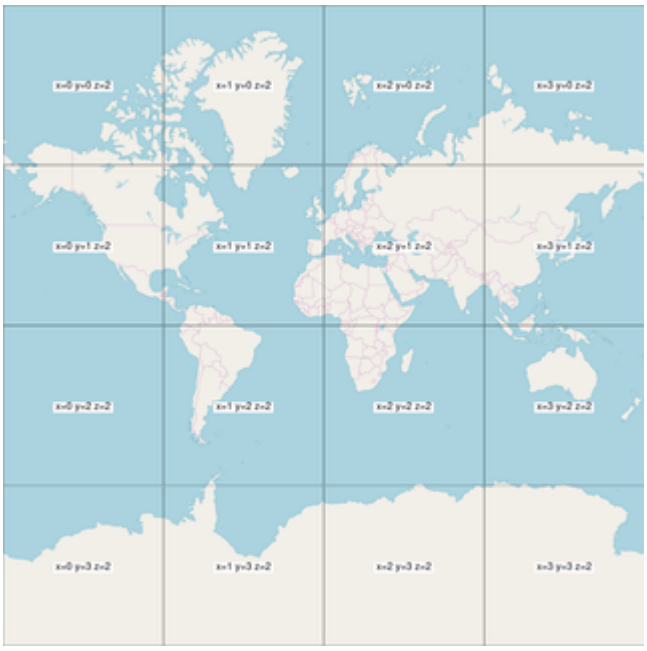
Slippy map tilenames

This article describes the **file naming conventions for the Slippy Map application**.

- Tiles are 256 × 256 pixel PNG files
- Each zoom level is a directory, each column is a subdirectory, and each tile in that column is a file
- Filename(url) format is `/zoom/x/y.png`

The slippy map expects tiles to be served up at URLs following this scheme, so all tile server URLs look pretty similar.



Tile numbering for `zoom=2`

Contents

Tile servers

It has been proposed that this page or section be merged with *TMS*. (Discuss)

The first part of the URL specifies the tile server, and perhaps other parameters which might influence the style.

> Generally several subdomains (server names) are provided to get around browser limitations on the number of simultaneous HTTP connections to each host. Browser-based applications can thus request multiple tiles from multiple subdomains faster than from one subdomain. For example, OSM, OpenCycleMap servers have three subdomains (a.tile, b.tile, c.tile), all pointing to the same CDN.

That all comes before the `/zoom/x/y.png` tail.

Here are some examples:

Name	URL template	zoomlevels
OSM 'standard' style	https://tile.openstreetmap.org/**zoom**/**x**/**y**.png	0-19
OpenCycleMap	http://**[abc]**.tile.thunderforest.com/cycle/**zoom**/**x**/**y**.png	0-22
Thunderforest Transport	http://**[abc]**.tile.thunderforest.com/transport/**zoom**/**x**/**y**.png	0-22
MapTiles API Standard (https://www.maptilesapi.com/)	https://maptiles.p.rapidapi.com/local/osm/v1/**zoom**/**x**/**y**.png?rapidapi-key=YOUR-KEY	0-19 globally
MapTiles API English (https://www.maptilesapi.com/)	https://maptiles.p.rapidapi.com/en/map/v1/**zoom**/**x**/**y**.png?rapidapi-key=YOUR-KEY	0-19 globally with English labels
MapQuest As of July 11, 2016, direct tile access has been discontinued.	http://otile**[1234]**.mqcdn.com/tiles/1.0.0/osm/**zoom**/**x**/**y**.jpg ("otile1-s.mqcdn.com" etc. for https)	0-18
MapQuest Open Aerial, As of July 11, 2016, direct tile access has been discontinued.	http://otile**[1234]**.mqcdn.com/tiles/1.0.0/sat/**zoom**/**x**/**y**.jpg	0-11 globally, 12+ in the U.S. (http://developer.mapquest.com/web/products/open/map)
Stamen Terrain (http://mike.teczno.com/notes/osm-us-terrain-layer/background.html)	http://tile.stamen.com/terrain-background/**zoom**/**x**/**y**.jpg	4-18, US-only (for now)

Further tilesets are available from various '3rd party' sources.

Zoom levels

The zoom parameter is an integer between 0 (zoomed out) and 18 (zoomed in). 18 is normally the maximum, but some tile servers might go beyond that.

zoom level	tile coverage	number of tiles	tile size(*) in degrees
0	1 tile covers whole world	1 tile	360° x 170.1022°
1	2 × 2 tiles	4 tiles	180° x 85.0511°
2	4 × 4 tiles	16 tiles	90° x [variable]
n	$2^n \times 2^n$ tiles	2^{2n} tiles	$360/2^{n}$° x [variable]
12	4096 x 4096 tiles	16 777 216	0.0879° x [variable]
16		$2^{32} \approx$ 4 295 million tiles	
17		17.2 billion tiles	
18		68.7 billion tiles	
19	Maximum zoom for Mapnik layer	274.9 billion tiles	

(*) While the width (longitude) in degrees is constant, given a zoom level, for all tiles, this does not happen for the height. In general, tiles belonging to the same row have equal height in degrees, but it decreases moving from the equator to the poles.

See Zoom levels for more details

X and Y

- X goes from 0 (left edge is 180 °W) to $2^{zoom} - 1$ (right edge is 180 °E)
- Y goes from 0 (top edge is 85.0511 °N) to $2^{zoom} - 1$ (bottom edge is 85.0511 °S) **in a Mercator projection**

For the curious, the number 85.0511 is the result of arctan(sinh(π)). By using this bound, the entire map becomes a (very large) square.

Derivation of tile names

The following is identical to the well-known Web Mercator projection.

- Reproject the coordinates to the Spherical Mercator projection (from EPSG:4326 to EPSG:3857):
  - $x = lon$
  - $y = \text{arsinh}(\tan(lat)) = \log[\tan(lat) + \sec(lat)]$

    (lat and lon are in radians)
- Transform range of x and y to 0 – 1 and shift origin to top left corner:
  - $x = [1 + (x / \pi)] / 2$
  - $y = [1 - (y / \pi)] / 2$
- Calculate the number of tiles across the map, n, using 2^{zoom}

- Multiply *x* and *y* by *n*. Round results down to give *tilex* and *tiley*.

Implementations

Pseudo-code

For those who like pseudo-code, here's some hints:

```
sec = 1/cos
arsinh(x) = log(x + (x^2 + 1)^0.5)
sec^2(x) = tan^2(x) + 1
→ arsinh(tan(x)) = log(tan(x) + sec(x))
```

Please note that "log" represents the natural logarithm (also known as ln or $\log_e$), not decimal logarithm ($\log_{10}$), as used on some calculators.

