

Core Bluetooth 101

Session 703

Brian Tucker

Manager, Wireless iOS Software Engineering

These are confidential sessions—please refrain from streaming, blogging, or taking pictures

Agenda

- Bluetooth 4.0 Low Energy
- Introduction to Core Bluetooth
- Core Bluetooth in practice

Bluetooth 4.0 Low Energy



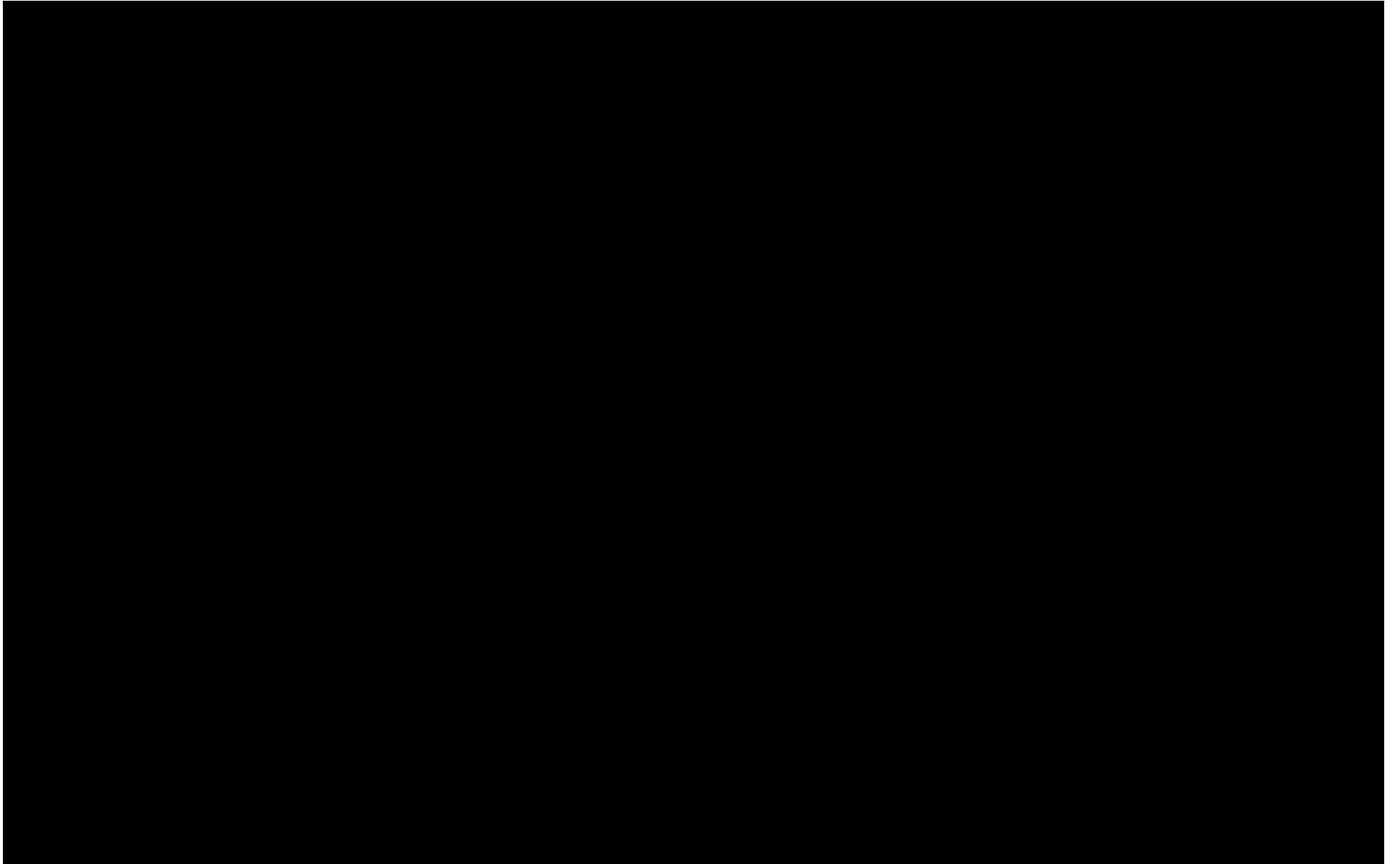
What You Will Learn

- Learn key Bluetooth 4.0 Low Energy concepts
 - Advertising
 - Device discovery
 - Connections
 - Service discovery
 - Characteristics



