

Indoor Location with Beacons

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Beacon Overview

What they are and how they work.

A vertical timeline chart showing the evolution of Bluetooth versions over time. A grey vertical line connects circular markers for each year, with horizontal lines extending to the right for each entry. The first six entries (2002-2010) use black markers, while the last two (2014-2016) use white markers with black outlines. The Bluetooth logo is included in the marker for version 4.0.

2002	Bluetooth 1.2	Signal strength indicator, speed up to 721 kbit/sec
2004	Bluetooth 2.0	Transfer rates up to 3 Mbit/sec
2007	Bluetooth 2.1	Improved pairing experience, reduced power consumption
2009	Bluetooth 3.0	High-speed (24 Mbit/sec), alternative transport (802.11)
2010	Bluetooth 4.0	Low power profile (coin battery), simple device discovery
2013	Bluetooth 4.1	Fast data advertising, dual mode topology (802.11n)
2014	Bluetooth 4.2	IoT emphasis, support for IPv6 connectivity
2016	Bluetooth 5.0	Double data rate (2 Mbit/sec), increased range (200 m)



iPhone 4S

(iOS 5)

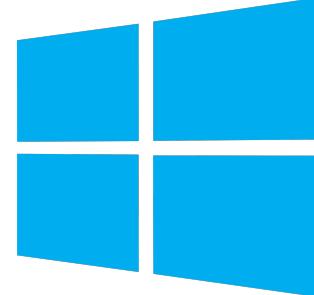
- iPad (3rd)
- iPad Mini
- iPod Touch (5th)
- Mavericks (10.9)



Android 4.3

(Jelly Bean)

- Galaxy S3
- Galaxy Note 3
- HTC One
- Nexus 5



Windows Phone 8

(Lumia Black)

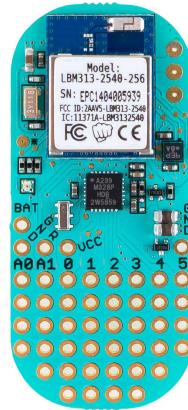
- Lumia 525
- Lumia 1320
- Surface
- Windows 8

Kontakt Beacon



- Coin cell battery
- 2.2in x 2.2in x 0.6in
- Customizable brand
- Up to 4 year battery

Light Blue Bean

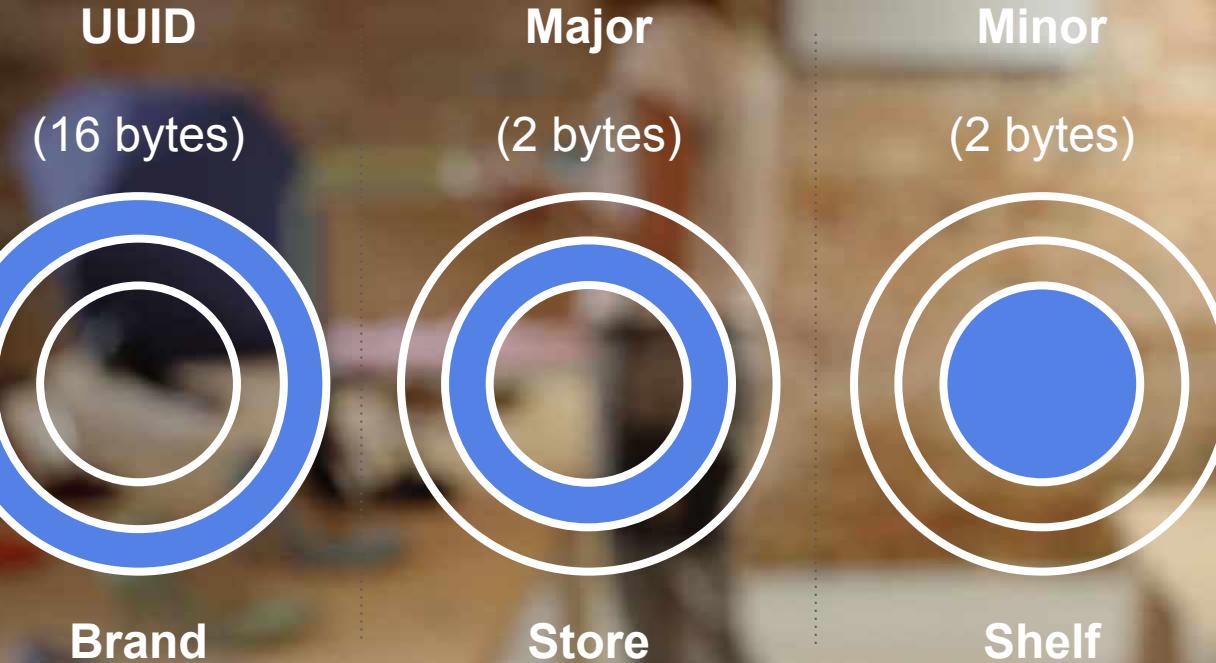


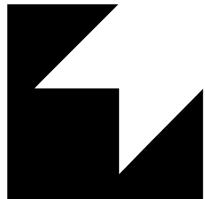
- Coin cell battery
- Under 3 inches long
- Built-in protoboard
- Arduino compatible