Lon./lat. to tile numbers

```
n = 2 ^ zoom
xtile = n * ((lon_deg + 180) / 360)
ytile = n * (1 - (log(tan(lat_rad) + sec(lat_rad)) / π)) / 2
```

Tile numbers to lon./lat.

```
n = 2 ^ zoom
lon_deg = xtile / n * 360.0 - 180.0
lat_rad = arctan(sinh(π * (1 - 2 * ytile / n)))
lat_deg = lat_rad * 180.0 / π
```

This code returns the coordinate of the _upper left_ (northwest-most)-point of the tile.

Mathematics

Idem with mathematic signs (lat and lon in degrees):

$$x = \left\lfloor \frac{lon + 180}{360} \cdot 2^z \right\rfloor$$

$$y = \left\lfloor \left(1 - \frac{\ln\left(\tan\left(lat \cdot \frac{\pi}{180}\right) + \frac{1}{\cos\left(lat \cdot \frac{\pi}{180}\right)}\right)}{\pi} \right) \cdot 2^{z-1} \right\rfloor$$

$$lon = \frac{x}{2^z} \cdot 360 - 180$$

$$lat = \arctan\left(\sinh\left(\pi - \frac{y}{2^z} \cdot 2\pi\right)\right) \cdot \frac{180}{\pi}$$

Python

Lon./lat. to tile numbers

```
import math
def deg2num(lat_deg, lon_deg, zoom):
  lat_rad = math.radians(lat_deg)
  n = 2.0 ** zoom
  xtile = int((lon_deg + 180.0) / 360.0 * n)
  ytile = int((1.0 - math.asinh(math.tan(lat_rad)) / math.pi) /
2.0 * n)
  return (xtile, ytile)
```

Tile numbers to lon./lat.

```
import math
def num2deg(xtile, ytile, zoom):
  n = 2.0 ** zoom
  lon_deg = xtile / n * 360.0 - 180.0
  lat_rad = math.atan(math.sinh(math.pi * (1 - 2 * ytile / n)))
```

```
  lat_deg = math.degrees(lat_rad)
  return (lat_deg, lon_deg)
```

This returns the NW-corner of the square. Use the function with xtile+1 and/or ytile+1 to get the other corners. With xtile+0.5 & ytile+0.5 it will return the center of the tile.

See also tilenames.py (https://svn.openstreetmap.org/applications/routing/pyroute/tilenames.py) and the 'mercantile' library (https://github.com/mapbox/mercantile)

Ruby

Lon./lat. to tile numbers

```
def get_tile_number(lat_deg, lng_deg, zoom)
  lat_rad = lat_deg/180 * Math::PI
  n = 2.0 ** zoom
  x = ((lng_deg + 180.0) / 360.0 * n).to_i
  y = ((1.0 - Math::log(Math::tan(lat_rad) + (1 /
Math::cos(lat_rad))) / Math::PI) / 2.0 * n).to_i

  {:x => x, :y =>y}
end
```

Tile numbers to lon./lat.

```
def get_lat_lng_for_number(xtile, ytile, zoom)
  n = 2.0 ** zoom
  lon_deg = xtile / n * 360.0 - 180.0
  lat_rad = Math::atan(Math::sinh(Math::PI * (1 - 2 * ytile /
n)))
  lat_deg = 180.0 * (lat_rad / Math::PI)
  {:lat_deg => lat_deg, :lng_deg => lon_deg}
end
```

Same as the Python implementation above, this returns the NW-corner of the square. Use the function with xtile+1 and/or ytile+1 to get the other corners. With xtile+0.5 & ytile+0.5 it will return the center of the tile.

Perl

Lon./lat. to tile numbers

```
use Math::Trig;
sub getTileNumber {
  my ($lat,$lon,$zoom) = @_;
  my $xtile = int( ($lon+180)/360 * 2**$zoom ) ;
  my $ytile = int( (1 - log(tan(deg2rad($lat)) +
sec(deg2rad($lat)))/pi)/2 * 2**$zoom ) ;
  return ($xtile, $ytile);
}
```

Tile numbers to lon./lat.

```
use Math::Trig;
sub Project {
  my ($X,$Y, $Zoom) = @_;
  my $Unit = 1 / (2 ** $Zoom);
  my $relY1 = $Y * $Unit;
  my $relY2 = $relY1 + $Unit;

  # note: $LimitY = ProjectF(degrees(atan(sinh(pi)))) =
log(sinh(pi)+cosh(pi)) = pi
  # note: degrees(atan(sinh(pi))) = 85.051128..
  #my $LimitY = ProjectF(85.0511);

  # so stay simple and more accurate
  my $LimitY = pi;
  my $RangeY = 2 * $LimitY;
  $relY1 = $LimitY - $RangeY * $relY1;
  $relY2 = $LimitY - $RangeY * $relY2;
  my $Lat1 = ProjectMercToLat($relY1);
  my $Lat2 = ProjectMercToLat($relY2);
```

```
  $Unit = 360 / (2 ** $Zoom);
  my $Long1 = -180 + $X * $Unit;
  return ($Lat2, $Long1, $Lat1, $Long1 + $Unit); # S,W,N,E
}
sub ProjectMercToLat($){
  my $MercY = shift;
  return rad2deg(atan(sinh($MercY)));
}
sub ProjectF
{
  my $Lat = shift;
  $Lat = deg2rad($Lat);
  my $Y = log(tan($Lat) + sec($Lat));
  return $Y;
}
```

Lon./lat. to bbox

```
use Math::Trig;

sub getTileNumber {
    my ($lat,$lon,$zoom) = @_;
    my $xtile = int( ($lon+180)/360 * 2**$zoom ) ;
    my $ytile = int( (1 - log(tan(deg2rad($lat)) +
sec(deg2rad($lat)))/pi)/2 * 2**$zoom ) ;
    return ($xtile, $ytile);
}

sub getLonLat {
    my ($xtile, $ytile, $zoom) = @_;
    my $n = 2 ** $zoom;
    my $lon_deg = $xtile / $n * 360.0 - 180.0;
    my $lat_deg = rad2deg(atan(sinh(pi * (1 - 2 * $ytile /
$n))));
    return ($lon_deg, $lat_deg);
}

# convert from permalink OSM format like:
# https://www.openstreetmap.org/?
```

```
lat=43.7310499999999996&lon=15.79375&zoom=13&layers=M
# to OSM "Export" iframe embedded bbox format like:
# https://www.openstreetmap.org/export/embed.html?
bbox=15.7444,43.708,15.8431,43.7541&layer=mapnik

sub LonLat_to_bbox {
    my ($lat, $lon, $zoom) = @_;

    my $width = 425; my $height = 350;  # note: must modify this
to match your embed map width/height in pixels
    my $tile_size = 256;

    my ($xtile, $ytile) = getTileNumber ($lat, $lon, $zoom);

    my $xtile_s = ($xtile * $tile_size - $width/2) / $tile_size;
    my $ytile_s = ($ytile * $tile_size - $height/2) /
$tile_size;
    my $xtile_e = ($xtile * $tile_size + $width/2) / $tile_size;
    my $ytile_e = ($ytile * $tile_size + $height/2) /
$tile_size;

    my ($lon_s, $lat_s) = getLonLat($xtile_s, $ytile_s, $zoom);
    my ($lon_e, $lat_e) = getLonLat($xtile_e, $ytile_e, $zoom);

    my $bbox = "$lon_s,$lat_s,$lon_e,$lat_e";
    return $bbox;
}
```

