

On-Device, Open Source Mobile Vector Rendering of OpenStreetMap

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Introduction

- Mobile lead at Mapbox
- Live & work here in Portland
- Working on mobile tools & strategy



Mapbox

- Building open source tools for custom map design and development ()
- Cloud hosting of custom maps for apps and websites ()
- ~100 folks worldwide ()

Mapbox GL

- Our name for on-device vector rendering
- As always, completely open source
- GPU accelerated (think: game tech to new ends)

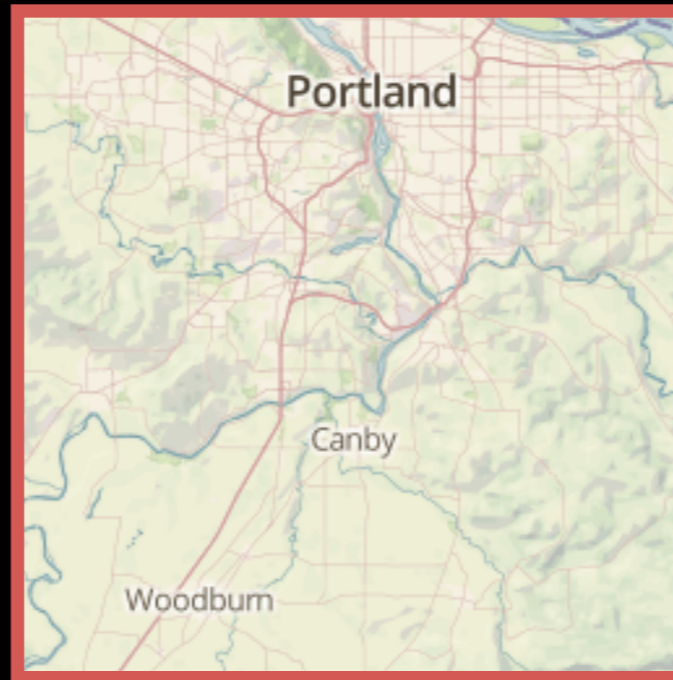


Demos