Why Bluetooth 4.0 Low Energy





CR2032

3V





The Big Idea



The Big Idea

- Less time on the air



The Big Idea

- Less time on the air
- Less energy when on the air



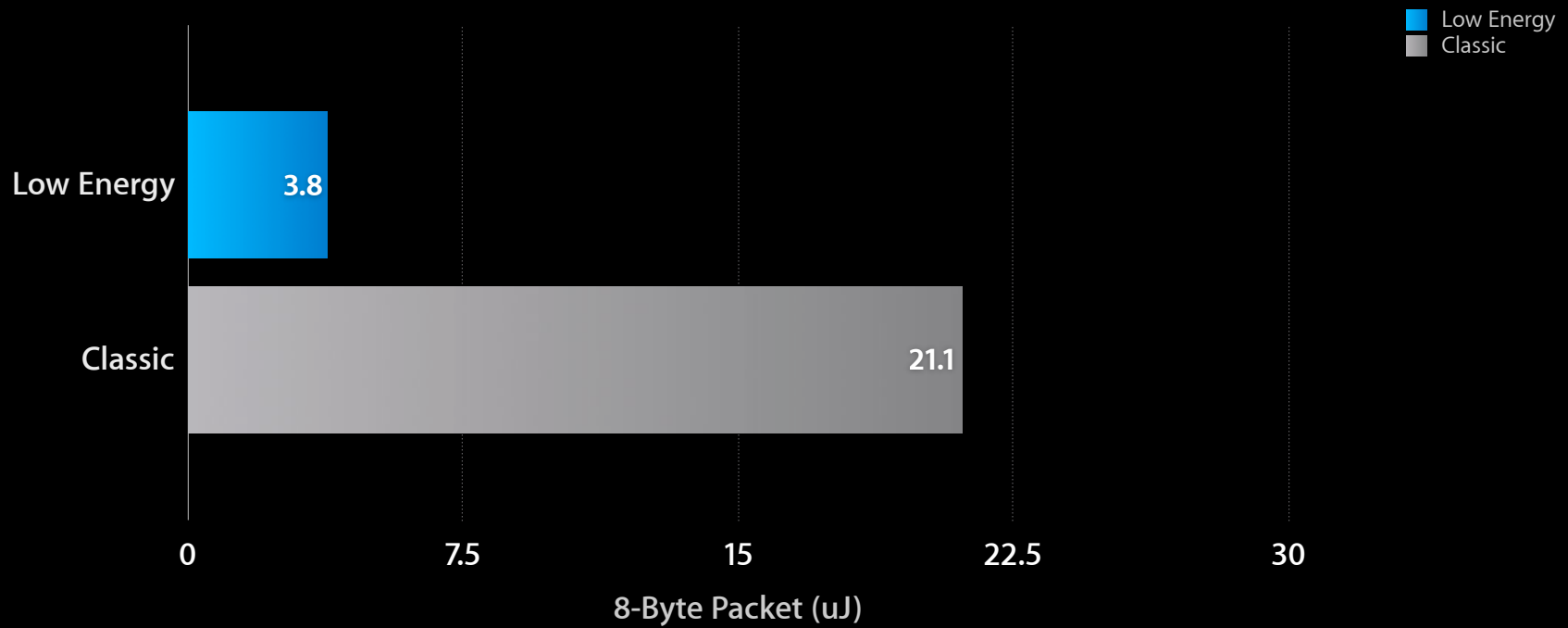
The Big Idea

- Less time on the air
- Less energy when on the air
- Completely new architecture