PHP

Lon./lat. to tile numbers

```
$xtile = floor((($lon + 180) / 360) * pow(2, $zoom));
$ytile = floor((1 - log(tan(deg2rad($lat)) + 1 /
```

```
cos(deg2rad($lat))) / pi()) /2 * pow(2, $zoom));
```

Tile numbers to lon./lat.

```
$n = pow(2, $zoom);
$lon_deg = $xtile / $n * 360.0 - 180.0;
$lat_deg = rad2deg(atan(sinh(pi() * (1 - 2 * $ytile / $n))));
```

ColdFusion

Lon./lat. to tile numbers

CFScript syntax:

```
<cfscript>
    function longitude2tile(longitude, zoom) {
        return floor((longitude + 180) / 360 * (2 ^ zoom));
        }

    function latitude2tile(latitude, zoom) {
        return floor((1 - log(tan(latitude * pi() / 180) + 1 /
cos(latitude * pi() / 180)) / pi()) / 2 * (2 ^ zoom));
        }

    xtile = longitude2tile(longitude, zoom);
    ytile = latitude2tile(latitude, zoom);
</cfscript>
```

CFML syntax:

```
<cffunction name="longitude2tile" output="no"
returntype="numeric">
    <cfargument name="longitude" type="numeric" required="yes"
/>
    <cfargument name="zoom" type="numeric" required="yes" />
    <cfreturn floor((arguments.longitude + 180) / 360 * (2 ^
```

```
arguments.zoom)) />
</cffunction>

<cffunction name="latitude2tile" output="no"
returntype="numeric">
    <cfargument name="latitude" type="numeric" required="yes" />
    <cfargument name="zoom" type="numeric" required="yes" />
    <cfreturn floor((1 - log(tan(arguments.latitude * pi() /
180) + 1 / cos(arguments.latitude * pi() / 180)) / pi()) / 2 *
(2 ^ arguments.zoom)) />
</cffunction>

<cfset xtile = longitude2tile(longitude, zoom) />
<cfset ytile = latitude2tile(latitude, zoom) />
```

Tile numbers to lon./lat.

CFScript syntax:

```
<cfscript>
    function tile2longitude(xtile, zoom) {
        return (xtile / (2 ^ zoom) * 360 - 180);
        }

    function tile2latitude(ytile, zoom) {
        var n = pi() - 2 * pi() * ytile / (2 ^ zoom);
        return (180 / pi() * atn(0.5 * (exp(n) - exp(-n))));
        }

    longitude = tile2longitude(xtile, zoom);
    latitude = tile2latitude(ytile, zoom);
</cfscript>
```

CFML syntax:

```
<cffunction name="tile2longitude" output="no"
returntype="numeric">
    <cfargument name="xtile" type="numeric" required="yes" />
```

```
    <cfargument name="zoom" type="numeric" required="yes" />
    <cfreturn (arguments.xtile / (2 ^ arguments.zoom) * 360 -
180) />
</cffunction>

<cffunction name="tile2latitude" output="no"
returntype="numeric">
    <cfargument name="ytile" type="numeric" required="yes" />
    <cfargument name="zoom" type="numeric" required="yes" />
    <cfset var n = pi() - 2 * pi() * arguments.ytile / (2 ^
arguments.zoom) />
    <cfreturn (180 / pi() * atn(0.5 * (exp(n) - exp(-n)))) />
</cffunction>

<cfset longitude = tile2longitude(xtile, zoom) />
<cfset latitude = tile2latitude(ytile, zoom) />
```

ECMAScript (JavaScript/ActionScript, etc.)

```
 function lon2tile(lon,zoom) { return
(Math.floor((lon+180)/360*Math.pow(2,zoom))); }
 function lat2tile(lat,zoom)  { return (Math.floor((1-
Math.log(Math.tan(lat*Math.PI/180) +
1/Math.cos(lat*Math.PI/180))/Math.PI)/2 *Math.pow(2,zoom))); }
```

Inverse process:

```
 function tile2long(x,z) {
  return (x/Math.pow(2,z)*360-180);
 }
 function tile2lat(y,z) {
  var n=Math.PI-2*Math.PI*y/Math.pow(2,z);
  return (180/Math.PI*Math.atan(0.5*(Math.exp(n)-Math.exp(-
n))));
 }
```

Example for calculating number of tiles within given extent and zoom-level:

```
var zoom        = 9;
var top_tile    = lat2tile(north_edge, zoom); //
eg.lat2tile(34.422, 9);
var left_tile   = lon2tile(west_edge, zoom);
var bottom_tile = lat2tile(south_edge, zoom);
var right_tile  = lon2tile(east_edge, zoom);
var width       = Math.abs(left_tile - right_tile) + 1;
var height      = Math.abs(top_tile - bottom_tile) + 1;

// total tiles
var total_tiles = width * height; // -> eg. 377
```

Example: Tilesname WebCalc V1.0 (http://oms.wff.ch/calc.htm)

