Taking Core Location Indoors

Session 708
Nav Patel
Software Engineer

Overview

Indoor Positioning

How do you use it?

Indoor Positioning and iBeacon Technology

Next steps

Today's Technology

Cellular, GPS, Wi-Fi

Today’s Technology

Cellular

Area in a city

Low power

Always available

Today’s Technology

GPS

Accurate enough for navigation

Available globally

Less accurate in urban canyons

Today's Technology

Wi-Fi

Within a city block

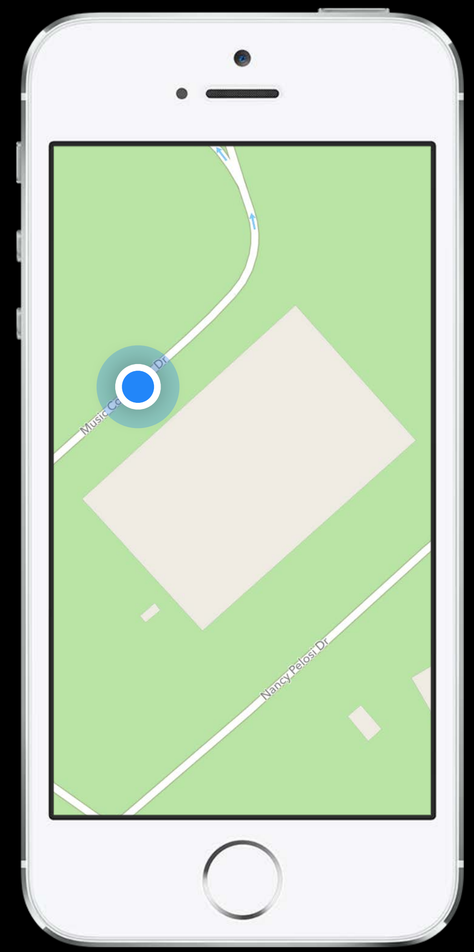
Augments GPS positioning

Wi-Fi only devices

Existing Location

Navigation outdoors

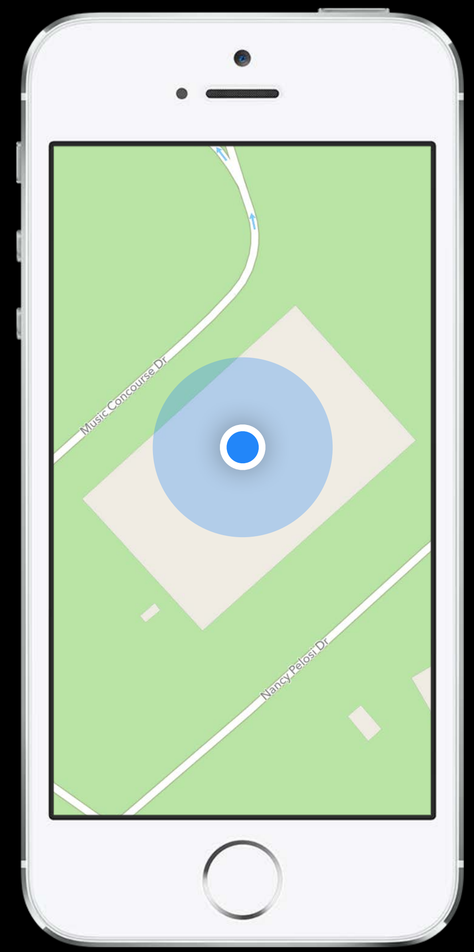
Works well globally



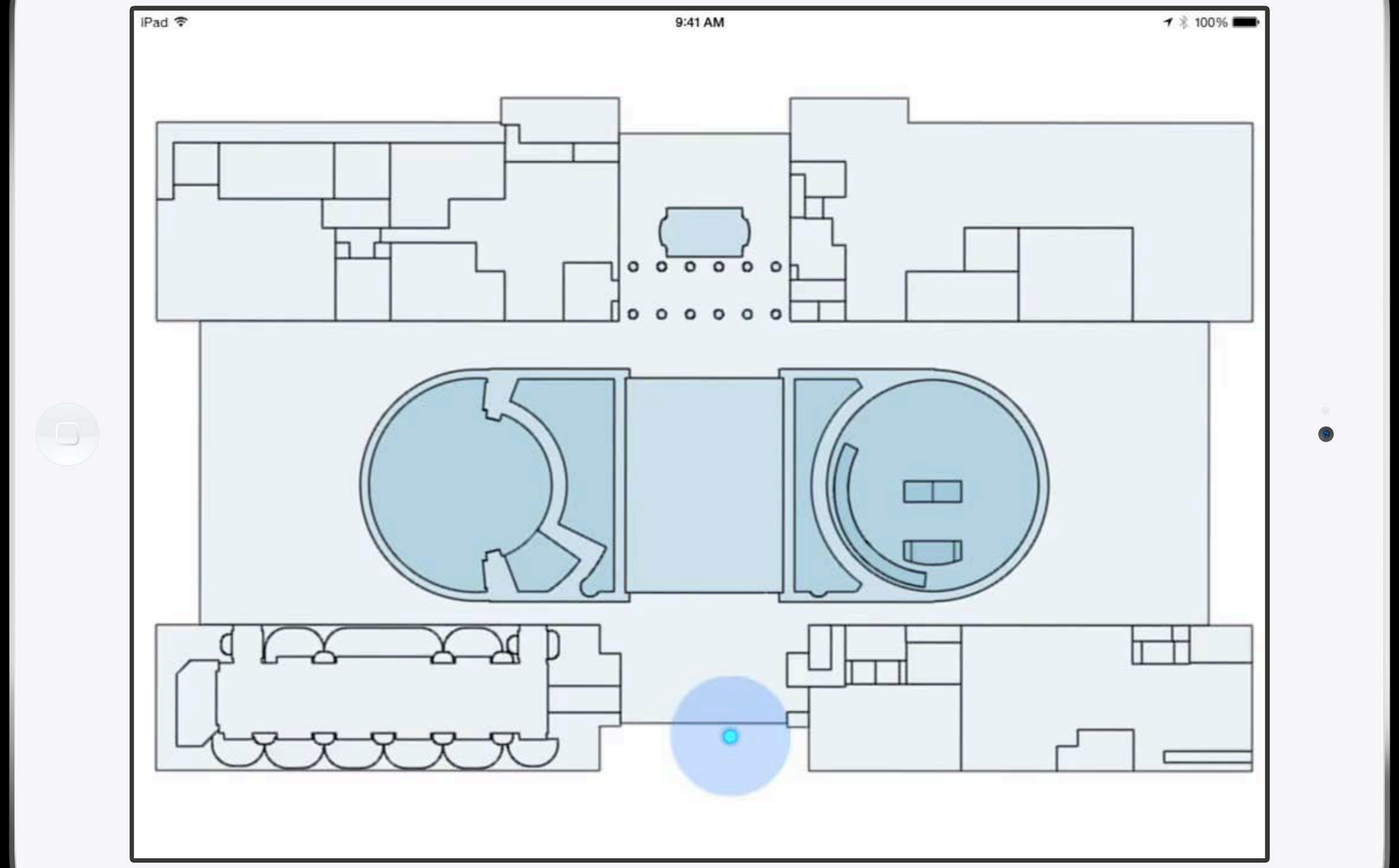
Problem

Not great indoors

Altitude, not floor



Indoor Positioning

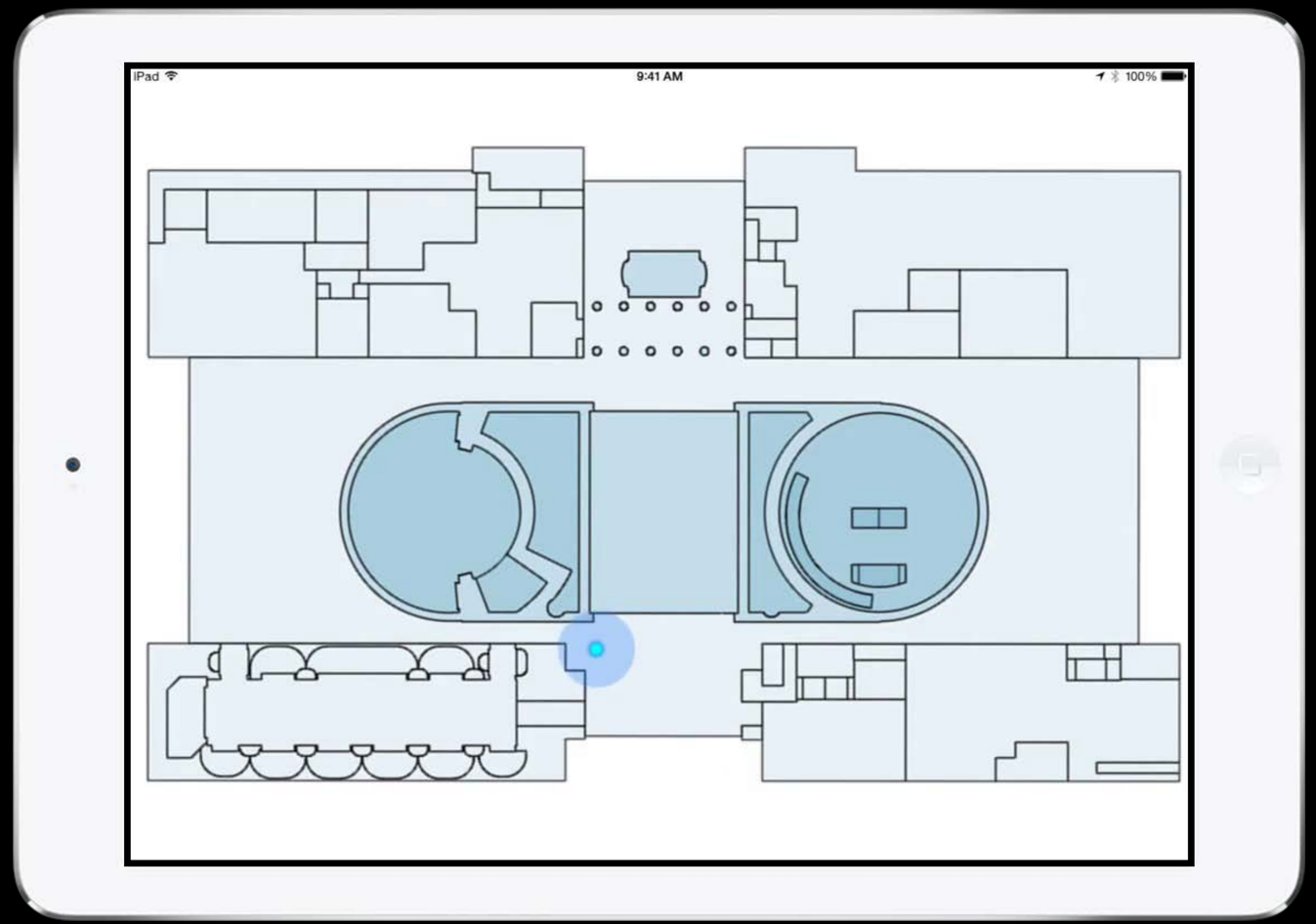


Playback Speed 10x

Indoor Positioning

RF Parametric data

Motion sensors



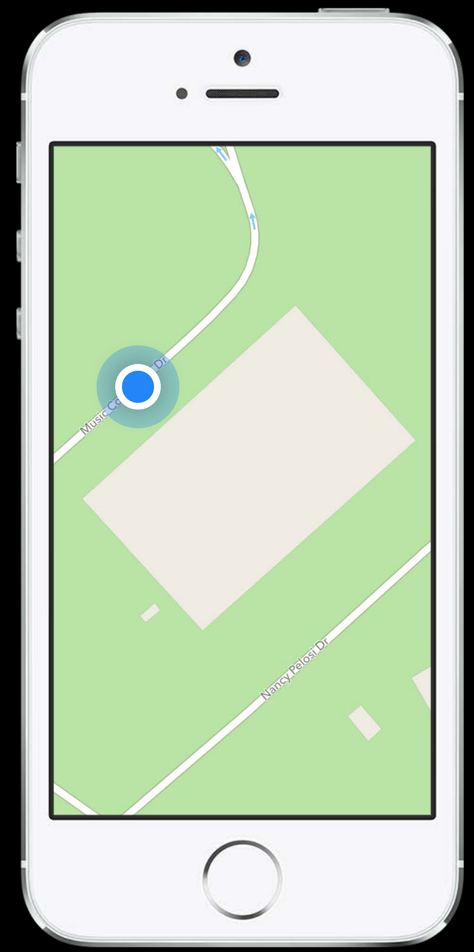
How Does It All Work?

