileset. Some variation may be permissible, but will always result in slower access to the image in the geoviewer via its API. For example, Google Maps' API will accept smaller images not in tilesets and will compute the tiles. Google Earth will also accept a variety of sizes and formats of images as temporary layers. A precomputed tileset provides for the fastest viewing of images of any size.

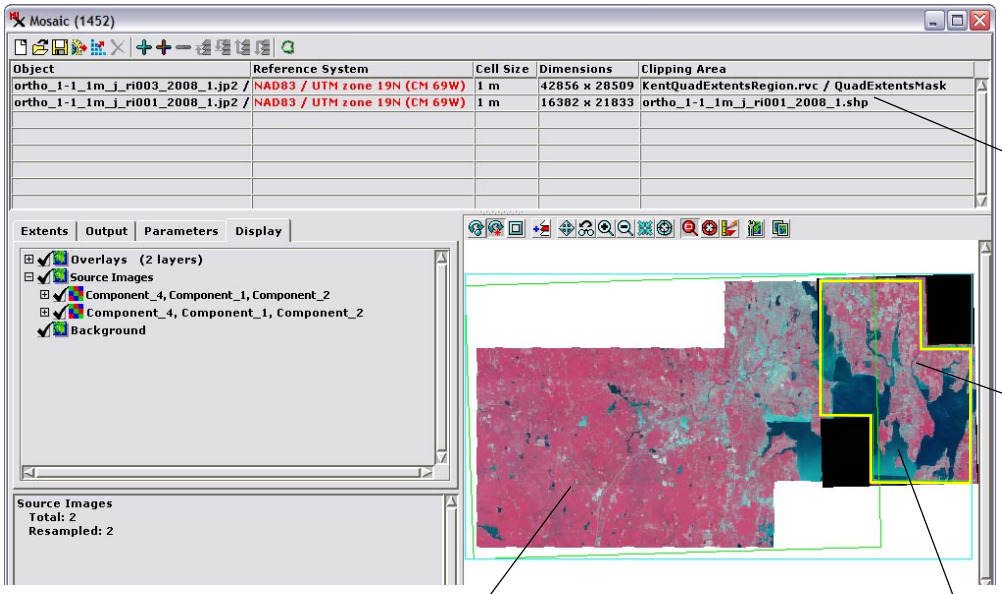
Geoviewer

This term refers to the viewing component of popular local and web applications that view geolocated source materials via the Internet. In connection with the TNT products the term refers to the map and image viewing area in Google Maps, Bing Maps, Google Earth, World Wind, and the TNT products. This geoviewer component can be used in a geomashup with other location-based information provided by tabbed panels, pop-in windows, side panels, etc.

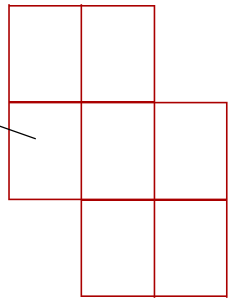
Clipping Area

http://www.microimages.com/documentation/TechGuides/76ClippingAreas.pdf

In a TNT process that creates tilesets, the clipping area is the irregular area that will be processed for each input image or tileset. The clipping area for each input is defined by a region containing one or many polygons TNTmips. A buffer zone can be applied to each polygon in the regions used in the process. A typical use with tilesets would be to merge tilesets each representing the image coverage of a county into a state level tileset and clip the boundary of each input to the area defined in a county region. Clipping areas are defined for each input object and the clipping is applied as part of the processing of the input.



The Clipping Area column in the Object list shows the name of the spatial object you have chosen to define the clipping area for that input image. The default entry in this field is *All* to use all of the input image if you haven't specified a clipping area.



The image on the left in this mosaic layout has a clipping area defined by a binary raster object, which is automatically applied as a mask to make the masked-out (clipped) areas transparent in the Mosaic window's view pane. The full rectangular extents of the input raster continue to be outlined in color (green in this illustration).

The input image on the right in this mosaic layout has a clipping area defined by a shape object (shown in the red outlines above right) made up of several shapes (polygons) outlining map quadrangles; only the outer boundary of this set of shapes is used to define the clipping area. When you define the clipping area using a shape, vector, or region object, the extents outline of that input raster is modified automatically to show only the clipping area you have defined (outline shown in yellow).