Lon./lat. to bbox

```
const EARTH_CIR_METERS = 40075016.686;
const degreesPerMeter = 360 / EARTH_CIR_METERS;

function toRadians(degrees) {
  return degrees * Math.PI / 180;
};

function latLngToBounds(lat, lng, zoom, width, height){ // width
and height must correspond to the iframe width/height
  const metersPerPixelEW = EARTH_CIR_METERS / Math.pow(2, zoom +
8);
  const metersPerPixelNS = EARTH_CIR_METERS / Math.pow(2, zoom +
8) * Math.cos(toRadians(lat));

  const shiftMetersEW = width/2 * metersPerPixelEW;
  const shiftMetersNS = height/2 * metersPerPixelNS;

  const shiftDegreesEW = shiftMetersEW * degreesPerMeter;
  const shiftDegreesNS = shiftMetersNS * degreesPerMeter;
```

```
  return {
    south: lat-shiftDegreesNS,
    west: lng-shiftDegreesEW,
    north: lat+shiftDegreesNS,
    east: lng+shiftDegreesEW
  }
}

// Usage Example: create the src attribute for Open Street Map:
const bb = latLngToBounds(latitude,longitude,zoom,width,height);
// e.g. latLngToBounds(47,12,16,450,350)

const src = [
  "https://www.openstreetmap.org/export/embed.html?bbox=",
  bb.west,
  ",",
  bb.south,
  ",",
  bb.east,
  ",",
  bb.north,
  "&layer=mapnik&marker=",
  latitude,
  ",",
  longitude,
].join('');
```

C/C++

```
int long2tilex(double lon, int z)
{
    return (int)(floor((lon + 180.0) / 360.0 * (1 << z)));
}

int lat2tiley(double lat, int z)
{
    double latrad = lat * M_PI/180.0;
```

```
    return (int)(floor((1.0 - asinh(tan(latrad)) / M_PI) / 2.0 *
(1 << z)));
}

double tilex2long(int x, int z)
{
    return x / (double)(1 << z) * 360.0 - 180;
}

double tiley2lat(int y, int z)
{
    double n = M_PI - 2.0 * M_PI * y / (double)(1 << z);
    return 180.0 / M_PI * atan(0.5 * (exp(n) - exp(-n)));
}
```

C#

```
int long2tilex(double lon, int z)
{
    return (int)(Math.Floor((lon + 180.0) / 360.0 * (1 << z)));
}

int lat2tiley(double lat, int z)
{
    return (int)Math.Floor((1 -
Math.Log(Math.Tan(ToRadians(lat)) + 1 /
Math.Cos(ToRadians(lat))) / Math.PI) / 2 * (1 << z));
}

double tilex2long(int x, int z)
{
    return x / (double)(1 << z) * 360.0 - 180;
}

double tiley2lat(int y, int z)
{
    double n = Math.PI - 2.0 * Math.PI * y / (double)(1 << z);
    return 180.0 / Math.PI * Math.Atan(0.5 * (Math.Exp(n) -
```

```
Math.Exp(-n)));
}
```

Go

Example(Deg2num had changed below.) : [1] (https://github.com/j4/gosm) Doc : [2] (https://godoc.org/github.com/j4/gosm)

```
import (
    "math"
)

type Tile struct {
    Z    int
    X    int
    Y    int
    Lat  float64
    Long float64
}

type Conversion interface {
    deg2num(t *Tile) (x int, y int)
    num2deg(t *Tile) (lat float64, long float64)
}

func (*Tile) Deg2num(t *Tile) (x int, y int) {
    n := math.Exp2(float64(z))
    x = int(math.Floor((lon + 180.0) / 360.0 * n))
    if float64(x) >= n {
        x = int(n - 1)
    }
    y = int(math.Floor((1.0 -
math.Log(math.Tan(lat*math.Pi/180.0)+1.0/math.Cos(lat*math.Pi/18
0.0))/math.Pi) / 2.0 * n))
    return
}

func (*Tile) Num2deg(t *Tile) (lat float64, long float64) {
    n := math.Pi -
```

```
2.0*math.Pi*float64(t.Y)/math.Exp2(float64(t.Z))
    lat = 180.0 / math.Pi * math.Atan(0.5*(math.Exp(n)-
math.Exp(-n)))
    long = float64(t.X)/math.Exp2(float64(t.Z))*360.0 - 180.0
    return lat, long
}
```

Java

```
 public class slippytest {
 public static void main(String[] args) {
   int zoom = 10;
   double lat = 47.968056d;
   double lon = 7.909167d;
   System.out.println("https://tile.openstreetmap.org/" +
getTileNumber(lat, lon, zoom) + ".png");
 }
 public static String getTileNumber(final double lat, final
double lon, final int zoom) {
   int xtile = (int)Math.floor( (lon + 180) / 360 * (1<<zoom) )
;
   int ytile = (int)Math.floor( (1 -
Math.log(Math.tan(Math.toRadians(lat)) + 1 /
Math.cos(Math.toRadians(lat))) / Math.PI) / 2 * (1<<zoom) ) ;
    if (xtile < 0)
     xtile=0;
    if (xtile >= (1<<zoom))
     xtile=((1<<zoom)-1);
    if (ytile < 0)
     ytile=0;
    if (ytile >= (1<<zoom))
     ytile=((1<<zoom)-1);
    return("" + zoom + "/" + xtile + "/" + ytile);
```

```
    }
  }
```

Tile bounding box

```
  class BoundingBox {
    double north;
    double south;
    double east;
    double west;
  }
  BoundingBox tile2boundingBox(final int x, final int y, final
int zoom) {
    BoundingBox bb = new BoundingBox();
    bb.north = tile2lat(y, zoom);
    bb.south = tile2lat(y + 1, zoom);
    bb.west = tile2lon(x, zoom);
    bb.east = tile2lon(x + 1, zoom);
    return bb;
  }

  static double tile2lon(int x, int z) {
     return x / Math.pow(2.0, z) * 360.0 - 180;
  }

  static double tile2lat(int y, int z) {
    double n = Math.PI - (2.0 * Math.PI * y) / Math.pow(2.0, z);
    return Math.toDegrees(Math.atan(Math.sinh(n)));
  }
```

Kotlin

```
import kotlin.math.*

fun getXYTile(lat : Double, lon: Double, zoom : Int) : Pair<Int,
Int> {
        val latRad = Math.toRadians(lat)
```

```
        var xtile = floor( (lon + 180) / 360 * (1 shl zoom)
).toInt()
        var ytile = floor( (1.0 - asinh(tan(latRad)) / PI) / 2 *
(1 shl zoom) ).toInt()

        if (xtile < 0) {
            xtile = 0
        }
        if (xtile >= (1 shl zoom)) {
            xtile= (1 shl zoom) - 1
        }
        if (ytile < 0) {
            ytile = 0
        }
        if (ytile >= (1 shl zoom)) {
            ytile = (1 shl zoom) - 1
        }

        return Pair(xtile, ytile)
}
```

VB.Net

```
Private Function CalcTileXY(ByVal lat As Single, ByVal lon As
Single, ByVal zoom As Long) As Point
   CalcTileXY.X  = CLng(Math.Floor((lon + 180) / 360 * 2 ^
zoom))
   CalcTileXY.Y = CLng(Math.Floor((1 - Math.Log(Math.Tan(lat *
Math.PI / 180) + 1 / Math.Cos(lat * Math.PI / 180)) / Math.PI) /
```

```
2 * 2 ^ zoom))
End Function
```