Gimbal Series 10



- Coin cell battery
- 1.6in x 1.1in x 0.2in
- Key fob form factor
- 2 - 3 weeks battery





Eddystone

Specification

Frame Data
20 bytes

Eddystone UID **20 bytes**

Namespace
10 bytes

Instance
6 bytes

Frame Type
Tx Power
4 bytes

Eddystone URL **6-20 bytes**

URL Data
Up to 17 bytes

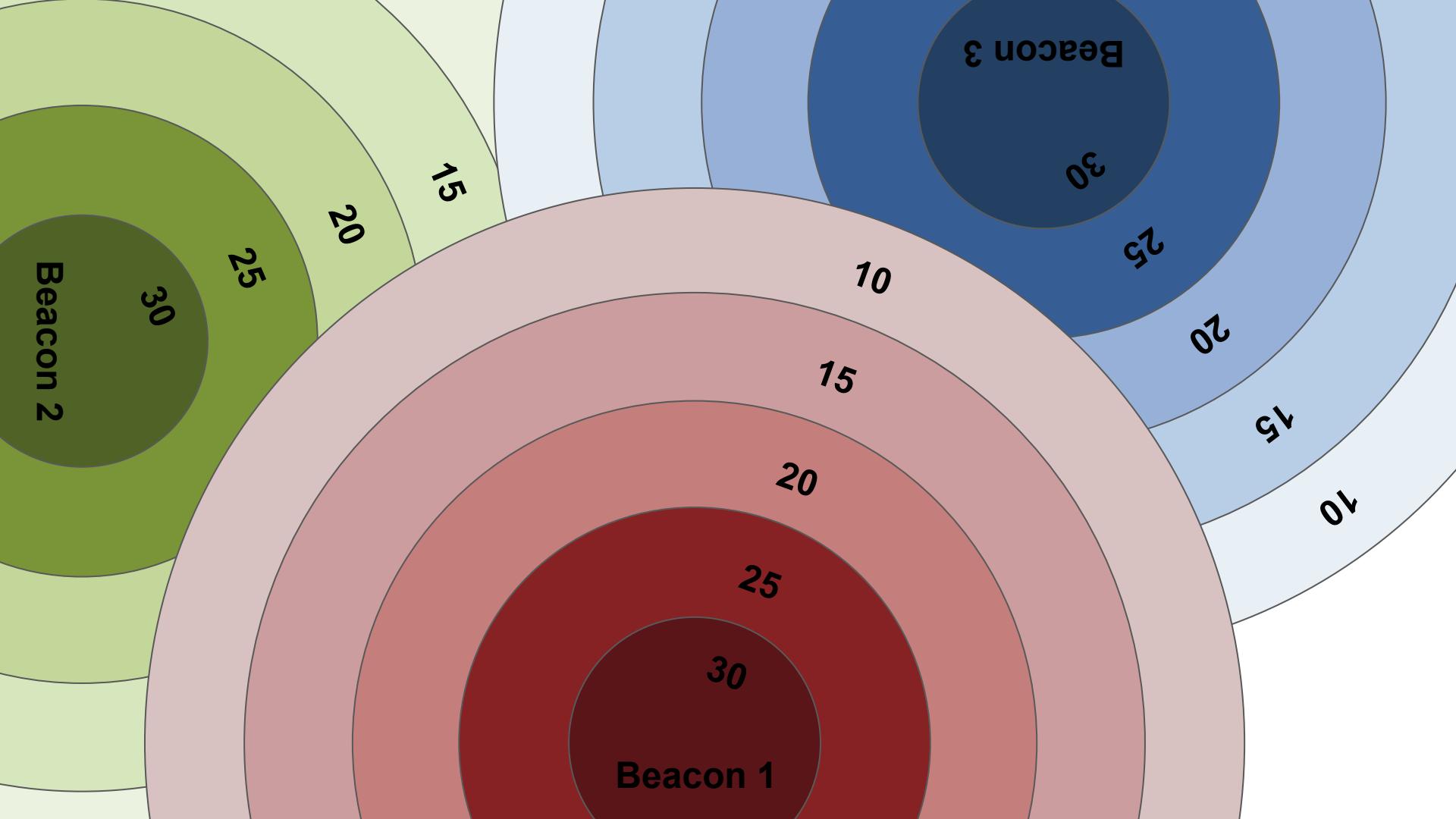
Frame Type
Tx Power
3 bytes

Eddystone TLM Telemetry **14 bytes**

Frame type, battery status ...

