High DPI & Retina Displays in the Eye of the Cartographer

Justin Miller • MapBox

NACIS 2012 Annual Meeting • Portland, Oregon

Introduction

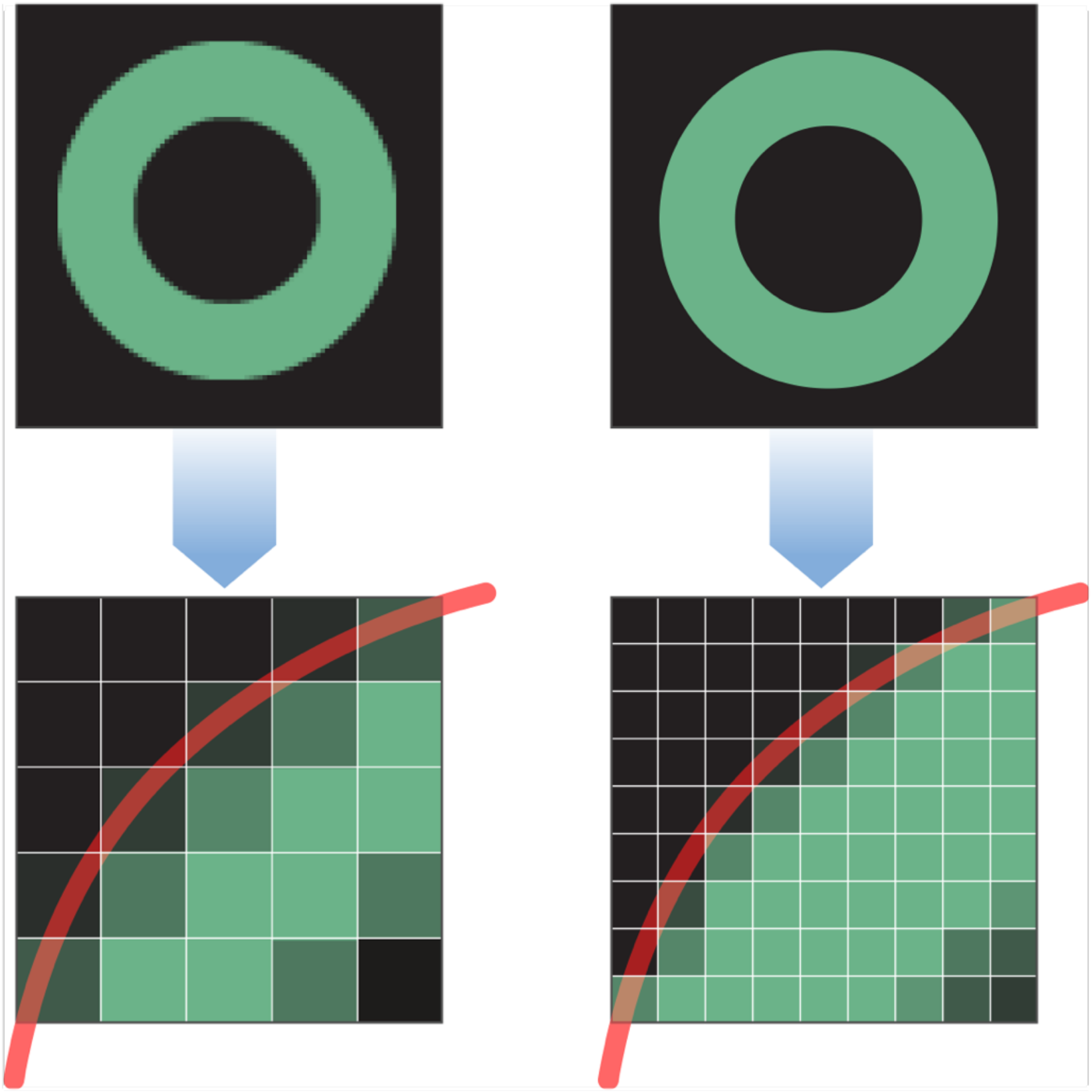
- Background in programming
- Not in cartography
- MapBox overview
  - Cartographic tools & online map hosting
  - Build the toolsets for iPhone & iPad

Perspective

- More about the medium than the message
- Practical realities of web/mobile mapping
- Awareness of a trend that is on the rise

DPI & PPI

- Dots per inch & pixels per inch
- Refers to RGB pixels, not sub-pixels
- Historical computer screens
  - Mac: 72 PPI
  - Windows: 96 PPI