Getting indoors

Cell

GPS

Wi-Fi



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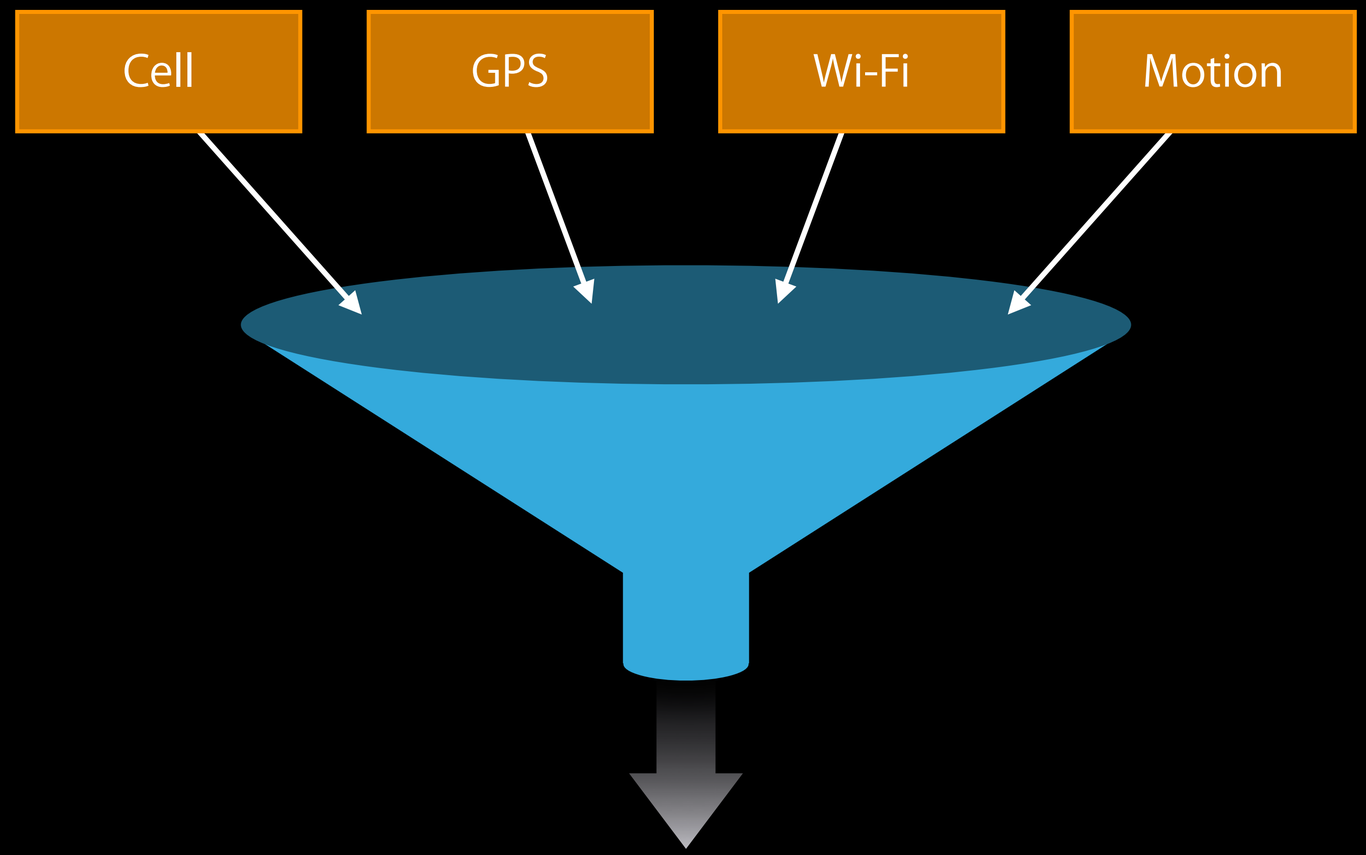

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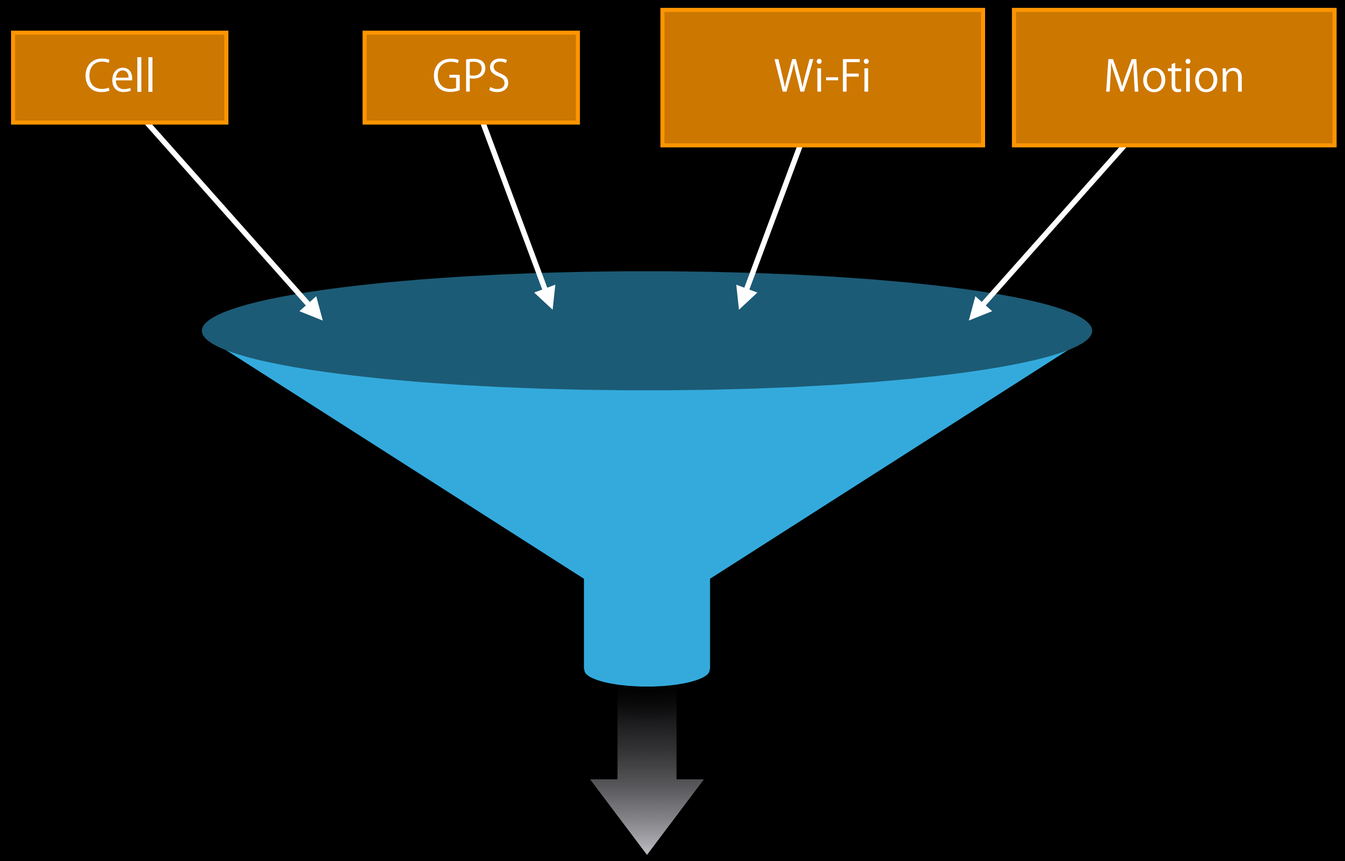

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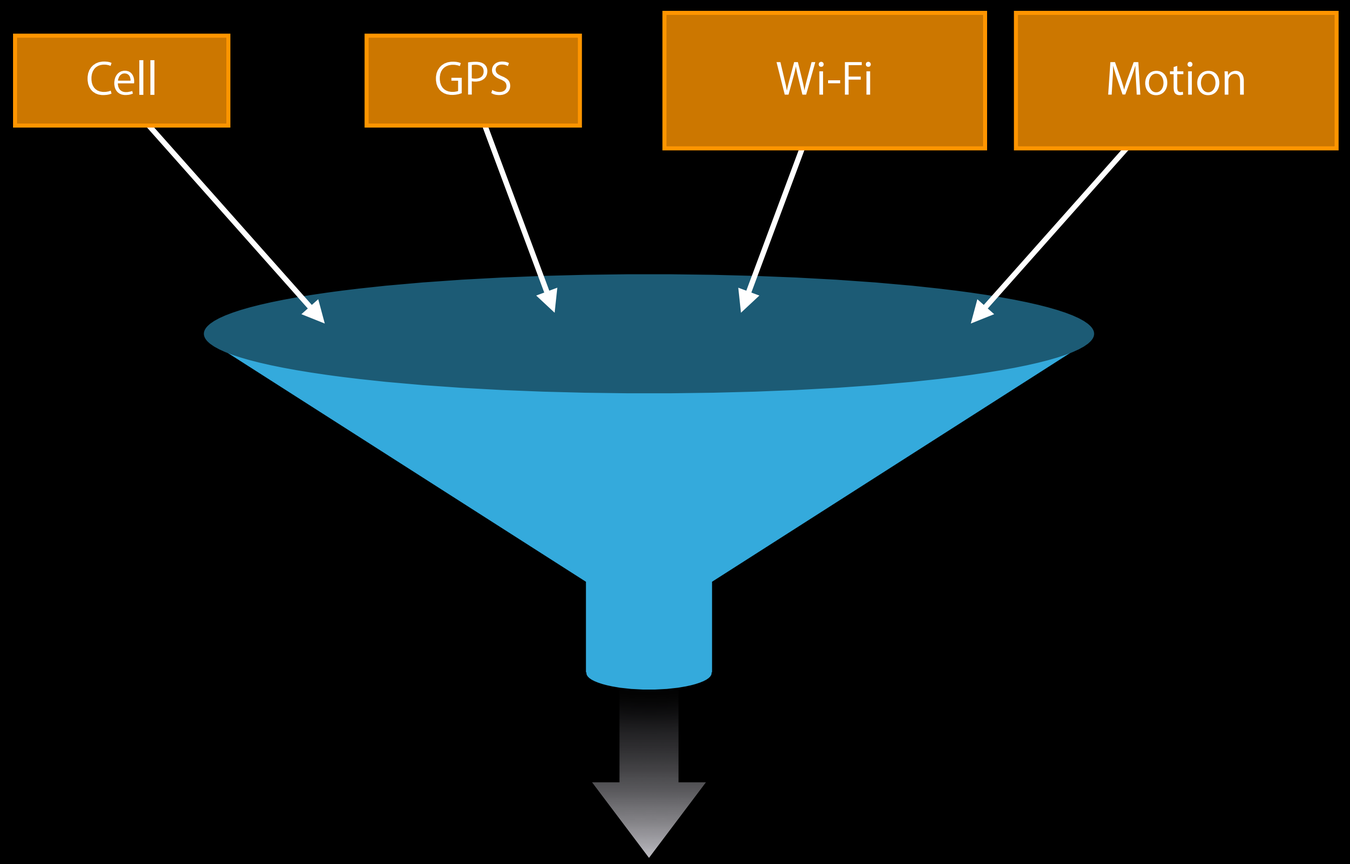
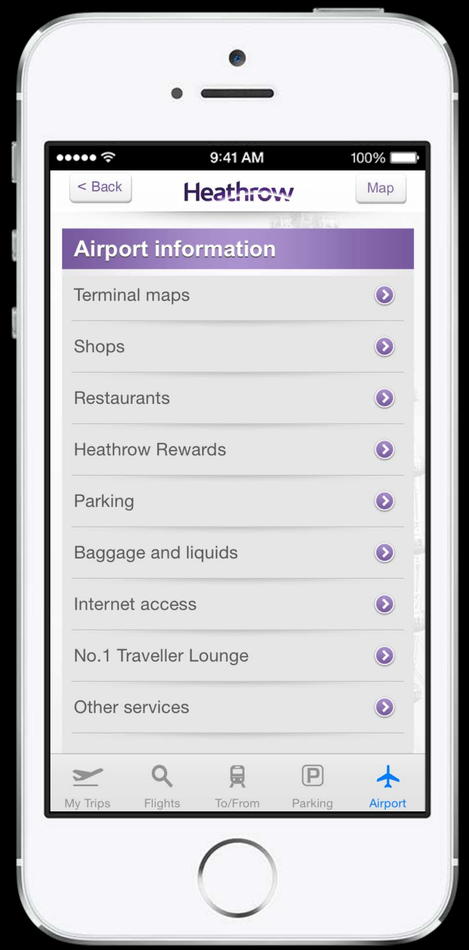


Why Indoors?

Why Indoors?

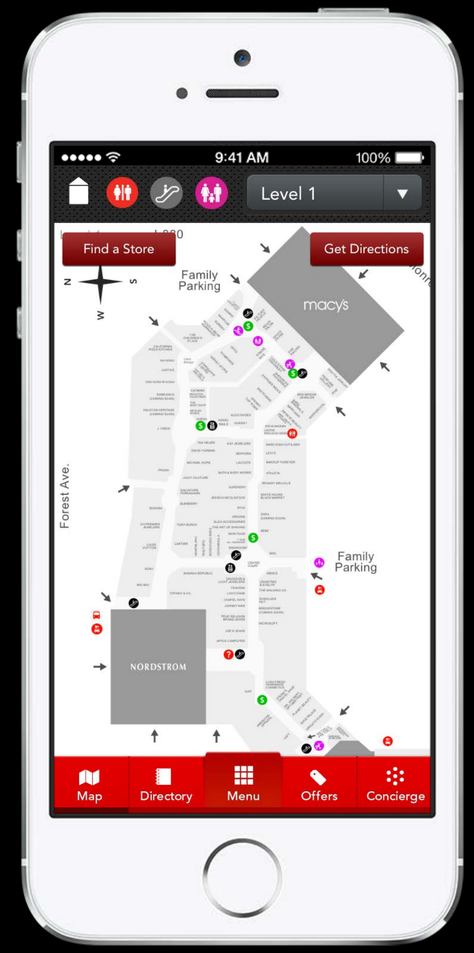
Directories



Why Indoors?

Directories

Venue maps

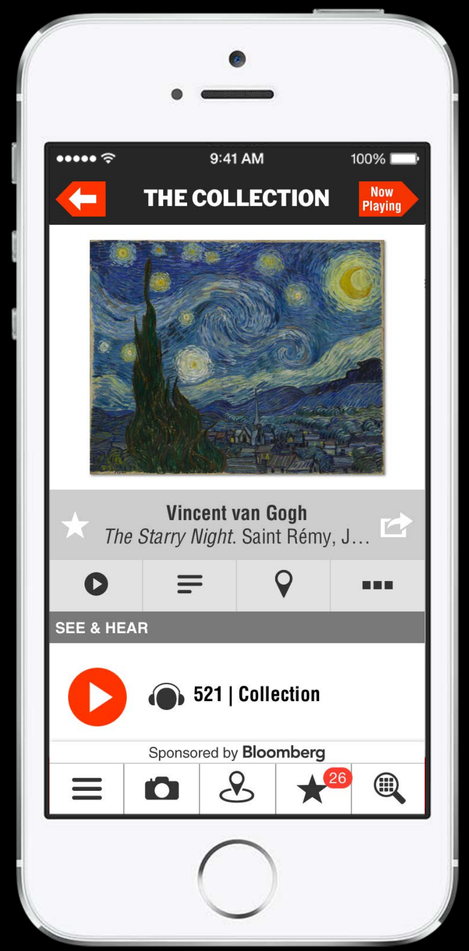


Why Indoors?