Advertising Interval	Broadcasting Power		
	-30 dBm (low)	-4 dBm	+4 dBm (high)
2000 ms (long)	3.3 years	3 years	2.3 years
1000 ms	1.9 years	1.7 years	1.3 years
600 ms	1.2 years	1 year	300 days
200 ms	160 days	140 days	104 days
50 ms (short)	40 days	35 days	26 days

Battery Life: Power (Range) vs. Interval



```
// Beacons are part of CoreLocation
import CoreLocation
import UIKit

// Implement controller as location delegate
// Alternatively implement in AppDelegate depending on needs
class ViewController: UIViewController, CLLocationManagerDelegate {

    // Track region and location manager
    var beaconRegion: CLBeaconRegion!
    var locationManager: CLLocationManager!

}
```

```
// Setup location manager
locationManager = CLLocationManager()
locationManager.delegate = self

// Check authorization
locationManager.requestWhenInUseAuthorization()

// All beacons for brand
let uuid = NSUUID(UUIDString: BRAND_UUID)
beaconRegion = CLBeaconRegion(
    proximityUUID: uuid!,
    identifier: BRAND_IDENTIFIER
)
beaconRegion.notifyOnEntry = true
beaconRegion.notifyOnExit = true

// Subscribe
locationManager.startMonitoringForRegion(beaconRegion)
locationManager.startRangingBeaconsInRegion(beaconRegion)
```

```
// Beacon with matching UUID is in range
func locationManager(
    manager: CLLocationManager,
    didRangeBeacons beacons: [CLBeacon],
    inRegion region: CLBeaconRegion) {

    // Found beacons
    if beacons.count > 0 {
        for beacon in beacons {
            if beacon.proximity == CLProximity.Immediate {
                labelTable.text = beacon.minor.stringValue
            }
        }
    }
}
```

Demonstration

Let's configure a beacon!



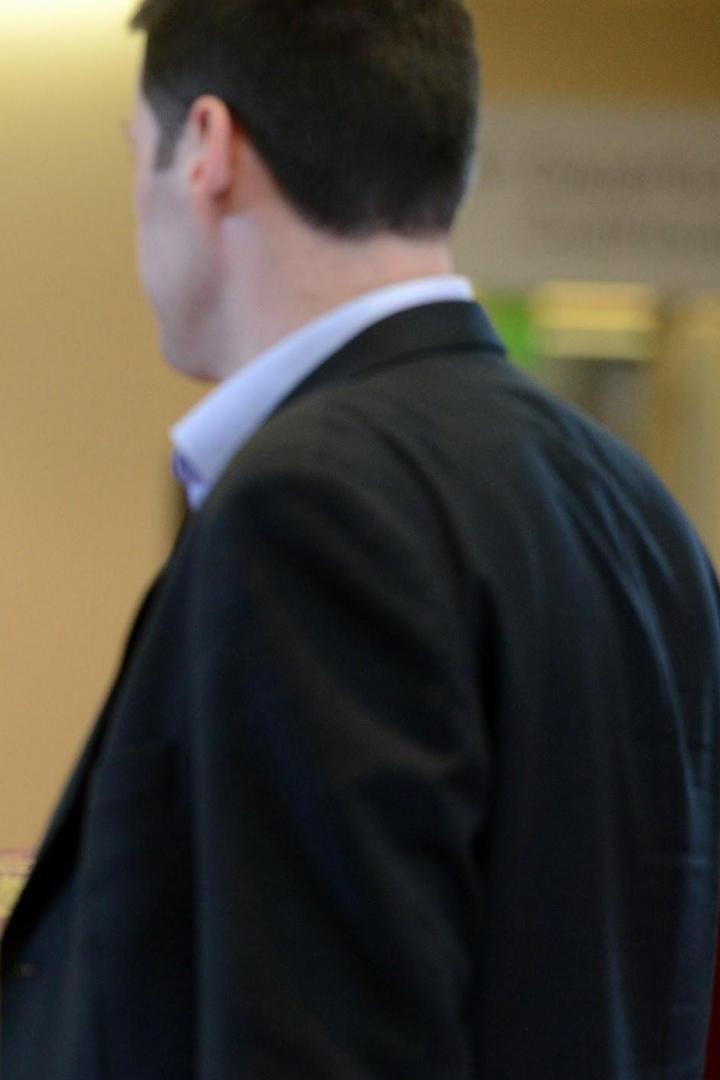
Logistics

Improving business processes beyond the customer.