C#

```
public PointF WorldToTilePos(double lon, double lat, int zoom)
{
    PointF p = new Point();
    p.X = (float)((lon + 180.0) / 360.0 * (1 << zoom));
    p.Y = (float)((1.0 - Math.Log(Math.Tan(lat * Math.PI /
180.0) +
        1.0 / Math.Cos(lat * Math.PI / 180.0)) / Math.PI) / 2.0
* (1 << zoom));

    return p;
}

public PointF TileToWorldPos(double tile_x, double tile_y, int
zoom)
{
    PointF p = new Point();
    double n = Math.PI - ((2.0 * Math.PI * tile_y) /
Math.Pow(2.0, zoom));

    p.X = (float)((tile_x / Math.Pow(2.0, zoom) * 360.0) -
180.0);
    p.Y = (float)(180.0 / Math.PI * Math.Atan(Math.Sinh(n)));

    return p;
}
```

XSLT

Requires math extensions from exslt.org.

```
<xsl:transform
 xmlns:xsl="http://www.w3.org/1999/XSL/Transform"
 xmlns:m="http://exslt.org/math"
 extension-element-prefixes="m"
 version="1.0">

 <xsl:output method="text"/>
 <xsl:variable name="pi" select="3.14159265358979323846"/>

 <xsl:template name="tiley">
    <xsl:param name="lat"/>
    <xsl:param name="zoomfact"/>
    <xsl:variable name="a" select="($lat * $pi) div 180.0"/>
    <xsl:variable name="b" select="m:log(m:tan($a) + (1.0 div
m:cos($a)))"/>
    <xsl:variable name="c" select="(1.0 - ($b div $pi)) div
2.0"/>
    <xsl:value-of select="floor($c * $zoomfact)"/>
 </xsl:template>

 <xsl:template name="tilename">
    <xsl:param name="lat"/>
    <xsl:param name="lon"/>
    <xsl:param name="zoom" select="10"/>
    <xsl:variable name="zoomfact" select="m:power(2,$zoom)"/>
    <xsl:variable name="x" select="floor((360.0 + ($lon * 2)) *
$zoomfact div 720.0)"/>
    <xsl:variable name="y">
        <xsl:call-template name="tiley">
            <xsl:with-param name="lat" select="$lat"/>
            <xsl:with-param name="zoomfact" select="$zoomfact"/>
        </xsl:call-template>
    </xsl:variable>
    <xsl:value-of select="concat($zoom,'/',$x,'/',$y)"/>
 </xsl:template>

 <xsl:template match="/">
    <xsl:call-template name="tilename">
        <xsl:with-param name="lat" select="49.867731999999997"/>
```

```
        <xsl:with-param name="lon" select="8.6295369999999991"/>
        <xsl:with-param name="zoom" select="14"/>
    </xsl:call-template>
 </xsl:template>
</xsl:transform>
```

Haskell

```
-- https://github.com/apeyroux/HSlippyMap

long2tilex lon z = floor((lon + 180.0) / 360.0 * (2.0 ** z))

lat2tiley lat z = floor((1.0 - log( tan(lat * pi/180.0) + 1.0 /
cos(lat * pi/180.0)) / pi) / 2.0 * (2.0 ** z))

tilex2long x z = x / (2.0 ** z) * 360.0 - 180

tiley2lat y z = 180.0 / pi * atan(0.5 * (exp(n) - exp(-n)))
        where
                n = pi - 2.0 * pi * y / (2.0 ** z)

-- Example
main = do
        --print $ long2tilex 2.2712 17
        --print $ lat2tiley 48.8152 17
        --print $ tilex2long 66362 17
        --print $ tiley2lat 45115 17
        putStrLn "gps: (lat=48.8152,long=2.2712)"
        putStrLn $ "https://tile.openstreetmap.org/17/" ++ show
x ++ "/" ++ show y ++ ".png"
        where
                z = 17
```

```
                    x = long2tilex 2.2712 z
                    y = lat2tiley 48.8152 z
```

Scala

```
import scala.math._

case class Tile(x: Int,y: Int, z: Short){
  def toLatLon = new LatLonPoint(
    toDegrees(atan(sinh(Pi * (1.0 - 2.0 * y.toDouble /
(1<<z))))),
    x.toDouble / (1<<z) * 360.0 - 180.0,
    z)
  def toURI = new
java.net.URI("https://tile.openstreetmap.org/"+z+"/"+x+"/"+y+".p
ng")
}

case class LatLonPoint(lat: Double, lon: Double, z: Short){
  def toTile = new Tile(
    ((lon + 180.0) / 360.0 * (1<<z)).toInt,
    ((1 - log(tan(toRadians(lat)) + 1 / cos(toRadians(lat))) /
Pi) / 2.0 * (1<<z)).toInt,
    z)
}

//Usage:
val point = LatLonPoint(51.51202,0.02435,17)
val tile = point.toTile
// ==> Tile(65544,43582,17)
val uri = tile.toURI
// ==> https://tile.openstreetmap.org/17/65544/43582.png
```

Revolution/Transcript

```
function osmTileRef iLat, iLong, iZoom --> part path
```

```
   local n, xTile, yTile
   put (2 ^ iZoom) into n
   put (iLong + 180) / 360 * n into xTile
   multiply iLat by (pi / 180) -- convert to radians
   put ((1 - ln(tan(iLat) + 1 / cos(iLat)) / pi) / 2) * n into
yTile
   return "/" & iZoom & "/" & trunc(xTile) & "/" & trunc(yTile)
end osmTileRef

function osmTileCoords xTile, yTile, iZoom --> coordinates
   local twoPzoom, iLong, iLat, n
   put (2 ^ iZoom) into twoPzoom
   put xTile / twoPzoom * 360 - 180 into iLong
   put pi - 2 * pi * yTile / twoPzoom into n
   put "n1=" && n
   put 180 / pi * atan(0.5 * (exp(n) - exp(-n))) into iLat
   return iLat & comma & iLong
end osmTileCoords
```

Mathematica / Wolfram Language

```
Deg2Num[lat_, lon_, zoom_] :=
 {IntegerPart[(2^(-3 + zoom)*(180 + lon))/45], IntegerPart[2^(-1
+ zoom)*(1 - Log[Sec[Degree*lat] + Tan[Degree*lat]]/Pi)]}
```

```
Num2Deg[xtile_,ytile_,zoom_] :=
 {ArcTan[Sinh[Pi*(1 - 2*(ytile/2^zoom))]]/Degree,
(xtile/2^zoom)*360 - 180} // N
```