Directories

Venue maps

Some interactivity



Why Indoors?

Location is context

Why Indoors?

Location is context

Way-finding

Why Indoors?

Location is context

Why Indoors?

Location is context

Find each other

Why Indoors?

Location is context

Find each other

Find you

Why Indoors?

Location is context

Why Indoors?

Location is context

Last piece of the puzzle

How Do You Use It?

Core Location

How Do You Use It?

Core Location

Wi-Fi on, device unlocked

How Do You Use It?

Core Location

Wi-Fi on, device unlocked

Exact same Core Location API

How Do You Use It?

Core Location

Wi-Fi on, device unlocked

Exact same Core Location API

Floor number

How Do You Use It?

CLFloor

How Do You Use It?

CLFloor

```
@property(readonly, nonatomic, copy) CLFloor *floor

@interface CLFloor
    @property(readonly, nonatomic) NSInteger level;
@end
```

Building an Indoor Application

Overcoming spherical coordinate challenges

Vitali Lovich

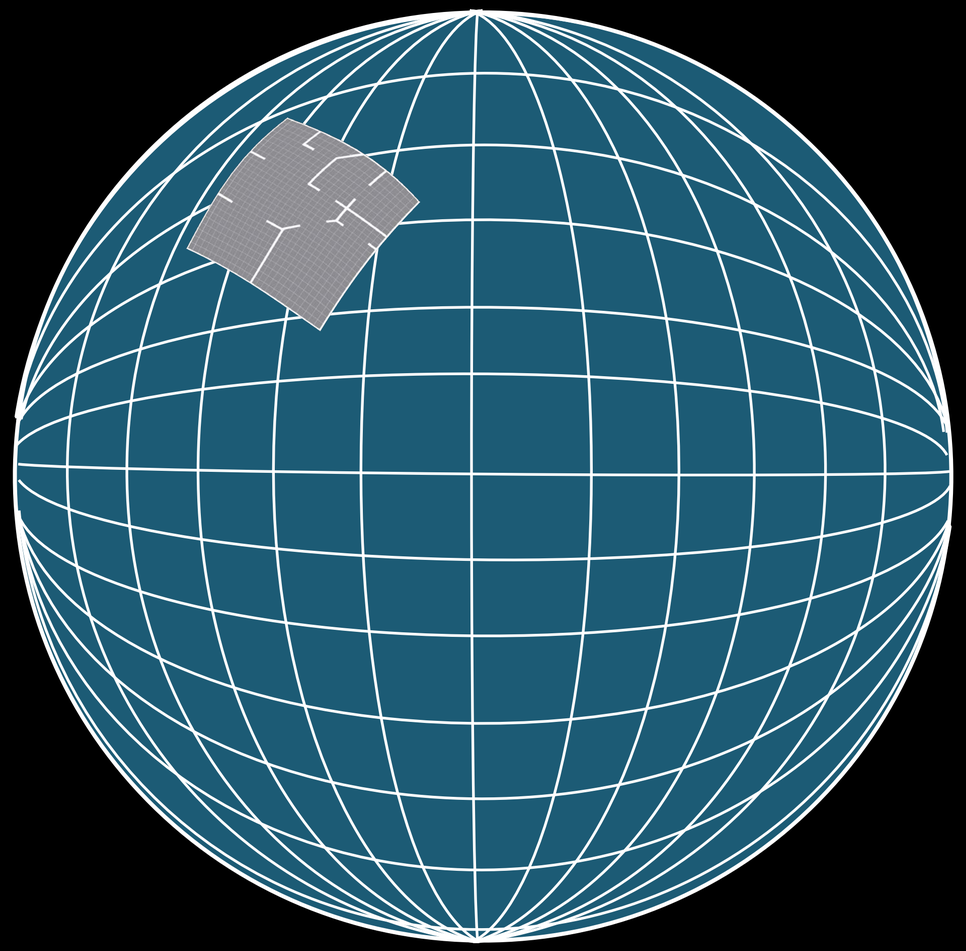
Geographic Coordinate System

Latitude/longitude

Common

Convenient

Difficult to work with

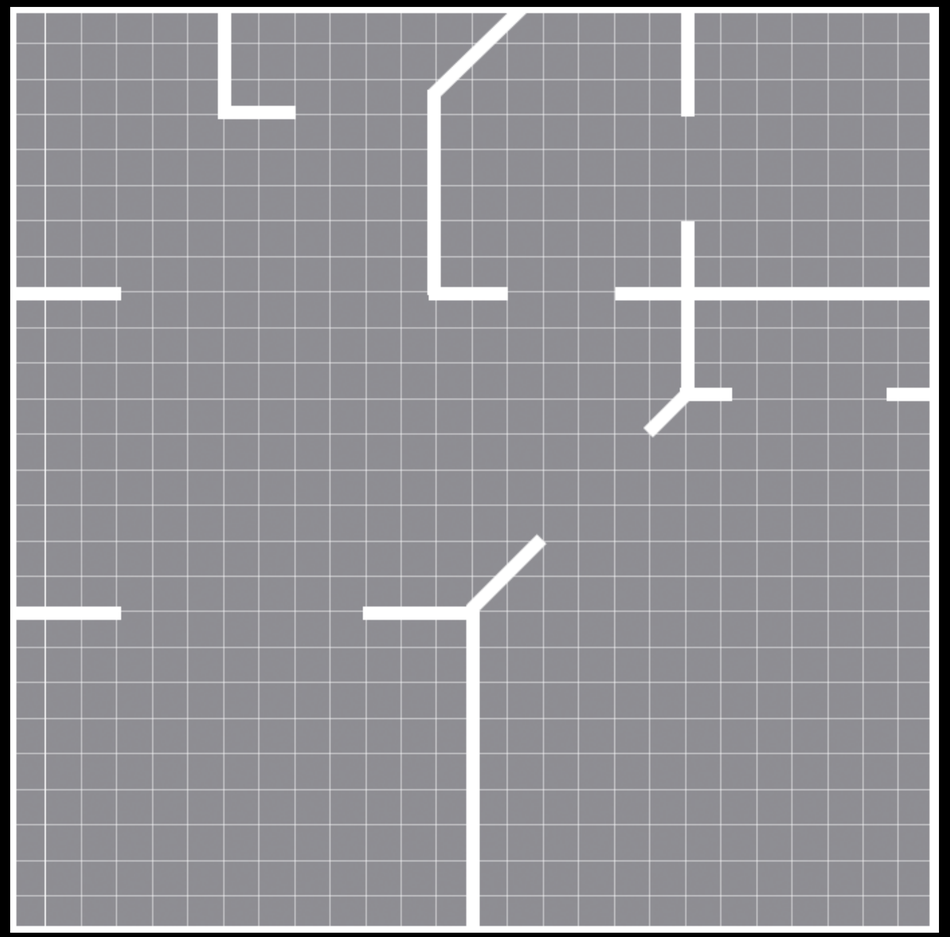


Floorplan Image

Easy for display

Convenient graphical coordinates

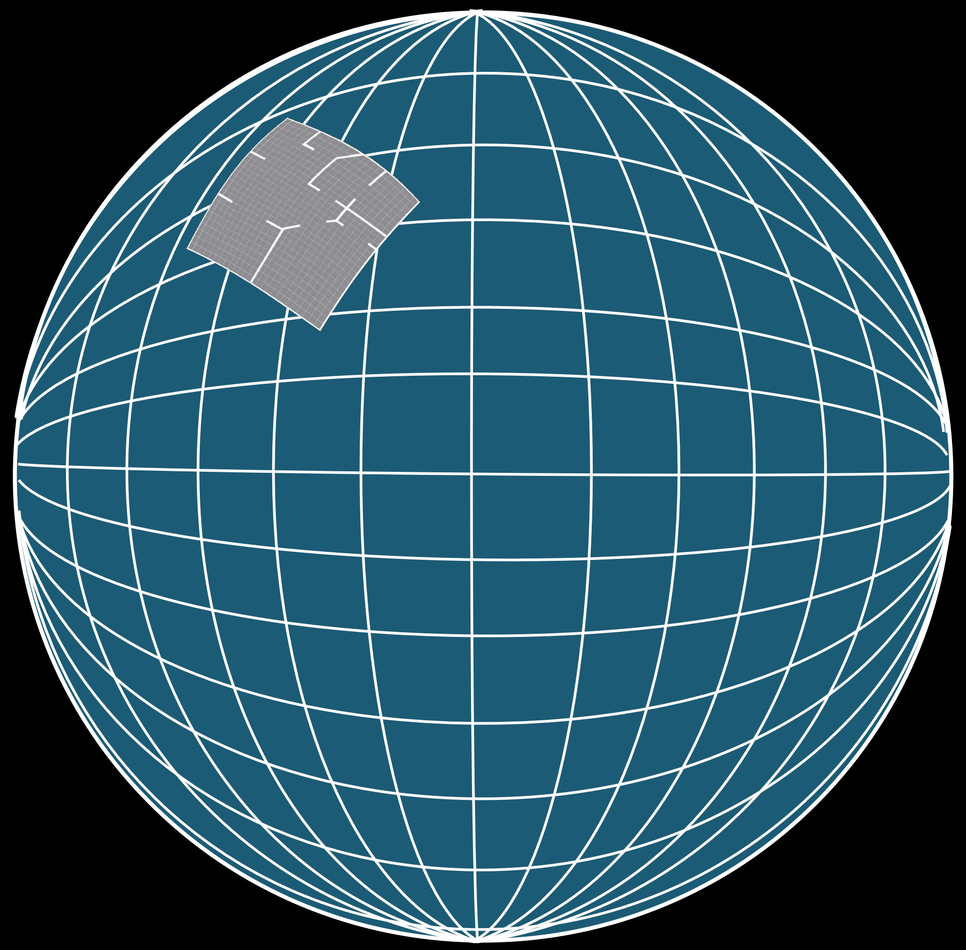
Display coordinate frame



Conversion

Three coordinate frames to consider

Watch out for spherical distortion



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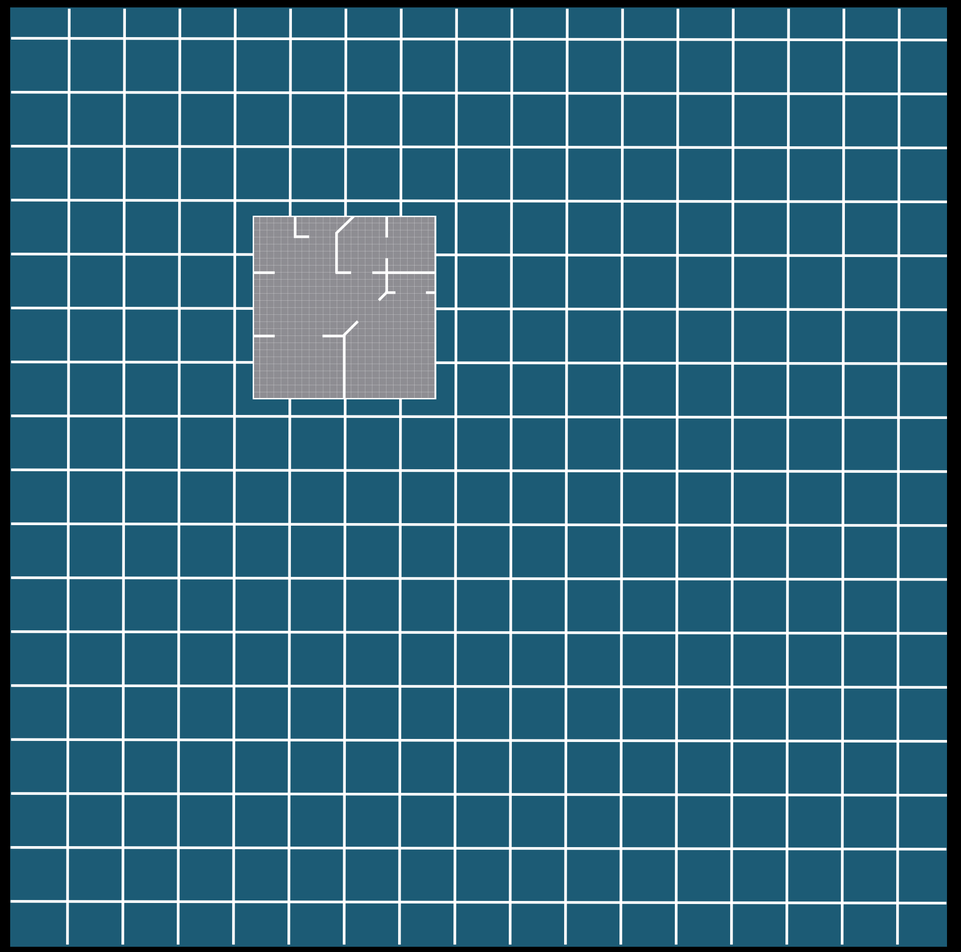