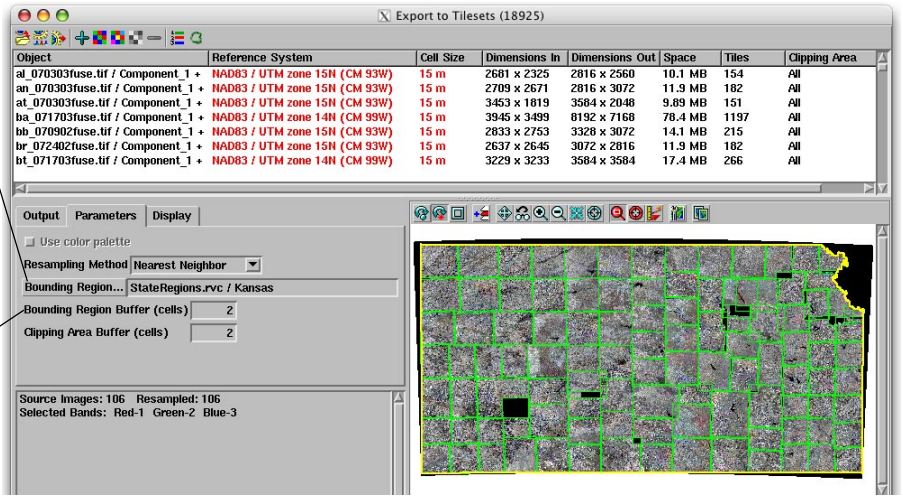
Project Boundary or Bounding Region

http://www.microimages.com/documentation/TechGuides/76LimitingRegion.pdf

A tileset prepared in TNTmips can have an irregular transparent edge and include holes defined by a bounding region or project boundary. It can also be an irregular image area embedded in a rectangle that provides a frame of a solid color. The Auto Mosaic process can use any vector or region object to define a bounding region so that areas outside this region are not included in the tileset. Thus areas outside the area of your project will show the geoviewer's base image and map layers. The tiles at edges cut by the bounding region can be specified to be transparent PNG tiles thus providing a smooth edge conforming to the actual bounding region.

In the Export to Tilesets process, use the Bounding Region push-button on the Parameters tabbed panel to select the geometric object to define the bounding area for all of the output tilesets. The outline of the selected object is automatically shown as an overlay in the Export to Tilesets window's view. In the illustration to the right, tilesets are being created for county images of the state of Kansas, and the bounding area is the outer boundary of the state (shown in yellow).

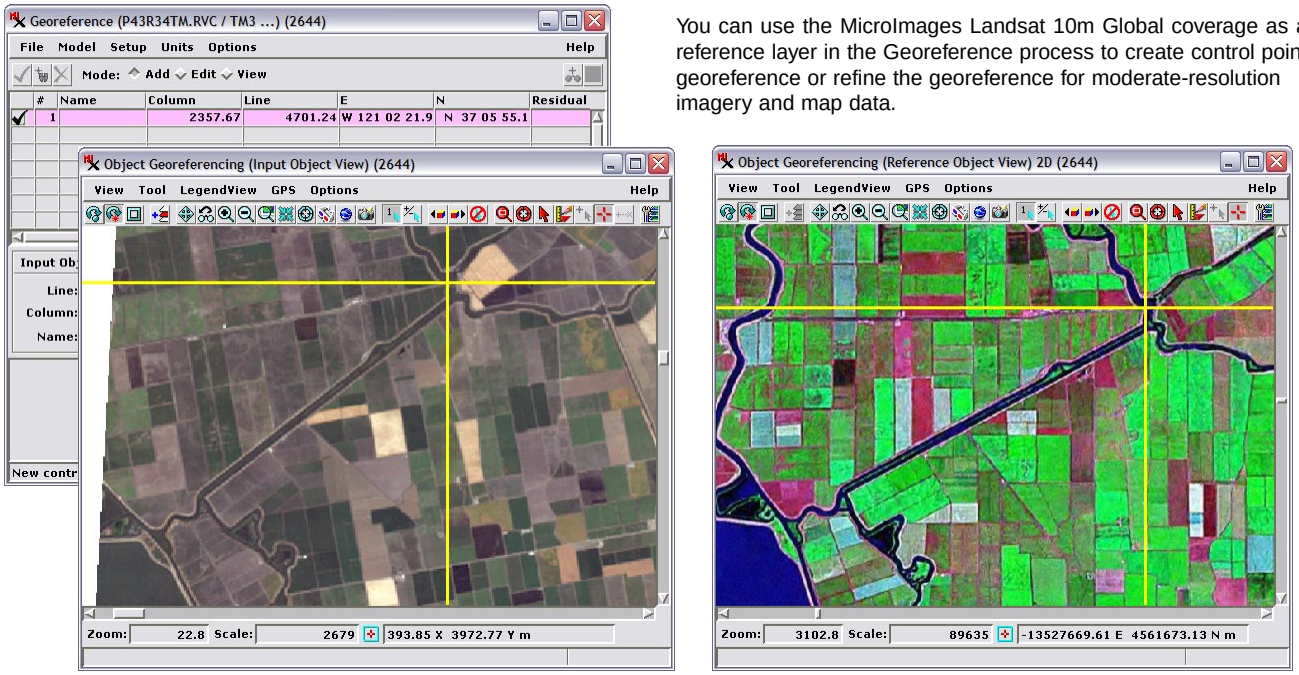
To create a buffer zone around the bounding region, enter the desired value in cells in the *Bounding Region Buffer* field on the same tabbed panel.