- 
- A close-up photograph of a Japan Airlines flight attendant. She has dark hair styled in a bob cut and is smiling warmly at the camera. She is wearing a dark blue uniform with red and white accents, including a red scarf with a circular logo and a red and white striped collar. A red ribbon or streamer is visible across the bottom of the frame.
- Tokyo Haneda Airport
 - Monitor staff location using smart watches
 - Samsung Galaxy Gear 2
 - LG G Watch (Android)
 - Assign location-dependant tasks



JAPAN AIRLINES





starwood
Hotels and
Resorts



aloftSM

W
HOTELS

- Notification to opt-in if room is eligible
- Notification again when room is ready (with room number)
- Skip the lobby and head straight to your room*
- Only good for one phone and one room



Venue Analytics

Brick and mortar stores get A/B testing.



BIRCHBOX[◆]
Local

BIRCHBOX[◆]

TRY

Create your own Birchbox
with 100+ samples

TRY SAMPLES

TRY SAMPLES

- Analyzing customer flow on the floor
- Customize product placement, highlighting and pairing
- 600% new application users
- 400% more time spent in application



Localization

Enjoying your vacation, one language at a time.

OUTFRONT

Subway service is
currently suspended.
Visit mta.info or call
511 for updates.



34 Street
Penn Station

1 2 3

Elevator across 7 Av & 34 St

FDNY

KENY

STREETS

DEPARTMENT

OF THE CITY OF NEW YORK

EMERGENCY NUMBER

911

72nd Street

7th Avenue

34th Street

Penn Station

Grand Central

