

MAPTILER: TILE MAP PUBLISHING A LA GOOGLE MAPS

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The demand for extremely fast online distribution of maps and raster geodata is increasingly growing in recent years. Developers and advanced users who are familiar with technologies such as Google Maps API and other map SDKs used for development of web 2.0 applications and native software applications on mobile devices need to access also custom geodata provided by commercial companies, geospatial agencies or government.

Typically the maps are published online using a map server with support of the OpenGIS® Web Map Service (WMS) standard. There is a variety of software products available on the market which supports this standard - both proprietary, available from commercial companies, and open-source. The most popular open source applications are the MapServer and the GeoServer.

Such software needs to be installed on a server connected to the Internet and configured properly. Then it distributes the maps to online visitors - directly from the source raster or vector geodata or geodatabases available on the server.

This dynamic form of distribution of maps can unfortunately be quite CPU intensive, as for every request and every visitor the same map is drawn again and again. The software is highly optimized to be as fast as possible, but there are still (quite low) limits on number of visitors the software could serve without slowing down, and the speed optimizations are compromised by lower quality of rendered maps. The speed and responsiveness of such projects can be empowered through a technique of caching or to be more precise map tile caching. A new standard is available for this technique: the OpenGIS® Web Map Tile Service (WMTS), which is derived from the OSGEO Tile Map Server (TMS). A separate software (such as TileCache or GeoWebCache) is placed between the dynamic server and the online visitors, so that the most requested parts of the map are cached and distributed to several visitors. Such technique is much more efficient and lowers the number of requests sent to the map server and also improves the displaying speed of the map, but only to certain extend.

This paper presents a software which uses a different approach. The input raster geodata are rendered in advance, in the moment when the whole dataset is available or updated. The complete map in all required resolution levels is processed by the software only once. All online visitors are accessing the pre-rendered map tiles.

The advantages of this approach are obvious:

- Significantly higher responsiveness and scalability of the final map application. The maps are extremely fast.
- Simplicity of the hosting, which means increased reliability of the whole map application.
- Possibility to use cloud hosting services or optimized CDN (content distribution network) for hosting the background maps used in interactive web or mobile applications. Amazon S3/CloudFront, Google Storage or AppEngine are typical examples of relatively cost efficient and very reliable services.
- Excellent visual quality of the maps. There is no need to make the speed vs. quality compromise known from dynamic WMS distribution. The workflow can use techniques such as antialiasing, color corrections, sharpening, high-quality watermarking etc.
- Best possible optimization of the size of tiles - to speed up the delivery of the maps and to save the disk space and fees for transferred data. The pre-rendering technique can utilize advanced techniques for reduction of image size with color palette, stripping of headers, improved compression algorithms, etc.

This technique has also disadvantages such as necessity to handle and store all of the pre-rendered map tiles on a hard drive. On the other side the disk space is quite affordable and its price gets lower from year to year. Pre-rendering is not suitable for maps with very dynamic form and frequent updates (such as live data streams). On the other hand, large class of background maps and geodata which are not frequently updated are perfect candidates to the presented approach.

The author of this article created during the years 2007 and 2008 a software tool which demonstrates this approach. The GDAL2Tiles command line utility, which is now distributed together with the popular open-source GDAL library (<http://www.gdal.org/>). This tool creates the tiles in the OSGEO TMS standard - following the popular spherical mercator profile, compatible with Google Maps, Bing Maps,

OpenStreetMap and other mapping services targeted to general public. Other profiles such as geodetic (unprojected) or raster (for non-georeferenced images) are available too. The software can also generate KML SuperOverlay for visualization in Google Earth. The tool has become quite popular and is recommended from Google engineers as a tool for rendering the maps.

To simplify the usage of this tool and make map publishing technique more available to general public and broader user-base, Maptiler, a desktop application with user-friendly interface in a form of step-by-step guide was created.

MapTiler desktop application is fully multi-platform, coming with an installer for operating systems Windows, Mac and Linux. And anybody can install it and start using it to render the maps immediately. The application generates from the supplied raster data the tiles according the OSGEO TMS, same as the GDAL2Tiles utility. The software is open-source and available for free from the website: <http://www.maptiler.org/>.

Usage is very simple, basically with a few clicks and optional metadata the tiles can be rendered: Firstly, the user has to choose what kind of tiles (which 'profile') is requested (one of mercator, geodetic, raster). Then the user opens the input raster file in one of the supported formats such as TIFF/GeoTIFF, MrSID, ECW, JPEG2000, Erdas HFA, NOAA BSB, JPEG and couple of others. The software automatically detects the embedded spatial reference system (the coordinates and used projection) in case it is available directly in the file, otherwise it can be specified in a form of EPSG code or provided as the correct WKT definition of the used coordinates. All coordinate systems supported by Proj4 software tools can be used in the input files. ESRI WorldFile and other forms of georeference are correctly loaded as well.