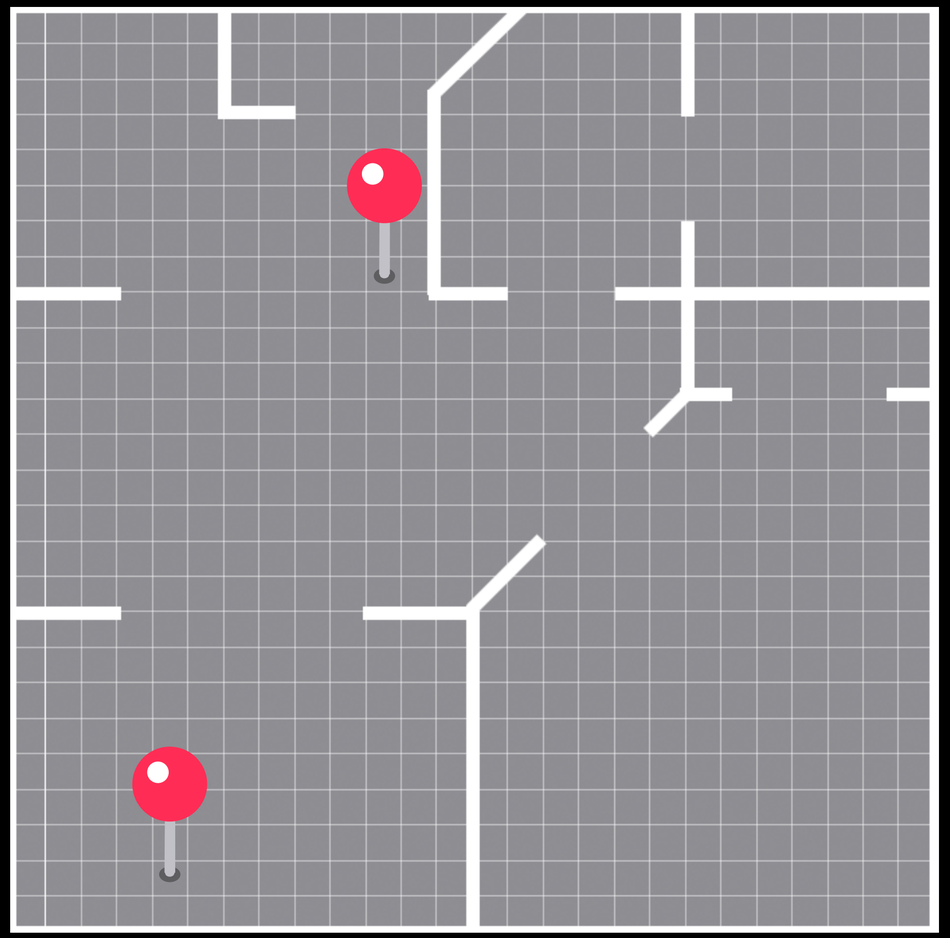
Helper Functions

```
MKMapPointForCoordinate
MKMetersBetweenMapPoints
MKMetersPerMapPointAtLatitude
CGAffineTransformMakeScale
CGAffineTransformMakeRotation
CGPointApplyAffineTransform
```

Required Data

Two anchor points

Anchor point = latitude/longitude + floorplan pixels



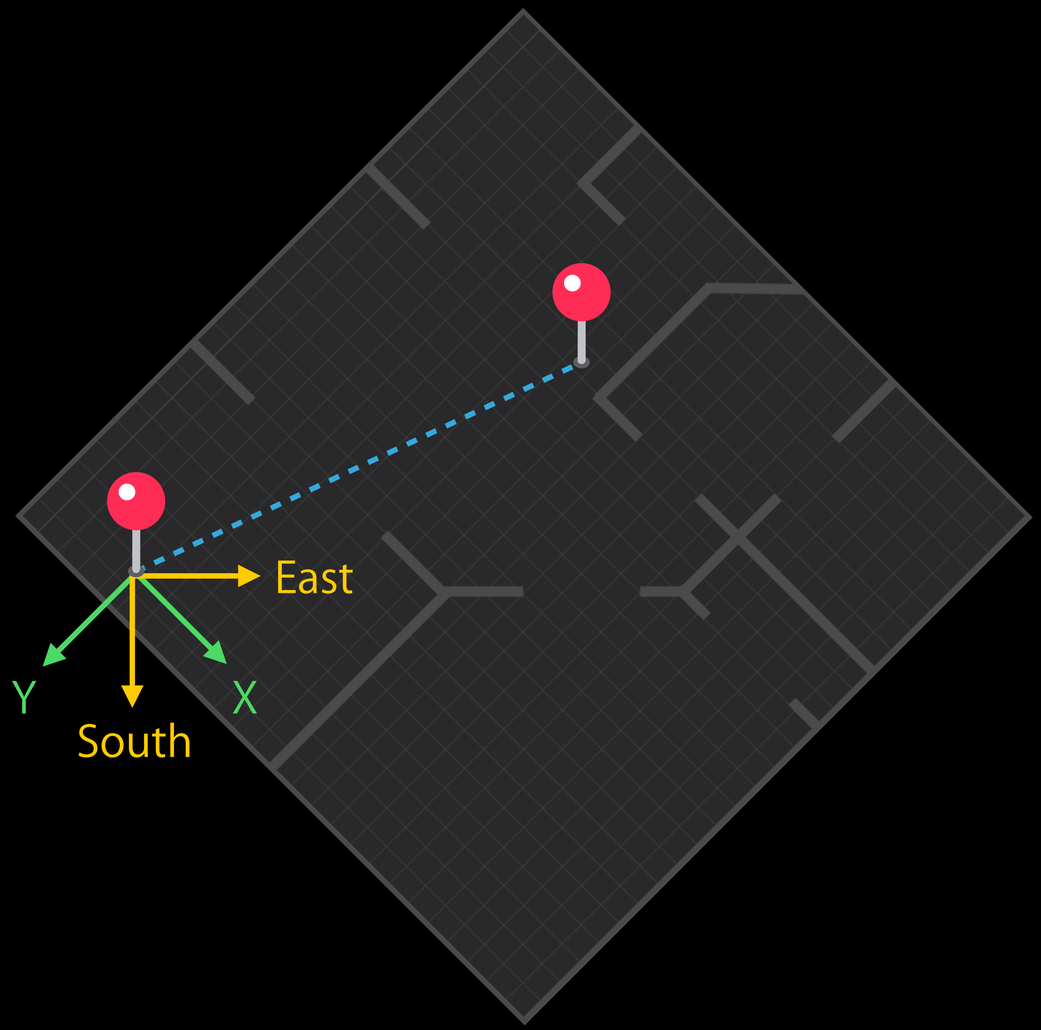
Scale

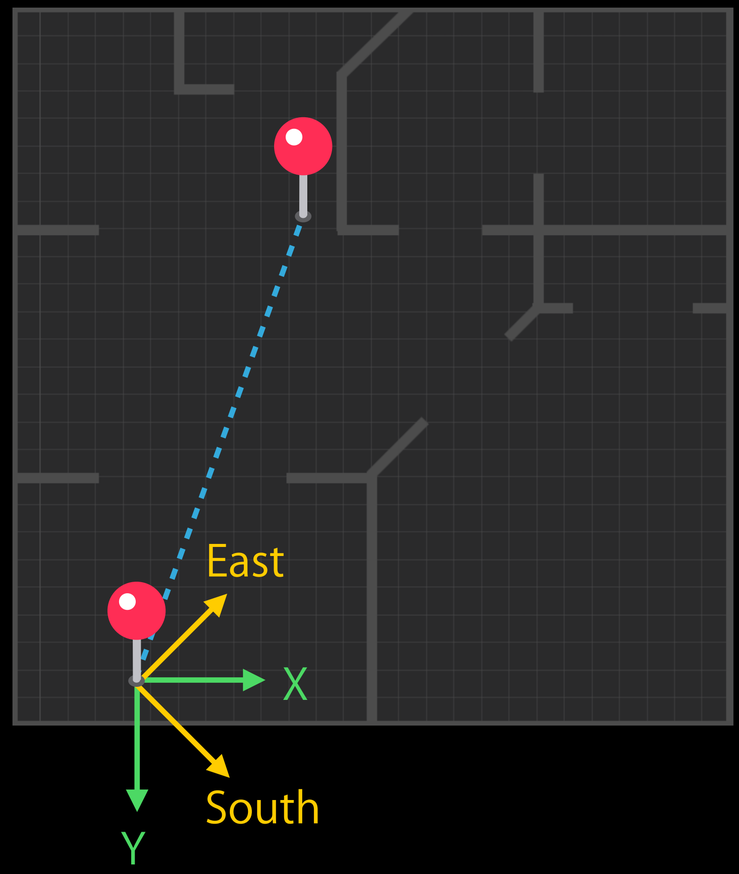
We need pixelsPerMeter

- P2 = MKMapPointForCoordinate(A1.Geo)
- P1 = MKMapPointForCoordinate(A2.Geo)
- MKMetersBetweenMapPoints(P1, P2)

hypot(A2.Pixels.x - A1.Pixels.x, A2.Pixels.y - A2.Pixels.y)

Orientation





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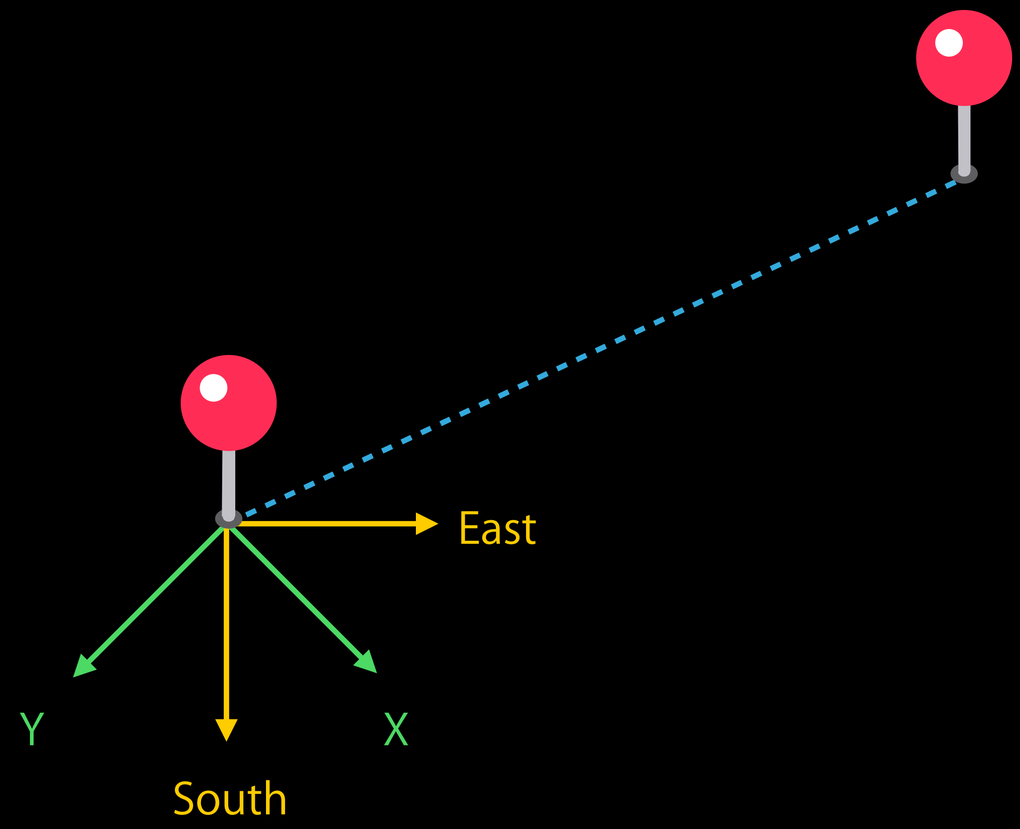

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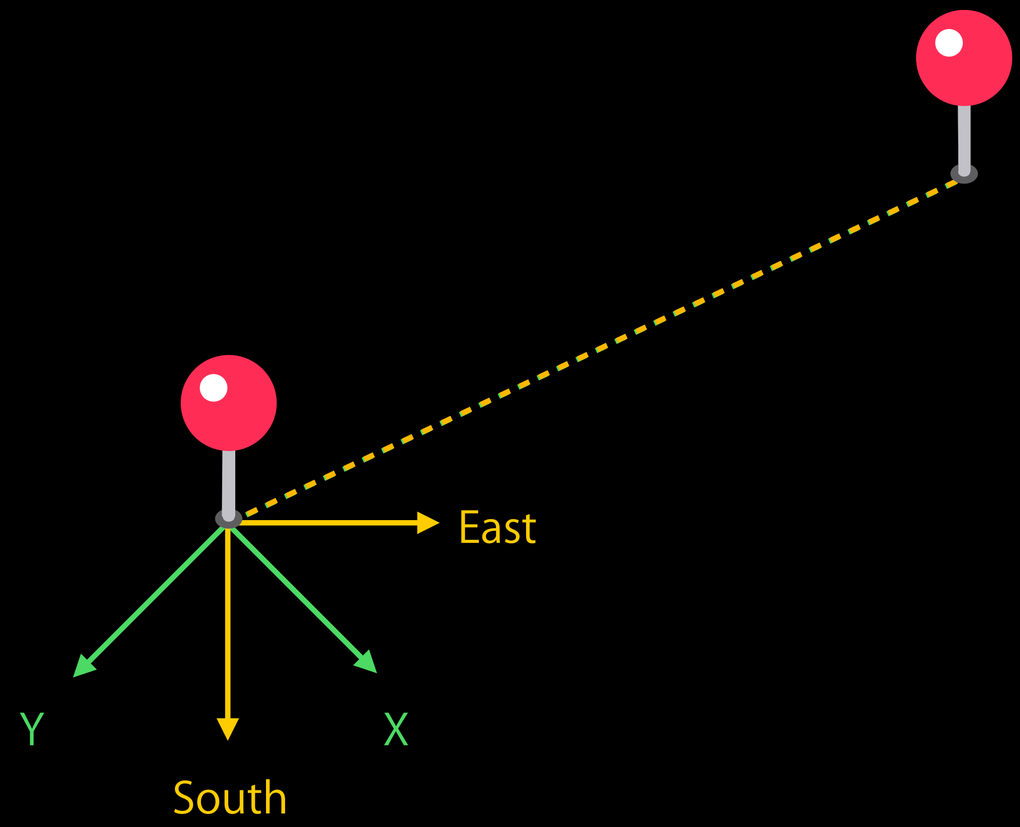