Georeferencing

http://www.microimages.com/documentation/TechGuides/76globalImg.pdf

Any tileset that has a local or remote TSD link file can be added as a reference layer in any TNT view. A tileset can be used in the TNT georeference process to provide control points for other imagery. MicroImages has assembled tilesets with global Landsat coverage at approximately 10 meters and orthoimage coverage for the United States at approximately 1 meter. These tilesets and their very small TSD link files are maintained at and can be used directly from microimages.com. Any other available orthoimagery, even older black and white coverage, can be assembled into a tileset coverage of a nation, province, or project area using TNTmips. This tileset can then be used locally or via the Internet to georeference new imagery.



You can use the MicroImages Landsat 10m Global coverage as a reference layer in the Georeference process to create control points to georeference or refine the georeference for moderate-resolution imagery and map data.

(continued)

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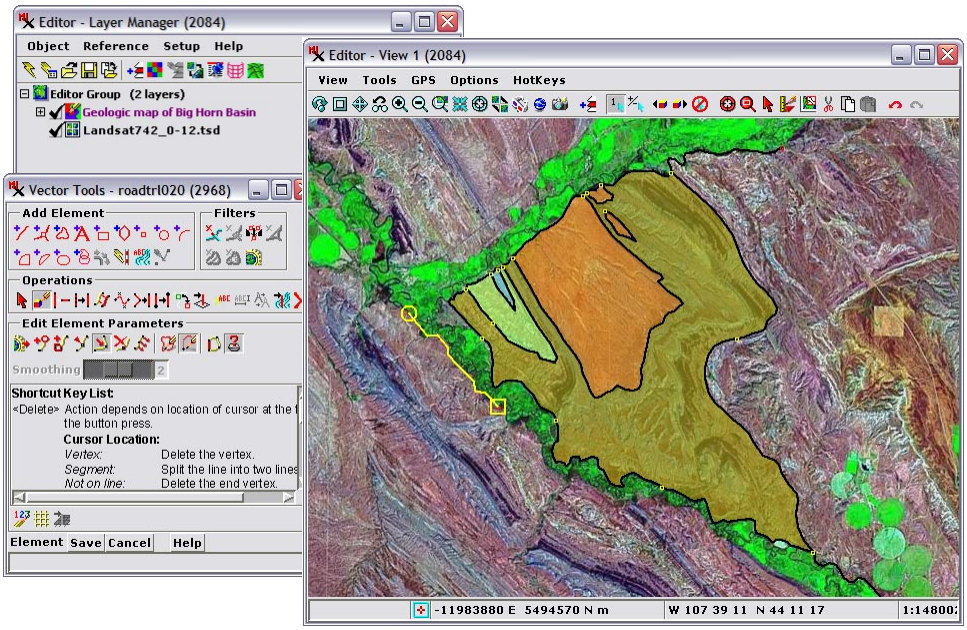
Editing

http://www.microimages.com/documentation/TechGuides/76globalImg.pdf

Any standard tileset structure supported by the TNT products can be viewed and interpreted from a local or Internet source in the TNT spatial Editor process. If the tileset was not produced in TNTmips, use the Tileset Manager or Link process in TNTmips to create the small TSD link file that defines the location and structure of the tileset for the TNT processes.