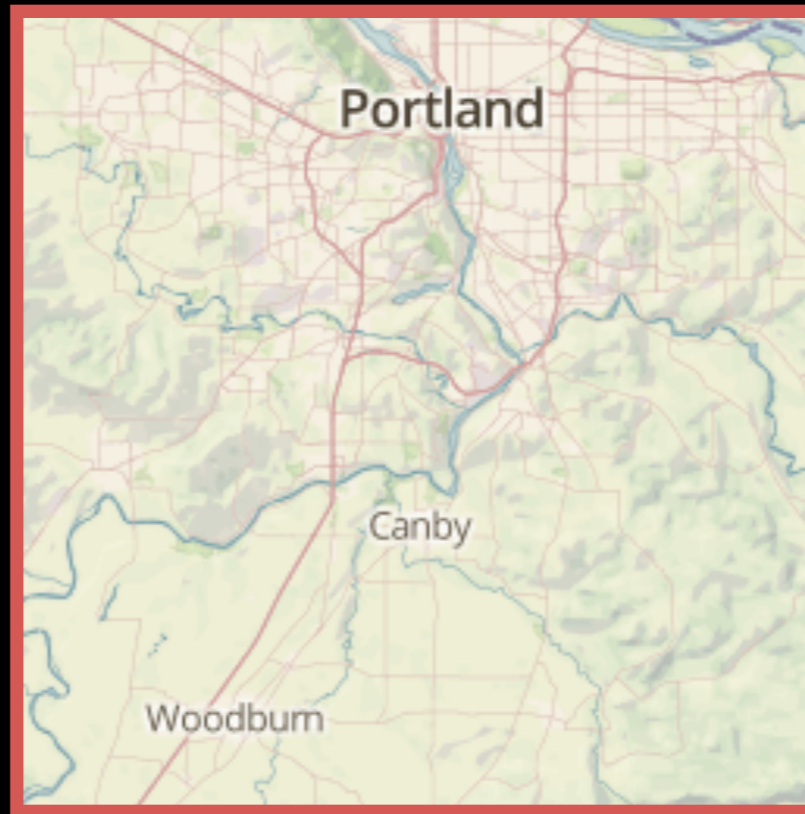
Raster Tiles: Zoom



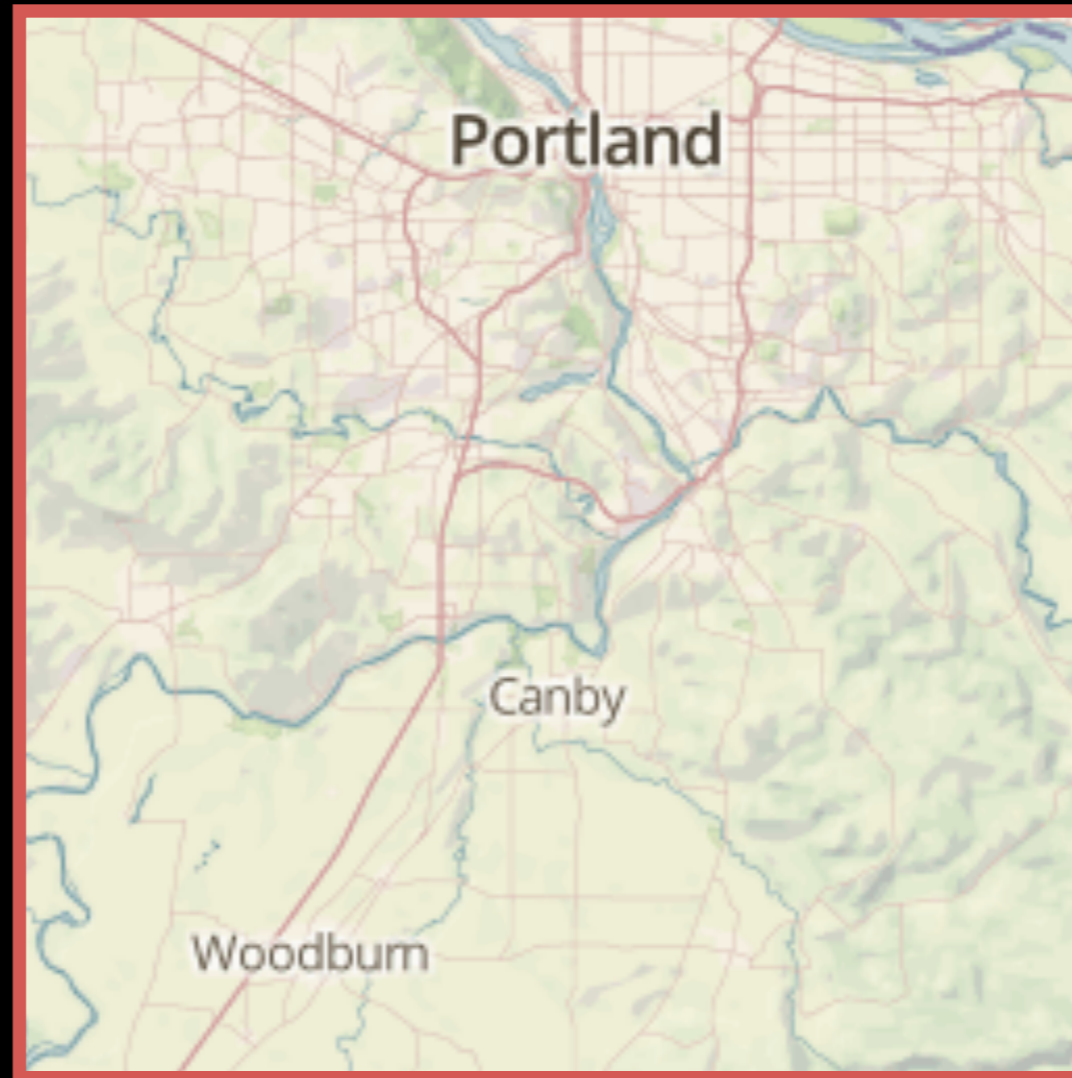
Raster Tiles: Zoom



Raster Tiles: Zoom



Raster Tiles: Zoom



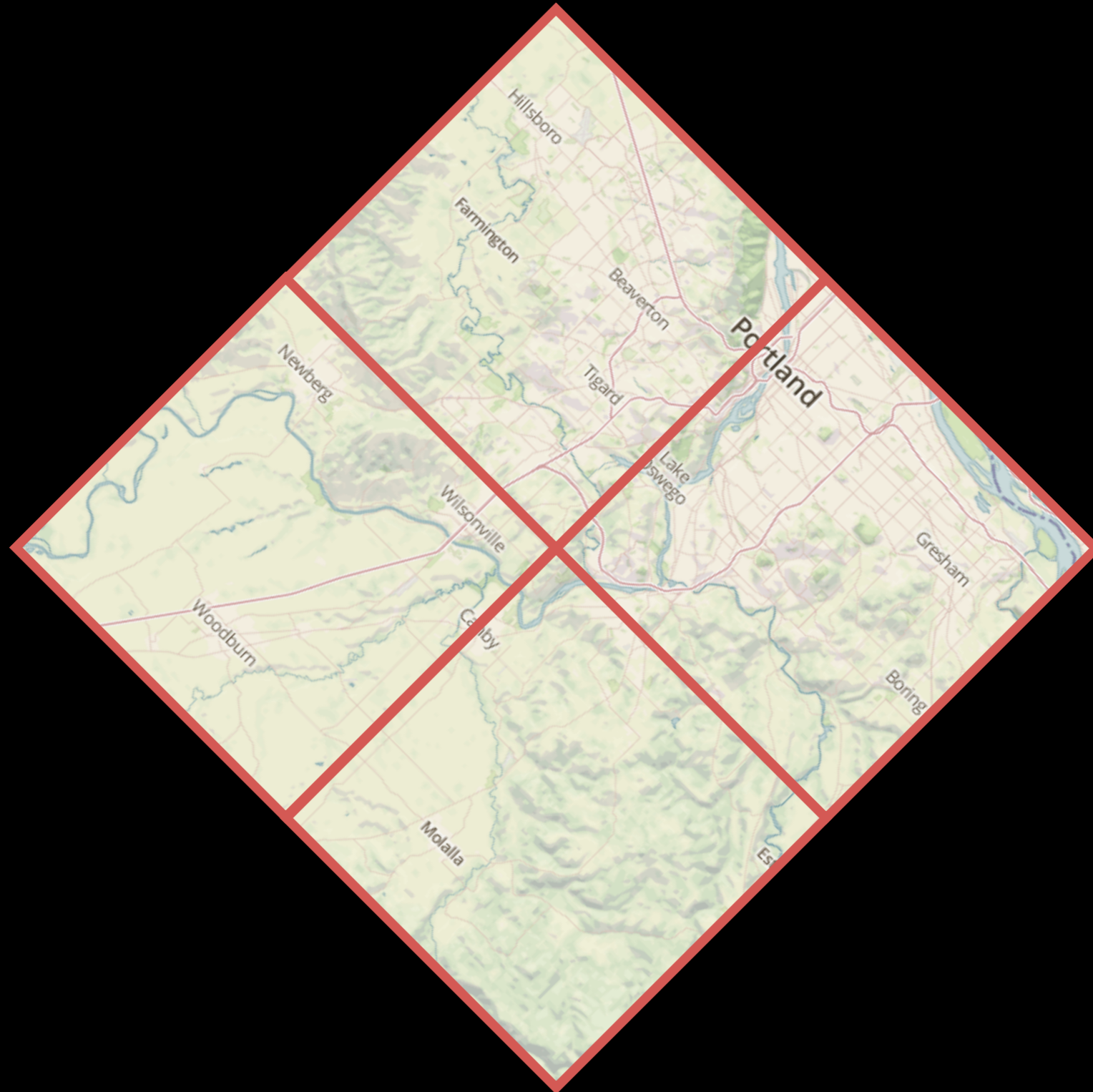
Raster Tiles: Zoom



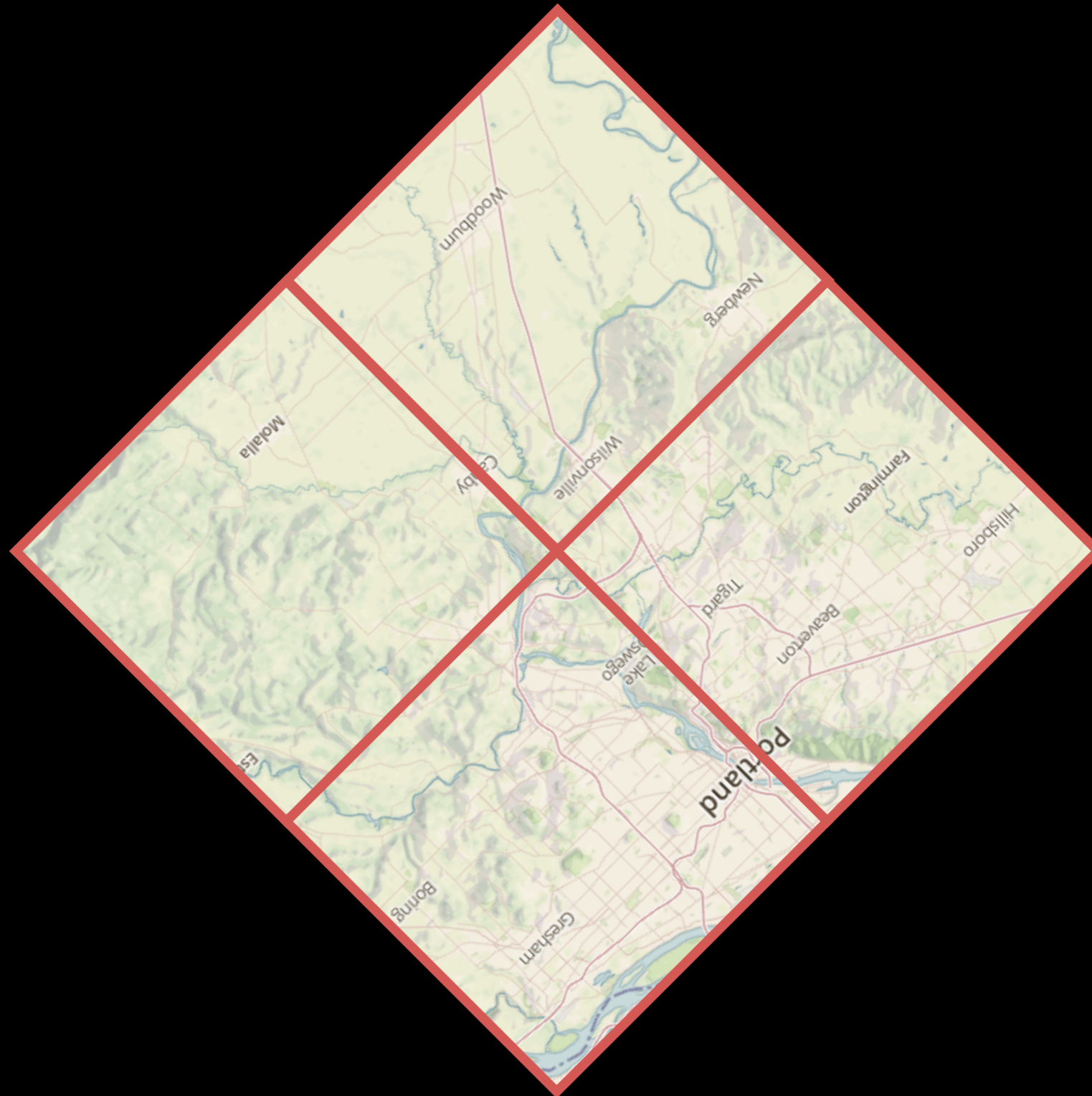
Raster Tiles: Rotation



Raster Tiles: Rotation



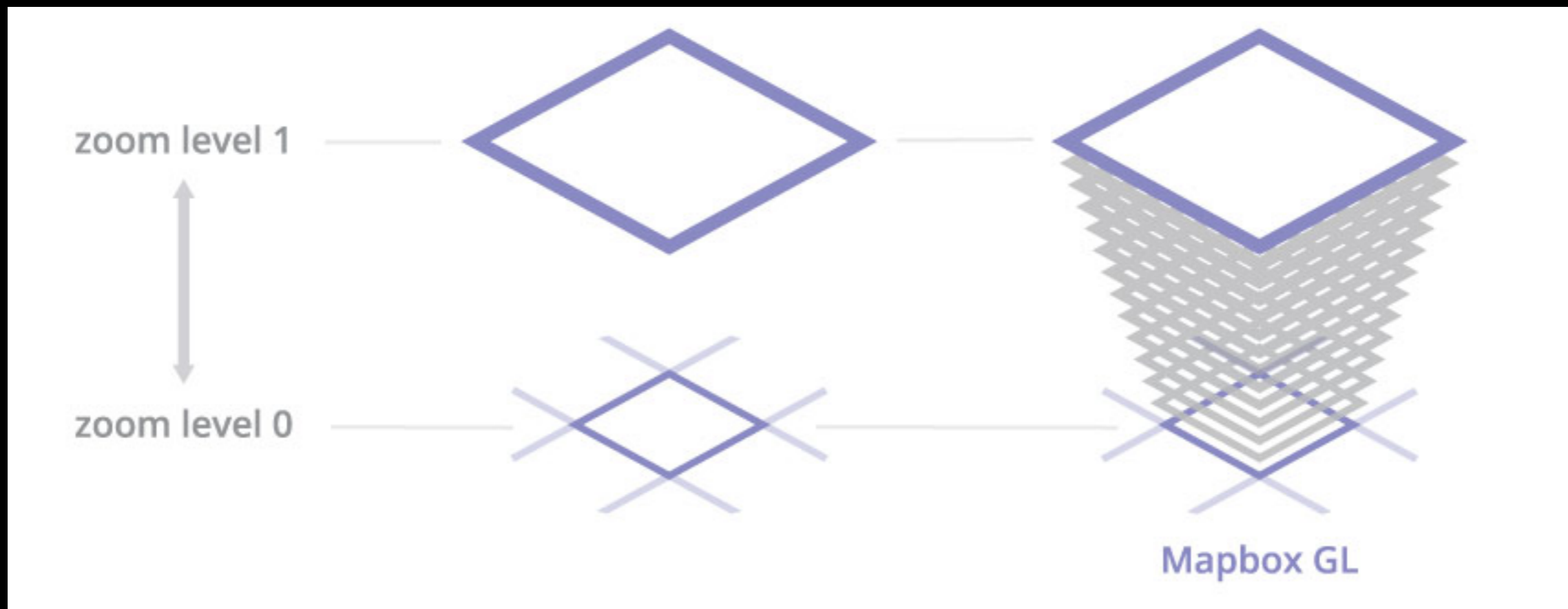
Raster Tiles: Rotation



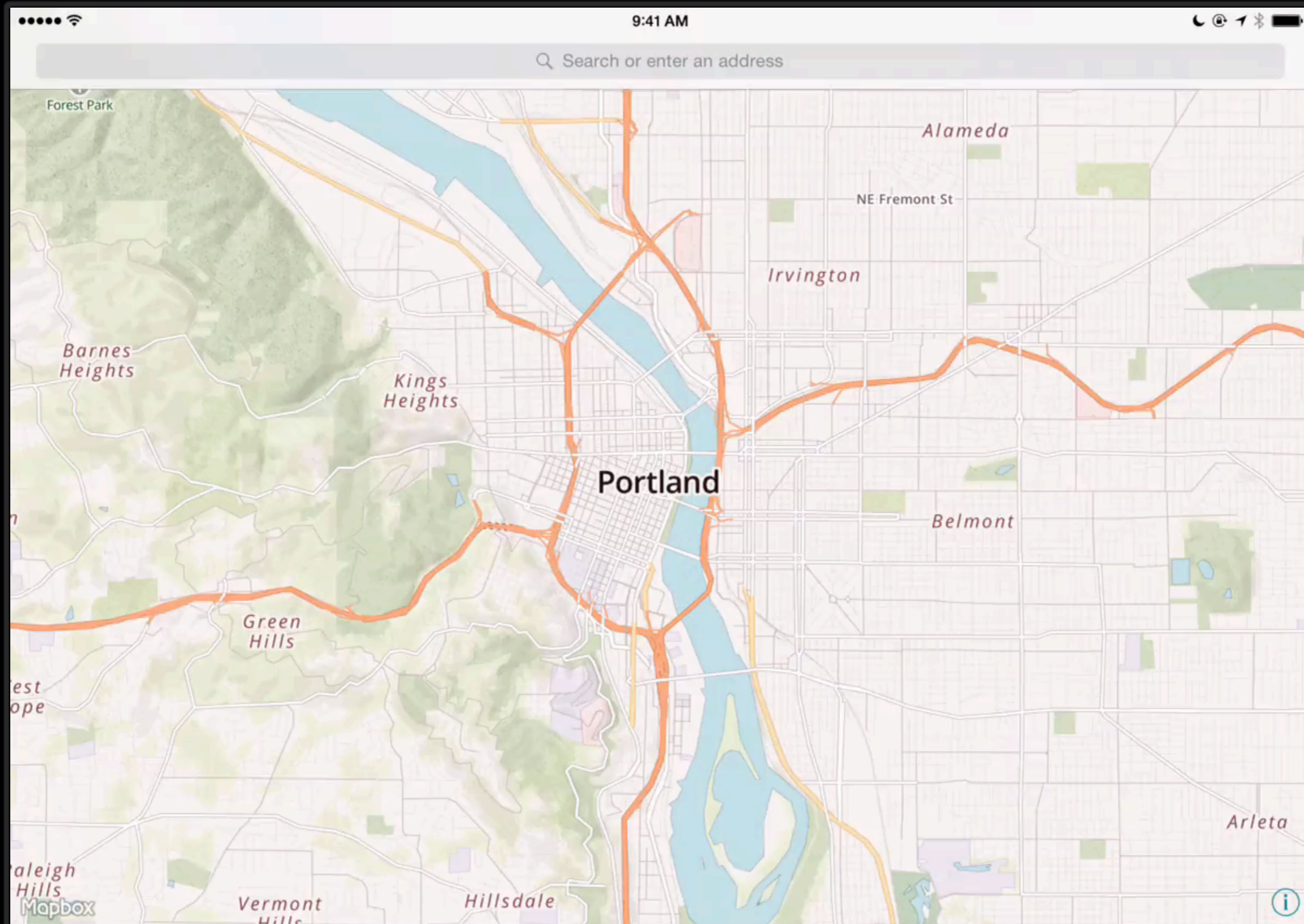
Vector Tiles

- You can't "see" vector tiles; they are just data
- But the "tile pyramid" works the same way
- Rendering continuity between zooms
 - Label placement is a great example