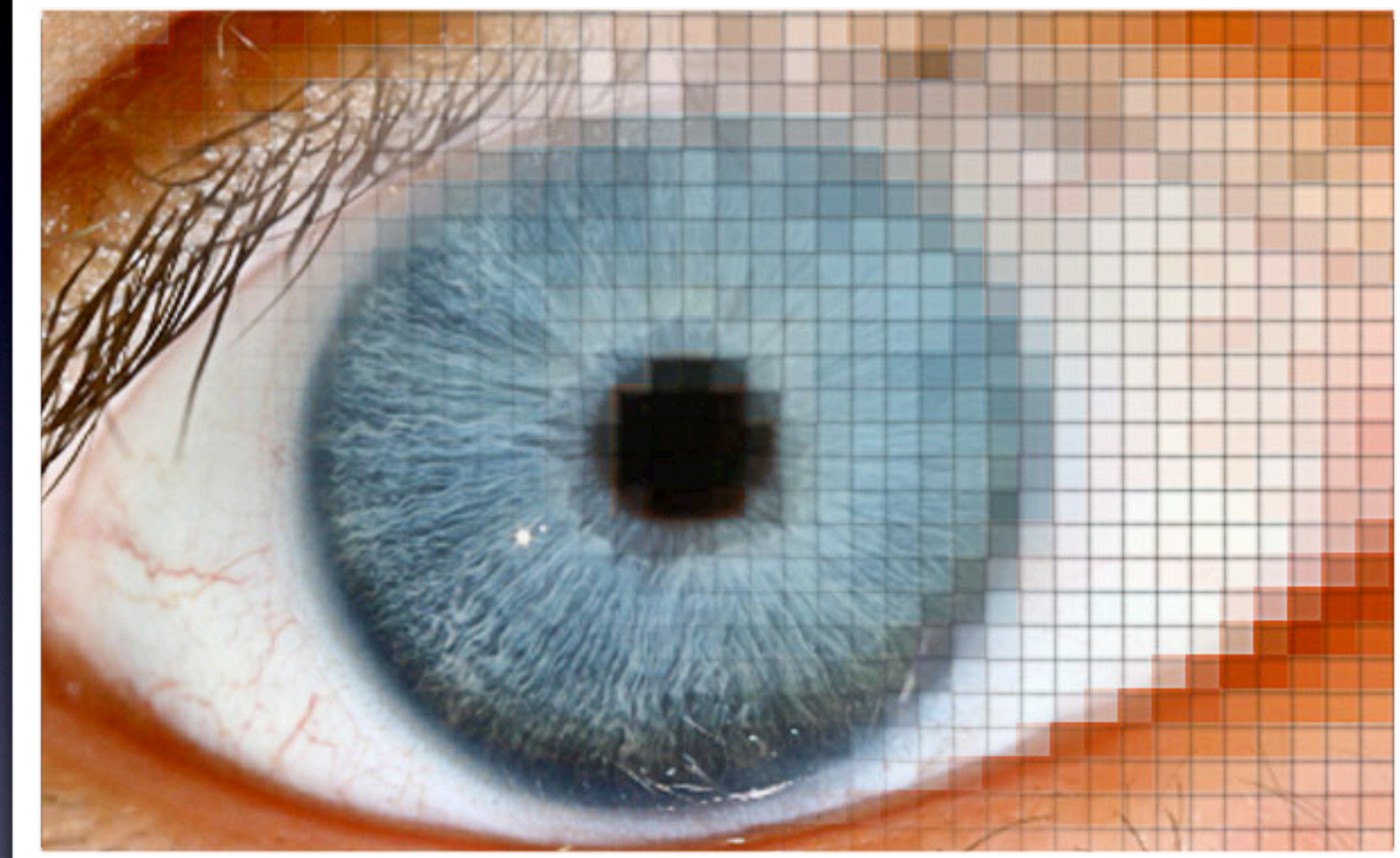


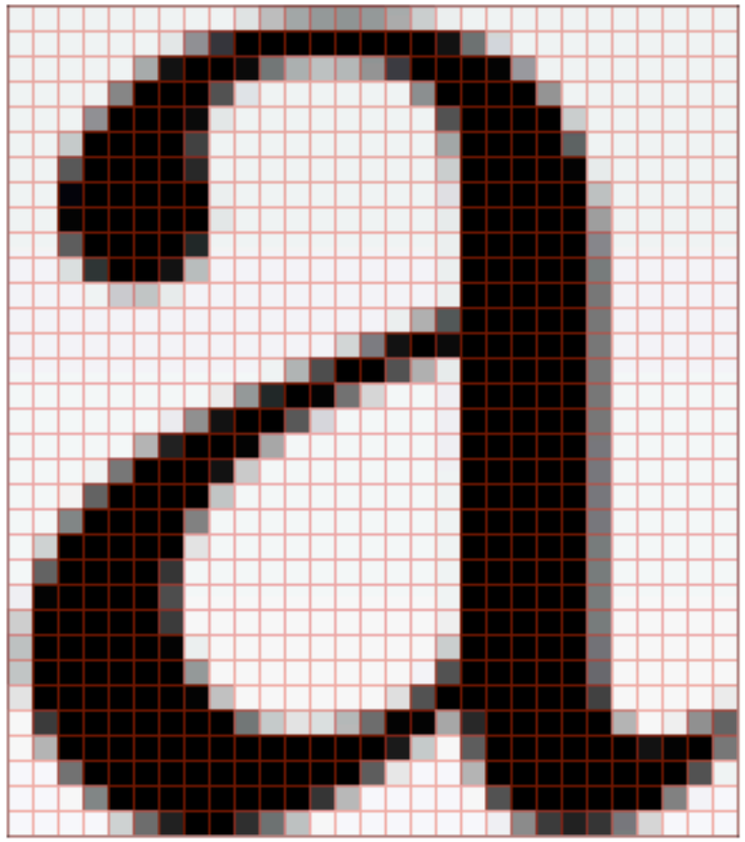
Normal Displays

HDTV	42”	**~50 PPI**
MacBook	13”	**114 PPI**
Kindle	6”	**167 PPI**
iPhone	3.5”	**163 PPI**