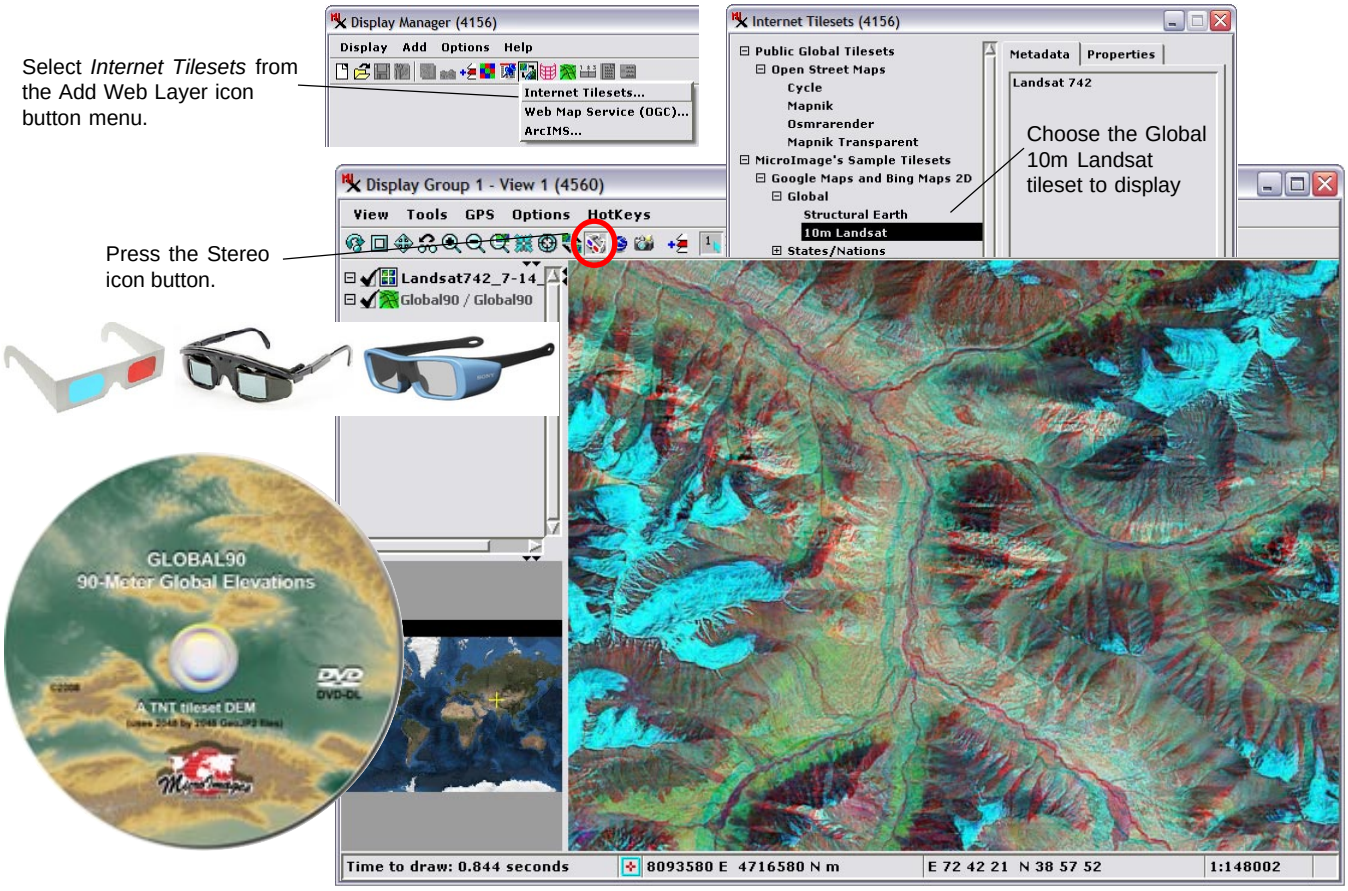
In the Spatial Editor you can use the Landsat 10m Global tileset as a reference layer for creating or editing geometric map data layers, such as the geologic map polygons shown in the Editor View illustration to the right.



Stereo

http://www.microimages.com/documentation/TechGuides/76tilesetStereo10.pdf

Any standard tileset structure that has a local or remote TSD link file can be directly viewed in stereo using your local stereo viewing device (e.g., anaglyph glasses). Make sure your TNT product has access to the global or USA digital elevation tilesets provided free with every TNT product and use the stereo view icon available in any 2D view. These elevation tilesets can be installed on your hard drive or used directly from their DVDs shipped with your TNT product.



Anaglyph stereo display of a confluence of valleys in the Pamir Mountains, Tajikistan using the ~10-meter global Landsat 742 tileset published at MicroImages and 90-meter global DEM provided by MicroImages with every TNTmips.

Available Tilesets

All standard tileset structures supported by TNTmips can be used for viewing in 2D and stereo, georeferencing, or extracting features by direct editing. The standard reference global and USA state tilesets and other sample tilesets can be selected and viewed as layers in your TNT product by using the Add Web Layer icon provided on the TNT Display Manager toolbar.

Global

http://www.microimages.com/documentation/TechGuides/76googleBingBox.pdf

Access to an approximately 10-meter global Landsat false color Google Maps and Bing Maps tileset is built into your TNT product.