Terminal

MetLife

Building

1 Penn Plaza

125th Street

125th Street

125th Street

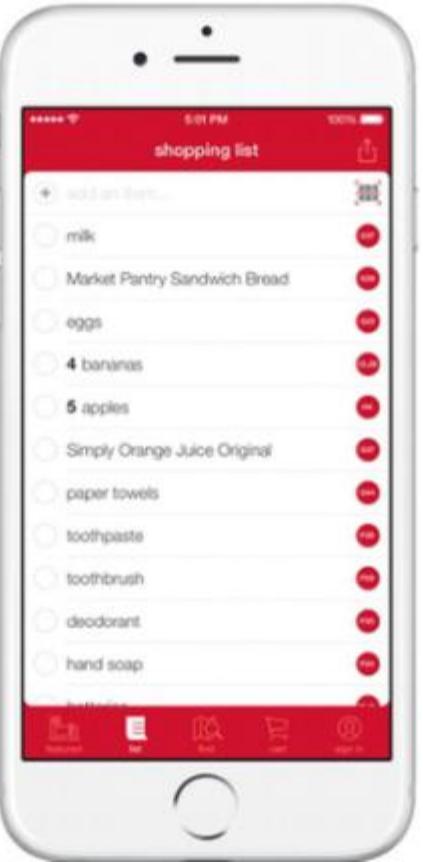
Pathfinding

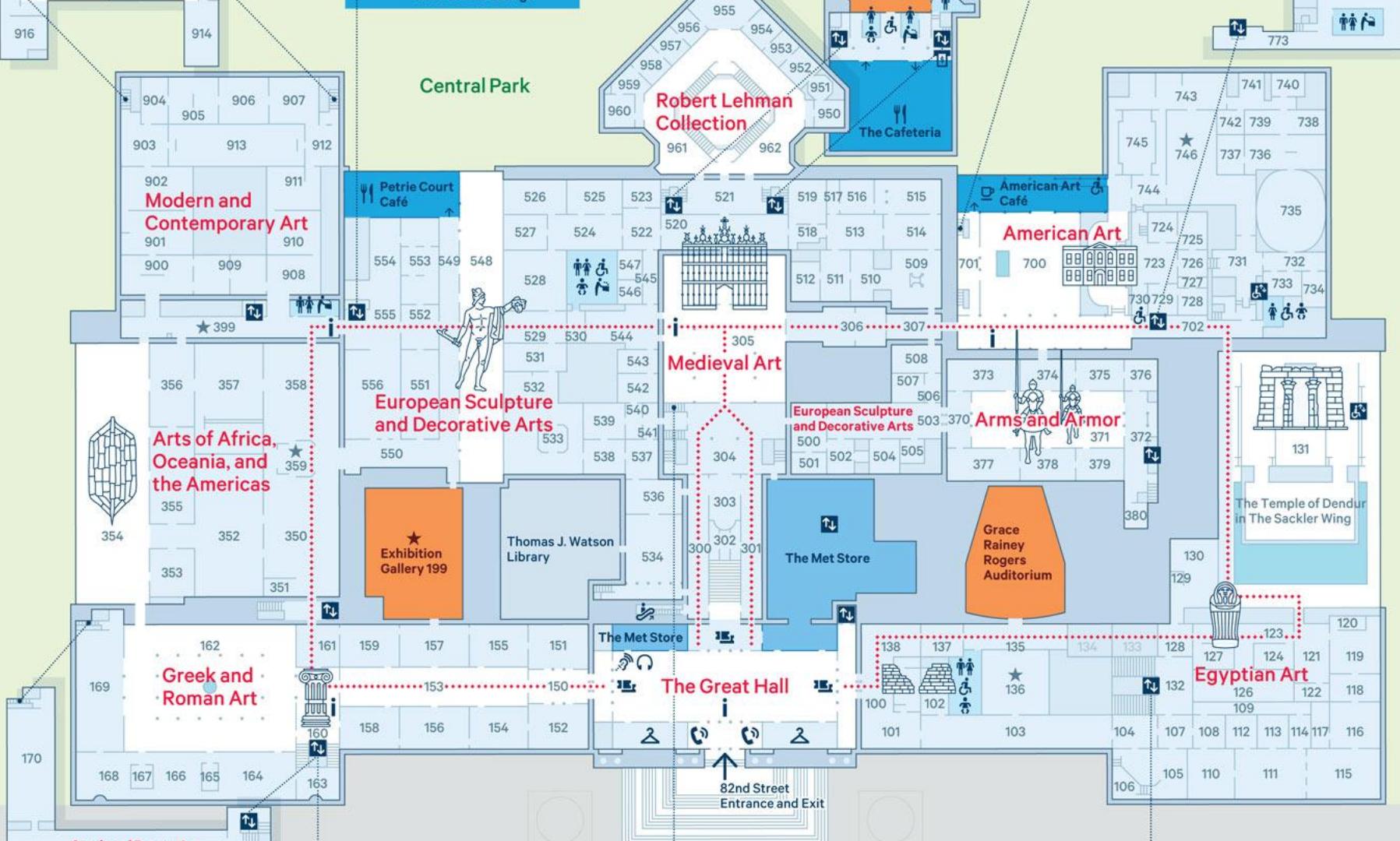
The hardest part of any journey ... is inside without GPS.

Walt Disney



TARGET®







Flying out of Miami?

Select a flight and we'll keep you posted.



Departures



Scan Boarding Pass

No, I'm picking someone up.

Weather Forecast in Miami

Fri



Home



Flights



Map

Mon

Sun



Saturday



Monday

WALKING THE ZOO

FRONT STREET 5
20-minute walk / Gateways to Discovery Outpost, Lost Forest, Outback, Urban Jungle, and Africa Rocks / Mild Terrain.

PARK WAY
30-minute walk / Gateways to Africa Rocks, Asian Passage, Panda Canyon, Northern Frontier, and Elephant Odyssey / Mild to Steep Terrain.

CENTER STREET
15-minute walk / Gateways to Asian Passage and Outback / Steep Terrain.

TREETOPS WAY 5
7-minute walk / Access to Fern Canyon, Tigers, Orangutans, Hippo, and Monkey Trails / Mild Terrain.

AVIARY TRAIL
15-minute walk from Treetops Way to Center Street / Mild to Steep Terrain.

BIG CAT TRAIL 5
15-minute walk from Center Street to Africa Rocks / Mild Terrain.

EAGLE TRAIL
10-minute walk / Access to Eagles / Gateways to Polar Bears and Elephant Odyssey / Steep Terrain.

FERN CANYON TRAIL
7-minute walk from Treetops Way to Park Way and Center Street / Steep Terrain and Stairs.

HIPPO TRAIL
30-minute walk from Treetops Way to Park Way / Mild to Steep Terrain.