Tcl

First of all, you need to use the package `map::slippy` from Tcllib:

```
package require map::slippy
```

Lat./lon. to tile number

```
map::slippy geo 2tile [list $zoom $lat $lon]
```

Tile number to lat/lon

```
map::slippy tile 2geo [list $zoom $row $col]
```

Pascal

(translated from the Pythoncode above to Pascal)

Coordinates to tile numbers

```
uses {...}, Math;
{...}
var
  zoom: Integer;
  lat_rad, lat_deg, lon_deg, n: Real;
begin
  lat_rad := DegToRad(lat_deg);
  n := Power(2, zoom);
  xtile := Trunc(((lon_deg + 180) / 360) * n);
  ytile := Trunc((1 - (ln(Tan(lat_rad) + (1 /Cos(lat_rad))) /
Pi)) / 2 * n);
end;
```

Tile numbers to coordinates

```
uses {...}, Math;
{...}
```

```
var
  lat_rad, n: Real;
begin
  n := Power(2, zoom);
  lat_rad := Arctan (Sinh (Pi * (1 - 2 * ytile / n)));
  lat_deg := RadtoDeg (lat_rad);
  lon_deg := xtile / n * 360.0 - 180.0;
end;
```

R

Coordinates to tile numbers

```
deg2num<-function(lat_deg, lon_deg, zoom){
  lat_rad <- lat_deg * pi /180
  n <- 2.0 ^ zoom
  xtile <- floor((lon_deg + 180.0) / 360.0 * n)
  ytile = floor((1.0 - log(tan(lat_rad) + (1 / cos(lat_rad))) /
pi) / 2.0 * n)
  return( c(xtile, ytile))
#  return(paste(paste("https://a.tile.openstreetmap.org", zoom,
xtile, ytile, sep="/"),".png",sep=""))
}

# Returns data frame containing detailed info for all zooms
deg2num.all<-function(lat_deg, lon_deg){
  nums <- as.data.frame(matrix(ncol=6,nrow=21))
  colnames(nums) <- c('zoom', 'x', 'y', 'mapquest_osm',
'mapquest_aerial', 'osm')
  rownames(nums) <- 0:20
  for (zoom in 0:20) {
    num <- deg2num(lat_deg, lon_deg, zoom)
    nums[1+zoom,'zoom'] <- zoom
    nums[1+zoom,'x'] <- num[1]
    nums[1+zoom,'y'] <- num[2]
    nums[1+zoom,'mapquest_osm'] <-
paste('http://otile1.mqcdn.com/tiles/1.0.0/map/', zoom, '/',
num[1], '/', num[2], '.jpg', sep='')
```

```
    nums[1+zoom,'mapquest_aerial'] <-
paste('http://otile1.mqcdn.com/tiles/1.0.0/sat/', zoom, '/',
num[1], '/', num[2], '.jpg', sep='')
    nums[1+zoom,'osm'] <-
paste('https://a.tile.openstreetmap.org/', zoom, '/', num[1],
'/', num[2], '.png', sep='')
  }
  return(nums)
}
```

Bourne shell with Awk

Tile numbers to lat./lon. / Coordinates to tile numbers / Sample of usage, with optional tms-format support

```
xtile2long()
{
 xtile=$1
 zoom=$2
 echo "${xtile} ${zoom}" | awk '{printf("%.9f", $1 / 2.0^$2 *
360.0 - 180)}'
}

long2xtile()
{
 long=$1
 zoom=$2
 echo "${long} ${zoom}" | awk '{ xtile = ($1 + 180.0) / 360 *
2.0^$2;
  xtile+=xtile<0?-0.5:0.5;
  printf("%d", xtile ) }'
}

ytile2lat()
{
 ytile=$1;
 zoom=$2;
 tms=$3;
```

```
 if [ ! -z "${tms}" ]
 then
 #  from tms_numbering into osm_numbering
  ytile=`echo "${ytile}" ${zoom} | awk '{printf("%d\n",
((2.0^$2)-1)-$1)}'`;
 fi
 lat=`echo "${ytile} ${zoom}" | awk -v PI=3.14159265358979323846
'{
       num_tiles = PI - 2.0 * PI * $1 / 2.0^$2;
       printf("%.9f", 180.0 / PI * atan2(0.5 * (exp(num_tiles) -
exp(-num_tiles)),1)); }'`;
 echo "${lat}";
}

lat2ytile()
{
 lat=$1;
 zoom=$2;
 tms=$3;
 ytile=`echo "${lat} ${zoom}" | awk -v PI=3.14159265358979323846
'{
   tan_x=sin($1 * PI / 180.0)/cos($1 * PI / 180.0);
   ytile = (1 - log(tan_x + 1/cos($1 * PI/ 180))/PI)/2 * 2.0^$2;
   ytile+=ytile<0?-0.5:0.5;
   printf("%d", ytile ) }'`;
 if [ ! -z "${tms}" ]
 then
  #  from oms_numbering into tms_numbering
  ytile=`echo "${ytile}" ${zoom} | awk '{printf("%d\n",
((2.0^$2)-1)-$1)}'`;
 fi
 echo "${ytile}";
}
# ---------------------------------
# Sample of use:
# Position Brandenburg Gate, Berlin
# ---------------------------------
LONG=13.37771496361961;
LAT=52.51628011262304;
ZOOM=17;
```

```
TILE_X=70406;
TILE_Y=42987;
TILE_Y_TMS=88084;
TMS=""; # when NOT empty: tms format assumed
# ------------------------------------
# assume input/output of y is in oms-format:
LONG=$( xtile2long ${TILE_X} ${ZOOM} );
LAT=$( ytile2lat ${TILE_Y} ${ZOOM} ${TMS} );
# Result should be longitude[13.375854492]
latitude[52.517892228]
TILE_X=$( long2xtile ${LONG} ${ZOOM} );
TILE_Y=$( lat2ytile ${LAT} ${ZOOM} ${TMS} );
# Result should be x[70406] y_oms[42987]
# ------------------------------------
# assume input/output of y is in tms-format:
TMS="tms";
TILE_Y_TMS=$( lat2ytile ${LAT} ${ZOOM} ${TMS} );
LAT_TMS=$( ytile2lat ${TILE_Y_TMS} ${ZOOM} ${TMS} );
echo "Result should be y_oms[${TILE_Y}] latitude[${LAT}] ;
y_tms[${TILE_Y_TMS}] latitude_tms[${LAT_TMS}] "
# latitude and latitude_tms should have the same value ; y_oms
and y_tms should have the given start values:
# Result should be y_oms[42987] latitude[52.517892228] ;
y_tms[88084] latitude_tms[52.517892228]
# ------------------------------------
```