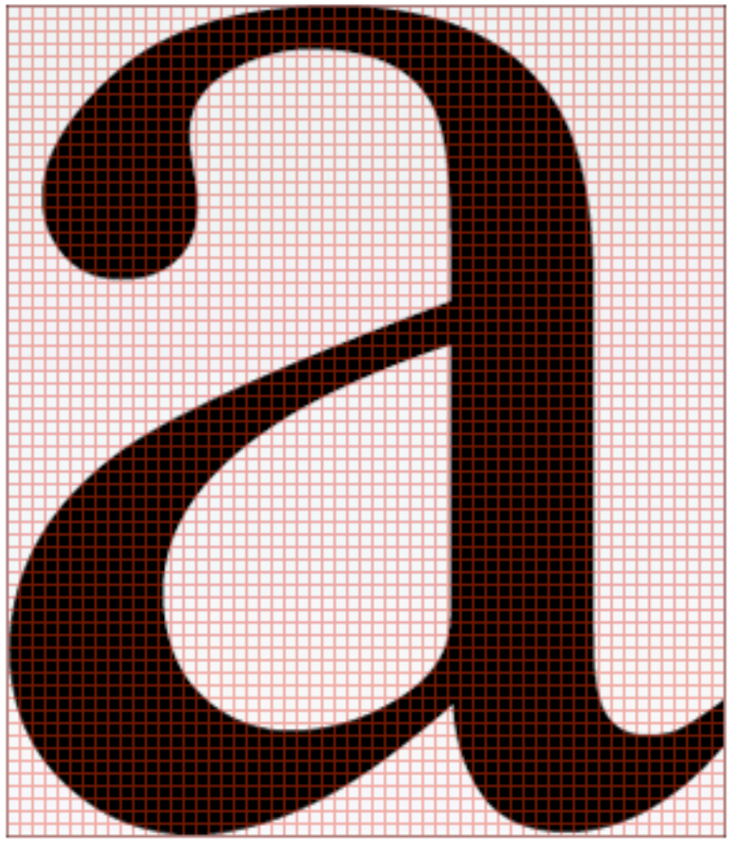
Retina Displays

iPhone 4	3.5”	**326 PPI**
iPad 3	10”	**264 PPI**
MacBook Pro	15”	**220 PPI**

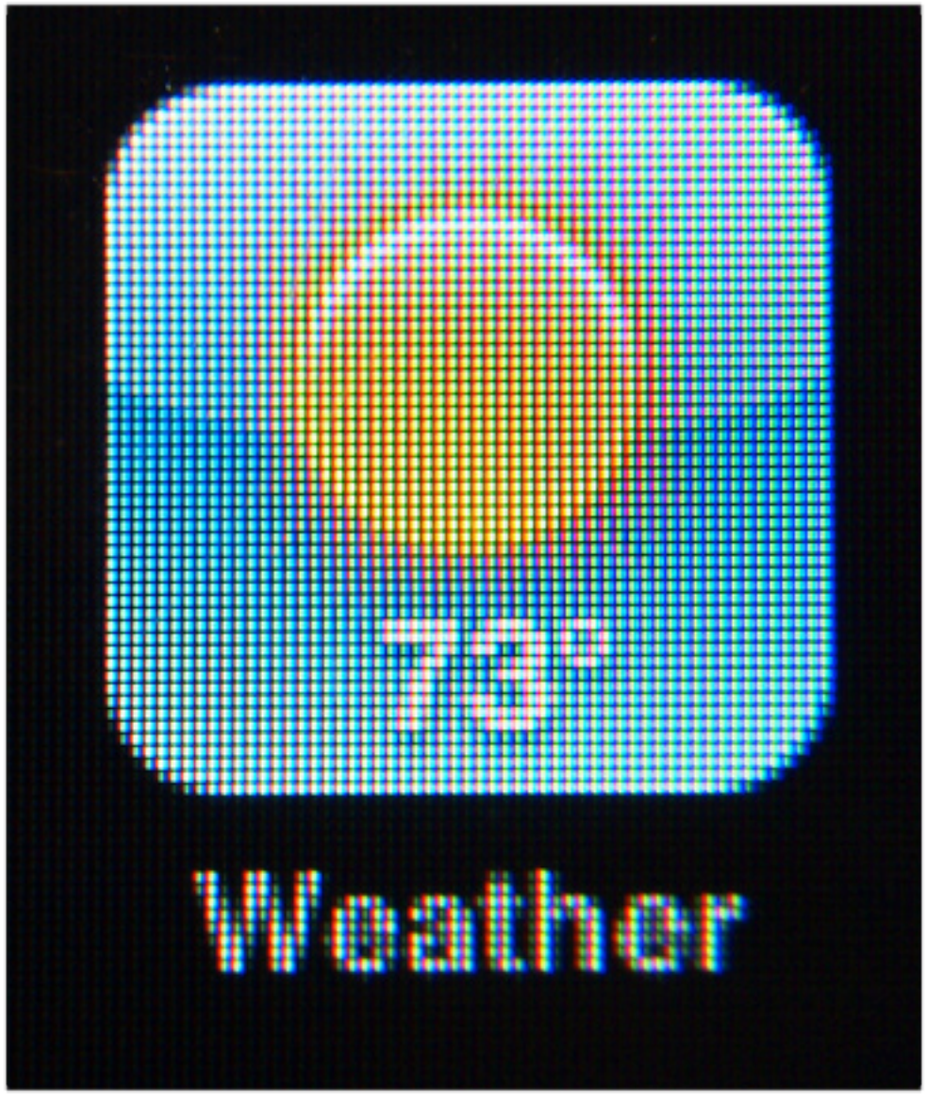


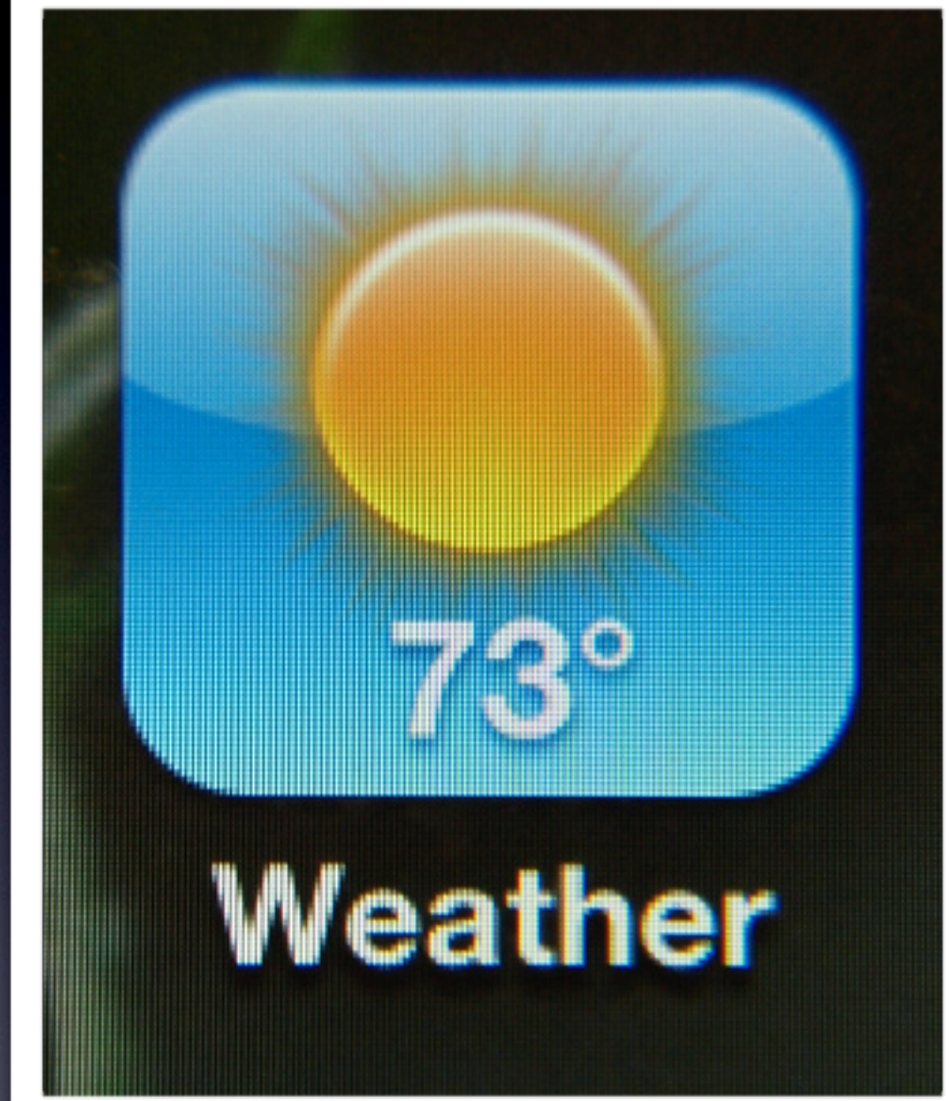


Previous Display (163 ppi)



Retina Display (326 ppi)





flickr.com/photos/itchykawa

Usage

- iPhone 4: first weekend sales of 1.7M
- iPhone 4S: first day preorders of 1M