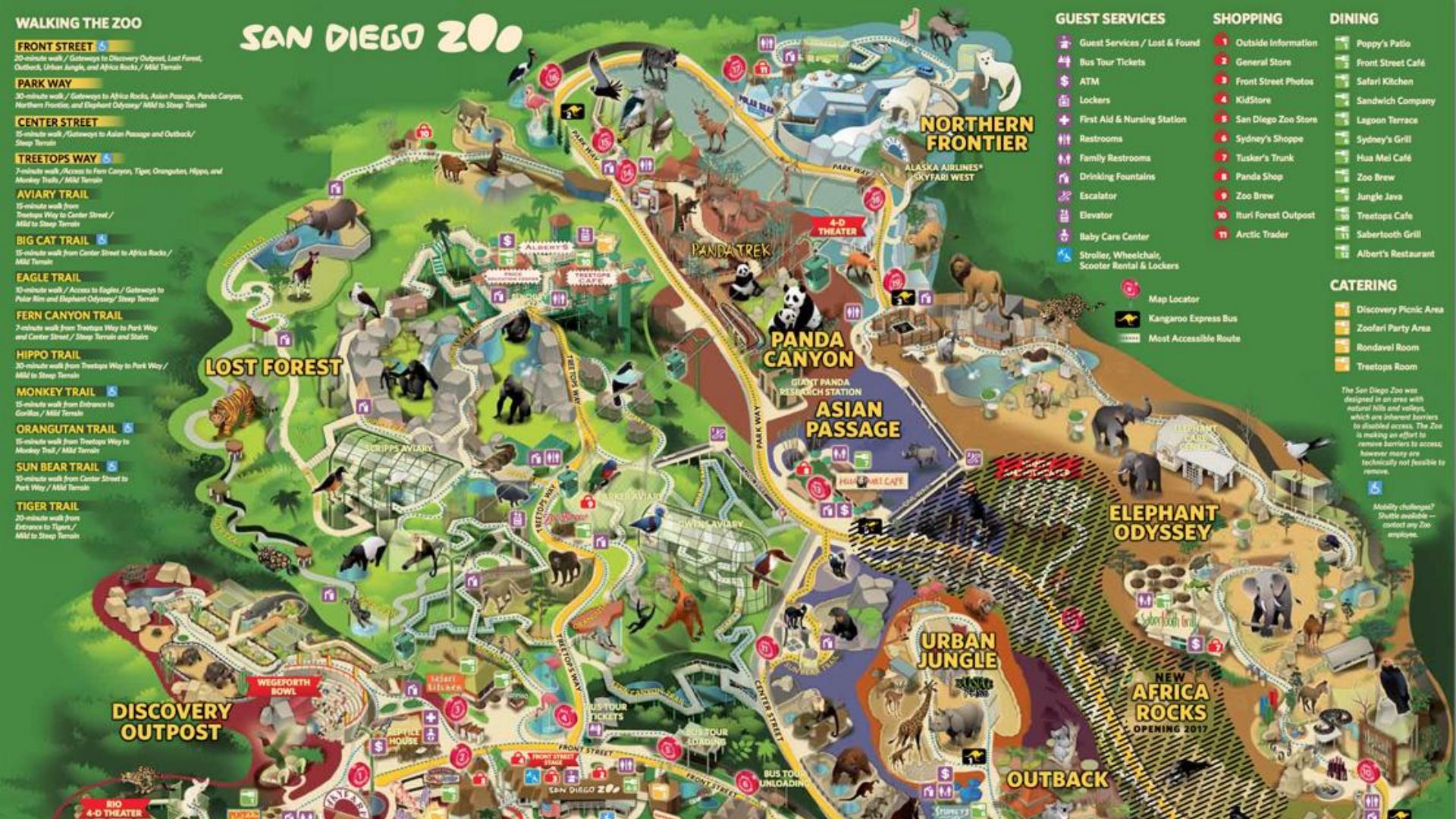
MONKEY TRAIL 5
15-minute walk from Entrance to Gorillas / Mild Terrain.

ORANGUTAN TRAIL 5
15-minute walk from Treetops Way to Monkey Trail / Mild Terrain.

SUN BEAR TRAIL 5
10-minute walk from Center Street to Park Way / Mild Terrain.

TIGER TRAIL
20-minute walk from Entrance to Tigers / Mild to Steep Terrain.

SAN DIEGO ZOO



GUEST SERVICES

- 1 Guest Services / Lost & Found
- 2 Bus Tour Tickets
- 3 ATM
- 4 Lockers
- 5 KidStore
- 6 First Aid & Nursing Station
- 7 Restrooms
- 8 Family Restrooms
- 9 Drinking Fountains
- 10 Escalator
- 11 Elevator
- 12 Baby Care Center
- 13 Stroller, Wheelchair, Scooter Rental & Lockers
- 14 Map Locator
- 15 Kangaroo Express Bus
- 16 Most Accessible Route

SHOPPING

- 1 Poppy's Patio
- 2 Front Street Café
- 3 Safari Kitchen
- 4 Sandwich Company
- 5 Lagoon Terrace
- 6 Sydney's Grill
- 7 Hua Mei Café
- 8 Zoo Brew
- 9 Jungle Java
- 10 Treetops Café
- 11 Sabertooth Grill
- 12 Albert's Restaurant

CATERING

- 1 Discovery Picnic Area
- 2 Zoolari Party Area
- 3 Rondavel Room
- 4 Treetops Room

The San Diego Zoo was designed in an area with natural hills and valleys, which are inherent barriers to disabled access. The Zoo is making an effort to remove barriers to access; however many are technically not feasible to remove.