There are public domain global road/feature tilesets covering many global urban areas assembled by the OpenStreetMap public project. There are three sites that maintain and provide public access to global tilesets for these features. These tilesets can be very useful as a reference layer in TNT views. Furthermore, if you have digitized features of an area of interest, you can also contribute your local road features that will subsequently appear in these tilesets. The TSD link files that you need to access these global map tilesets are provided at http://www.microimages.com/geodata/tsd/. These TSD files provide good models if you wish to edit one of these XML files to point to use other global tilesets in your TNTmips. You can edit them in any text editor, an XML editor, or in the Edit TSD function in the Tileset Manager process in TNTmips.

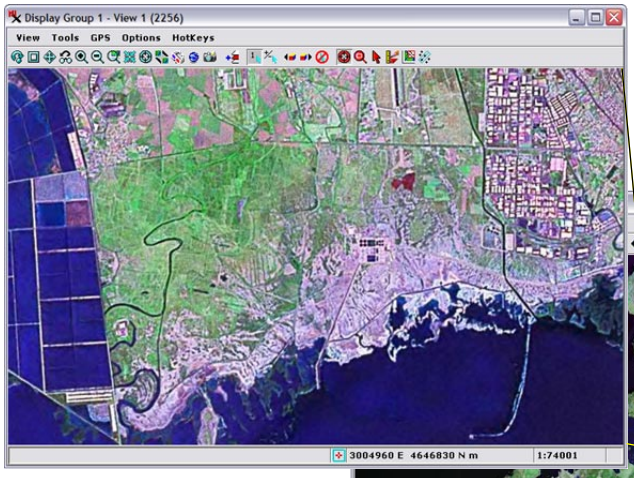
Google Maps and Bing Maps have global tilesets that already provide proprietary high-resolution image and map coverage that could be used in TNT products, such as for a reference layer in a view, for georeferencing, and in the spatial Editor to capture geometric features. Alas, all these tilesets are proprietary and controlled by licenses that state that these tilesets can not be used outside a browser, such as in TNTmips.

The Google Maps and Bing Maps web applications provide you with layers or parts of layers that are licensed by these companies. These licenses restrict the other uses of their content so that they can market other products that rely on their content, such as the use of their road networks in automobile navigation applications. Furthermore, use of these layers outside of a browser would block the advertisements used as the basis for the collection and your use of these proprietary images and maps.

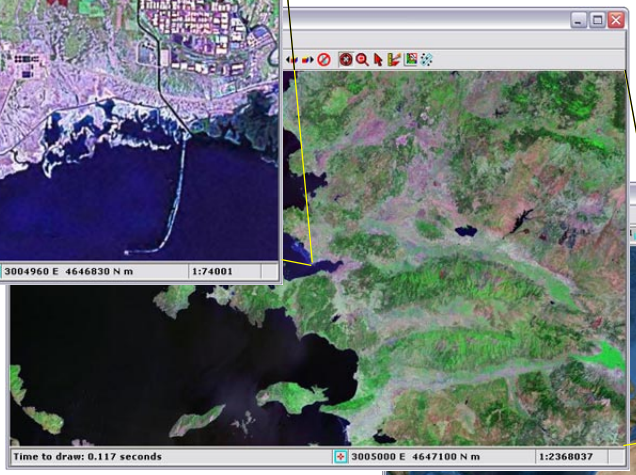
Perhaps you have observed that both Google and Microsoft are now collecting or buying more of these valuable materials to gain exclusive control of their licenses and uses. Google is driving roads around the world with their Google Bugs collecting route information and frontal images and contracting for satellite imagery. Microsoft owns Vexcel and uses its cameras to acquire very high resolution orthoimage coverage for use in Bing Maps.

The use of these proprietary images as reference layers in the TNT products would be very

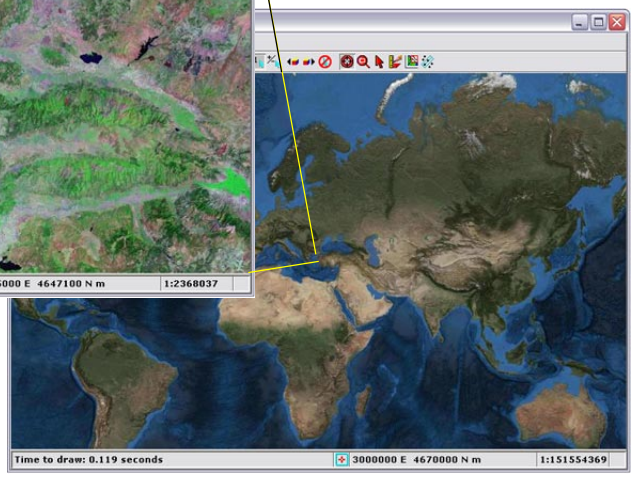
Zoom Level 13: Landsat 742 (19-m pixel size at equator)



Zoom Level 8: Landsat 742 (611-m pixel size at equator)



Zoom Level 2: Structural Earth (39-km pixel size at equator)



The Landsat 10m Global tileset switches seamlessly from natural-color Structural Earth imagery at low resolution (Google/Bing Maps zoom levels 0 to 7) to false-color Landsat Geocover 742 imagery at higher resolution (zoom levels 8 to 14). These views of the tileset at three different zoom levels center on an area on the west coast of Turkey. TNTmips treats the fixed zoom levels in the tileset in the same manner as the stored pyramid tiers in a standard image, automatically computing and displaying any required intermediate zoom level.