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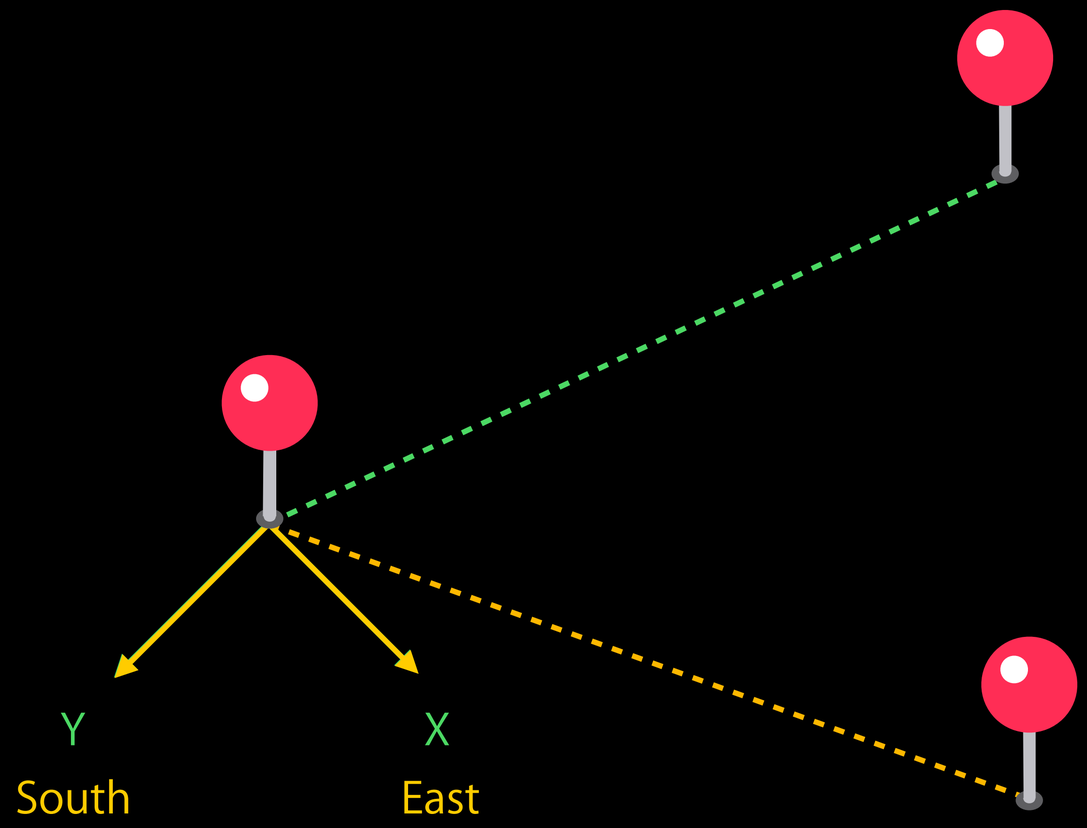

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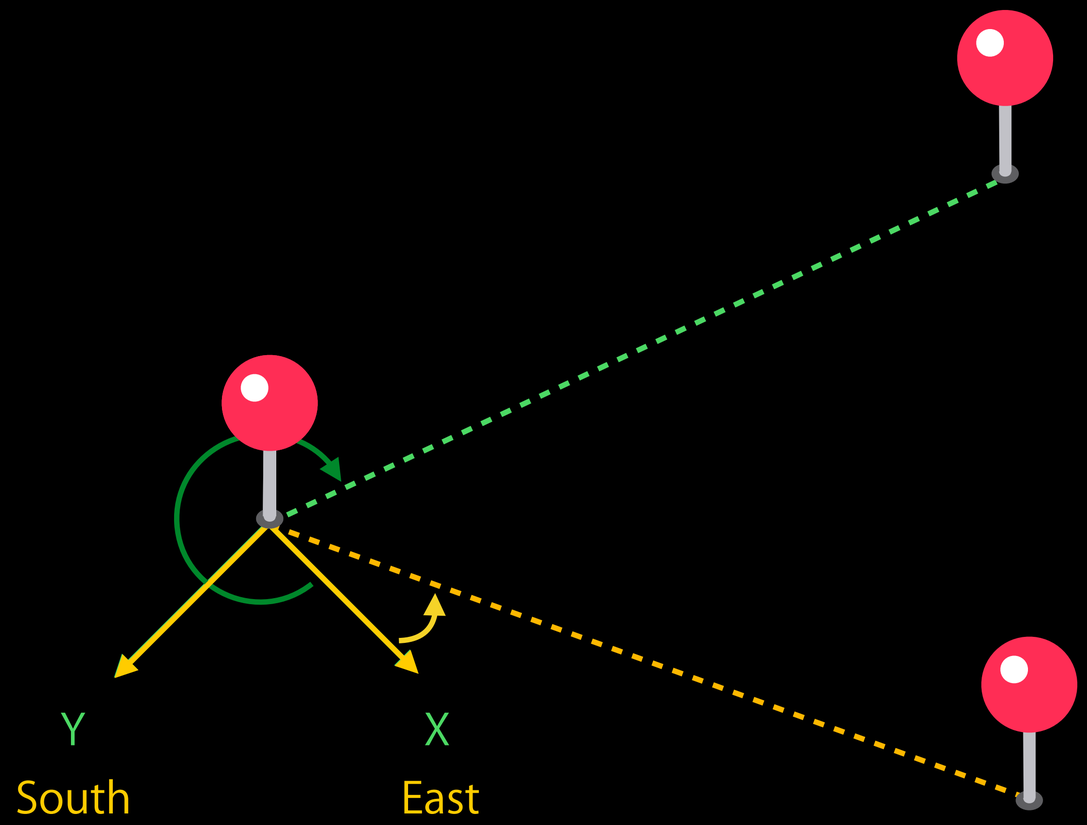

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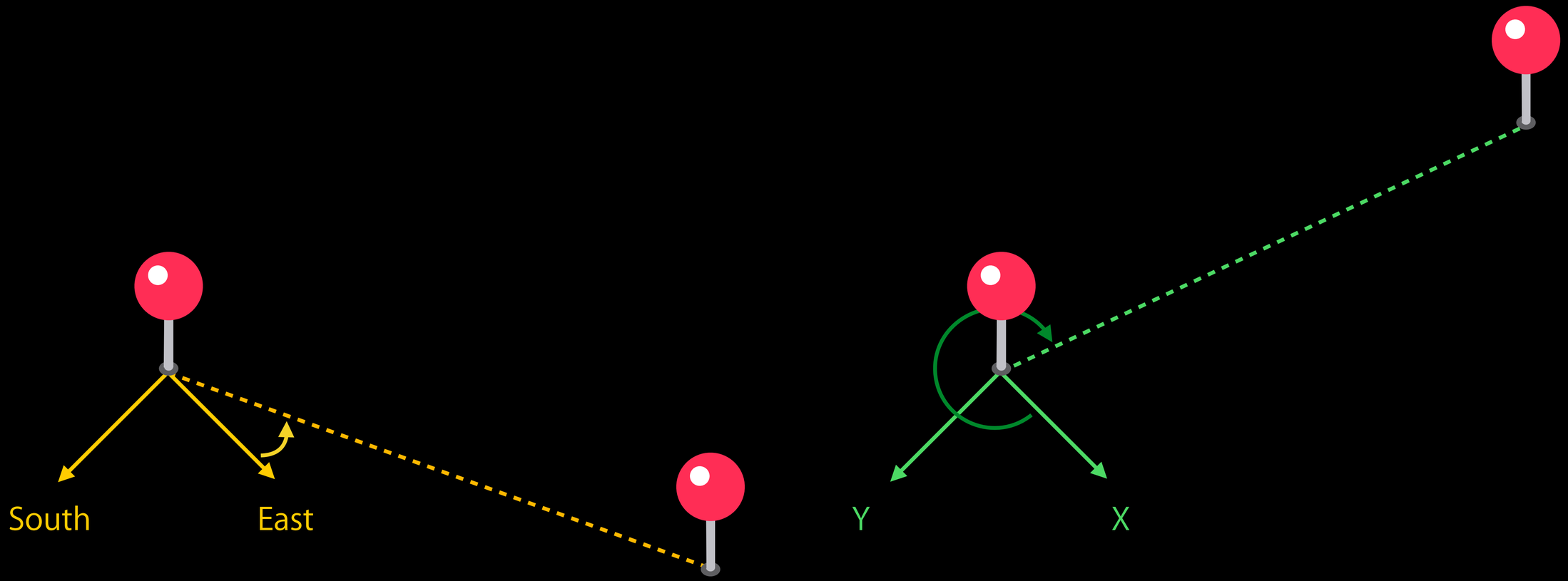

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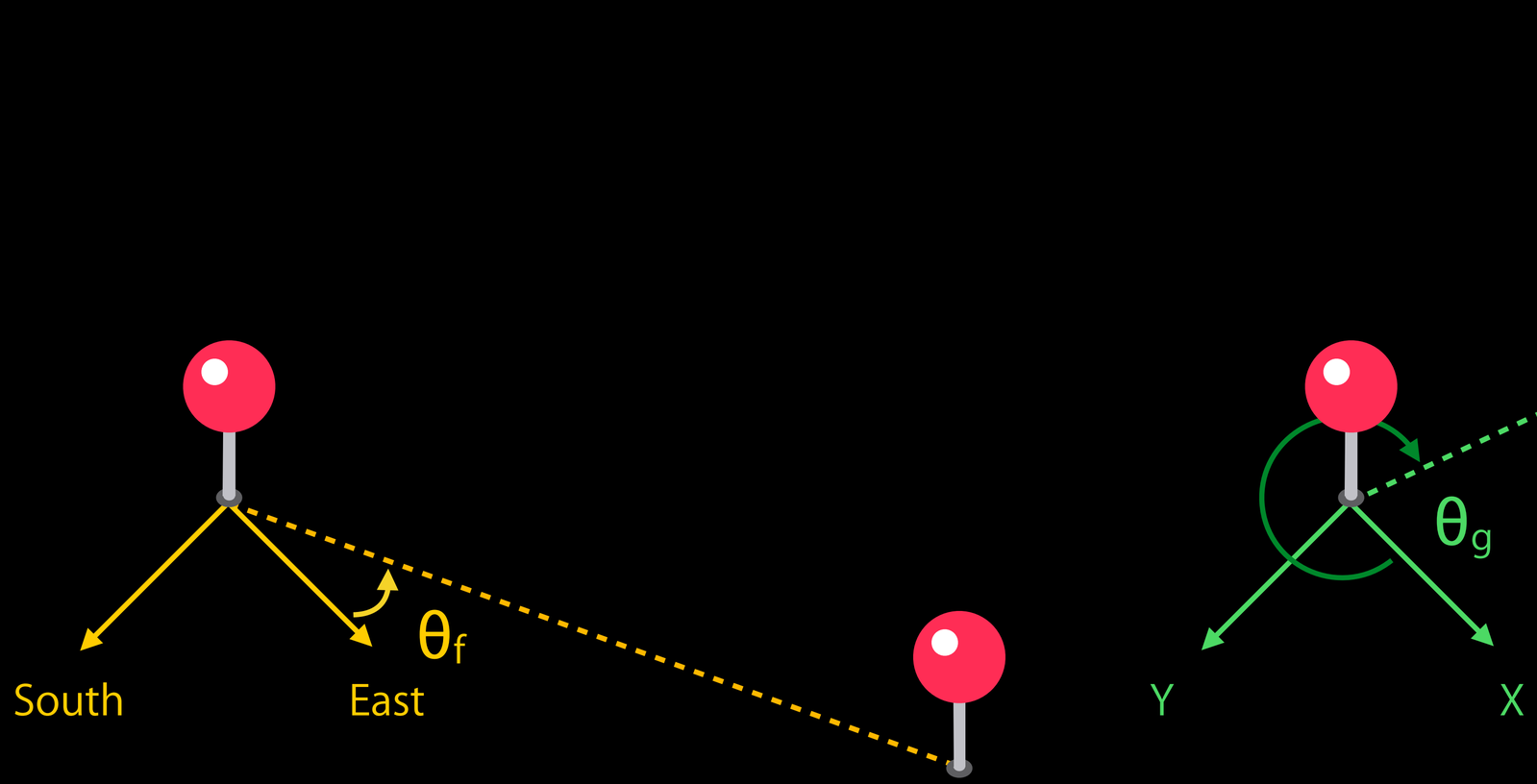

$$\theta_r = \theta_f - \theta_g$$

Putting It Together

$Point_{user}$ = MKMapPointForCoordinate(UserPosition)

MetersScale = MKMetersPerMapPointAtLatitude(A1.Geo)

$Meters_{user}$ = ($Point_{user}$ - $Point_{A1}$) * MetersScale

CGPointApplyAffineTransform($Meters_{user}$, CGAffineTransformMakeScale(Pixels/Meter))

CGPointApplyAffineTransform($Pixels_{user}$, CGAffineTransformMakeRotation(θ_r))