Mobility challenges? Shuttle available — contact any Zoo employee.

THE
HOME
DEPOT

Table Service

Order food, and pay your bill, with your phone.



Beacons in the Wild

How not to fail at deploying beacons.

More Than a Gimmick

Mobile provides a wealth of data, not an alternative channel.

Measure and Refine

Testing plans that improve program performance over time.

Have a Contingency Plan

Do not rely on Bluetooth being on or present.

Provide Real Benefit

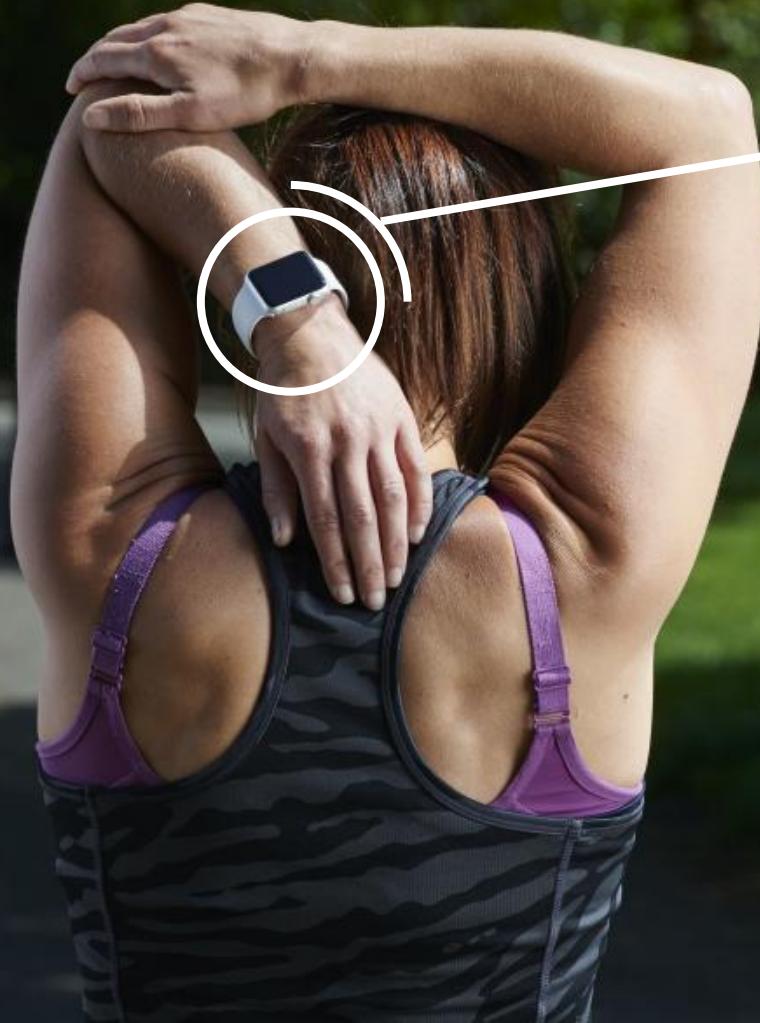
Beacon notifications are the equivalent of spam.

Indoor Location with Beacons

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Appendix

Content that did not make the cut, but you may want.