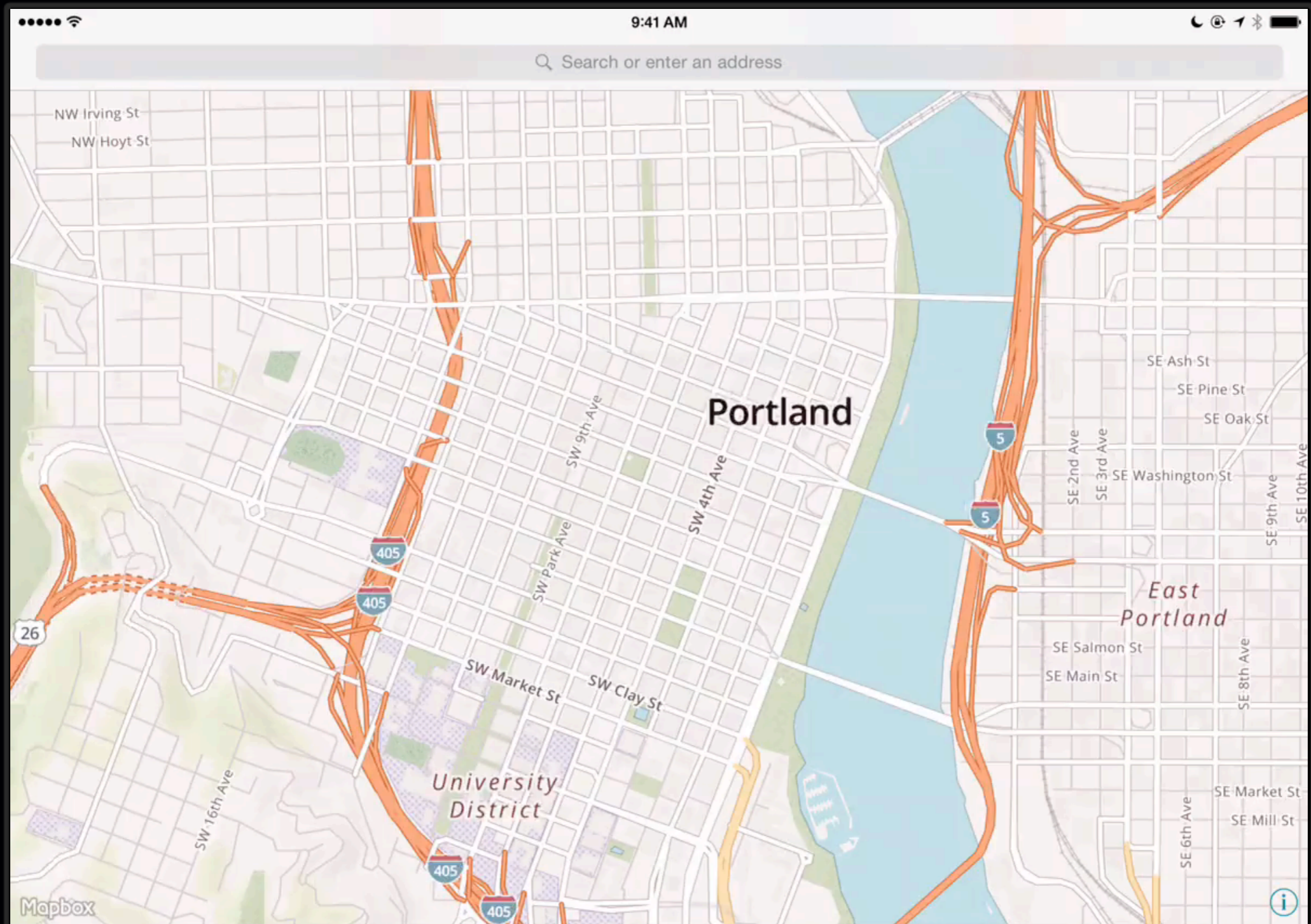
Incremental Zoom



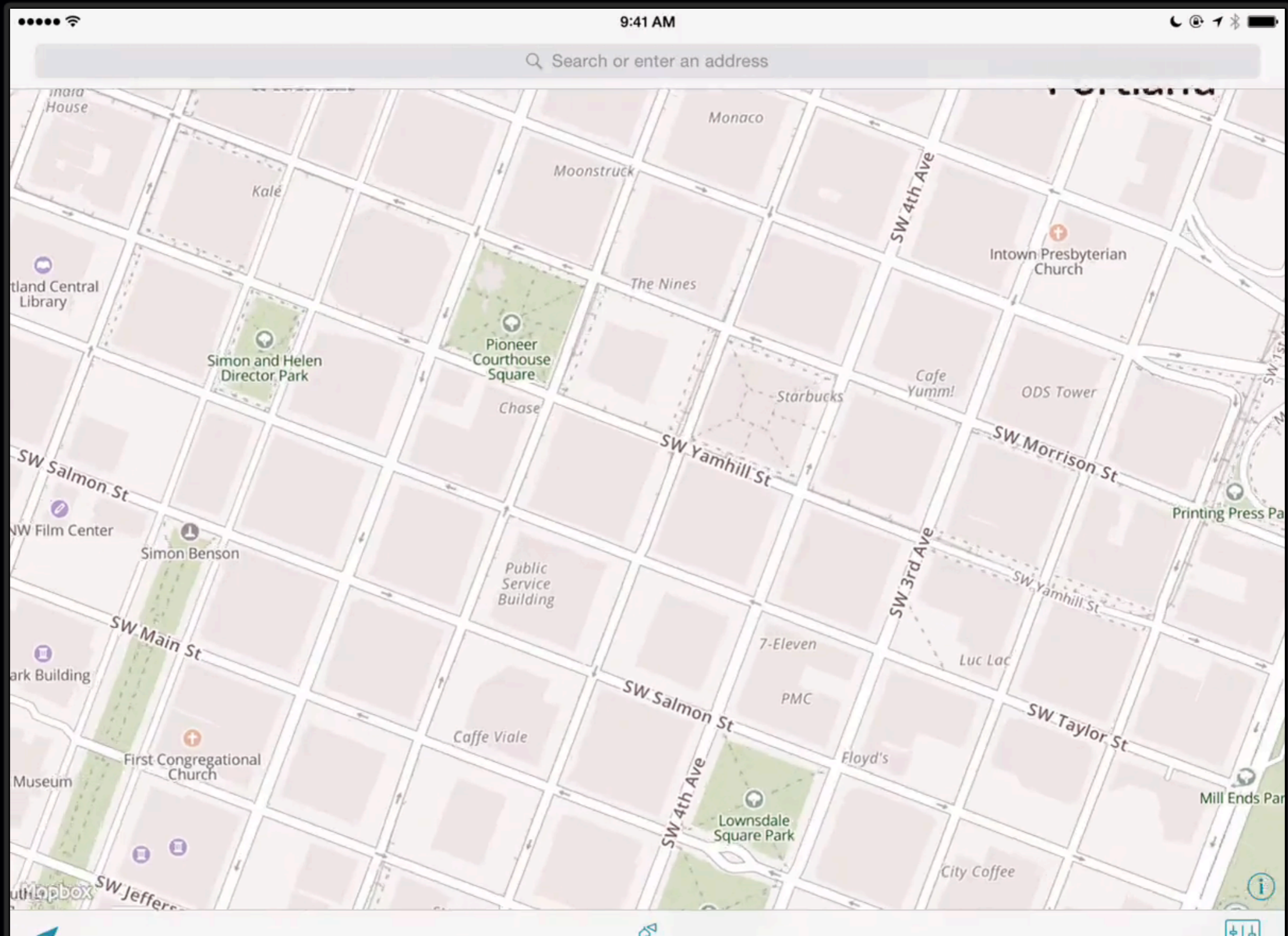
Zoom-Dependent Styling



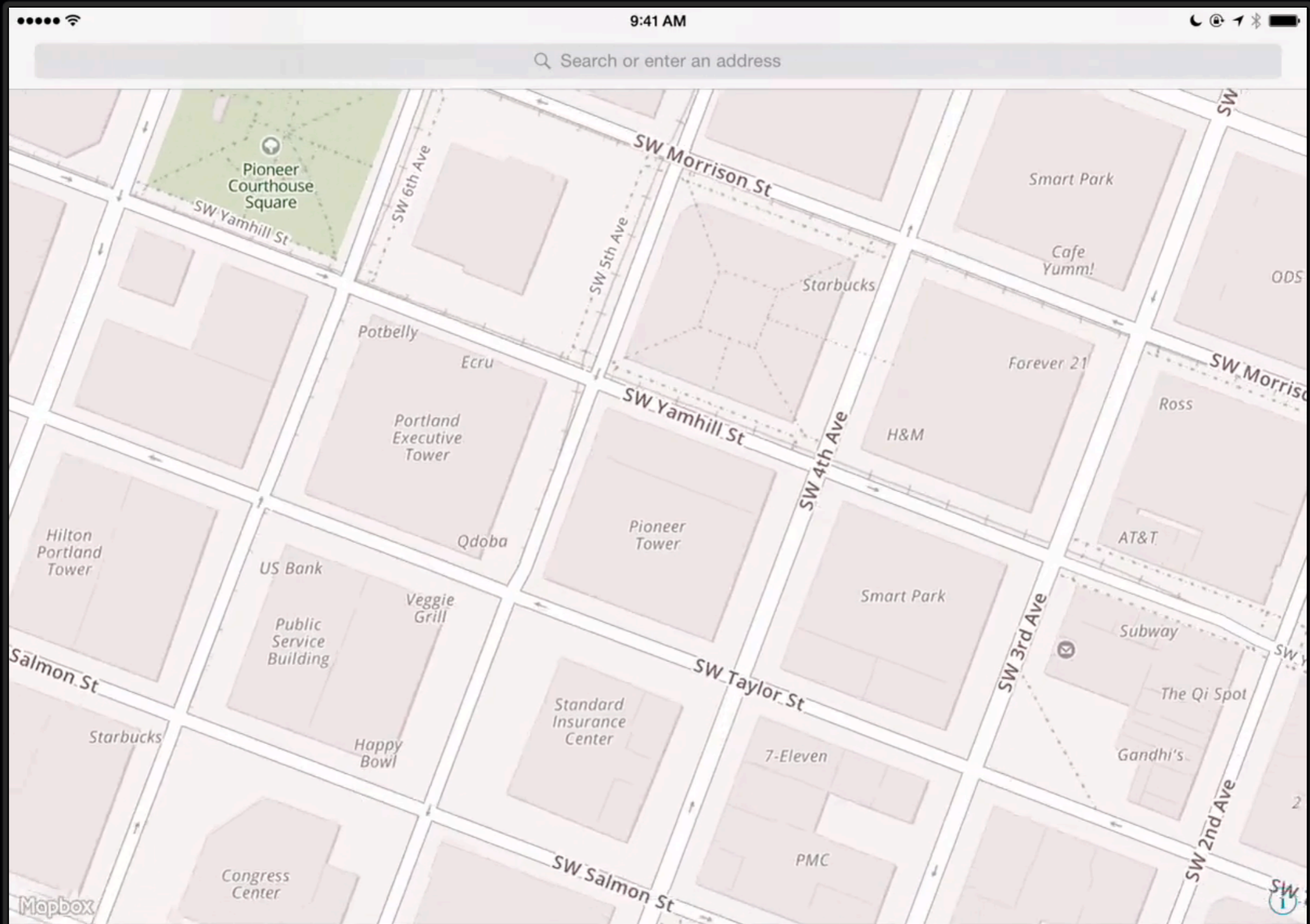
Zoom-Dependent Styling



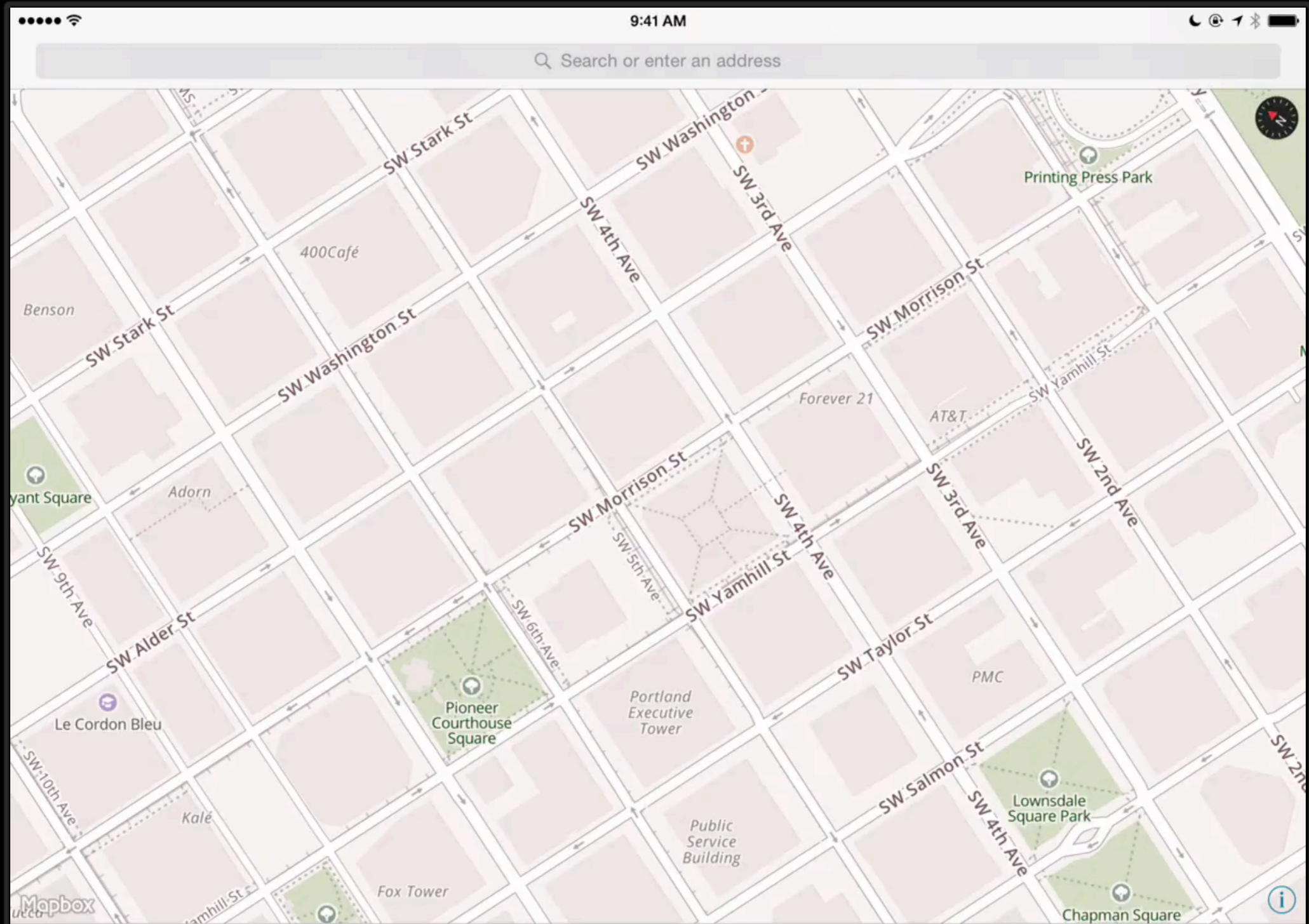
Zoom-Dependent Styling



Zoom-Dependent Styling



Zoom-Dependent Styling



Zoom-Dependent Styling

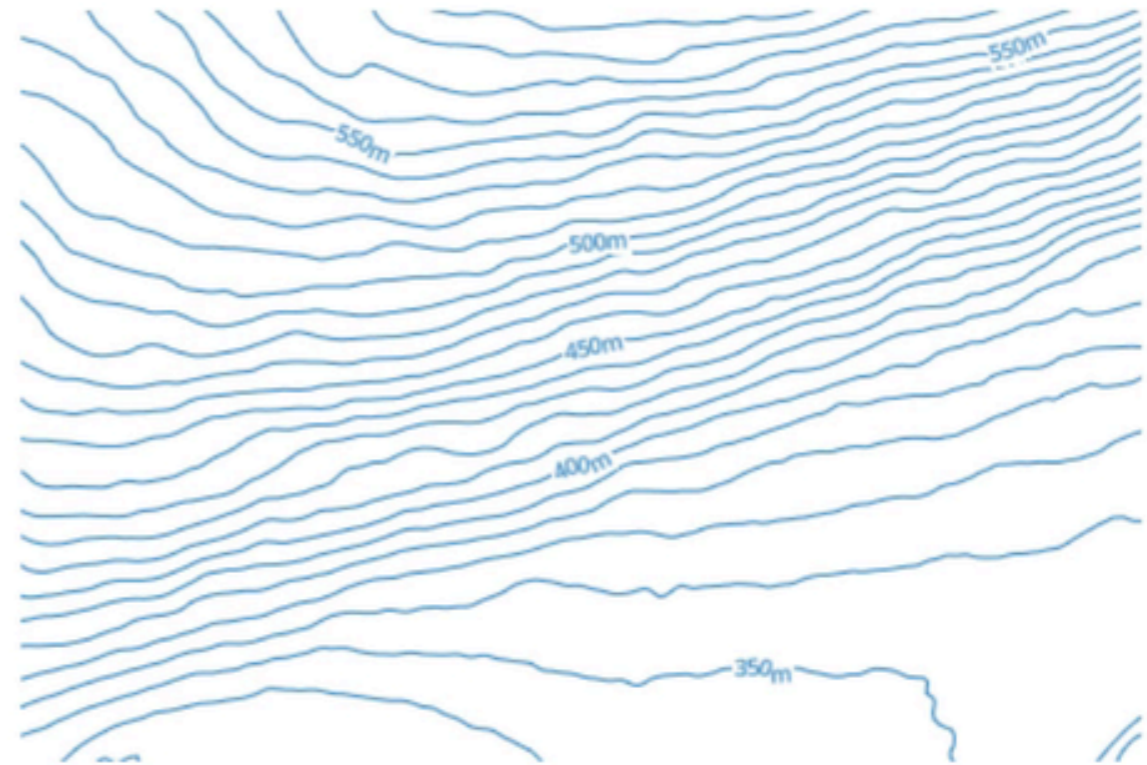
ZOOM 14

VALUE: 0.1

ZOOM 16

```
...  
"style": {  
  "line-width": {  
    "stops": [[14, 1], [15, 3], [16, 4]]  
  }  
}
```

Functions are specified in `[zoom, value]` pairs.