Availability

Coming soon

Availability

Coming soon

California Academy of Sciences, San Francisco

Westfield San Francisco Centre, San Francisco

Mineta San Jose International Airport, San Jose

Discover Your App

Discover Your App

Advertise at your venue

Discover Your App

Advertise at your venue

App Store—Near Me

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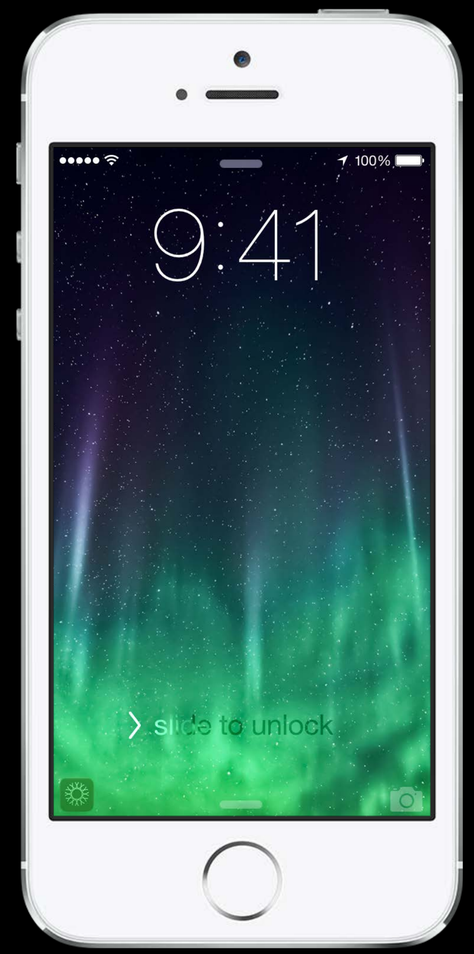
Advertise at your venue