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easy to implement by building a TNT Tileset Definition file (*.tsd) pointing to the web location of each of their tilesets. However, doing this would violate their licenses with regard to the use of these maps and images. It is also possible for an end user organization to buy a license to use the Bing Maps or Google Maps layers in their other products, such as TNTmips. Any interest in obtaining such a license should be directed to Google or Microsoft. MicroImages could easily provide the method used under their licensing using their license access codes and the TSD file.

Structure and size of this global tileset:

Folders, Tiles, and File Size by Zoom Level*

Zoom Level	Number of Folders	Number of Tiles	Size	Size on Disk
0	1	1	60 KB	64 KB
1	2	4	218 KB	288 KB
2	3	12	795 KB	960 KB
3	6	44	2.9 MB	3.7 MB
4	11	153	10 MB	13 MB
5	21	495	32.1 MB	41 MB
6	42	1,724	89.1 MB	118 MB
7	83	6,319	242 MB	339.4 MB
8	166	23,878	735 MB	1,082 MB
9	331	92,457	2.5 GB	3.8 GB
10	660	364,177	9.6 GB	14.5 GB
11	1,319	1,445,437	38.5 GB	57.4 GB
12	2,453	5,542,645	137 GB	209 GB
13	3,990	17,319,271	371 GB	593 GB
14	4,600	35,789,413	652 GB	1,155 GB

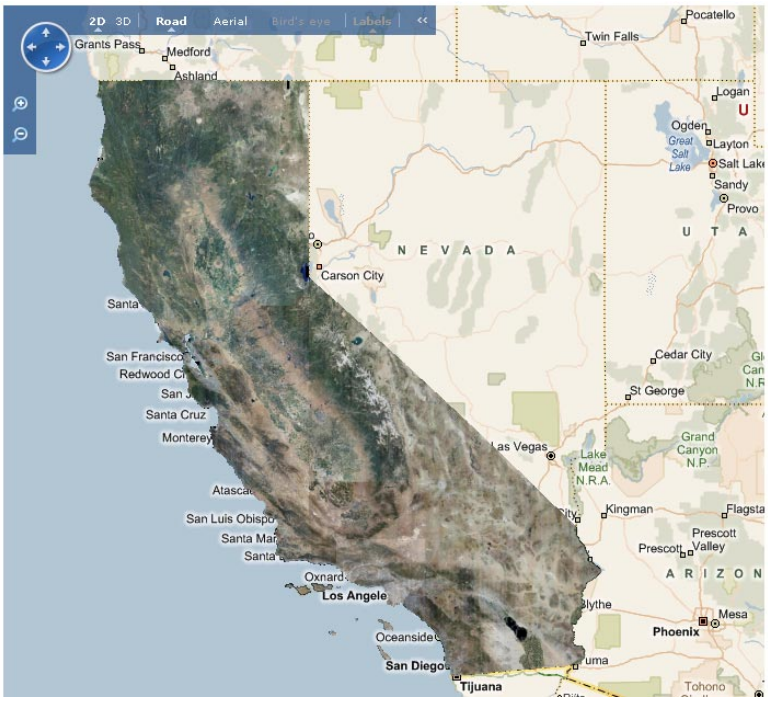
*See the TechGuide entitled *Tilesets: Understanding Sizes*.

States

http://www.microimages.com/geodata/us-orthophotos/2009BingMaps.htm

Access to the mostly 1-meter USA state Google Maps and Bing Maps tilesets is built into your TNT product. These state tilesets have been assembled from the most recent USDA county by county orthoimage coverage of each state available from USDA / NRCS / NAIP. This 2009 coverage is supplemented by 2008 and 2007 coverage for states that were not flown in 2009.

Anyone georeferencing areas in the United States can easily assemble tilesets suitable for direct local use in TNTmips for georeferencing any other images and maps, for viewing in all popular browsers, or for assembling geomashups. Simply download the USDA / NRCS / NAIP 1-meter resolution 2008 or 2009 county orthoimages of your state located at http://datagateway.nrcs.usda.gov/. Use the TNTmips Auto Mosaic process to build the statewide Google/Bing tileset directly from the provided MrSID images or export all the county images to county tilesets using job processing, and then merge the county tilesets into a statewide tileset.