Zoom-Dependent Styling

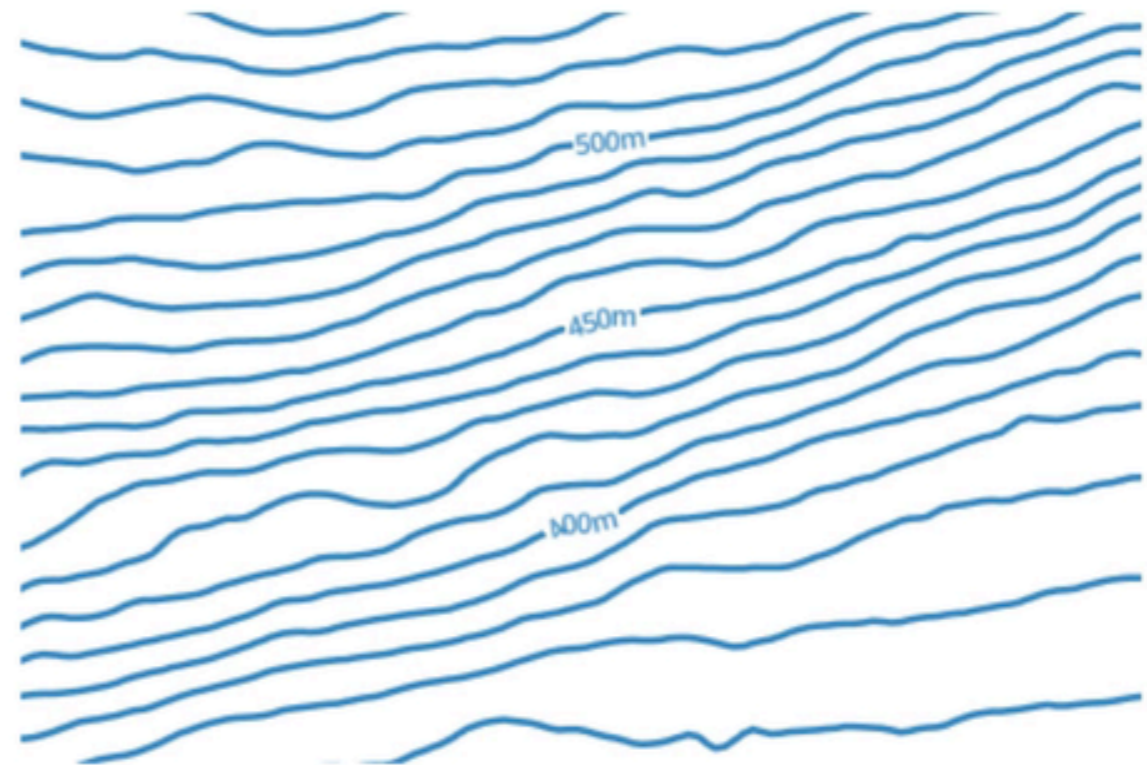
ZOOM 14

VALUE: 2.5

ZOOM 16

```
...  
"style": {  
  "line-width": {  
    "stops": [[14, 1], [15, 3], [16, 4]]  
  }  
}
```

Functions are specified in `[zoom, value]` pairs.



Zoom-Dependent Styling

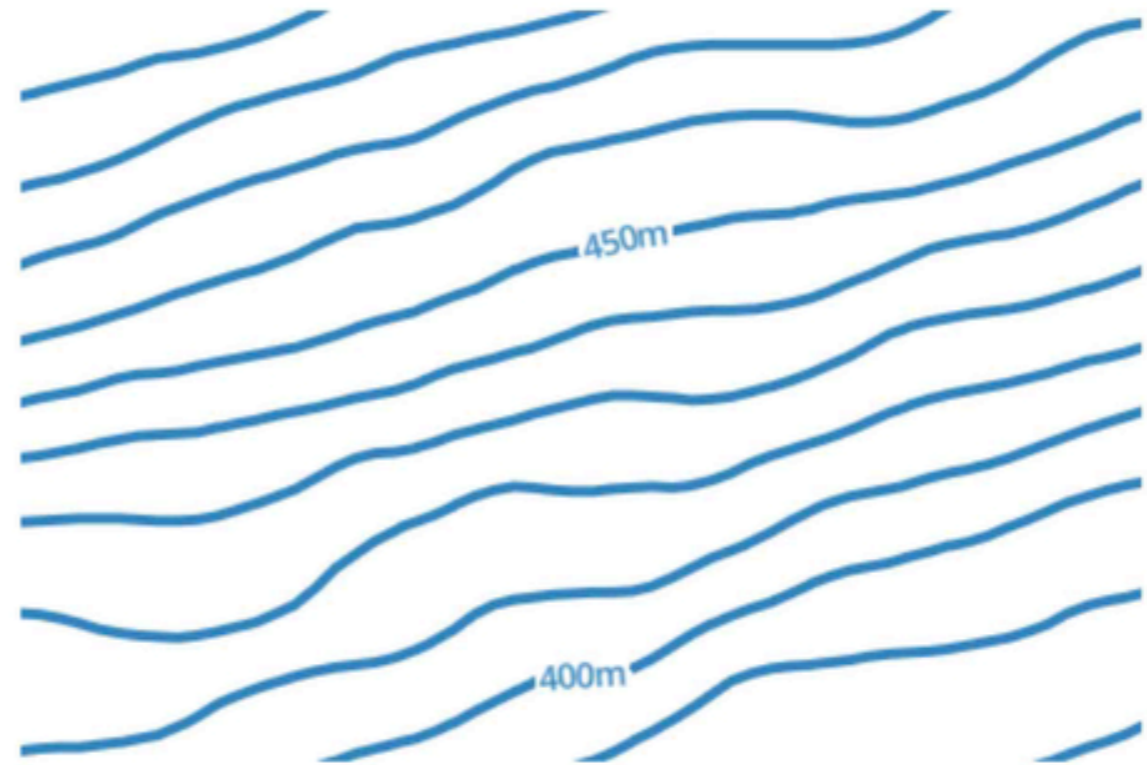
ZOOM 14

VALUE: 3.88

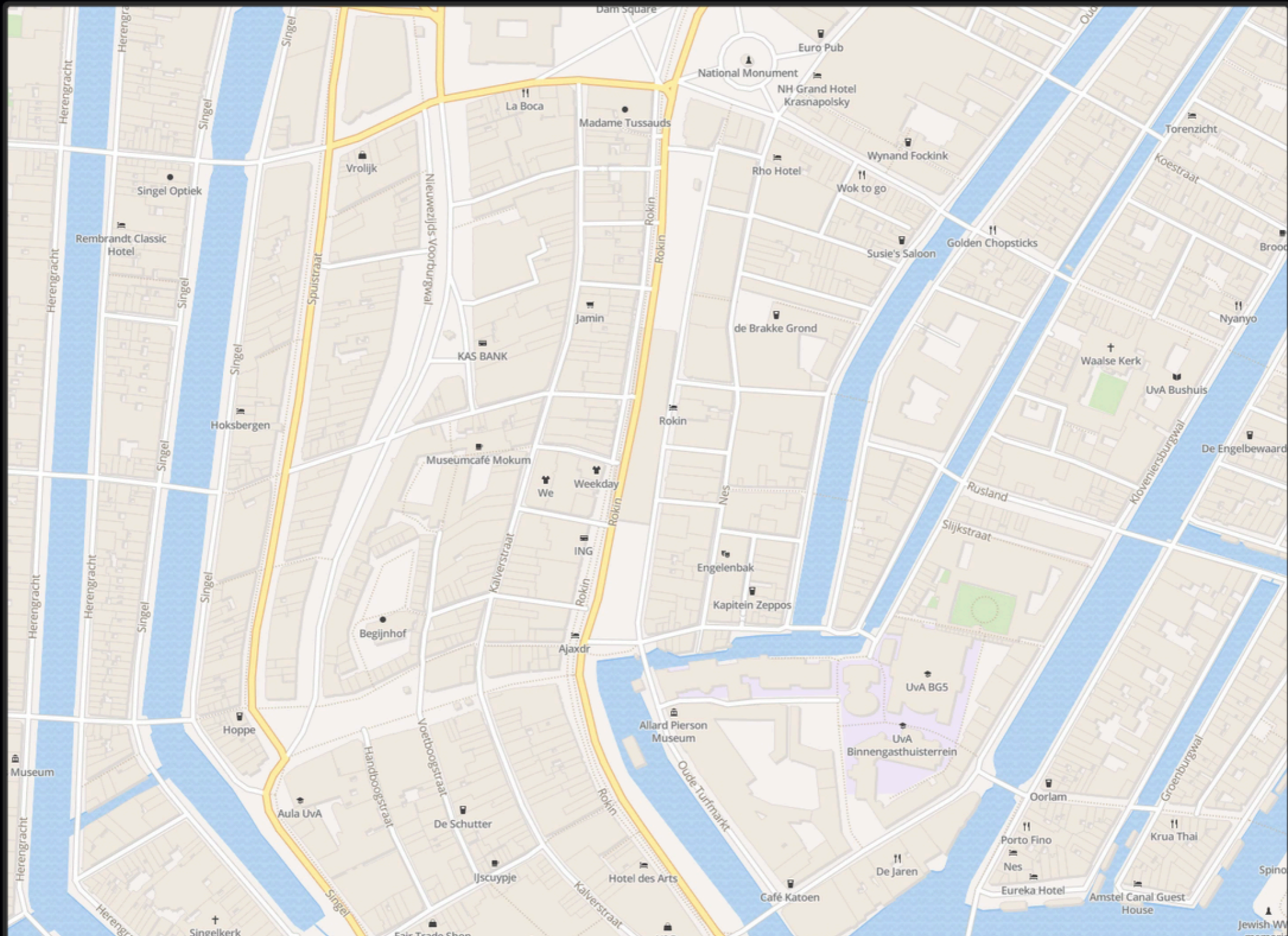
ZOOM 16

```
...  
"style": {  
  "line-width": {  
    "stops": [[14, 1], [15, 3], [16, 4]]  
  }  
}
```

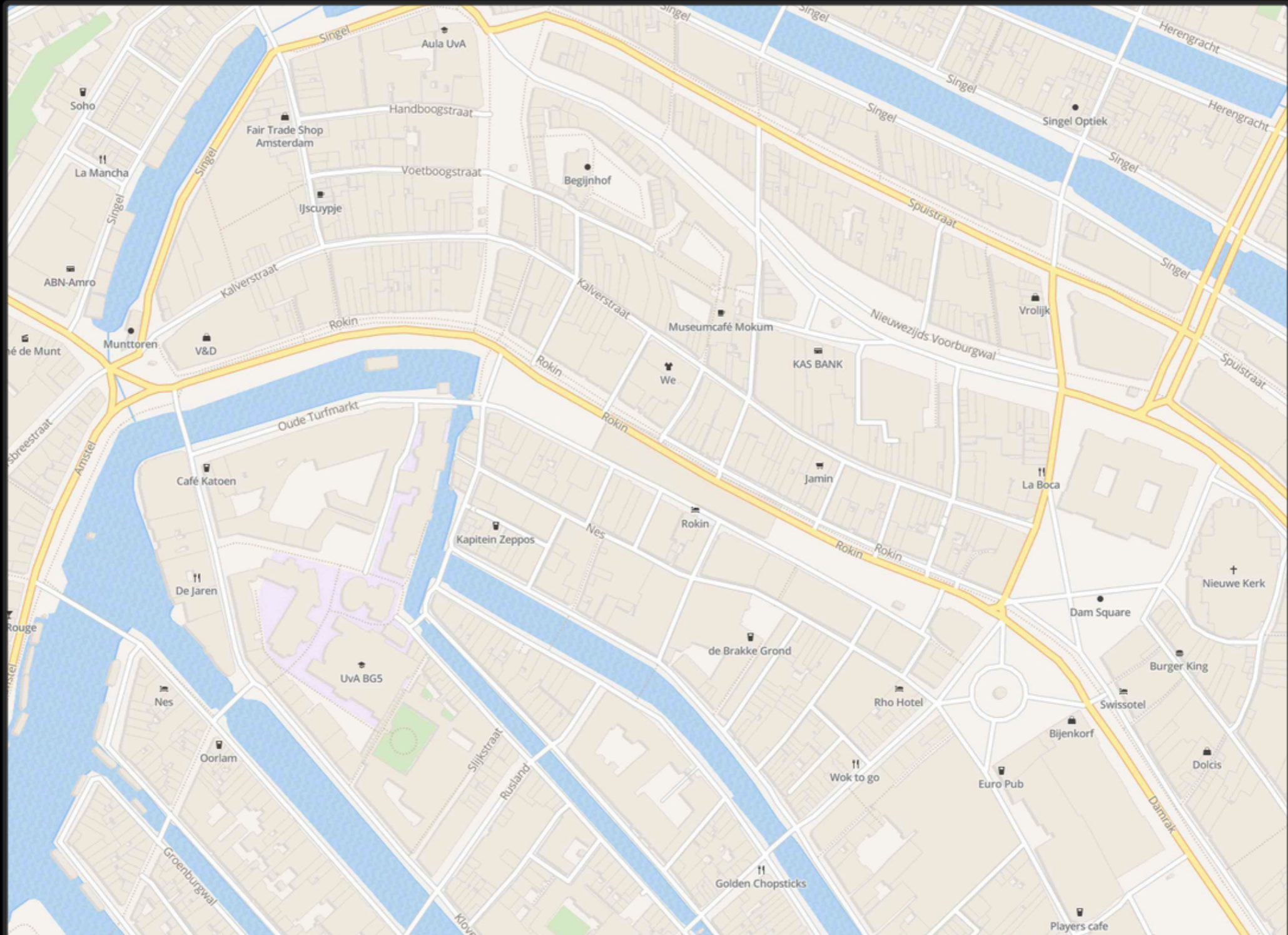
Functions are specified in `[zoom, value]` pairs.