Tile bounding box and center

```
n=$(ytile2lat `expr ${TILE_Y}` ${ZOOM})
s=$(ytile2lat `expr ${TILE_Y} + 1` ${ZOOM})
e=$(xtile2long `expr ${TILE_X} + 1` ${ZOOM})
w=$(xtile2long `expr ${TILE_X}` ${ZOOM})

echo "bbox=$w,$s,$e,$n"
echo "-I-> Result should be
[bbox=13.375854492,52.516220864,13.378601074,52.517892228]";

center_lat=`echo "$s $n" | awk '{printf("%.8f", ($1 + $2) /
2.0)}'`
```

```
center_lon=`echo "$w $e" | awk '{printf("%.8f", ($1 + $2) /
2.0)}'`

echo "center=$center_lat,$center_lon"
echo "-I-> Result should be [center=52.51705655,13.37722778]";
```

Octave

Lon./lat. to tile numbers

```
% convert the degrees to radians
rho = pi/180;
lon_rad = lon_deg * rho;
lat_rad = lat_deg * rho;

n = 2 ^ zoom
xtile = n * ((lon_deg + 180) / 360)
ytile = n * (1 - (log(tan(lat_rad) + sec(lat_rad)) / pi)) / 2
```

Tile numbers to lon./lat.

```
n=2^zoom
lon_deg = xtile / n * 360.0 - 180.0
lat_rad = arctan(sinh(pi * (1 - 2 * ytile / n)))
lat_deg = lat_rad * 180.0 / pi
```

Emacs-lisp

```
(defun longitude2tile (lon zoom) (* (expt 2 zoom) (/ (+ lon 180)
360)))

(defun tile2longitude (x zoom) (- (/ (* x 360) (expt 2 zoom))
180))
```

```
(defun latitude2tile (lat zoom) (* (expt 2 zoom) (/ (- 1 (/ (log
(+ (tan (/ (* lat pi) 180)) (/ 1 (cos (/ (* lat pi) 180)))))
pi)) 2)))

(defun sinh (value) (/ (- (exp value) (exp (- value))) 2))
(defun tile2latitude (y zoom) (/ (* 180 (atan (sinh (* pi (- 1
(* 2 (/ y (expt 2 zoom))))))))) pi))
```

Erlang

```
-module(slippymap).
-export([deg2num/3]).
-export([num2deg/3]).

deg2num(Lat,Lon,Zoom)->
    X=math:pow(2, Zoom) * ((Lon + 180) / 360),
    Sec=1/math:cos(deg2rad(Lat)),
    R = math:log(math:tan(deg2rad(Lat)) + Sec)/math:pi(),
    Y=math:pow(2, Zoom) * (1 - R) / 2,
    {round(X),round(Y)}.

num2deg(X,Y,Zoom)->
    N=math:pow(2, Zoom),
    Lon=X/N*360-180,
    Lat_rad=math:atan(math:sinh(math:pi()*(1-2*Y/N))),
    Lat=Lat_rad*180/math:pi(),
    {Lon,Lat}.

deg2rad(C)->
    C*math:pi()/180.
```

Lua

```
function deg2num(lon, lat, zoom)
    local n = 2 ^ zoom
    local lon_deg = tonumber(lon)
```

```
    local lat_rad = math.rad(lat)
    local xtile = math.floor(n * ((lon_deg + 180) / 360))
    local ytile = math.floor(n * (1 -
(math.log(math.tan(lat_rad) + (1 / math.cos(lat_rad))) /
math.pi)) / 2)
    return xtile, ytile
end

function num2deg(x, y, z)
    local n = 2 ^ z
    local lon_deg = x / n * 360.0 - 180.0
    local lat_rad = math.atan(math.sinh(math.pi * (1 - 2 * y /
n)))
    local lat_deg = lat_rad * 180.0 / math.pi
    return lon_deg, lat_deg
end
```

PostgreSQL

```
CREATE OR REPLACE FUNCTION lon2tile(lon DOUBLE PRECISION, zoom
INTEGER)
  RETURNS INTEGER AS
$BODY$
    SELECT FLOOR( (lon + 180) / 360 * (1 << zoom) )::INTEGER;
$BODY$
  LANGUAGE SQL IMMUTABLE;

CREATE OR REPLACE FUNCTION lat2tile(lat double precision, zoom
integer)
  RETURNS integer AS
$BODY$
    SELECT floor( (1.0 - ln(tan(radians(lat)) + 1.0 /
cos(radians(lat))) / pi()) / 2.0 * (1 << zoom) )::integer;
$BODY$
  LANGUAGE sql IMMUTABLE;

CREATE OR REPLACE FUNCTION tile2lat(y integer, zoom integer)
  RETURNS double precision AS
```

```
$BODY$
DECLARE
 n float;
 sinh float;
 E float = 2.7182818284;
BEGIN
    n = pi() - (2.0 * pi() * y) / power(2.0, zoom);
    sinh = (1 - power(E, -2*n)) / (2 * power(E, -n));
    return degrees(atan(sinh));
END;
$BODY$
  LANGUAGE plpgsql IMMUTABLE;


CREATE OR REPLACE FUNCTION tile2lon(x integer, zoom integer)
  RETURNS double precision AS
$BODY$
 SELECT CAST(x * 1.0 / (1 << zoom) * 360.0 - 180.0 AS double
precision);
$BODY$
  LANGUAGE sql IMMUTABLE;
```

Objective-C

```
+(NSString*) transformWorldCoordinateToTilePathForZoom:(int)zoom
fromLon:(double) lon  fromLat:(double) lat
{
    int tileX = (int)(floor((lon + 180.0) / 360.0 * pow(2.0,
zoom)));
    int tileY = (int)(floor((1.0 - log( tan(lat * M_PI/180.0) +
1.0 / cos(lat * M_PI/180.0)) / M_PI) / 2.0 * pow(2.0, zoom)));
    NSString * path = [NSString
stringWithFormat:@"%d/%d/%d",zoom,tileX,tileY];
```

```
    return path;
}
```

Swift

```
func tranformCoordinate(_ latitude: Double, _ longitude: Double,
withZoom zoom: Int) -> (x: Int, y: Int) {
    let tileX = Int(floor((longitude + 180) / 360.0 * pow(2.0,
Double(zoom))))
    let tileY = Int(floor((1 - log( tan( latitude * Double.pi /
180.0 ) + 1 / cos( latitude * Double.pi / 180.0 )) / Double.pi )
/ 2 * pow(2.0, Double(zoom))))

    return (tileX, tileY)
}
```

```
    func tileToLatLon(tileX : Int, tileY : Int, mapZoom: Int) ->
(lat_deg : Double, lon_deg : Double) {
        let n : Double = pow(2.0, Double(mapZoom))
        let lon = (Double(tileX) / n) * 360.0 - 180.0
        let lat = atan( sinh (.pi - (Double(tileY) / n) * 2 *
Double.pi)) * (180.0 / .pi)

        return (lat, lon)
    }
```