- iPad 3: first weekend sales of 3M
- iPhone 5: first weekend sales of 5M
- Total iOS devices: 400M
- i.e. probably not going away anytime soon

apple.com/pr

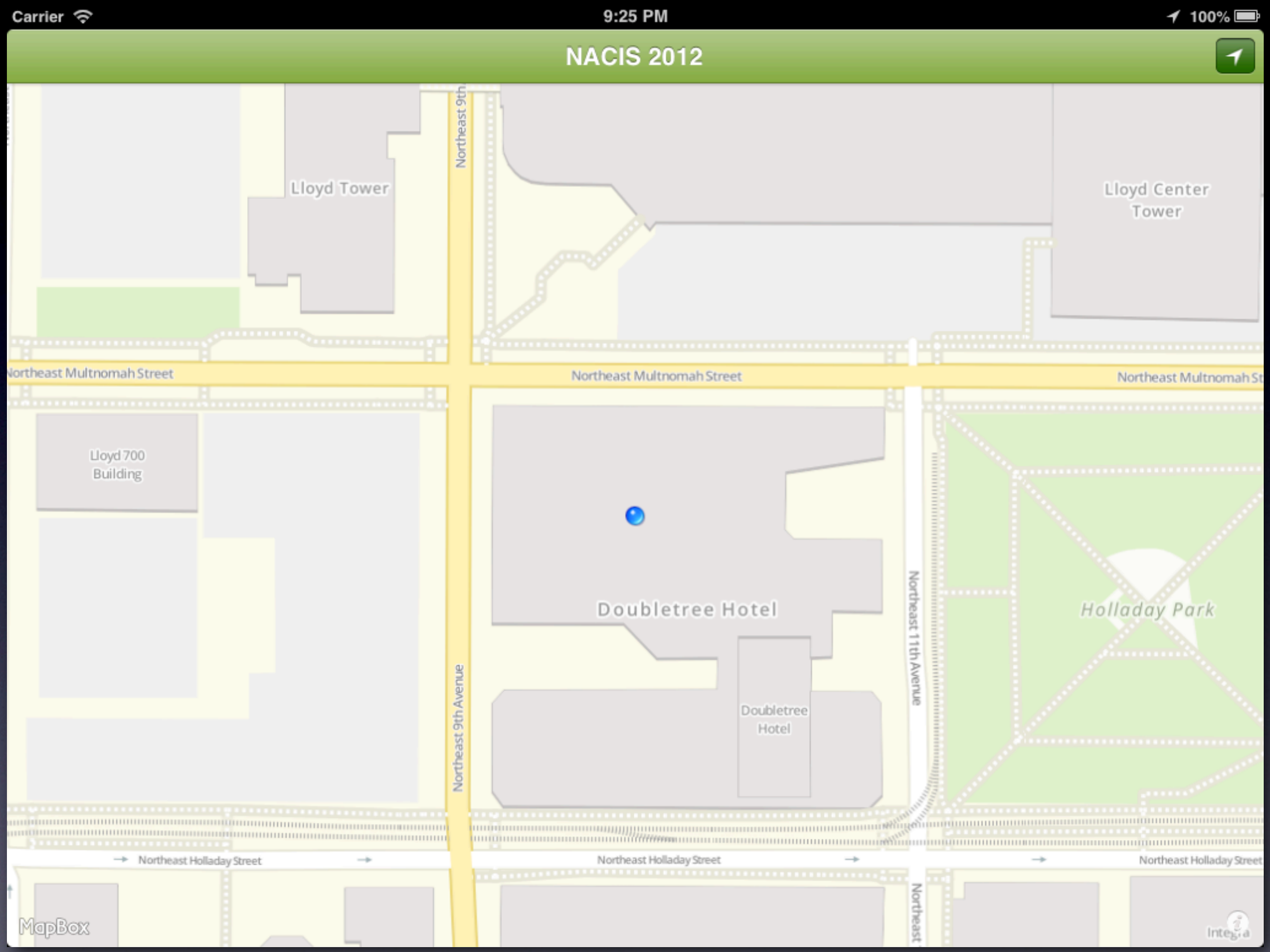
High-Level Effects

- Sharp, crisp imagery & text
- 2x pixel density horizonally & vertically
- 4x pixel count for same physical size
- Increased legibility of smaller features