App Store—Near Me

Continuity

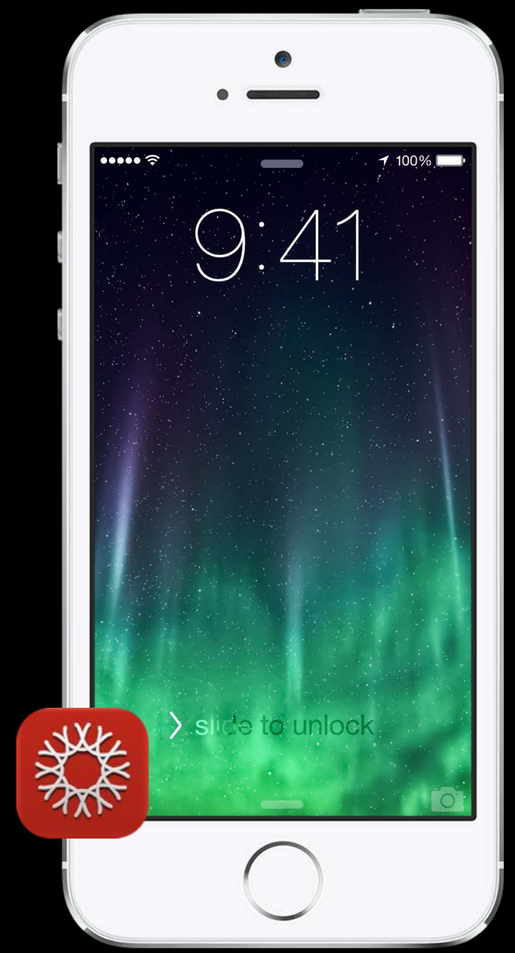


Discover Your App

Advertise at your venue

App Store—Near Me

Continuity



Indoor Positioning and iBeacon Technology

Position and proximity

iBeacon Technology

Review

Indoor Positioning	iBeacon Technology
Position	Proximity
Navigation	Notification

Art Gallery Example

Art Gallery Example

Region entrance

Art Gallery Example

Region entrance

Art Gallery Example

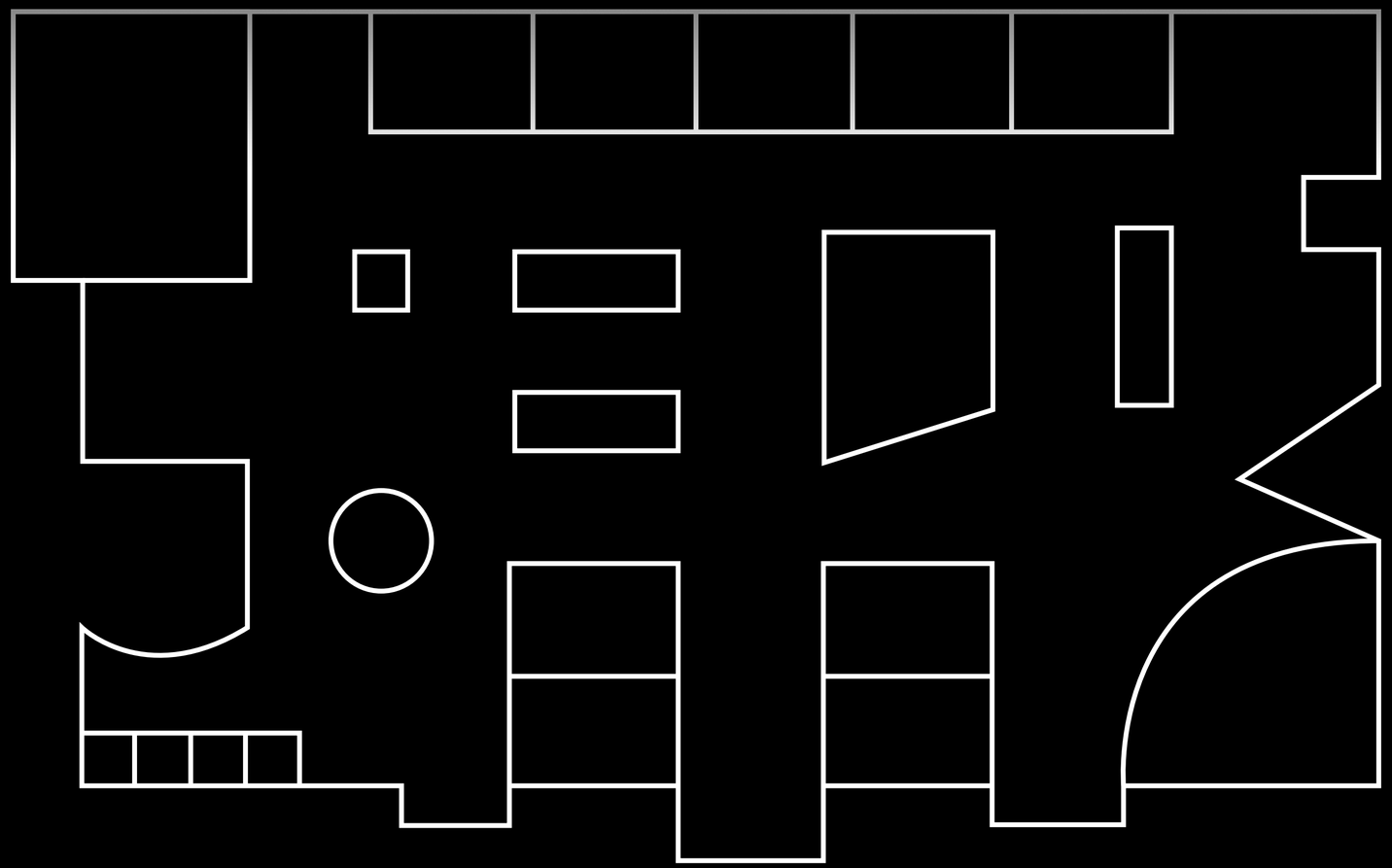
Region entrance

Art Gallery Example

Region entrance

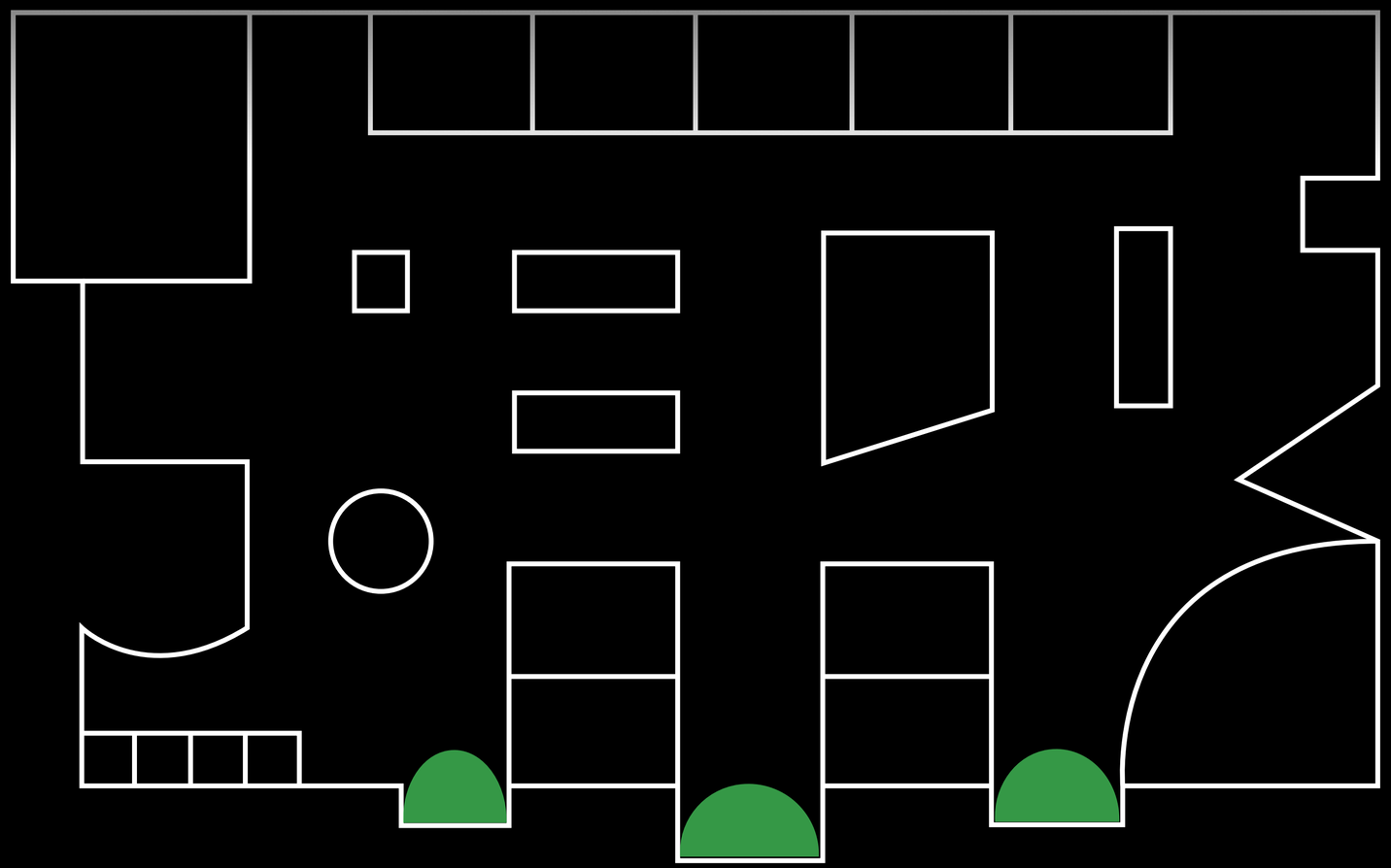
Art Gallery Example

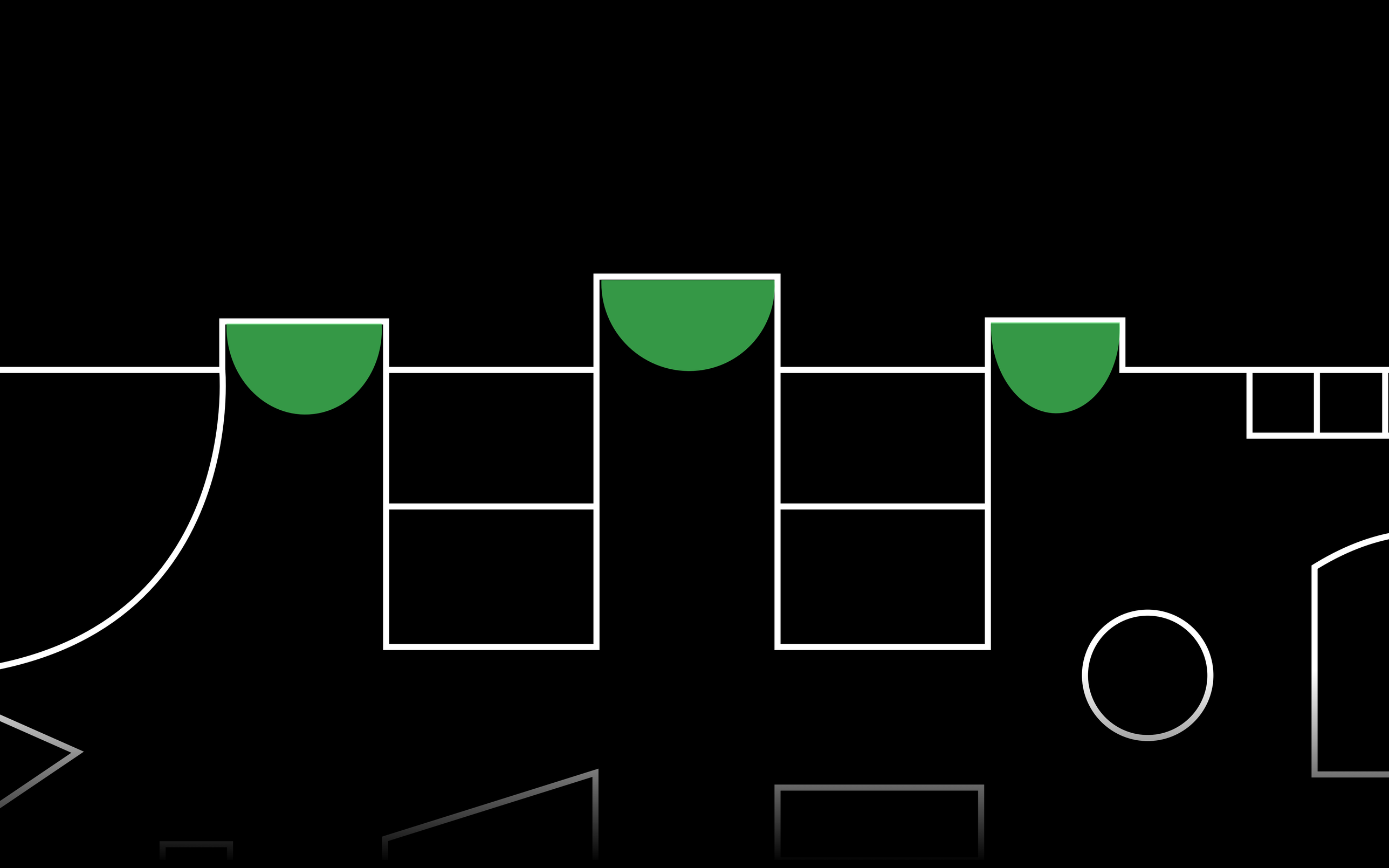
Region entrance

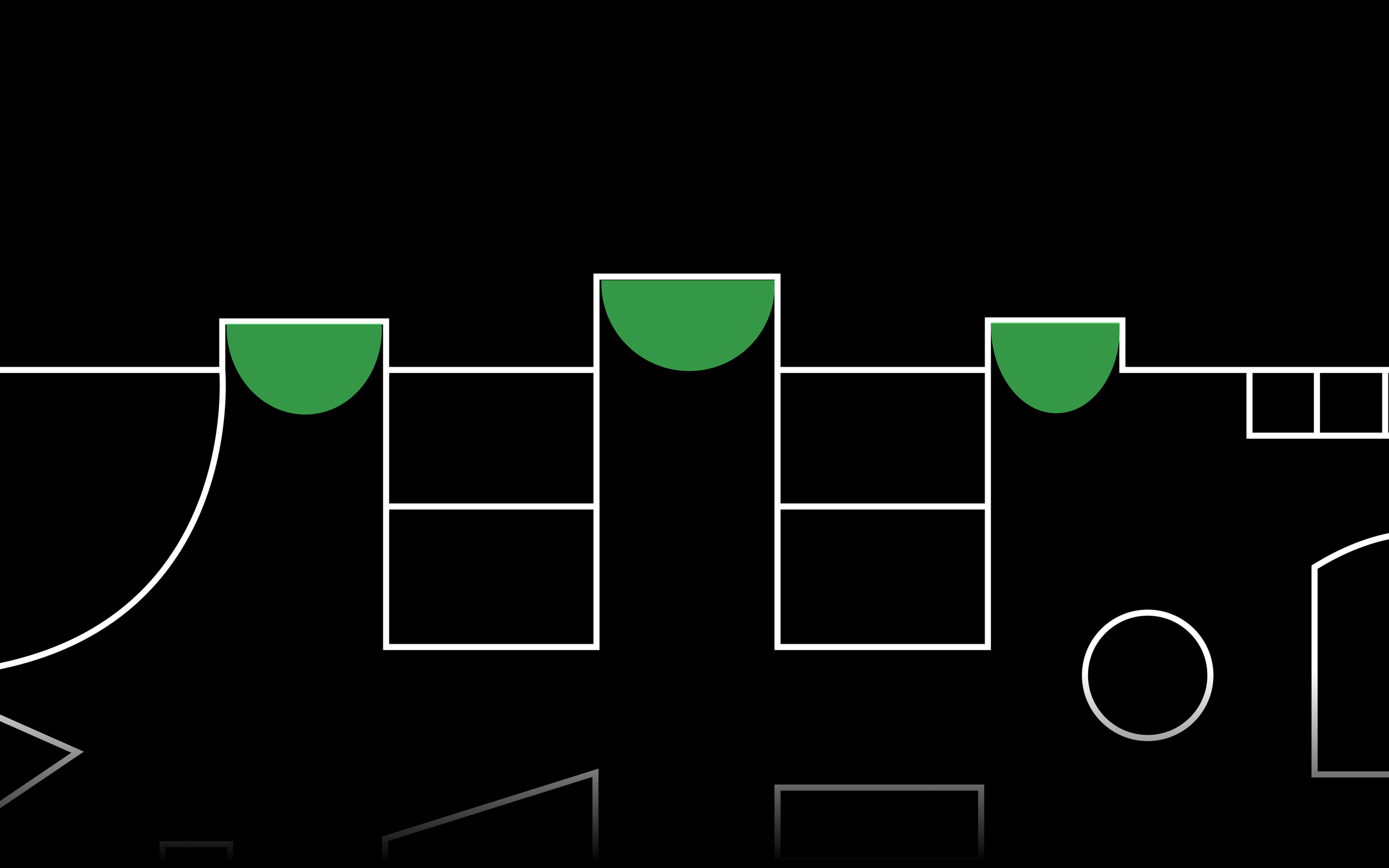


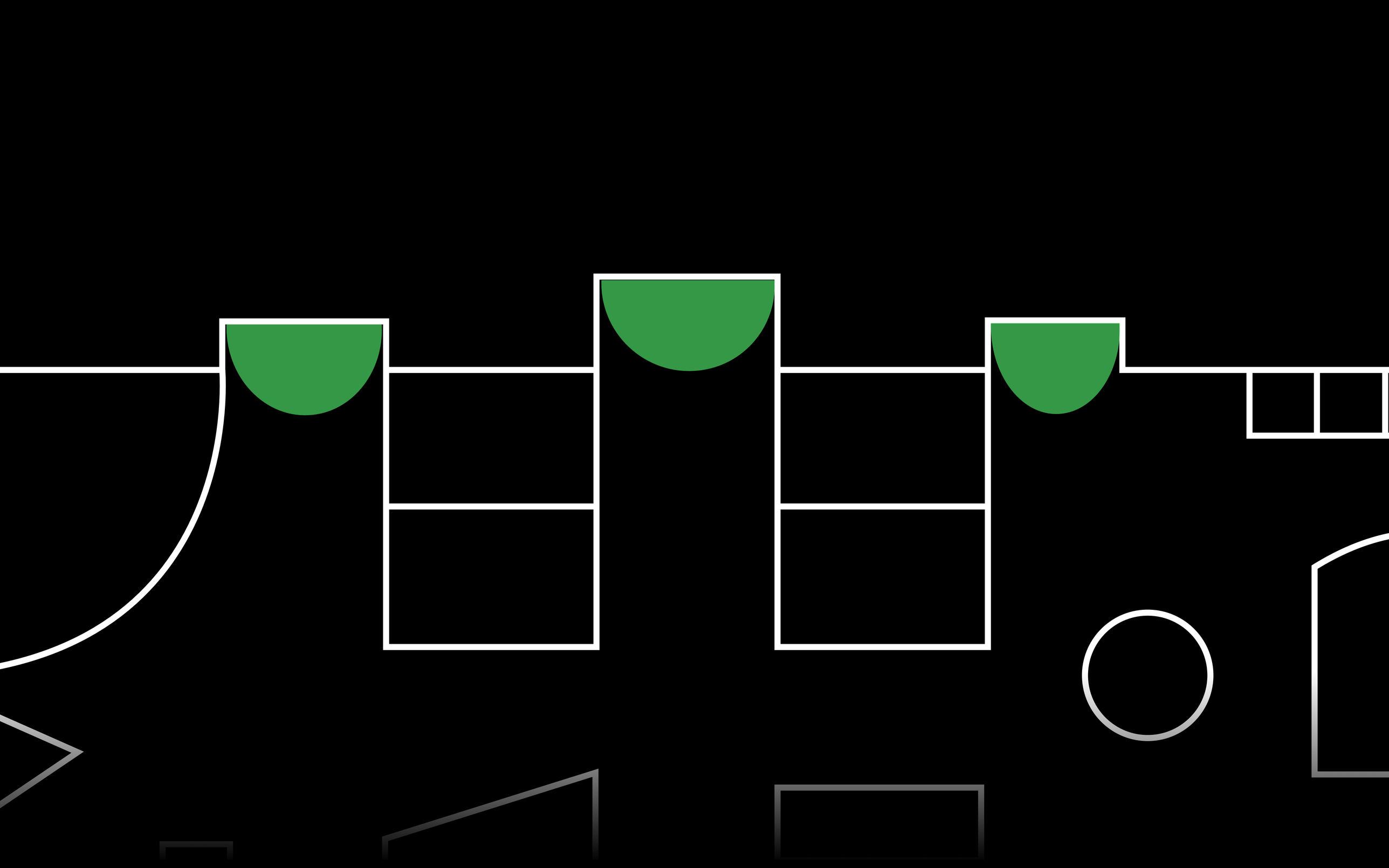
Art Gallery Example

Beacon regions










9:41 AM
100%
Messages
Calendar
Photos
Camera
Weather
Clock
Maps
Videos
Notes
Reminders
Stocks
Game Center
Newsstand
iTunes Store
App Store
Passbook
Compass
Settings
Phone
Mail
Safari
Music

Art Gallery Example

Beacon at entrance—Region monitoring

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[self.locationManager startMonitoringForRegion:beaconRegion];

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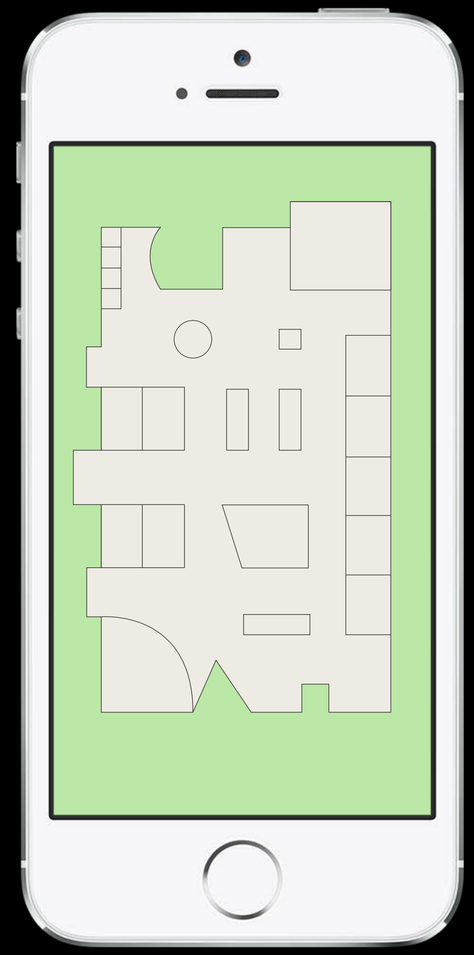
Art Gallery Example

Navigation and commentary



Art Gallery Example

Navigation and commentary

Display user position on map

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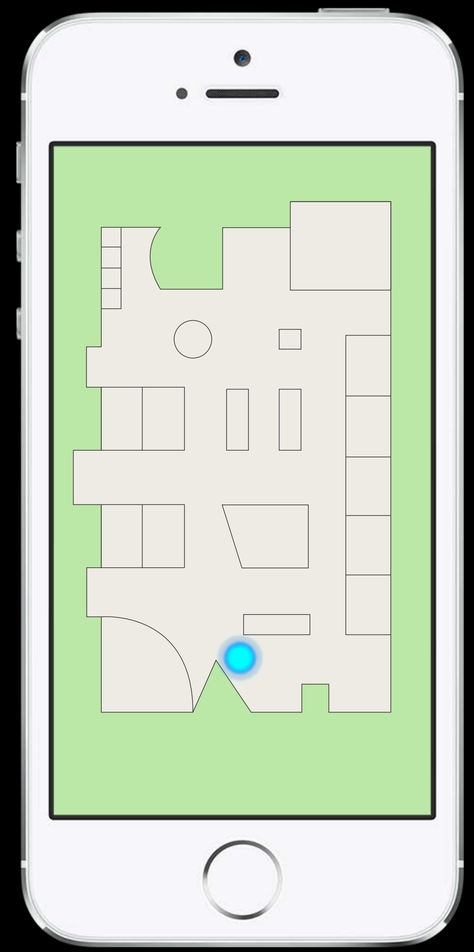

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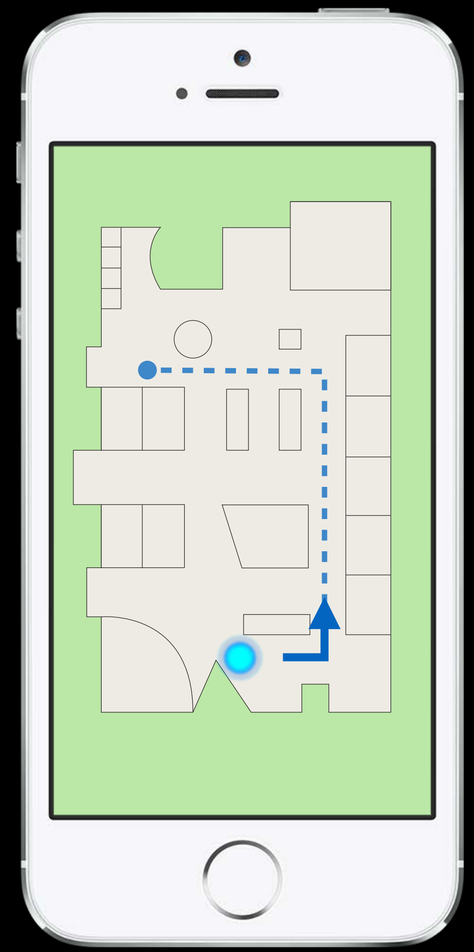