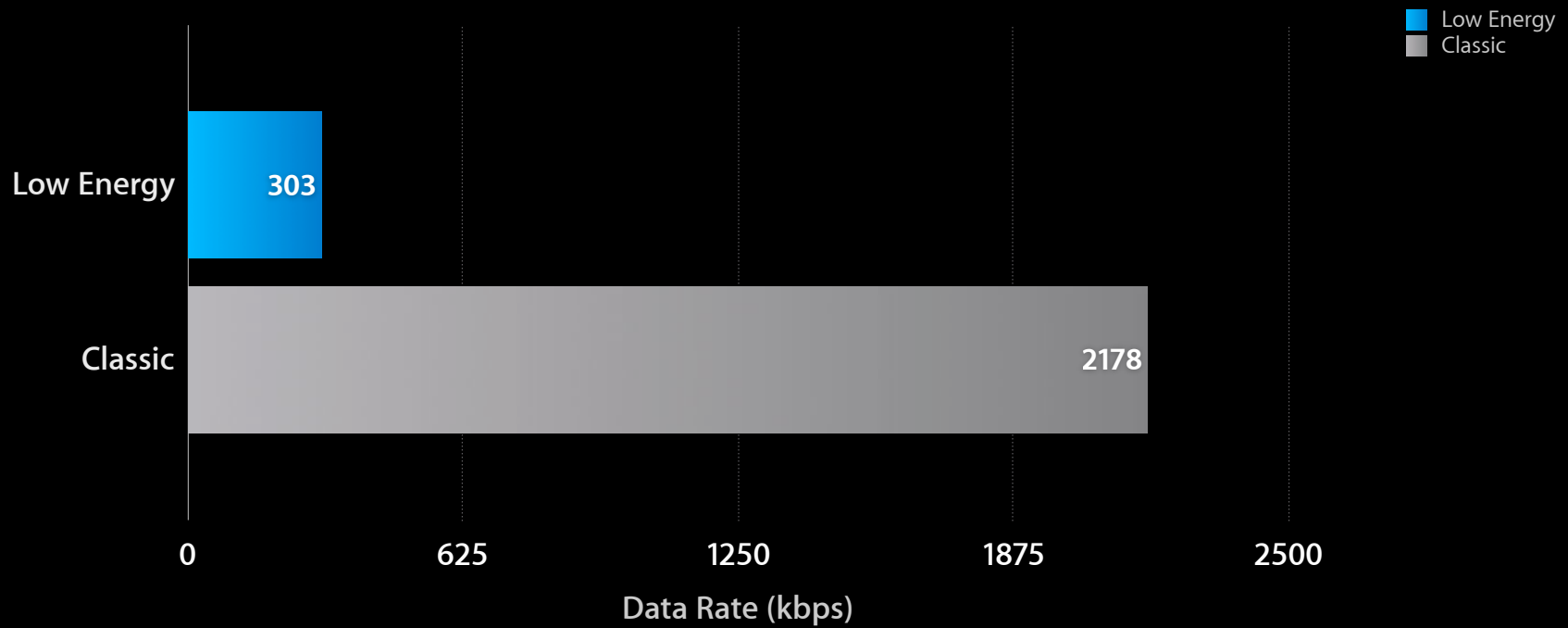
Classic vs. Low Energy

Power consumption comparison



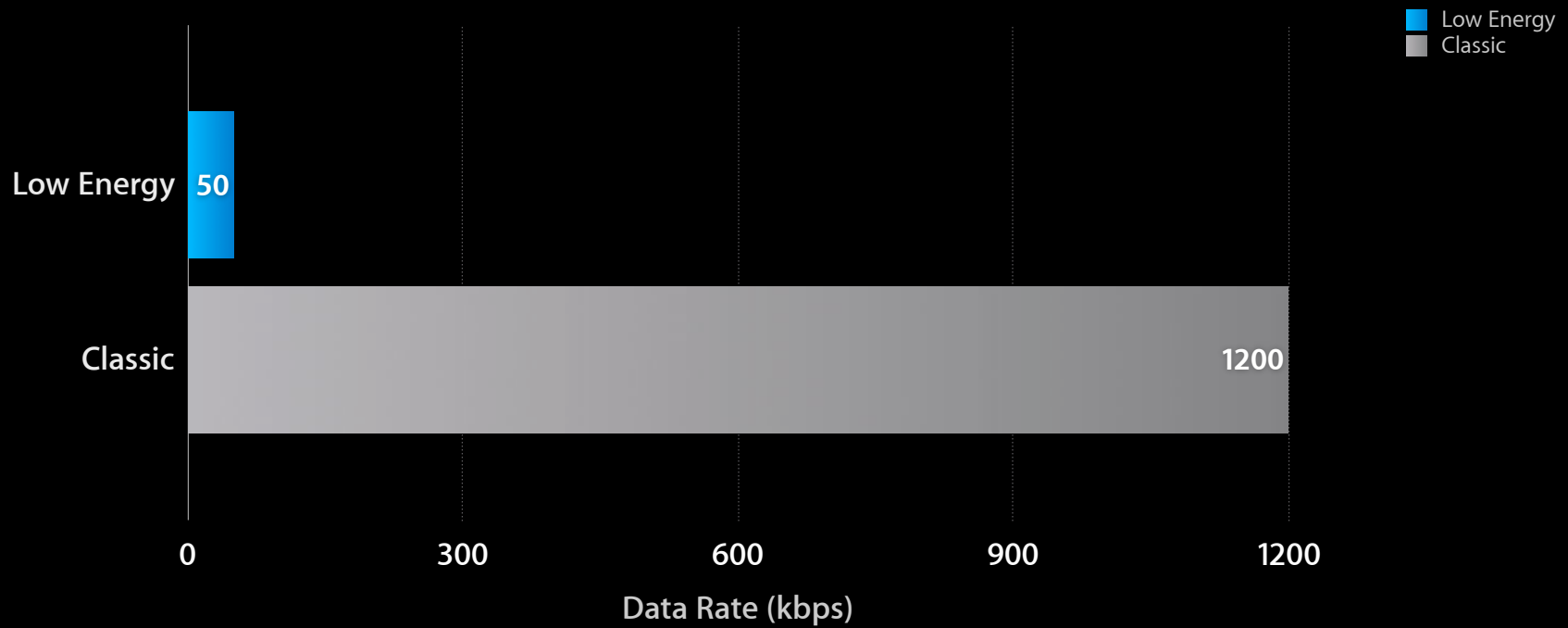
Classic vs. Low Energy

Max data rate comparison theoretical

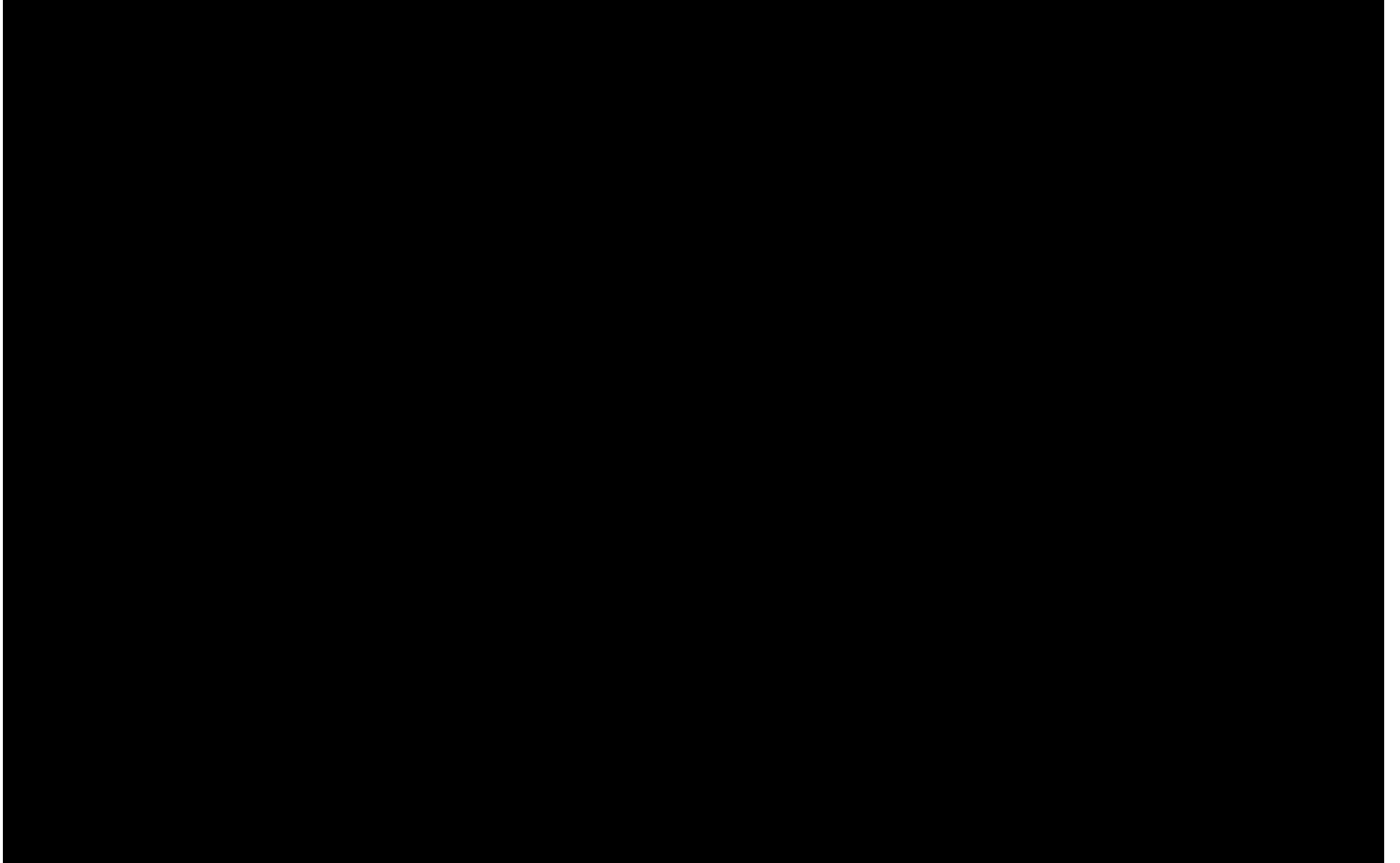


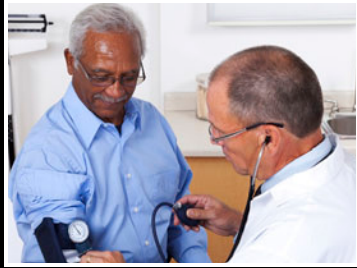
Classic vs. Low Energy

Max data rate comparison theoretical



Bluetooth Low Energy Use Cases





Health Care



Health Care



Sports/Fitness



Health Care



Sports/Fitness