Lower-Level Effects

- Map tile count increased by 4x
  - Impacts network & render performance
- Absolute image size decreases ¼x
  - Impacts coverage for given zoom level
- Designing for multi-scale cartography
  - Vectors are still a programmer's realm

www.animalwallpapers.us


Carrier
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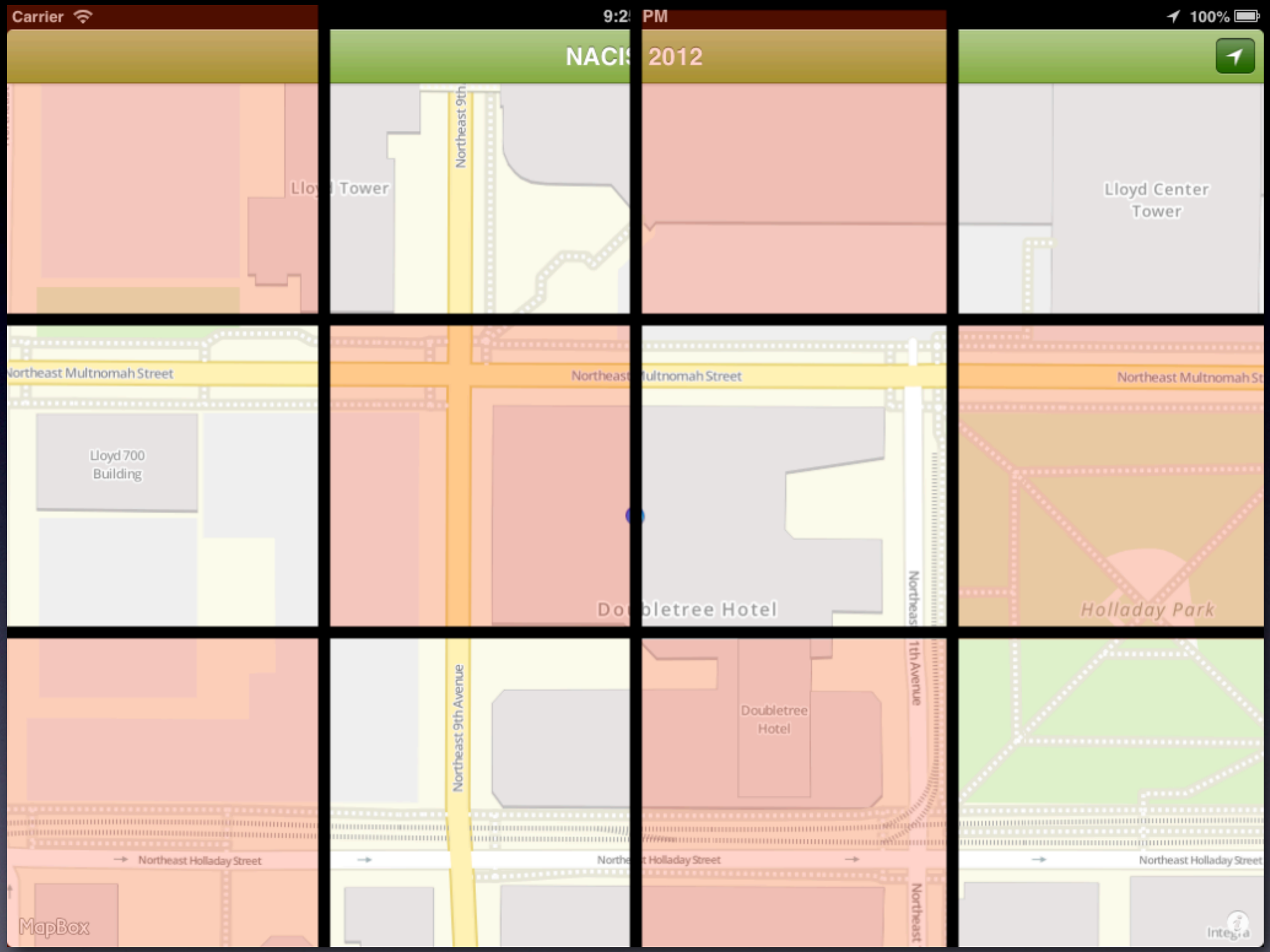
NACIS 2012
Lloyd Tower