(continued)

Cities

http://www.microimages.com/gallery/local/localBM.htm

Major cities and some counties in the USA are covered with much higher resolution orthoimages, up to 15-centimeter, or 6-inch, resolution. If the local area of interest is available at http://seamless.usgs.gov/products/listofortho.php and downloaded, it can be easily mosaicked into a Google/Bing tileset for local or network use in your browser or in a TNT product. Examples of this very high resolution coverage can be viewed via the Remote Tileset list built into your TNT product or via your browser from microimages.com

Samples

http://www.microimages.com/gallery/local/localBM.htm

Many other sample standard tilesets can be viewed from the list built into your TNT product or via their associated browser geoviewer (e.g., Google Maps or Bing Maps). These include vector samples of topographic and geologic maps, overlays generated from geometric features, very high resolution orthoimages, and local engineering projects. These samples illustrate the versatility of using tilesets to publish and use your project materials.

Geomashup of a tileset created from the *Geologic and Mineral Resource Map of Afghanistan*, U.S. Geological Survey Open-File Report 2006-1038, shown in Bing Maps. The rasterized map was extracted from a PDF file, masked, and converted to a tileset in TNTmips. The web page containing this geomashup was modified to include a title and links (brown buttons) to legends for the geologic map and mineral symbols (PDF files).

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Other

If you are using TNTmips for areas in other nations, you may be able to locate other high resolution orthoimage or map collections to assemble into a province or nationwide tileset for frequent use as your TNT reference layer.

Local Tile Overlay alone (no Google layers)

Local Tile Overlay with superimposed Google roads and labels

Local Tile Overlay over Google maps layer

Local Tile Overlay over Google satellite image layer

Local Tile Overlay with superimposed Google roads and labels, over Google satellite image layer

New 30-centimeter orthoimage Tile Overlay for Tuusula and Kerava, Finland, added as a local layer to Google Maps. The default HTML produced by the TNTmips Mosaic process creates a Local menu that provides various combinations (mashups) of the local Tile Overlay with native Google Maps layers, as annotated above. The default mashup overlays the local image over Google's map layer, as shown in the illustration.

API

An API (Application Programming Interface) is an interface implemented by a software program to enable interaction with other software, much in the same way that a user interface facilitates interaction between humans and computers. APIs are implemented by applications, libraries, and operating systems to determine the vocabulary and calling conventions the programmer should employ to use their services.

Google and Microsoft provide web-based JavaScript APIs for their online geoviewers (Google Maps, Google Earth, and Bing Maps) that enable users to embed these geoviewers in their own web pages and to overlay local or remote tilesets on the proprietary layers in these geoviewers (create geomashups).

API Key

An API key is a mechanism used by Google to authorize users to access the Google Maps Application Programming Interface (API) to embed the Google Maps geoviewer in their own web pages. A Google Maps API key is valid for a single web domain (e.g., www.yourdomain.com) and can be freely obtained at http://code.google.com/apis/maps/signup.html.

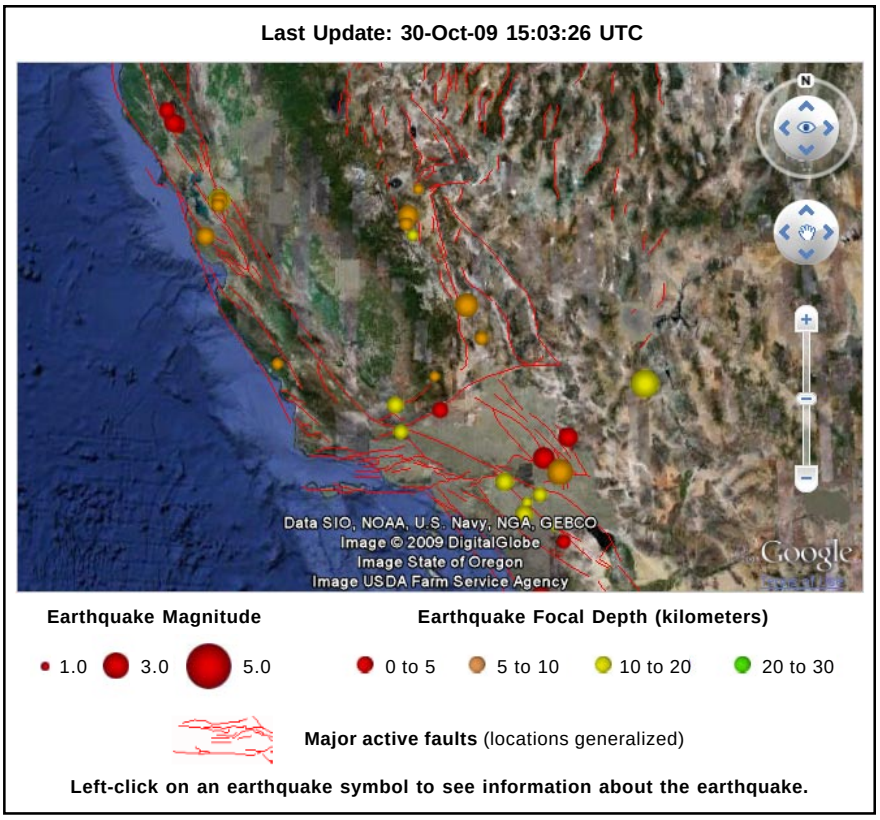
The actual API key issued by Google is an alphanumeric string that should be embedded in the JavaScript code of each web page or geomashup (HTML file) that accesses the Google Maps API. TNT processes that create Google Maps tilesets allow you to provide your API Key when you set up the process, which automatically includes it in the correct location in the JavaScript code for immediate use.