Rotation Response



Rotation Response

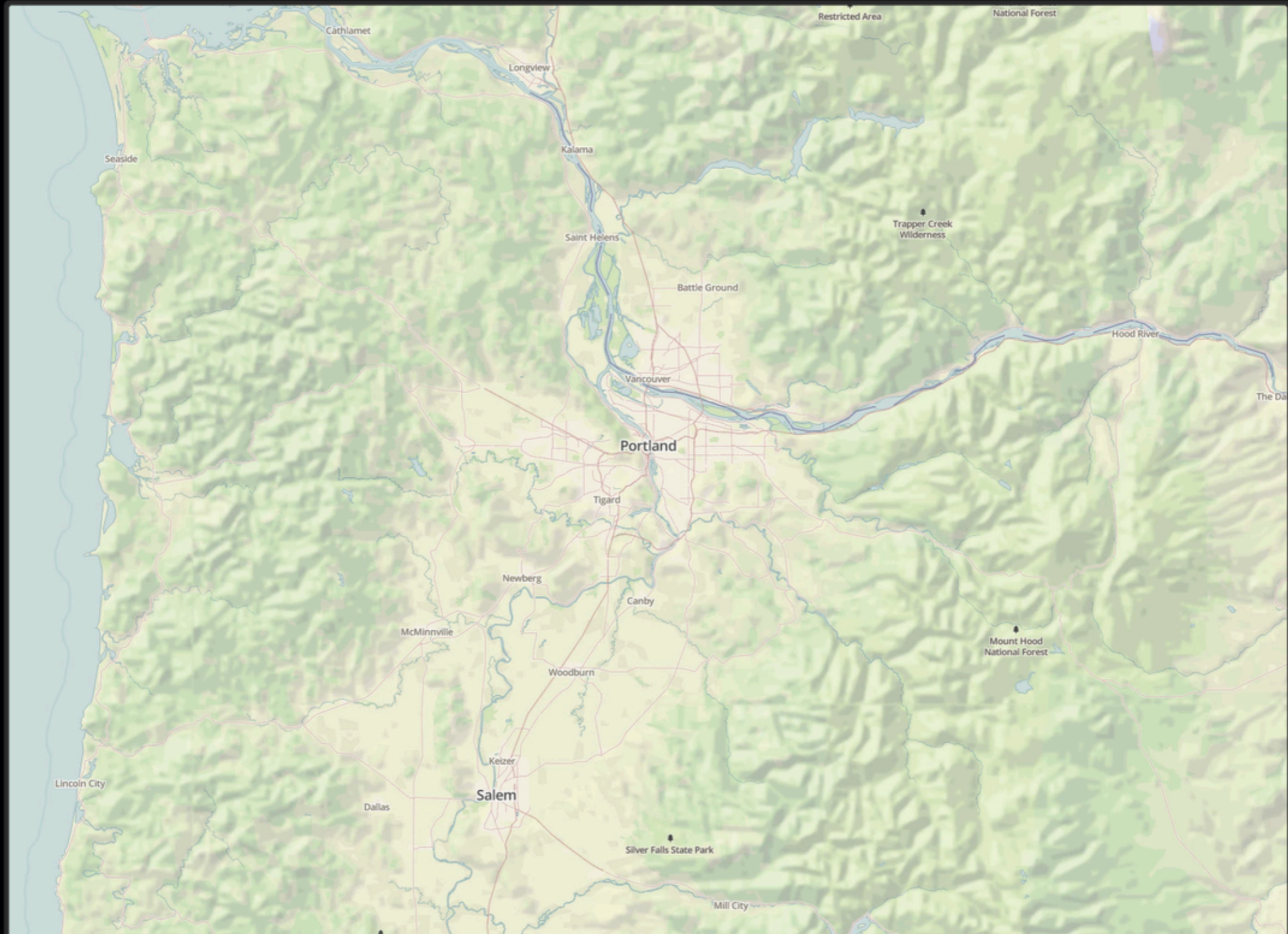


Vector/Raster Combos

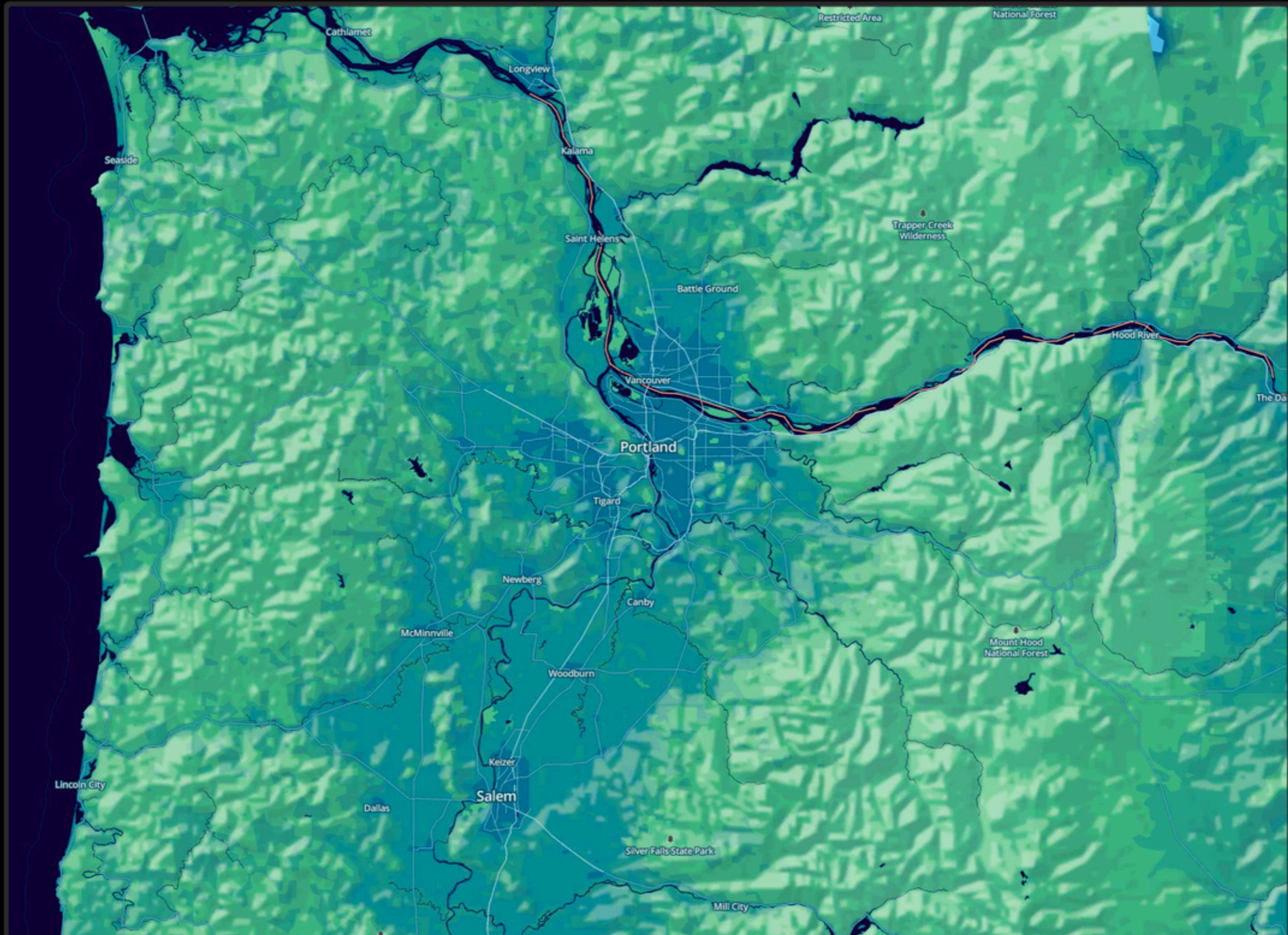
- Rasters aren't going away
- All satellite imagery is rasters
- Can combine raster base & vector features & labels