Northeast 9th
Lloyd Center Tower
Northeast Multnomah Street
Northeast Multnomah Street
Northeast Multnomah St
Lloyd 700 Building
Doubletree Hotel
Doubletree Hotel
Northeast 11th Avenue
Holladay Park
Northeast 9th Avenue
Northeast Holladay Street
Northeast Holladay Street
Northeast Holladay Street
MapBox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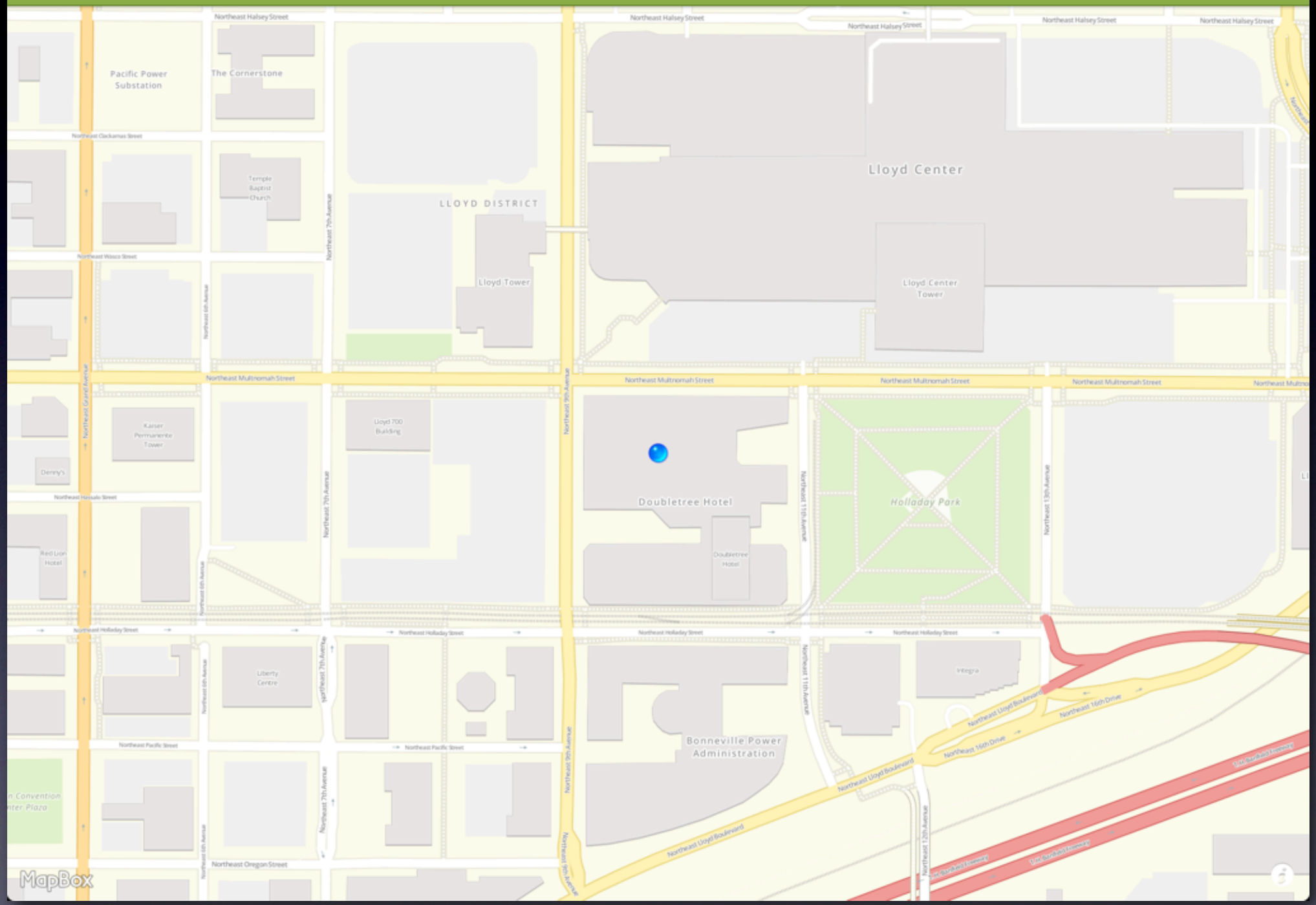