(continued)

KML

http://www.microimages.com/documentation/TechGuides/76PubCaNvQuakes.pdf

A file(s) containing geometric and other data for use as an overlay in Google Earth. A KML file also can be added to a Google Maps mashup in the TNT Geomashup process to provide an overlay for a tileset mashup. Large KML files can be slow to render and use. Complex geometric data covering large areas in detail should be converted to a tileset using the TNTmips Render to Tileset process.



Google Earth plugin and legend from the MicroImages' demonstration California-Nevada Earthquake web page. The earthquake epicenters (colored spheres) and fault lines are in a KML file that is created once per hour using a TNT geospatial script (SML) that is run automatically by the TNT Job Processing System.

OpenLayers

http://en.wikipedia.org/wiki/OpenLayers

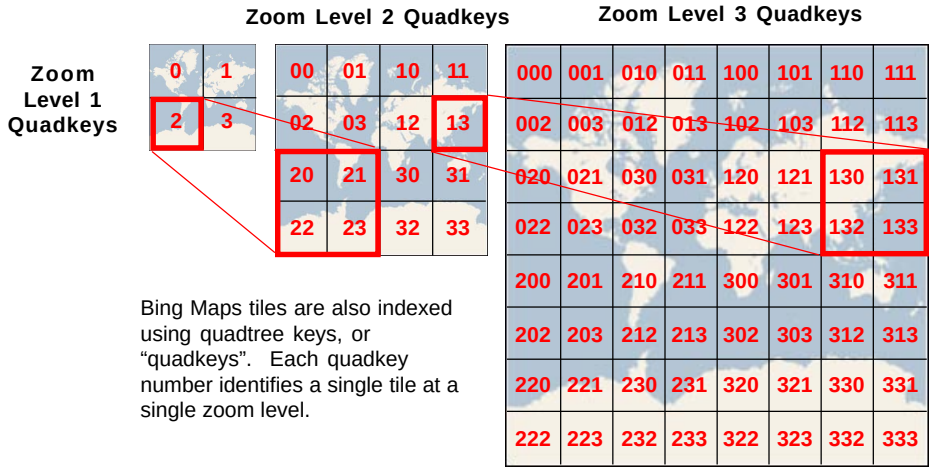
OpenLayers is an open source (provided under a modified BSD license) JavaScript library for displaying map data in web browsers. It provides an API for building rich web-based geographic applications similar to Google Maps and Bing Maps. See http://www.openlayers.org for more information.

You can use this library to build your own web applications or installable applications to view local or web-based tilesets produced by TNTmips. Some of MicroImages' free, stand alone geoviewers, such as TNTmap, are assembled using components of OpenLayers. More example OpenLayers applications of tilesets are planned as their open source can be used as models for your own web projects.

Quadkeys

http://msdn.microsoft.com/en-us/library/bb259689.aspx

A term Microsoft uses in connection with Bing Map tilesets to index the positions of individual tiles in a tileset. To optimize the indexing and storage of Bing tile files, the two-dimensional tile XY coordinates are combined into one-dimensional strings called quadtree keys, or "quadkeys" for short. Each quadkey uniquely identifies a single tile at a particular level of detail (i.e., zoom level), and it can be used as a key in common database B-tree indexes. For more information see http://msdn.microsoft.com/en-us/library/bb259689.aspx.



Bing Maps tiles are also indexed using quadtree keys, or "quadkeys". Each quadkey number identifies a single tile at a single zoom level.

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