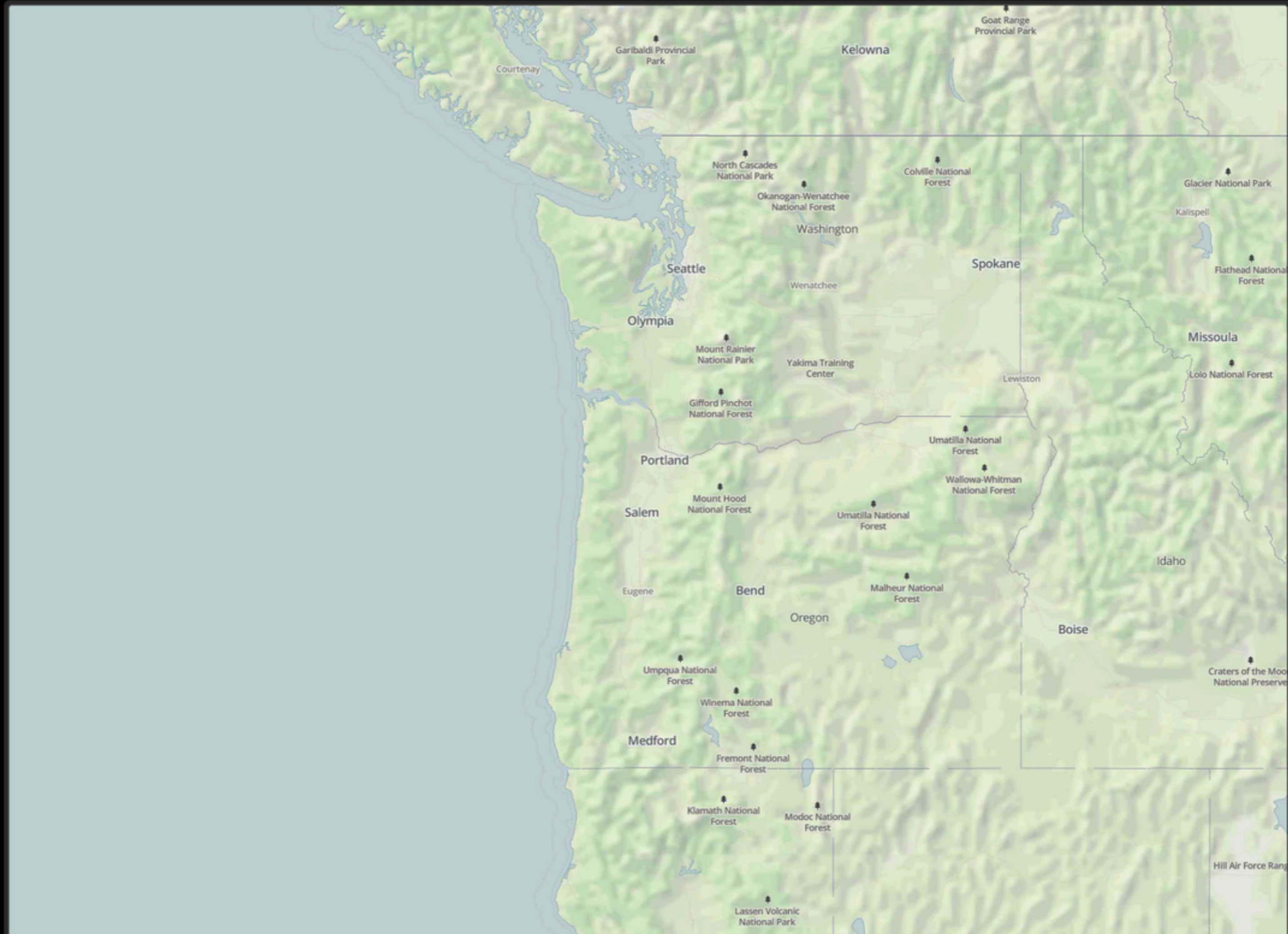
Style Transitions



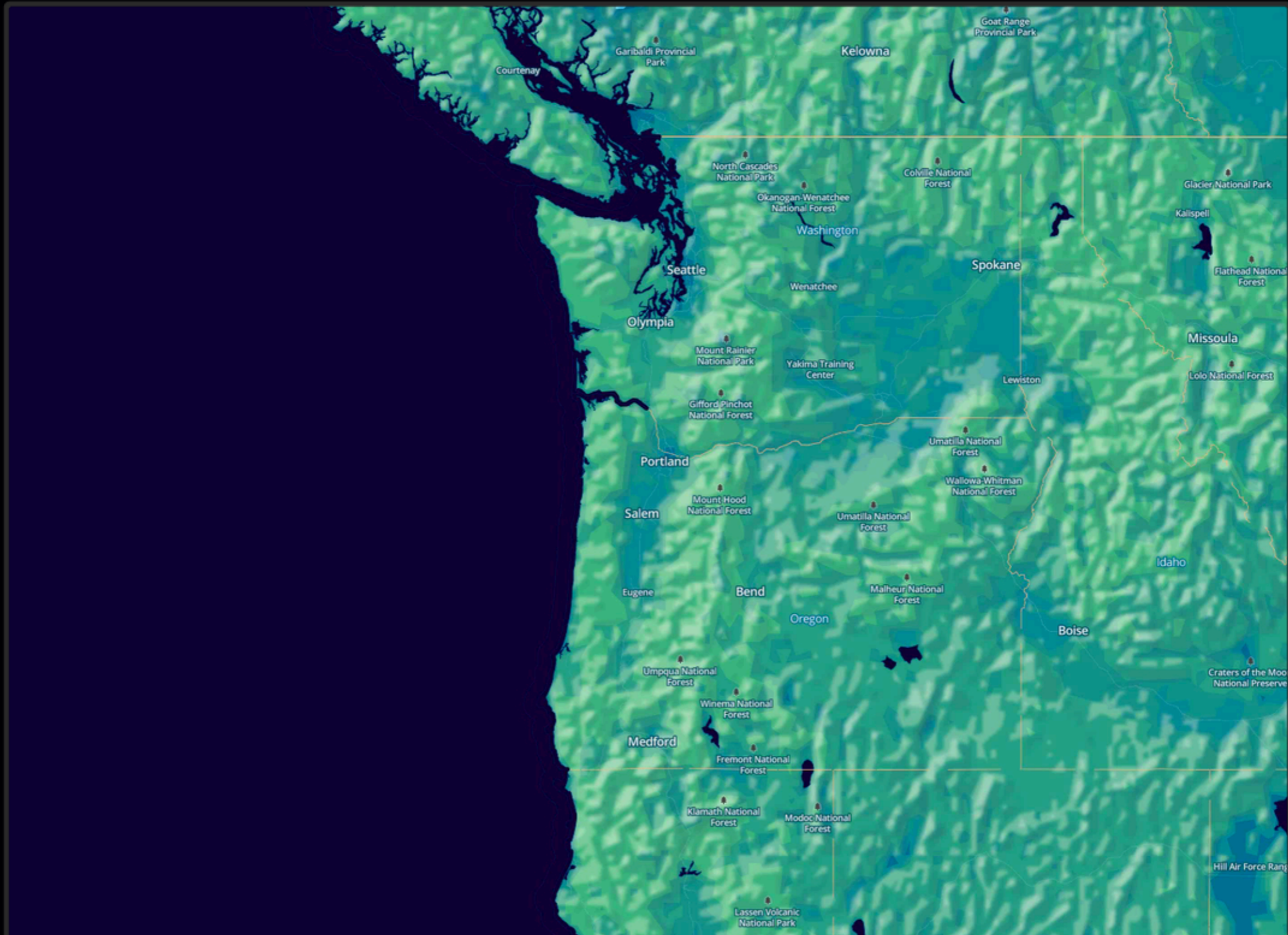
Style Transitions



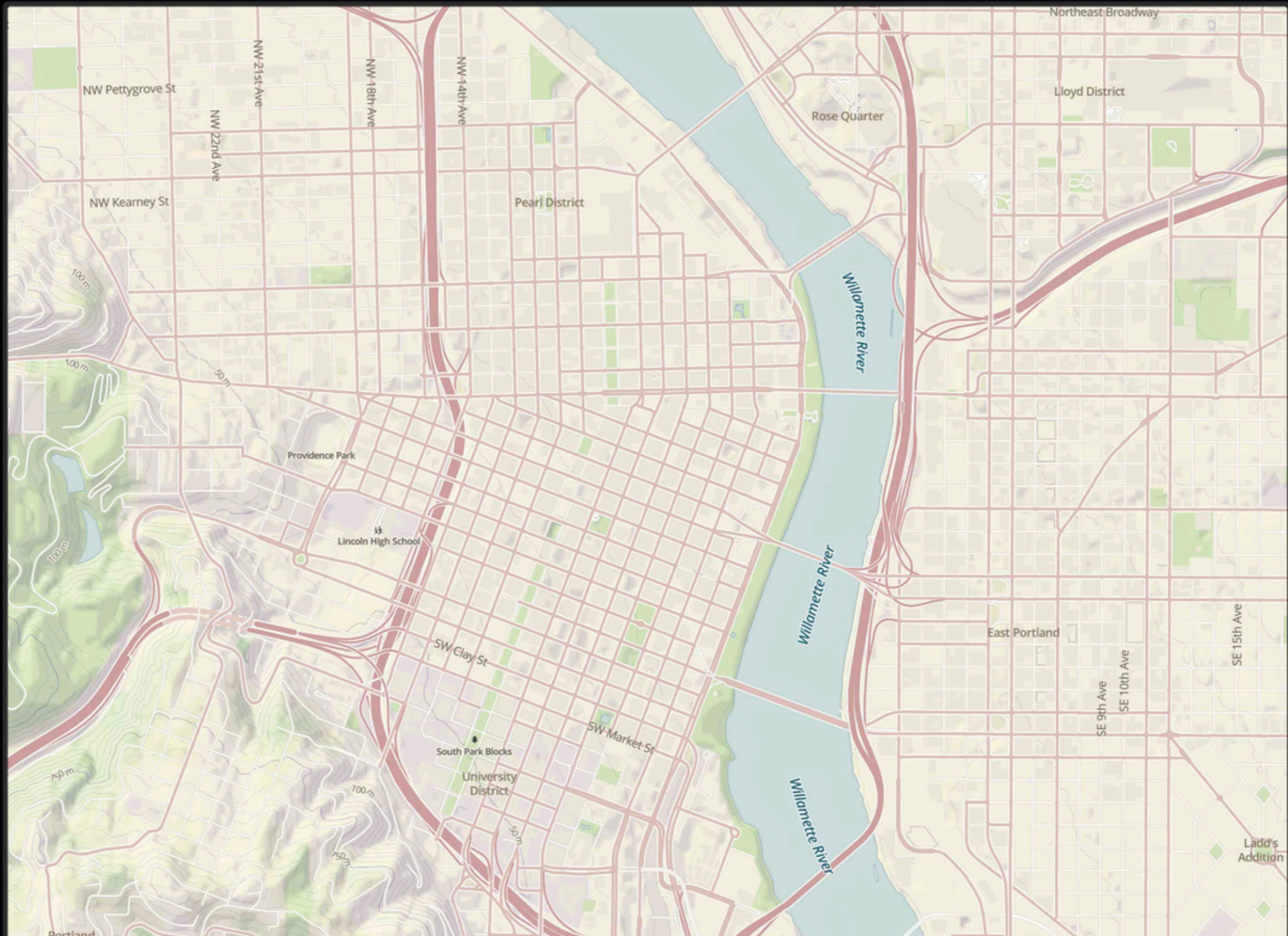
Style Transitions



Style Transitions



Style Transitions



Style Transitions



Superimposed Video



Mapbox GL Stack

- Dual-stack approach (native devices + JS)
- JS variant is not designed for mobile
 - Works, but not ideal (heavy WebGL is resource-constrained)
- Native is written in C++14

Mapbox GL Stack

- Atop native we have per-platform bindings
 - Cocoa/ObjC/Swift for iOS, Java for Android
- All open source on GitHub
- Aims to support non-Mapbox
 - Regular ol' slippy map tile URLs, etc.

High-level Goals

- Run on mobile & web using best frameworks
- Easy to get up and running in apps & websites
- Fun to design & iterate with
- Built on open standards (created, if necessary)

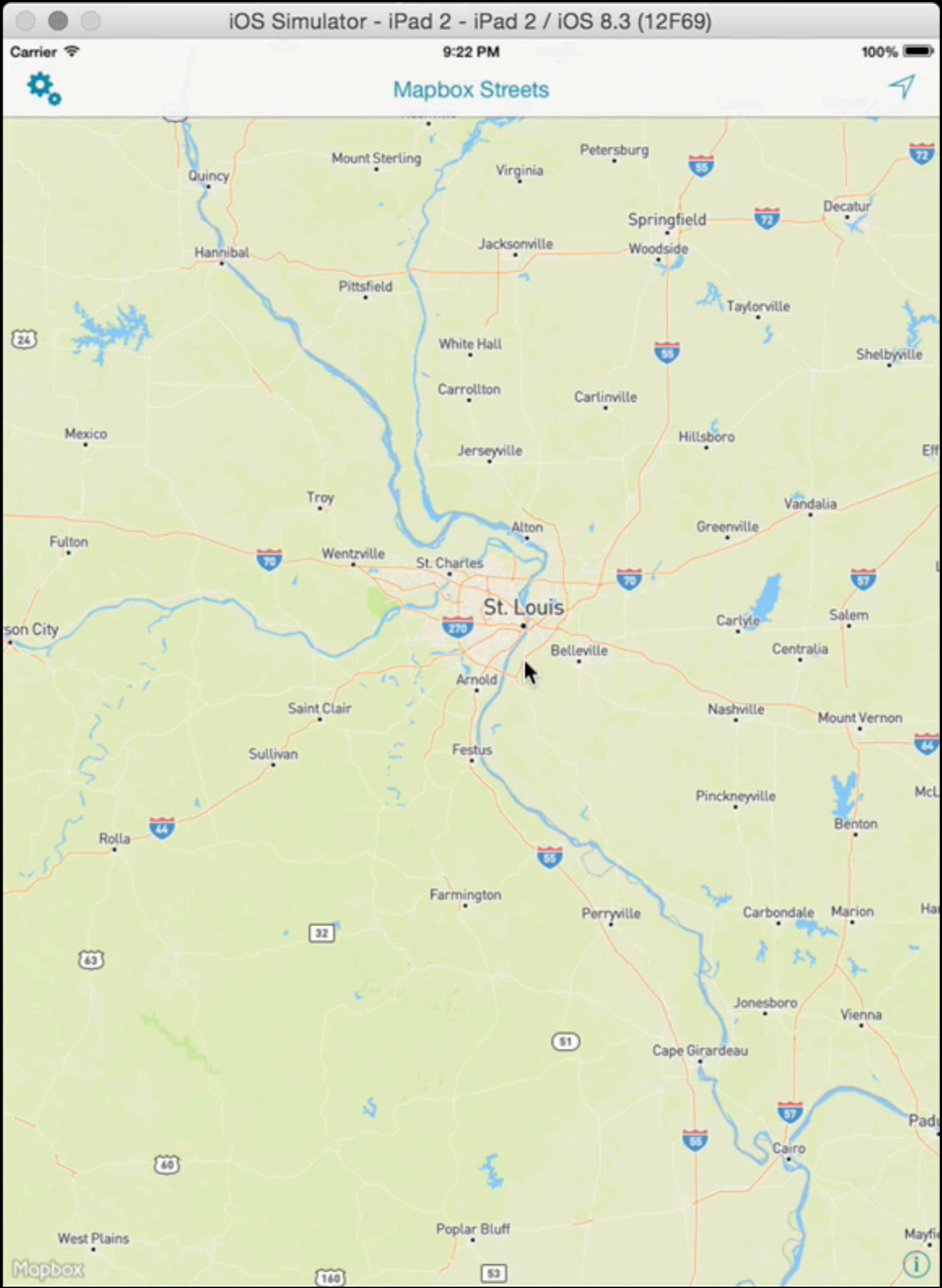
Vector Tiles

- Basic tenet: eliminating the database, particularly for global maps
- Instead of indexing DBs, we pre-tile X+Y by Z
- Pre-optimize with polygon simplification
- Tile format spec is open on GitHub
 - github.com/mapbox/vector-tile-spec



Mapbox Streets

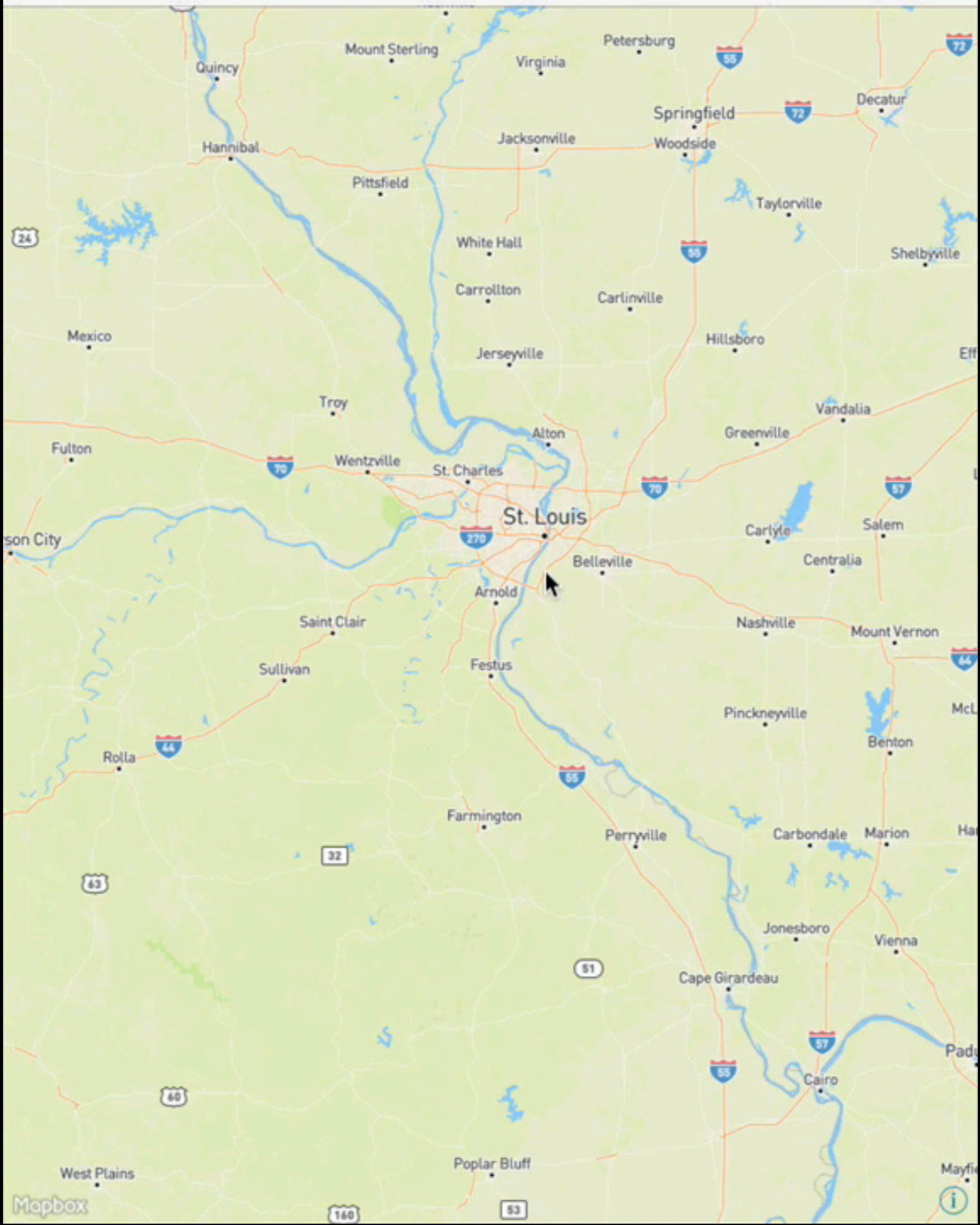




iOS Simulator - iPad 2 - iPad 2 / iOS 8.3 (12F69)