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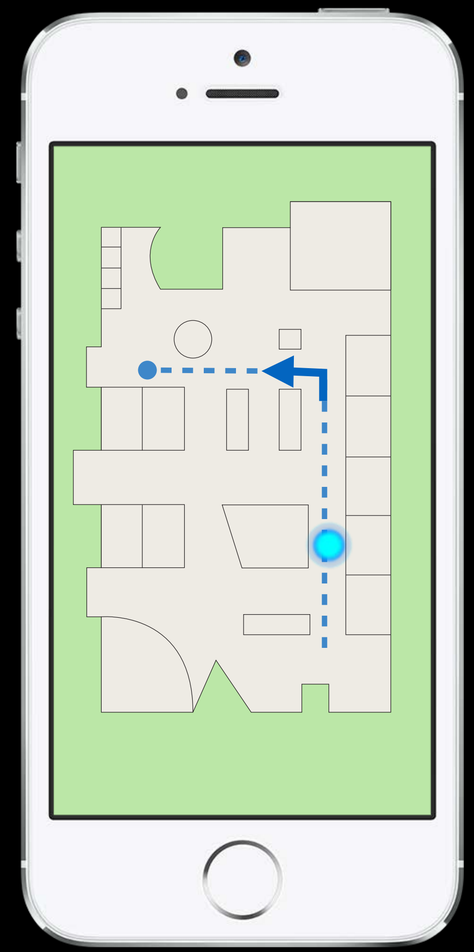

Art Gallery Example

Navigation and commentary

Display user position on map

Navigate

Art Gallery Example

Navigation and commentary

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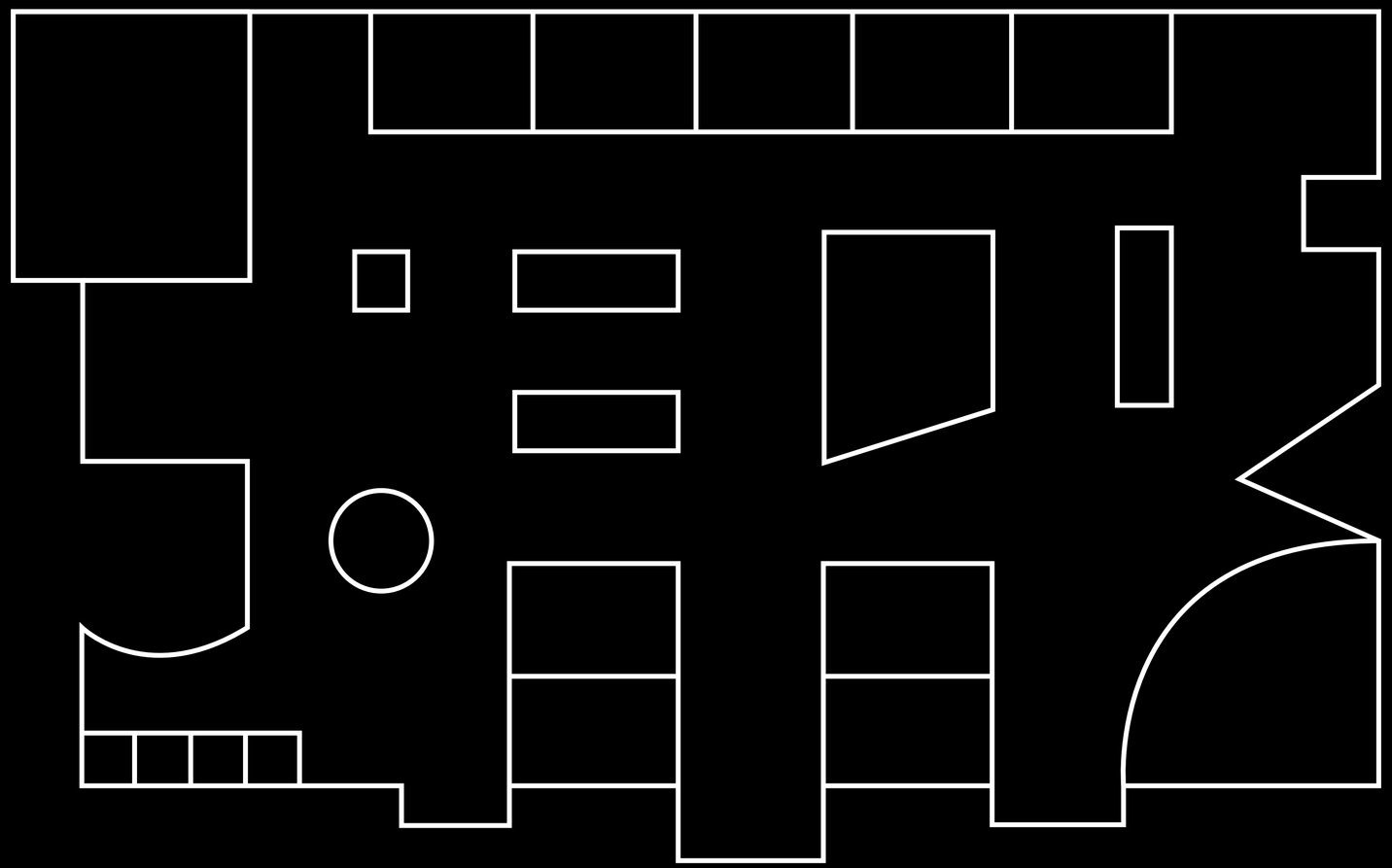
Navigate

Relevant content based on exhibits nearby

Art Gallery Example

Proximity to exhibits



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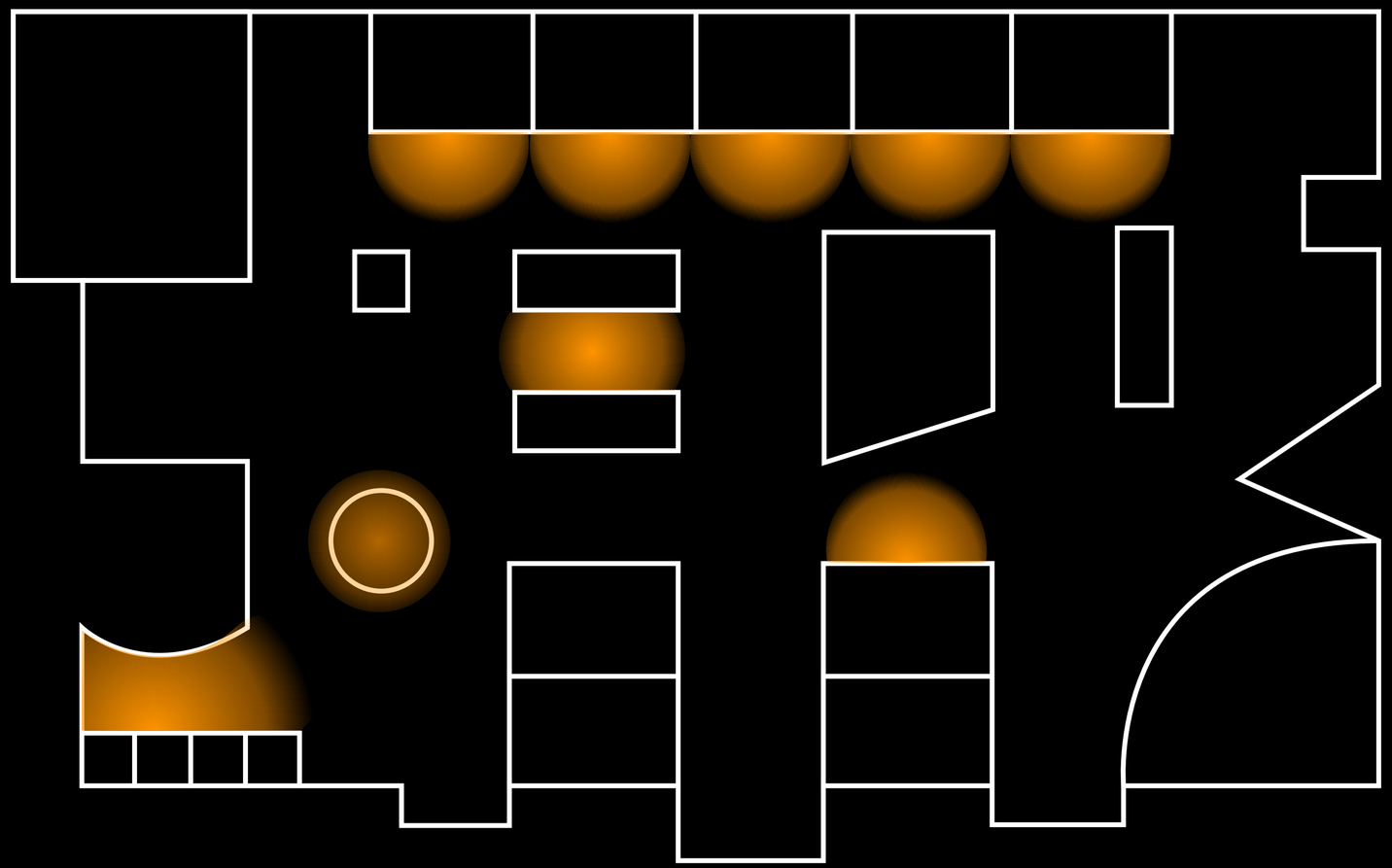

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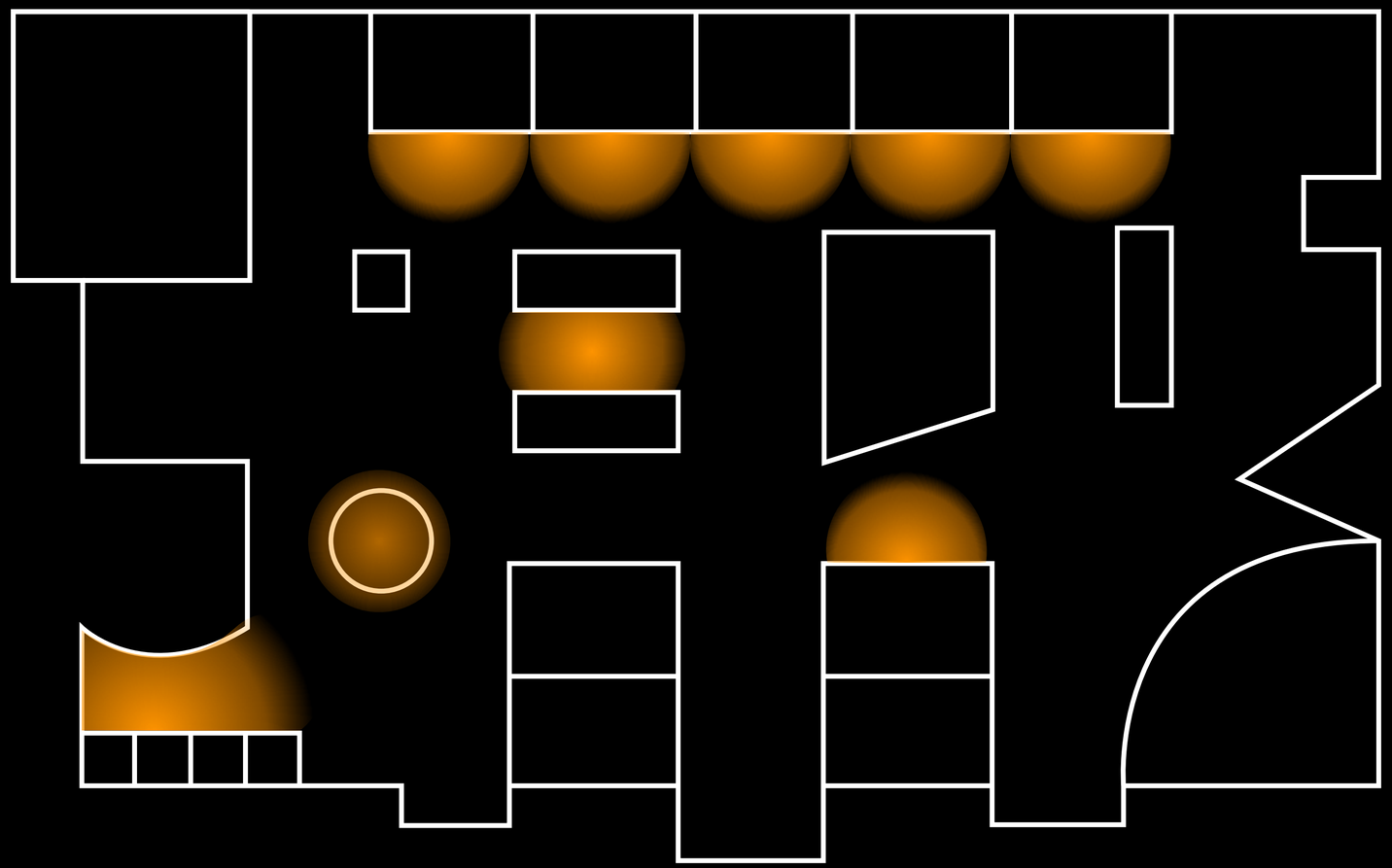

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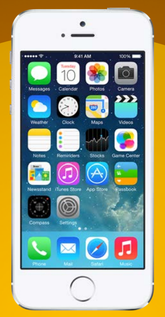

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    beacon.proximity

    beacon.major

    beacon.minor
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With Great Power

Strict security and privacy guidelines

Request location only as you need it

When In Use authorization

Have a clear purpose string

Next Steps

Sign up

Maps Connect
Indoor Positioning—Sign up
http://mapsconnect.apple.com

Maps
Maps & Core Location API
http://developer.apple.com/maps

iBeacon
iBeacon Technology & Licensing
http://developer.apple.com/ibeacon

Summary

Indoor Positioning

Precise Indoor Positioning

Core Location APIs

Indoor Positioning and iBeacon Technology

More Information

Craig Keithley
MFi and I/O Technologies Evangelist
keithley@apple.com

Documentation
Location and Maps Programming Guide
http://developer.apple.com

Apple Developer Forums
http://devforums.apple.com

Related Sessions

• What's New in Core Location	Marina	Tuesday 2:00PM
• User Privacy in iOS and OS X	Nob Hill	Thursday 2:00PM

Labs

• Core Location Lab	Core OS Lab B	Thursday 12:45PM

WWDC14