Service

Heart Rate Service

Characteristic

Heart Rate Measurement

Characteristic

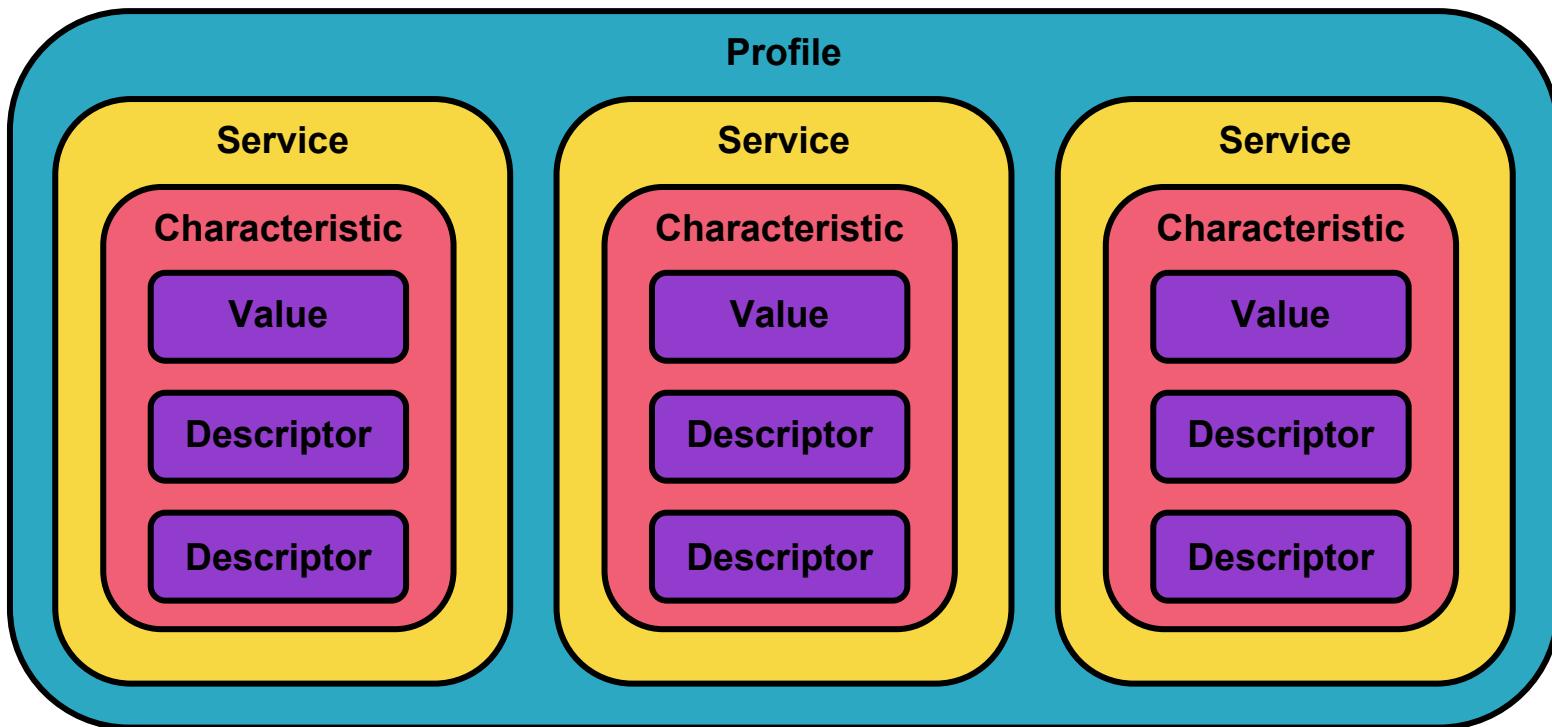
Body Sensor Location

Generic Attribute Profile

Generic Attribute Profile (GATT)

- **Health care** - blood pressure, thermometer, glucose
- **Sport and fitness profiles** - speed, cadence, power, heart rate
- **Internet connectivity**
- **Generic sensors** - environmental sensing
- **HID connectivity** (Human Interface Device)
-  **Proximity sensing** - find me (electronic leash), range
- **Alert and time profiles** - Incoming notifications, time from other devices
- **Battery** - State and level information

Generic Attribute Profile (GATT)



Byte Offset	Default Value	Description	Properties
0	0x02	Data length – 2 bytes	Constant preamble
1	0x01	Data type – flags	Constant preamble
2	0x06	LE and BR/EDR flag	Constant preamble
3	0x1a	Data length – 26 bytes	Constant preamble
4	0xff	Data type - manufacturer specific data	Constant preamble
5	0x4c	Manufacturer data	Constant preamble
9	0xf7	Proximity UUID 1st byte	User UUID
25	xx	Major 1st byte	Major value
26	xx	Major 2nd byte	Major value
27	xx	Minor 1st byte	Minor value
28	xx	Minor 2nd byte	Minor value
29	0xb3	Signal power (calibrated RSSI @ 1 m)	Signal power va

PathFinding.js

Kevin

qiao.github.io/PathFinding.js/visual/

length: 28.83
time: 3.2000ms
operations: 519

Project Hosted on [Github](#)

Select Algorithm

- A*
- IDA*
- Breadth-First-Search
- Best-First-Search
- Dijkstra
- Jump Point Search
- Orthogonal Jump Point Search
- Trace

Heuristic

- Manhattan
- Euclidean
- Octile
- Chebyshev

Options

- Allow Diagonal
- Bi-directional
- Don't Cross Corners
- Weight

Restart Search Clear Path Clear Walls

Why Beacons Deployments Fail

Benefit - Notifications are the equivalent of spam

Reliance - Have a contingency plan for when Bluetooth is off

Isolation - Do not give me a coupon for something I just bought

Integration - Point of sale, inventory, loyalty, campaign, analytics

Infrastructure - Number of beacons, placement, interaction

Metrics - Testing plans that improve program performance over time

Commit - Mobile provides a wealth of data, not an alternative channel