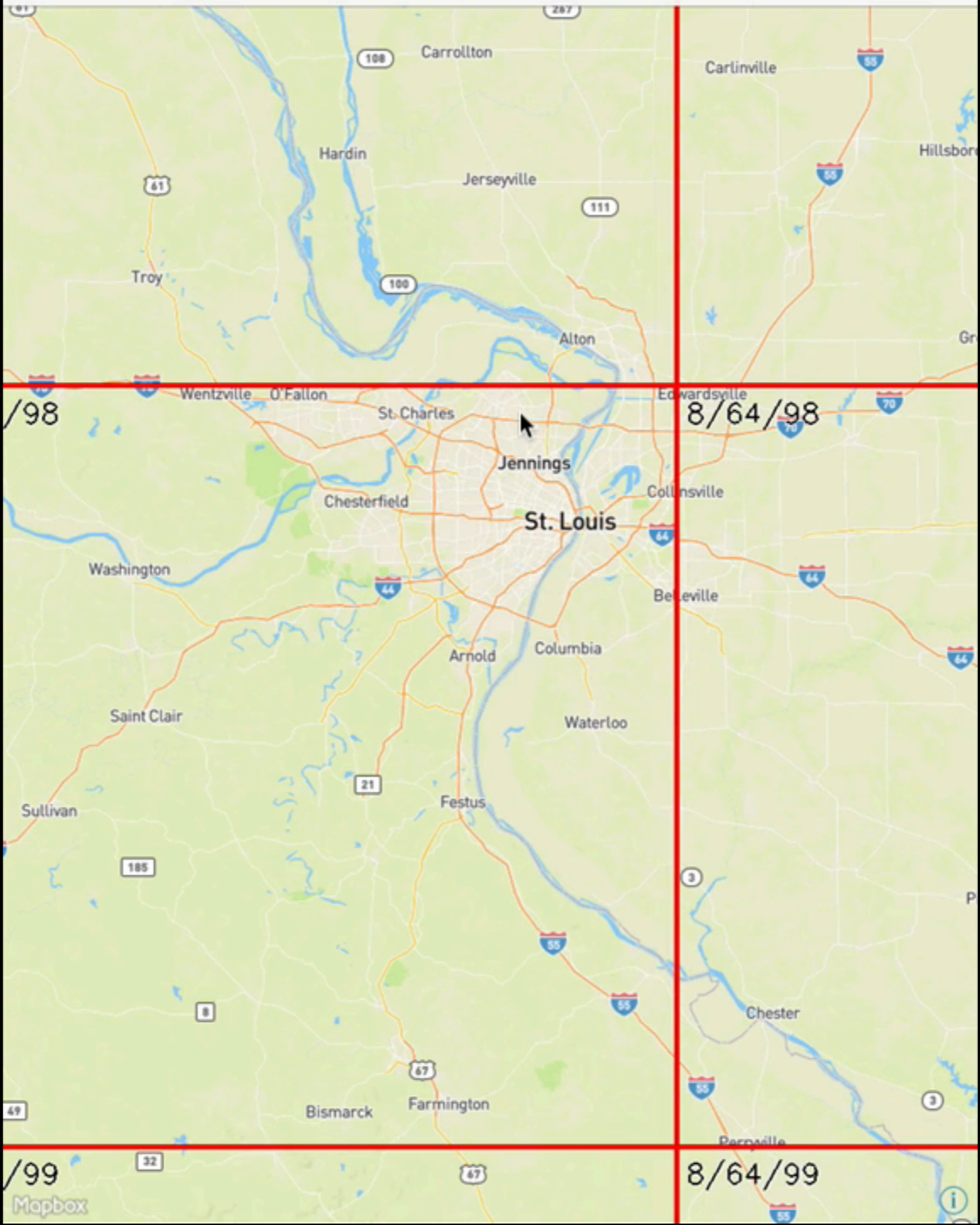
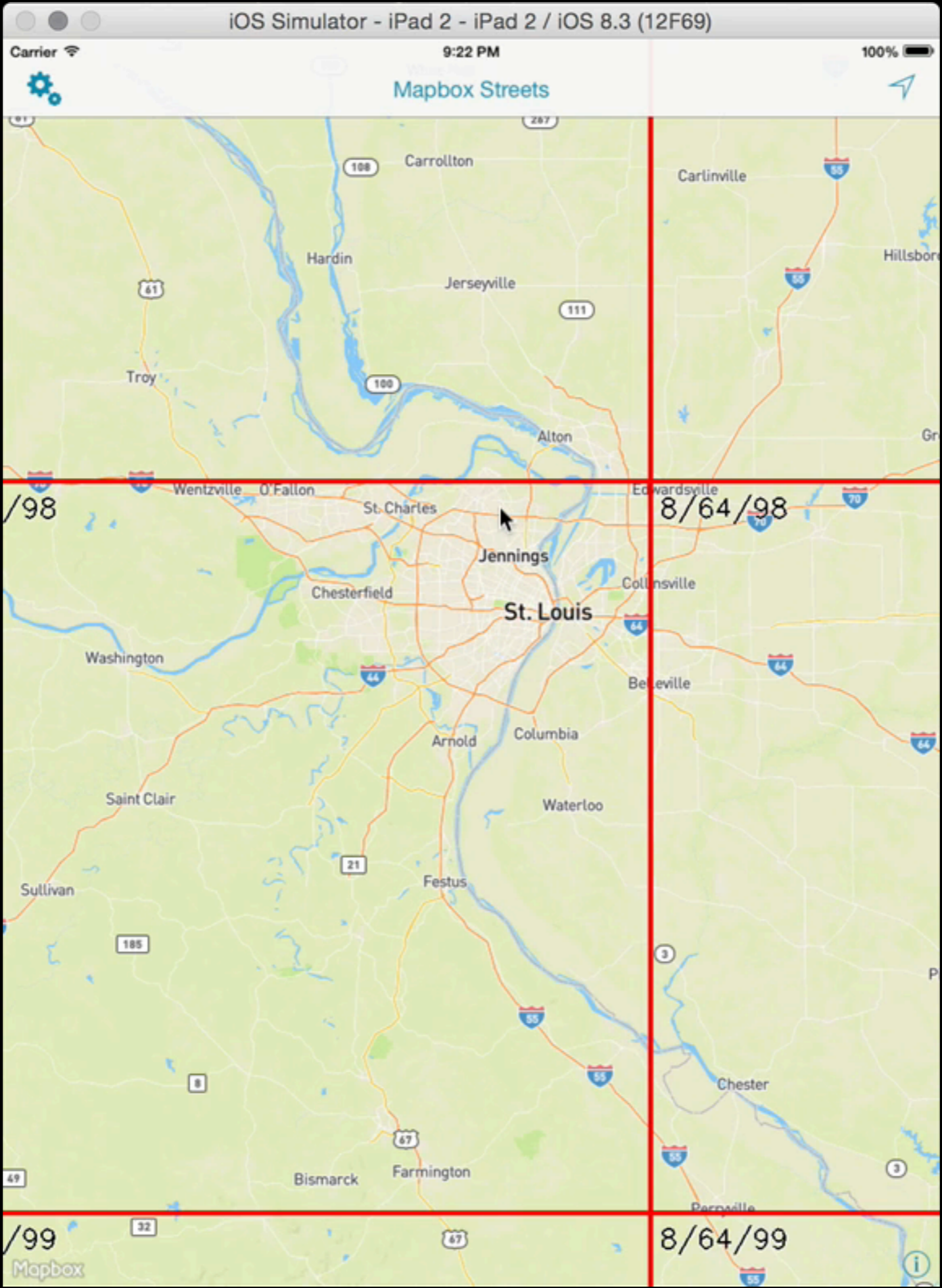
Carrier 9:22 PM 100%

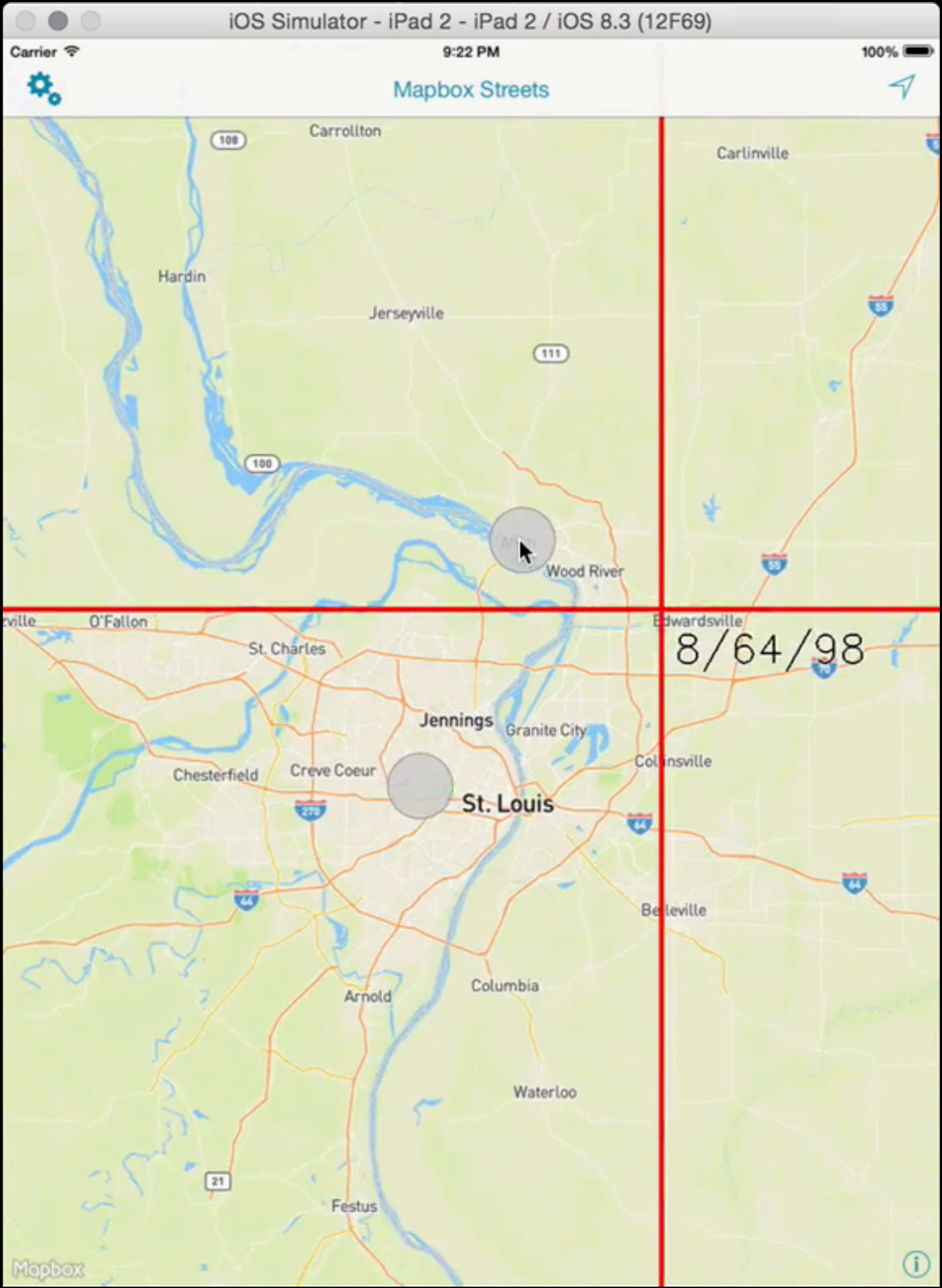
Mapbox Streets



Mapbox







8/64/98



Vector Tile Goals

- Tiling/clipping
- Pre-simplification
- Binary format
 - Reduce size of overall data
 - Eliminate duplication of bytes
- Tools for creation
 - mapnik.org
 - github.com/mapbox/tilelive-bridge
- Tools for parsing
 - [github.com/mapbox/mapbox-vector-tile-{js,py}](https://github.com/mapbox/mapbox-vector-tile-js-py)

Styling Spec

- Style spec is also on GitHub
 - github.com/mapbox/mapbox-gl-style-spec
- Reference docs
 - mapbox.com/mapbox-gl-style-spec

```
1  {
2  "constants": {},
533 "created": "2015-05-07T16:00:16.592Z",
534 "glyphs": "mapbox://fontstack/{fontstack}/{range}.pbf",
535 "id": "nicki.7bfc461f",
536 "layers": [
537   {
538     "id": "background",
539     "interactive": true,
540     "layout": {
541       "visibility": "visible"
542     },
543     "maxzoom": 22,
544     "minzoom": 0,
545     "paint": {
546       "background-color": "@land"
547     },
548     "type": "background"
549   },
550   {
551     "filter": [
552       "all",
553       [
554         "in",
555         "class",
556         "crop"
557       ]
558     ],
559     "id": "landcover_crop",
560     "interactive": true,
561     "layout": {
562       "visibility": "visible"
563     },
564     "maxzoom": 14,
565     "minzoom": 0,
566     "paint": {
567       "fill-antialias": false,
```

```

1 | {
2 |
533 | "cre
534 | "gly
535 | "id"
536 | "lay
537 |
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543 |
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556 |
557 |
558 |
559 |
560 |
561 |
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566 |
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568 |