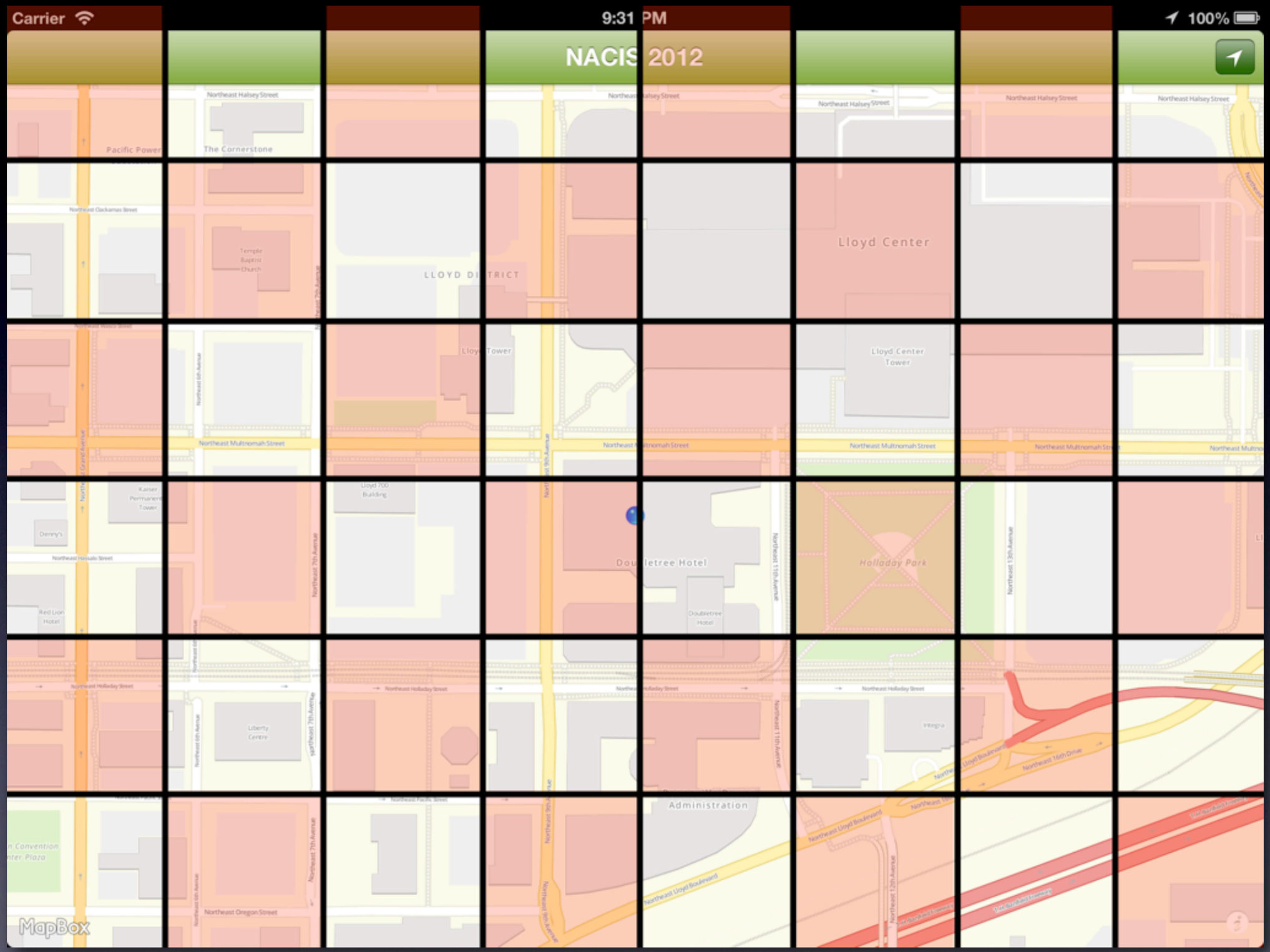
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NACIS 2012
Pacific Power
The Cornerstone
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Northeast Clackamas Street
Temple Baptist Church
LLOYD DISTRICT
Lloyd Tower
Lloyd Center
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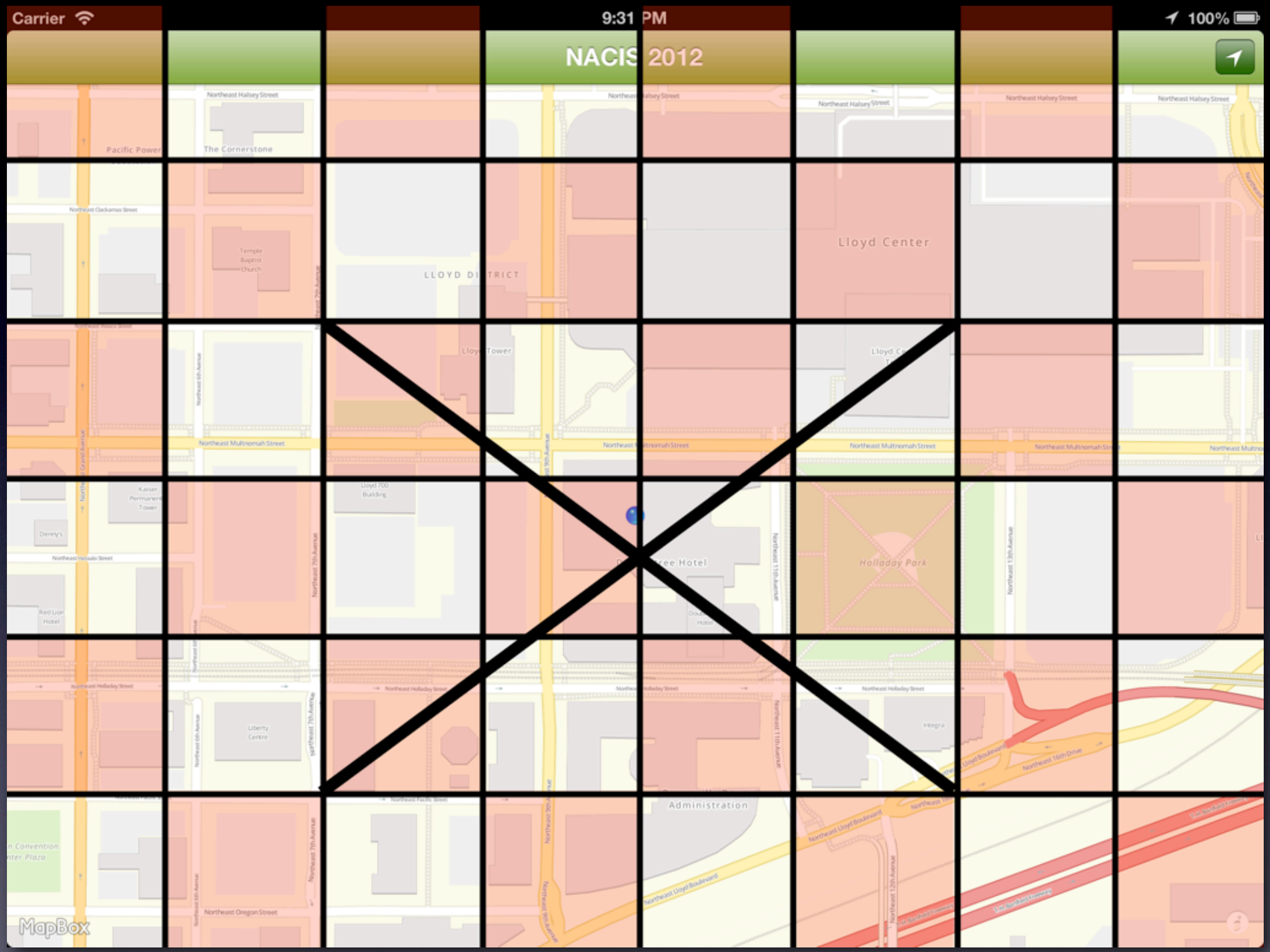
Northeast Multnomah Street
Northeast 7th Avenue
Northeast 9th Avenue
Northeast 11th Avenue
Northeast 13th Avenue
Kaiser Permanente Tower
Denny's
Red Lion Hotel
Doubletree Hotel
Holladay Park
Northeast Holladay Street
Liberty Centre
Integra
Northeast Lloyd Boulevard
Northeast 16th Drive
Administration
Northeast Oregon Street
MapBox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Integra
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Administration
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MapBox