Clojure

```
(defn tile [lat lon zoom]
  (let [zoom-shifted (bit-shift-left 1 zoom)
        lat-radians (Math/toRadians lat)
        xtile (int (Math/floor (* (/ (+ 180 lon) 360) zoom-
shifted)))
        ytile (int (Math/floor (* (/ (- 1
                                        (/
```

```
                                                (Math/log (+ (Math/tan
lat-radians)
                                                          (/ 1
(Math/cos lat-radians))))
                                                   Math/PI))
                                              2)
                                           zoom-shifted)))]
    (str zoom
         "/"
         (cond (< xtile 0) 0
               (>= xtile zoom-shifted) (- zoom-shifted 1)
               :else xtile)
         "/"
         (cond (< ytile 0) 0
               (>= ytile zoom-shifted) (- zoom-shifted 1)
               :else ytile))))
```

Julia

```
lng2tile(lng, zoom) = floor((lng+180)/360*2^zoom)
lat2tile(lat, zoom) = floor((1-
log(tan(lat*pi/180)+1/cos(lat*pi/180))/pi)/2*2^zoom)
```

```
tile2lng(x, z) = (x/2^z*360)-180
tile2lat(y, z) = 180/pi*atan(0.5*(exp(pi-2*pi*y/2^z)-
exp(2*pi*y/2^z-pi)))
```

Subtiles

If you're looking at tile *x*,*y* and want to zoom in, the subtiles are (in the next zoom-level's coordinate system):

2x, 2y	2x + 1, 2y

2x, 2y + 1	2x + 1, 2y + 1

Similarly, zoom out by halving *x* and *y* (in the previous zoom level)

Resolution and Scale

Exact length of the equator (according to Wikipedia) is 40075.016686 km in WGS-84. At zoom 0, one pixel would equal 156543.03 meters (assuming a tile size of 256 px):

```
40075.016686 * 1000 / 256 ≈ 6378137.0 * 2 * pi / 256 ≈ 156543.03
```

Which gives us a formula to calculate resolution at any given zoom:

```
resolution = 156543.03 meters/pixel * cos(latitude) / (2 ^
zoomlevel)
```

Some applications need to know a map scale, that is, how 1 cm on a screen translates to 1 cm of a map.

```
scale = 1 : (screen_dpi * 1/0.0254 in/m * resolution)
```

And here is the table to rid you of those calculations. All values are shown for equator, and you have to multiply them by `cos(latitude)` to adjust to a given latitude. For example, divide those by 2 for latitude 60 (Oslo, Helsinki, Saint-Petersburg).

zoom	resolution, m/px	scale 90 dpi	1 screen cm is	scale 96 dpi	scale 120 dpi
0	156543.03	1 : 554 680 041	5547 km	1 : 591 658 711	1 : 739 573 389
1	78271.52	1 : 277 340 021	2773 km	1 : 295 829 355	1 : 369 786 694
2	39135.76	1 : 138 670 010	1387 km	1 : 147 914 678	1 : 184 893 347
3	19567.88	1 : 69 335 005	693 km	1 : 73 957 339	1 : 92 446 674
4	9783.94	1 : 34 667 503	347 km	1 : 36 978 669	1 : 46 223 337
5	4891.97	1 : 17 333 751	173 km	1 : 18 489 335	1 : 23 111 668
6	2445.98	1 : 8 666 876	86.7 km	1 : 9 244 667	1 : 11 555 834
7	1222.99	1 : 4 333 438	43.3 km	1 : 4 622 334	1 : 5 777 917
8	611.50	1 : 2 166 719	21.7 km	1 : 2 311 167	1 : 2 888 959
9	305.75	1 : 1 083 359	10.8 km	1 : 1 155 583	1 : 1 444 479
10	152.87	1 : 541 680	5.4 km	1 : 577 792	1 : 722 240
11	76.437	1 : 270 840	2.7 km	1 : 288 896	1 : 361 120
12	38.219	1 : 135 420	1.35 km	1 : 144 448	1 : 180 560
13	19.109	1 : 67 710	677 m	1 : 72 224	1 : 90 280
14	9.5546	1 : 33 855	339 m	1 : 36 112	1 : 45 140
15	4.7773	1 : 16 927	169 m	1 : 18 056	1 : 22 570
16	2.3887	1 : 8 464	84.6 m	1 : 9 028	1 : 11 285
17	1.1943	1 : 4 232	42.3 m	1 : 4 514	1 : 5 642
18	0.5972	1 : 2 116	21.2 m	1 : 2 257	1 : 2 821

See also Zoom levels

Tools

- Javascript Example: Tilesname WebCalc V1.0 (http://oms.wff.ch/calc.htm)
- Geo-OSM-Tiles: a Perl module that calculates tile numbers along with a script that downloads map tiles (http://search.cpan.org/dist/Geo-OSM-Tiles/)
- Kachelbrowser (http://www.netzwolf.info/kartografie/osm/tilebrowser?lat=51.157800&lon=6.865500&zoom=14)
- File:Lat lon.odt feuille de calcul openoffice (sheet)
- Geofabrik map (http://tools.geofabrik.de/map/#2/29.1466/31.9609&type=Geofabrik_Standard&grid=1) showing tile grid and coordinates on the map
- Same as above plus Tiles preview and direct link to Bigmap (http://oms.wff.ch/calc.php?baseurl=cylce&lat=47.629000&long=7.262000&longto=7.906000&latto=47.354000)

References

- http://code.google.com/apis/maps/documentation/overlays.html#Google_Maps_Coordinates
- http://cfis.savagexi.com/articles/2006/05/03/google-maps-deconstructed
- "Google Map" projection, see Spatialreference.org [3] (http://www.spatialreference.org/ref/user/6/)

- OSM mailing list (https://lists.openstreetmap.org/pipermail/dev/2008-May/010385.html) refering to this page.
- Setting up TMS
- TMS specification (http://wiki.osgeo.org/wiki/Tile_Map_Service_Specification) from the OSGeo Foundation (http://www.osgeo.org)

(**note**: *Slippy tiles and Google map tiles count tile 0,0 down from the top-left of the tile grid; the TMS spec specifies tiles count up from 0,0 in the lower-left!*)