```

```

1006 | "maxzoom": 22,
1007 | "minzoom": 0,
1008 | "paint": {
1009 |   "fill-color": "@landuse-industrial",
1010 | },
1011 | "source": "composite",
1012 | "source-layer": "landuse",
1013 | "type": "fill",
1014 | },
1015 | {
1016 |   "filter": [
1017 |     "all",
1018 |     [
1019 |       "in",
1020 |       "class",
1021 |       "sand"
1022 |     ]
1023 |   ],
1024 |   "id": "sand",
1025 |   "interactive": true,
1026 |   "layout": {
1027 |     "visibility": "visible",
1028 |   },
1029 |   "maxzoom": 22,
1030 |   "minzoom": 0,
1031 |   "paint": {
1032 |     "fill-color": "@landuse-sand",
1033 |   },
1034 |   "source": "composite",
1035 |   "source-layer": "landuse",
1036 |   "type": "fill",
1037 | },
1038 | {
1039 |   "filter": [
1040 |     "all",
1041 |     [
1042 |       "in",
1043 |       "level",

```

1	▼	{
2	▶	"cor"
533		"cre 1006
534		"gly 1007
535		"id" 1008 ▼
536	▼	"lay 1009
537	▼	1010 ▲
538		1011
539		1012
540	▼	1013
541		1014 ▲
542	▲	},
543		{
544		1017
545	▼	1018 ▼
546		1019
547	▲	1020
548		1021
549	▲	1022 ▲
550	▼	1023 ▲
551	▼	1024
552		1025
553	▼	1026 ▼
554		1027
555		1028 ▲
556		1029
557	▲	1030
558	▲	1031 ▼
559		1032
560		1033 ▲
561	▼	1034
562		1035
563	▲	1036
564		1037 ▲
565		1038 ▼
566	▼	1039 ▼
567		1040
568		1041 ▼
		1042
		1043

1006		"maxzoom": 22,
1007		"minzoom": 0,
1008	▼	all,
1009		[
1010	▲	"in",
1011		"type",
1012		"suburb"
1013]
1014	▲	},
1015	▼	{
1016	▼	1017
1018	▼	1018
1019		1019
1020		1020
1021		1021
1022	▲	1022
1023	▲	1023
1024		1024
1025		1025
1026	▼	1026
1027		1027
1028	▲	1028
1029		1029
1030		1030
1031	▼	1031
1032		1032
1033	▲	1033
1034		1034
1035		1035
1036		1036
1037	▲	1037
1038	▼	1038
1039	▼	1039
1040		1040
1041	▼	1041
1042		1042
1043		1043

6031	▼	[
6032		"in",
6033		"type",
6034		"suburb"
6035	▲]
6036	▲	},
6037		{
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6040		"layout": {
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6044		"text-max-size": {
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6046	▼	"stops": [
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6048		11,
6049	▲	11,
6050	▼],
6051		[
6052		15,
6053	▲	18,
6054	▲],
6055	▲	},
6056		"text-max-width": 7,
6057		"text-padding": 3,
6058		"text-transform": "uppercase",
6059		"visibility": "visible"
6060	▲	},
6061		"maxzoom": 16,
6062		"minzoom": 10,
6063	▼	"paint": {
6064		"text-color": "@label-neighbourhood",
6065		"text-halo-color": "rgba(255,255,255, 0.5)",
6066		"text-halo-width": 1.75,
6067	▼	"text-size": {

6031	▼	[
6032		"in",
6033		"type",
6034		"suburb"
6035	▲]
6036	▲	},
6037		{
6038		"id": "place-suburb",
6039	▼	"interactive": true,
6040		"layout": {
6041		"text-field": "{name_en}",
6042		"text-font": "DIN Offc Pro Regular, Arial Unicode MS Regular",
6043	▼	"text-letter-spacing": 0.15,
6044		"text-max-size": {
6045	▼	"base": 1,
6046	▼	"stops": [
6047		[
6048		11,
6049	▲	11,
6050	▼],
6051		[
6052		15,
6053	▲	18,
6054	▲],
6055	▲	},
6056		"text-max-width": 7,
6057		"text-padding": 3,
6058		"text-transform": "uppercase",
6059		"visibility": "visible"
6060	▲	},
6061		"maxzoom": 16,
6062		"minzoom": 10,
6063	▼	"paint": {
6064		"text-color": "@label-neighbourhood",
6065		"text-halo-color": "rgba(255,255,255, 0.5)",
6066		"text-halo-width": 1.75,
6067	▼	"text-size": {



Style Reference v7

Version

Sprite

Glyphs

Constants

Transition

Sources

Vector

Raster

GeoJSON

Video

Layers

Background

Fill

Line

Symbol

Raster

Values

Color

Enum

String

Boolean

Number

Array

GL Mapbox GL

Overview

API

Style Reference

Examples

Mapbox GL Style Reference

The Mapbox GL style is an object that defines what data to draw, the order to draw it in, and how to style the data when drawing it. The [JSON](#) structure follows the renderer implementation very closely. It provides the basic building blocks out of which more complex styles can be built.

Key:  supports interpolated functions  transitionable

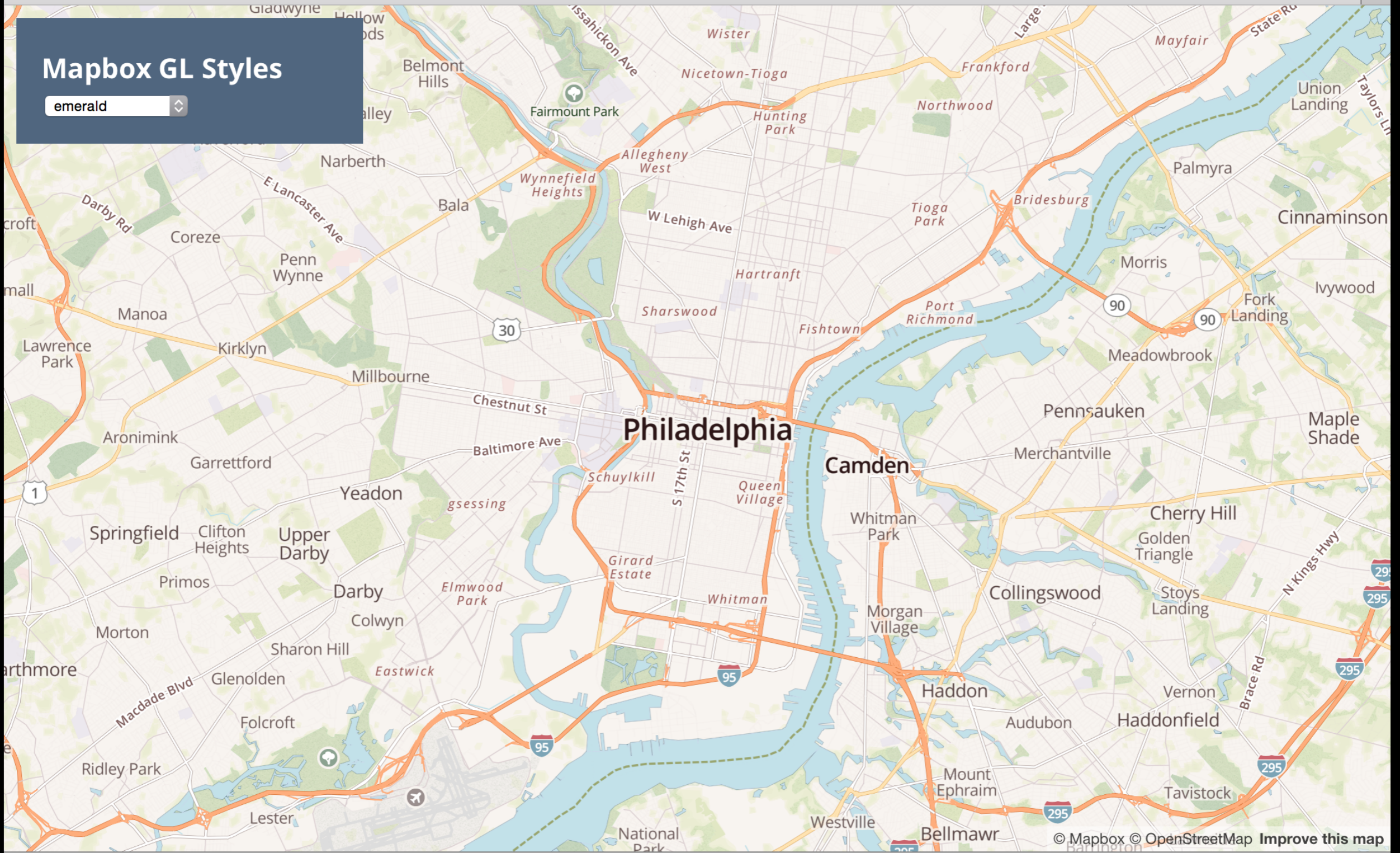
```
{  
  
  "version": 7,  
  // Stylesheet version number. Must be 7.  
  
  "sprite": "https://www.mapbox.com/mapbox-gl-styles/sprites/bright",  
  // A base URL for retrieving the sprite image and metadata. The extensions `.png`, `.json` and scale factor `@2x.png`  
  // will be automatically appended.
```

Example Styles

- Repo of JSON styles
 - github.com/mapbox/mapbox-gl-styles
- Web-based live examples
 - mapbox.com/mapbox-gl-styles

Mapbox GL Styles

emerald



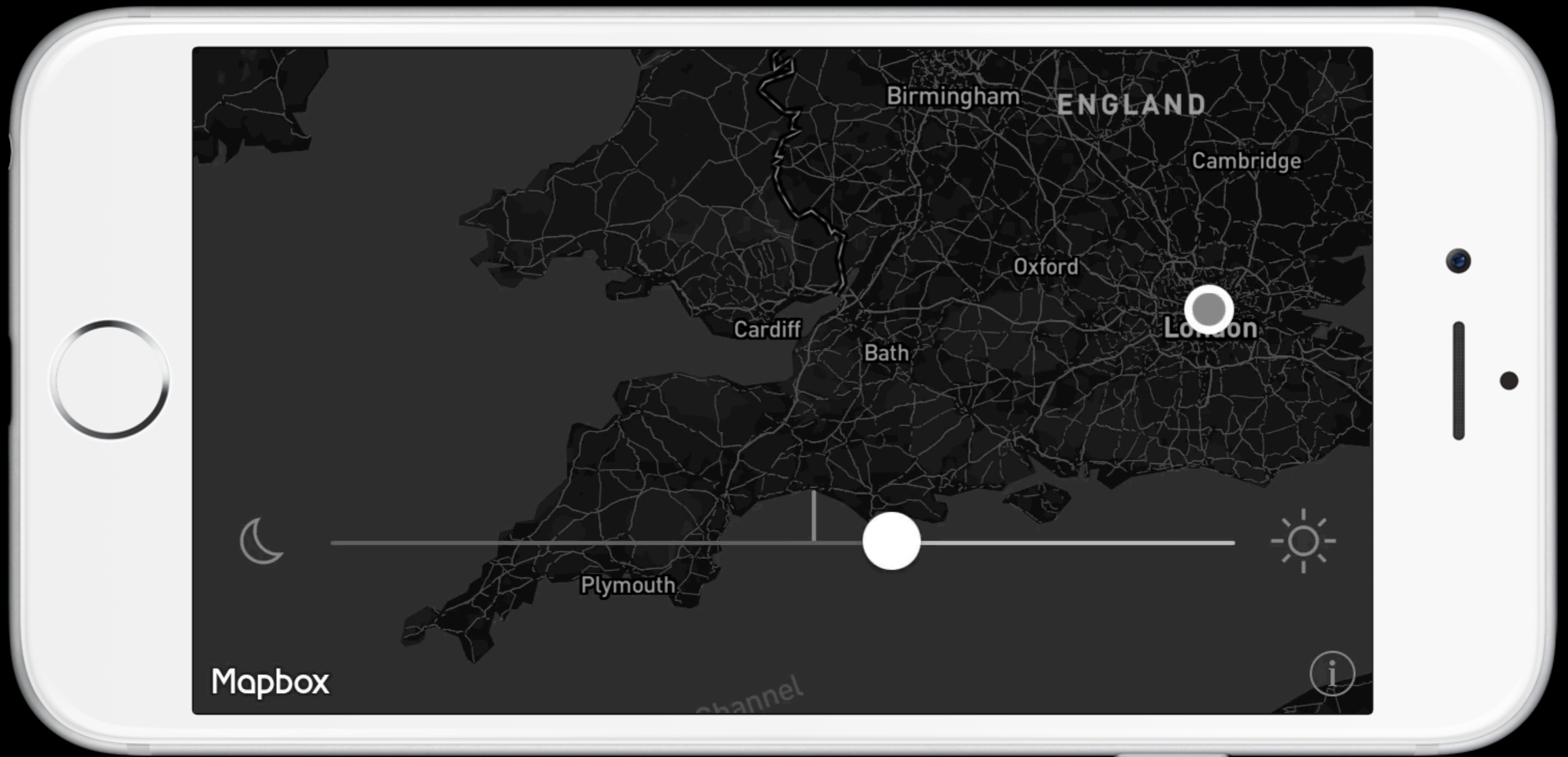
Mobile Potential

- Mobile doesn't just mean phone
- Mobile means **personal & hyper-local**
- Pocket computers with an ever-increasing number of sensors
- This space will grow (wearables, anyone?)

Ambient Light

- Dark room: lower contrast map & night mode
- Bright outdoors: high contrast map & day mode
- Mobile devices have sensors, so we can automate this!

Ambient Light



Ambient Light



Pedometers

- Change map info density & scale
- Based on walk/run/bike/drive/fly activity
- Walk/run: show dog parks, water fountains
- Drive (or run): show highways (or not)
- Fly: show state & park borders, major cities

What's Next?

- Better high-level APIs for easier integration
- Testing on more devices
 - Particularly looking for Android hackers!
- Your apps!



In Closing

- Vector tiles + on-device rendering are here today
- Lots of app potential & Mapbox is trying to build the ball bearings
- Hackers welcome!

Thanks & Questions

- github.com/mapbox (450+ repos)
- mapbox.com/blog (almost daily)
- justin@mapbox.com
- [@incanus77](https://twitter.com/incanus77)