Cartographic Effects

- Map tile size effectively reduced by ¼x
- Legibility problems for fine details
- More potential for multi-scale cartography

Decent Solution

- Double tile size to 512px
- Results in blurry, but legible, text & imagery
- Merely a stopgap

Better Solution

- Larger text, lines, and markers
- Pros
  - Legibility & clarity
- Cons
  - Requires duplication of effort
  - Requires runtime detection & logic

Solution Details

- Variable(s) representing scale factor
- Two copies of image assets
- JavaScript for web

```
if (window.devicePixelRatio === undefined)
```

- Cocoa for iOS

```
if ([[UIScreen mainScreen] scale] == 1.0)
```

TileMill

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Settings

ZOOM 17

Northeast Halsey Street
Lloyd Center
LLOYD DISTRICT
Lloyd Tower
Lloyd Center Tower
Northeast 7th Avenue
Northeast 9th Avenue
Northeast Multnomah Street
Doubletree Hotel
Holladay Park
Northeast 11th Avenue
Northeast 13th Avenue
Northeast Holladay Street
Bonneville Power Administration
Northeast Pacific Street
Northeast Lloyd Boulevard
I-84 Banfield Freeway
Oregon Building
Northeast Irving Street
Vic Alfonso Cadillac
Benson Polytech High School

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Save | Export

palette.mss | base.mss | roads.mss | labels.mss | +

```
/* ********************************************************************** */
/* OSM BRIGHT for Imposm                                                  */
/* ********************************************************************** */

/* For basic style customization you can simply edit the colors and
 * fonts defined in this file. For more detailed / advanced
 * adjustments explore the other files.
 *
 * GENERAL NOTES
 *
 * There is a slight performance cost in rendering line-caps.  An
 * effort has been made to restrict line-cap definitions to styles
 * where the result will be visible (lines at least 2 pixels thick).
 */

@s: 1;

/* ====================================================================== */
/* FONTS
/* ====================================================================== */

/* directory to load fonts from in addition to the system directories */
Map {
  font-directory: url(./fonts);
  buffer-size: 256;
}

/* set up font sets for various weights and styles */
@sans_lt:          "Open Sans Regular","DejaVu Sans Book","unifont Medium";
@sans_lt_italic:   "Open Sans Italic","DejaVu Sans Italic","unifont Medium";
@sans:             "Open Sans Semibold","DejaVu Sans Book","unifont Medium";
@sans_italic:      "Open Sans Semibold Italic","DejaVu Sans Italic","unifont Med
@sans_bold:        "Open Sans Bold","DejaVu Sans Bold","unifont Medium";
@sans_bold_italic: "Open Sans Bold Italic","DejaVu Sans Bold Italic","unifont Me

/* Some fonts are larger or smaller than others. Use this variable to
   globally increase or decrease the font sizes. */
/* Note this is only implemented for certain things so far */
@text_adjust: 0;

/* ====================================================================== */
/* LANDUSE & LANDCOVER COLORS
/* ====================================================================== */

@land:             #FCFBE7;
@water:            #C4DFF6;
@grass:            #E6F2C1;
```

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```
334   marker-line-width:0 * @s;
335   marker-line-opacity:0;
336   marker-allow-overlap:true;
337 }
338 #turning_circle_case,
339 #turning_circle_fill {
340   [zoom=14] { marker-width:@rdz14_min * 1.1 * @s; }
341   [zoom=15] { marker-width:@rdz15_min * 1.1 * @s; }
342   [zoom=16] { marker-width:@rdz16_min * 1.1 * @s; }
343   [zoom=17] { marker-width:@rdz17_min * 1.1 * @s; }
344   [zoom>=18] { marker-width:@rdz18_min * 1.1 * @s; }
345 }
346
347 /* ================================================================== */
348 /* AEROWAYS
349 /* ================================================================== */
350
351 #aeroway[zoom>9] {
352   line-color:@aeroway;
353   line-cap:butt;
354   line-join:miter;
355   [type='runway'] {
356     [zoom=10]{ line-width:1 * @s; }
357     [zoom=11]{ line-width:2 * @s; }
358     [zoom=12]{ line-width:3 * @s; }
359     [zoom=13]{ line-width:5 * @s; }
360     [zoom=14]{ line-width:7 * @s; }
361     [zoom=15]{ line-width:11 * @s; }
362     [zoom=16]{ line-width:15 * @s; }
363     [zoom=17]{ line-width:19 * @s; }
364     [zoom>17]{ line-width:23 * @s; }
365   }
366   [type='taxiway'] {
367     [zoom=10]{ line-width:0.2 * @s; }
368     [zoom=11]{ line-width:0.2 * @s; }
369     [zoom=12]{ line-width:0.2 * @s; }
370     [zoom=13]{ line-width:1 * @s; }
371     [zoom=14]{ line-width:1.5 * @s; }
372     [zoom=15]{ line-width:2 * @s; }
373     [zoom=16]{ line-width:3 * @s; }
374     [zoom=17]{ line-width:4 * @s; }
375     [zoom>17]{ line-width:5 * @s; }
376   }
377 }
378
379 /*************************************************************************** */
380
```

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12  * effort has been made to restrict line-cap definitions to styles
13  * where the result will be visible (lines at least 2 pixels thick).
14  */
15
16 @s: 2;
17
18 /* ==================================================================== */
19 /* FONTS
20 /* ==================================================================== */
21
22 /* directory to load fonts from in addition to the system directories */
23 Map {
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37    globally increase or decrease the font sizes. */
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41 /* ==================================================================== */
42 /* LANDUSE & LANDCOVER COLORS
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```

Conclusion

- High DPI (and beyond) is here to stay
- Maps can and will look better
- Practical implications for existing maps
- Stopgaps are available
- Properly addressing requires (re-)design

Thank You!

- Twitter: @*incanus77* and @*MapBox*
- Email: *justin@mapbox.com*
- Blog: *http://mapbox.com/blog*
- Code: *http://github.com/mapbox*
- Find me later!