Security



Health Care



Sports/Fitness



Security



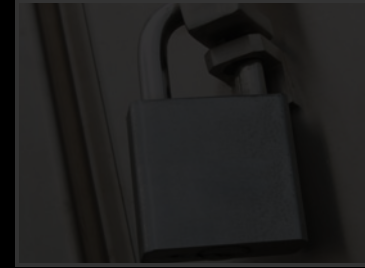
Automation



Health Care



Sports/Fitness



Security



Automation



Entertainment



Health Care



Sports/Fitness



Security



Automation



Entertainment



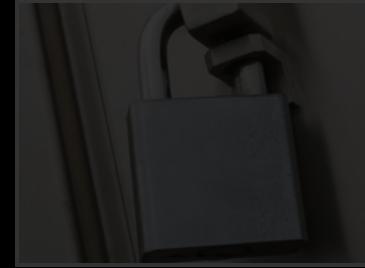
Toys



Health Care



Sports/Fitness



Security



Automation



Entertainment



Toys



Pay Systems



Health Care



Sports/Fitness



Security



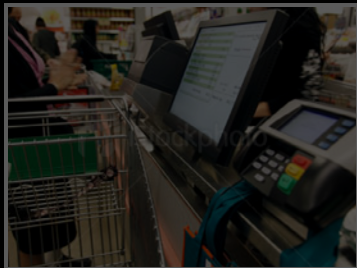
Automation



Entertainment



Toys



Pay Systems



Time Services



Health Care



Sports/Fitness



Security



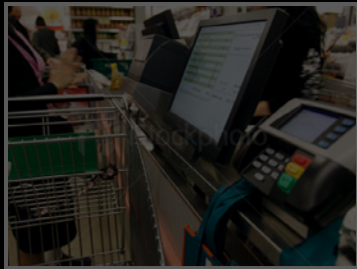
Automation



Entertainment



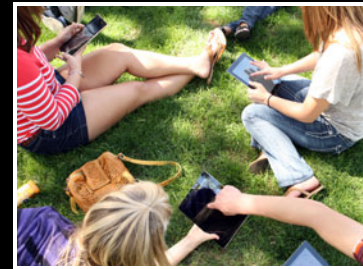
Toys



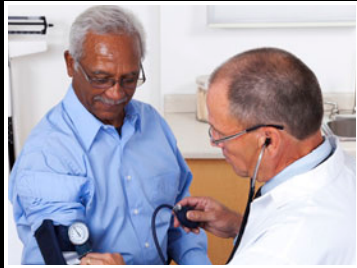
Pay Systems



Time Services



Proximity



Health Care



Sports/Fitness



Security



Automation



Entertainment



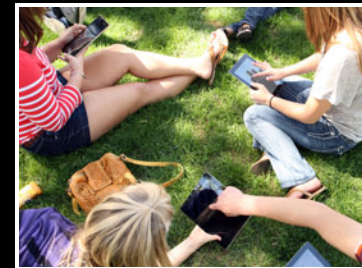