In the next step a fast preview of covered area is displayed - for visual confirmation of selected coordinate system. Tiles are rendered into JPEG or PNG files - into a directory structure which is following OSGEO TMS REST maximally.

A ready to use simple HTML viewer based on OpenLayers and Google Maps API is generated as well as XML metadata. The user can directly open it and with a simple double click provide viewers immediately with the available interactive map presentation filled with supplied raster data. The provided HTML/JavaScript viewer can be easily customized according the needs of users. MapTiler is also able to generate KML SuperOverlay metadata for efficient and fast 3D visualization of your raster geodata in Google Earth - both desktop application or the web browser plugin.

Publishing the map on the Internet is very simple, all what is necessary to do is just use the standard upload to any webhosting. There is no need to make any extensive configuration or installation of any server software to distribute the maps online. This enables the user to choose from variety of hosting services such as any server from a high quality and reliable CDN or cloud hosting. Traditional windows or linux servers to free web hosting can be used to host such maps as well.

Typical input raster geodata are aerial images, scanned paper maps, signal coverage maps, maps rendered with custom design from a desktop GIS or digital elevation model data. The most popular tile profile generated with MapTiler is the Spherical Mercator. If user chooses this profile the raster data practically creates an overlay of any of the popular online base maps (Google Maps, OpenStreet View). There is a possibility to change the transparency of the overlay maps and compare the data with the available road maps or aerial images.

The authors of the free MapTiler software, employees of Klokan Technologies GmbH, have further developed a parallelized rendering system, the MapTiler Cluster (<http://www.maptiler.com/>), which is using full power of modern multi-core CPUs and is designed to repetitively render large map tilesets. It is faster and significantly improved against the free application MapTiler. The software can run on a computer cluster too, including Amazon EC2 (with possibility to rent powerful computers from the cloud only for the rendering task). This rendering software powers already several online services which are in production use. Several online web applications and dozen of iPhone, iPad and Android applications are using based maps rendered with this advanced software. As stated before, this solution provide its users with excellent visual quality of rendered tiles. The authors provide also consulting services, customization of the software and related commercial support.

An example of large base map (whole United Kingdom) is available at <http://nls.tileservers.com/>. The base map is composed from hundreds of scanned map sheets rendered for National Library of Scotland Maps API: <http://geo.nls.uk/maps/api/>. This map is optimized for iPhone and Android mobile phones as well and demonstrates how the pre-rendered large maps can be visualised on the mobile devices as well.

Similar way of rendering was used for the freely available Ordnance Survey OpenData raster dataset where the individual sheets were merged to form a seamless, zoomable and optimized base map for several purposes. This dataset can also be explored online at <http://os.tileserver.com/>.

The rendered tiles are very useful also for offline applications, which is very well demonstrated by the Maps on Stick (<http://mapbox.com/tools/maps-stick>) open-source project and MapBox iPad application. Both of these are using prerendered tiles in the OSGEO TMS format and packing them into a form of simple database.

The online distribution of maps follows OSGEO TMS specification. MapTiler Cluster can render also tiles which follow OGC WMTS standard. In case the tiles are accessible from a server with installed MapServer, fallback for OGC WMS is also possible. Custom JavaScript API to access the published datasets by third-parties can be deployed as well.

The free and open-source GDAL2Tiles command-line utility and the desktop application MapTiler has been developed with the support and thanks to funding from Google Summer of Code, Moravian Library in Brno (research project OldMapsOnline.org) and CZ.NIC VIP.

The presentation at the ICC 2011 conference contains practical demonstration of the free MapTiler software including demonstration of the publishing sample map to Amazon S3 and also shows use real cases and examples of the maps rendered with MapTiler software.

This paper has presented an alternative approach for traditional online publishing of the maps: the pre-rendering of map tiles. The advantages as well as disadvantages of this approach are noted, as well as practical examples of the usage and demonstration of real online maps. Pre-rendered maps are providing users with higher quality and lower response time than traditional solutions. An original, free and open-source software tools were developed by the author of this text. One of those solutions is the software Maptiler, which offers an user-friendly, fast and simple solution to render and publish maps online accessible to anybody, who is willing to try this technology. Application can be installed and used on multiple platforms and is therefore an ideal tool for getting started with publishing maps online.

The functionality of the popular application Maptiler is further extended in the commercial MapTiler Cluster developed by Klokan technologies GmbH. Maptiler Cluster allows its users to render the tiles significantly faster through usage of multi-core rendering on a single computer or even rendering on computer cluster (such as Amazon EC2). The pre-rendered map has excellent visual quality and can be further optimized (smallest PNGs/JPEGs tiles) - to speed up the delivery of maps and to save the disk space.