Toys



Pay Systems



Time Services



Proximity

Key Bluetooth 4.0 Terms

Key Bluetooth 4.0 Terms

Dual Mode

Single Mode

Key Bluetooth 4.0 Terms

Dual Mode

Single Mode

Key Bluetooth 4.0 Terms

Dual Mode

Single Mode



Bluetooth Classic
and Bluetooth Low Energy

Key Bluetooth 4.0 Terms

Dual Mode



Bluetooth Classic
and Bluetooth Low Energy

Single Mode



Bluetooth
Low Energy

Key Bluetooth 4.0 Terms

Key Bluetooth 4.0 Terms

Client

Server

Key Bluetooth 4.0 Terms



Client

Server

Key Bluetooth 4.0 Terms



Client

Server

Has Data

Key Bluetooth 4.0 Terms



Client

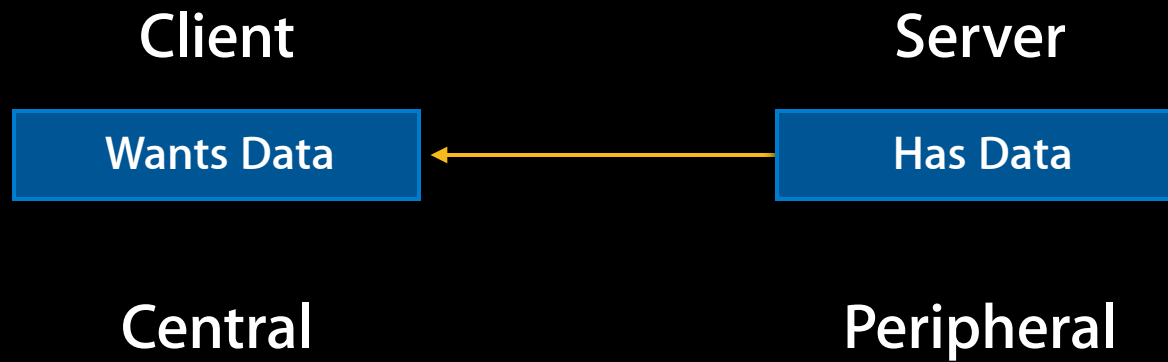
Server

Wants Data

Has Data



Key Bluetooth 4.0 Terms



Key Bluetooth 4.0 Terms



Client

Server

Wants Data

Has Data



Central

Peripheral



Key Bluetooth 4.0 Terms



Client

Server

Wants Data

Has Data



Central

Peripheral



Advertising

Observer
iPhone



Broadcaster



Advertising

Observer
iPhone

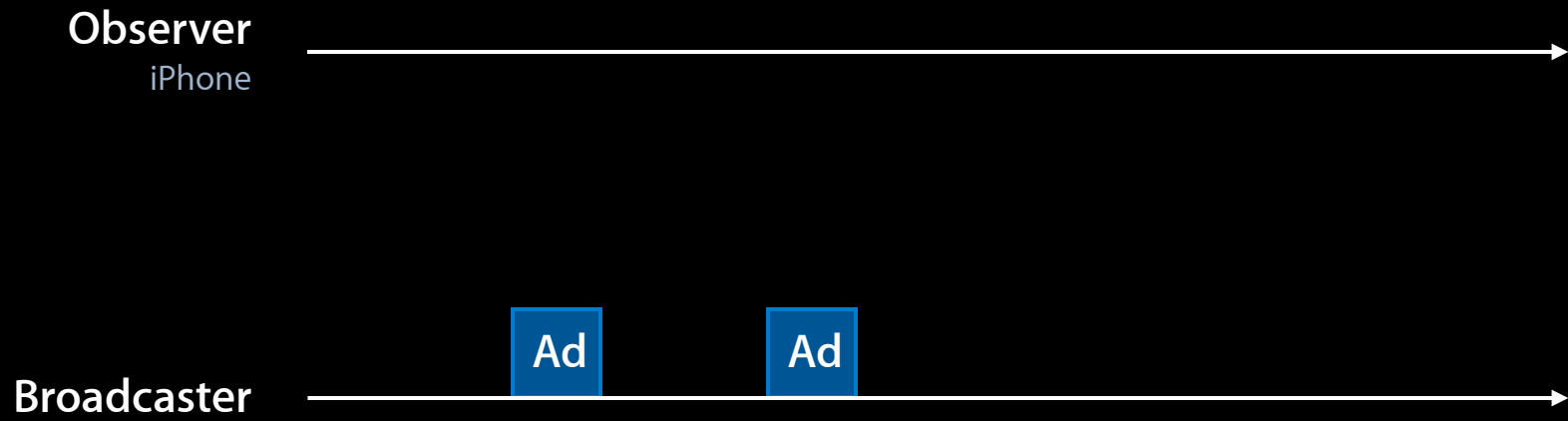


Broadcaster

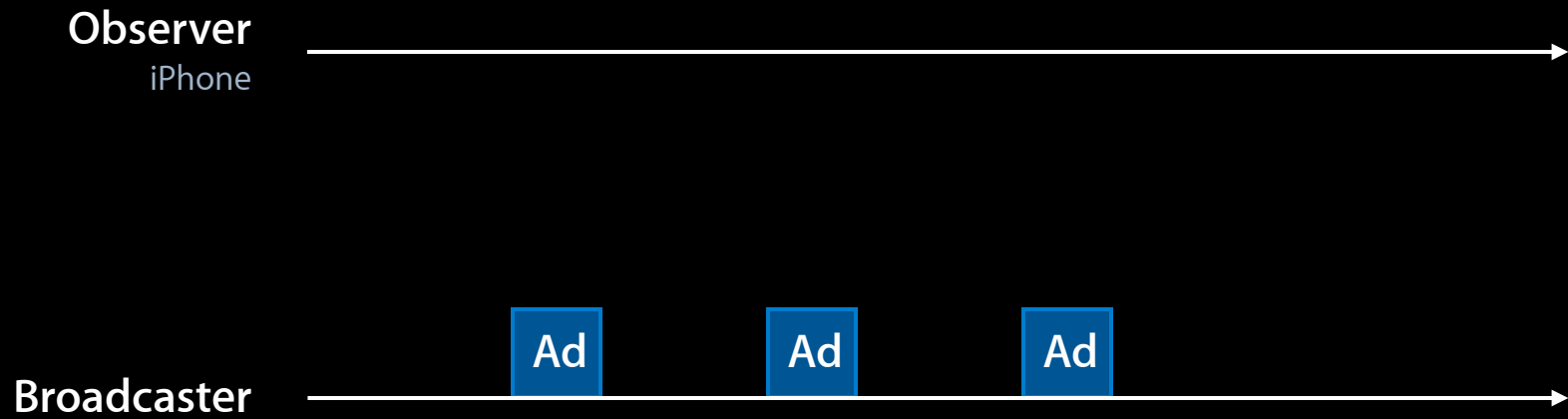
Ad



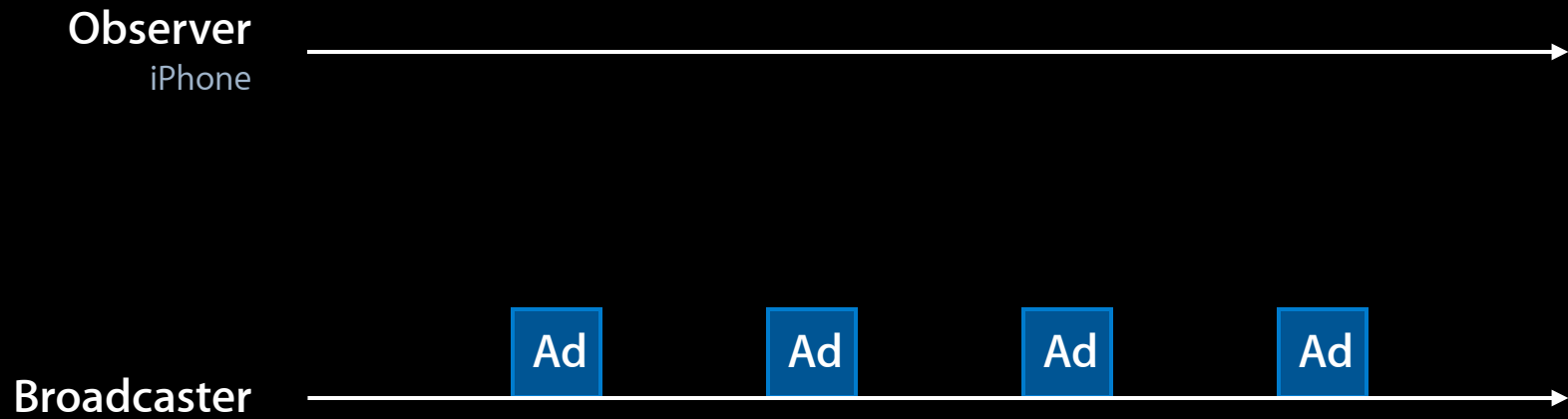
Advertising



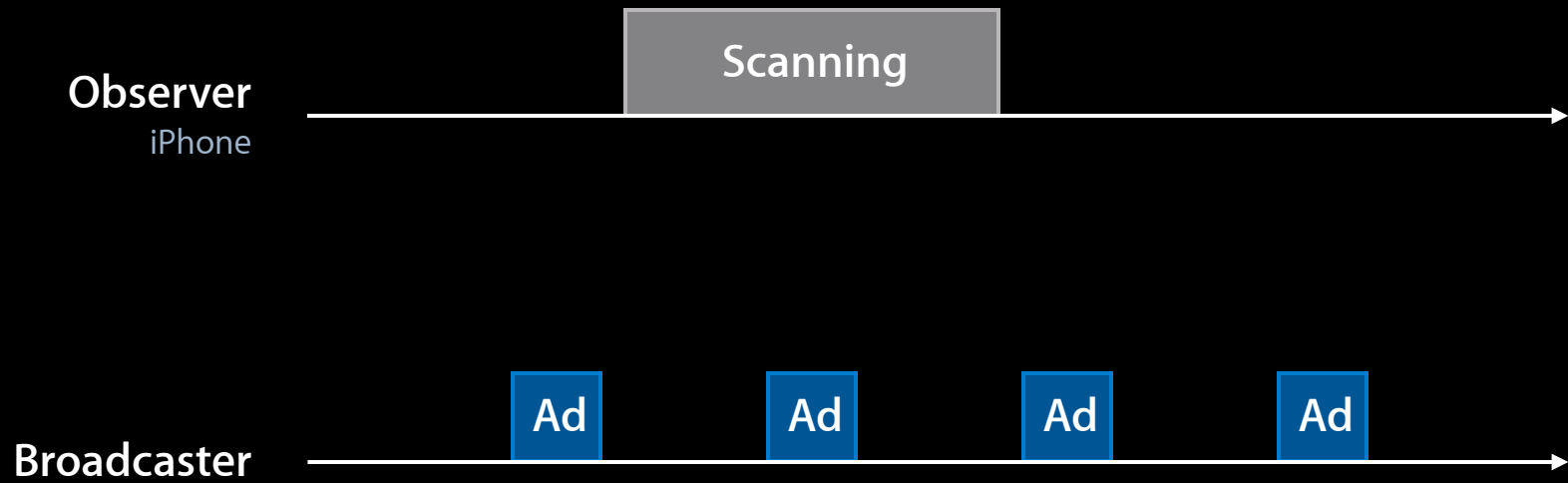
Advertising



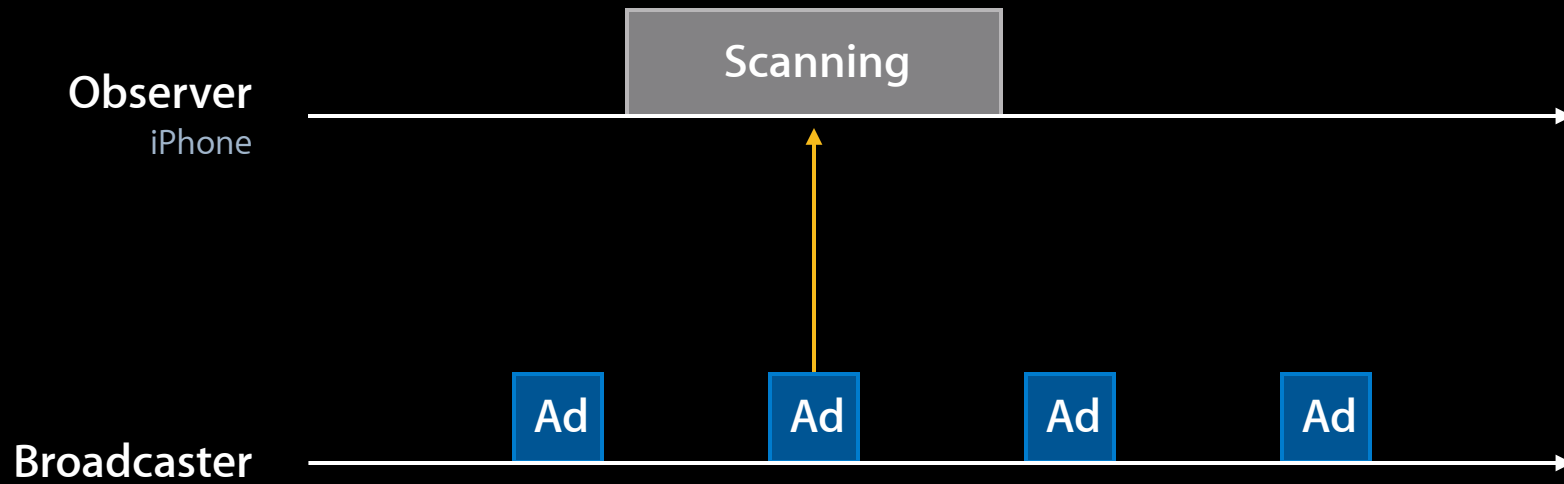
Advertising



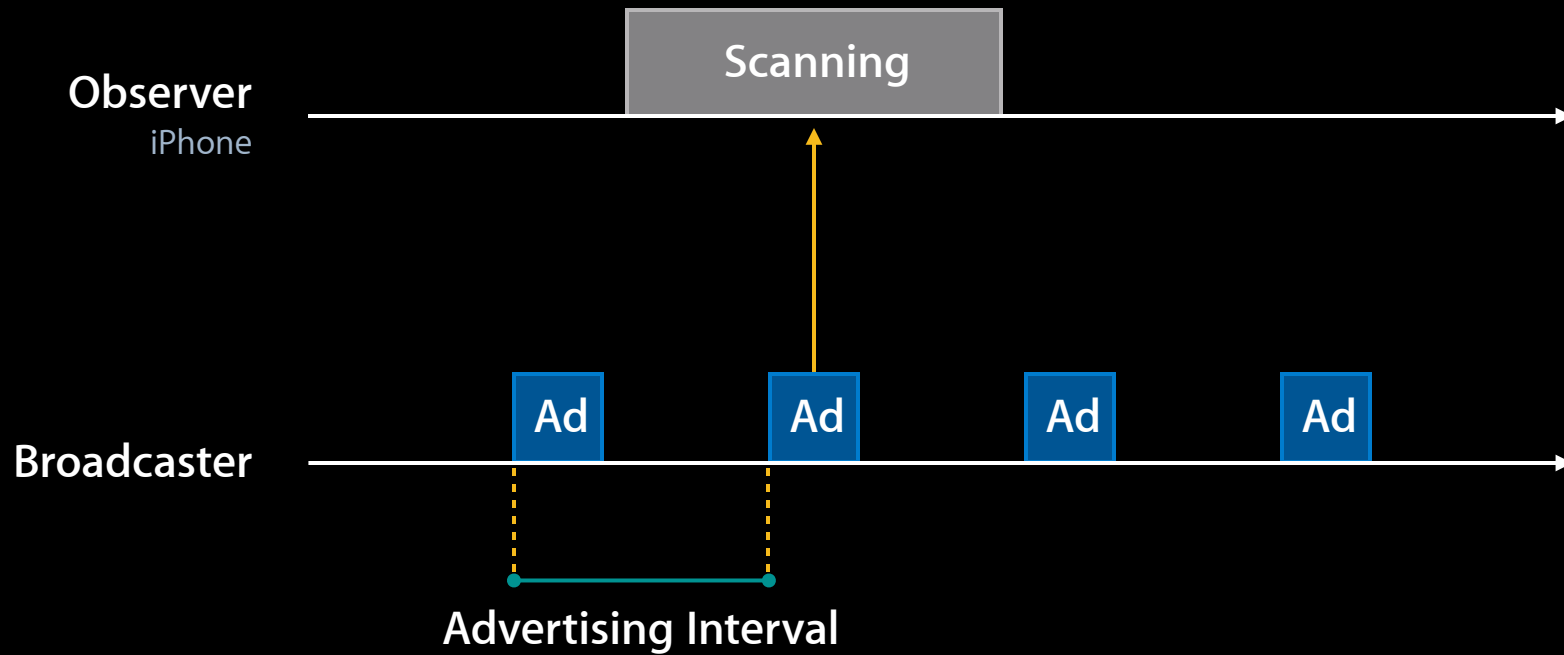
Advertising



Advertising



Advertising



Advertising on Multiple Channels

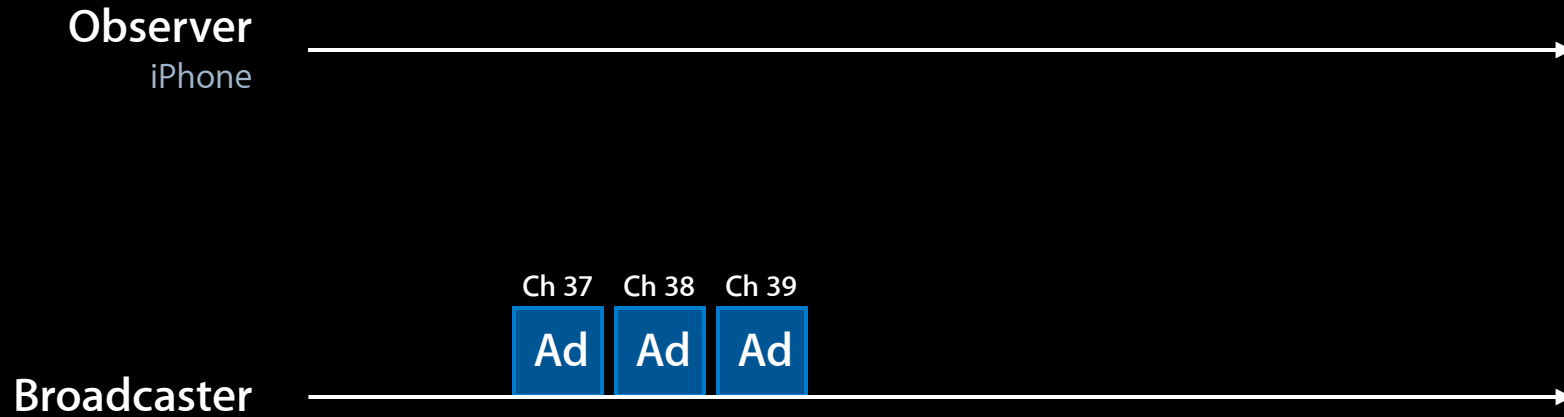
Observer
iPhone



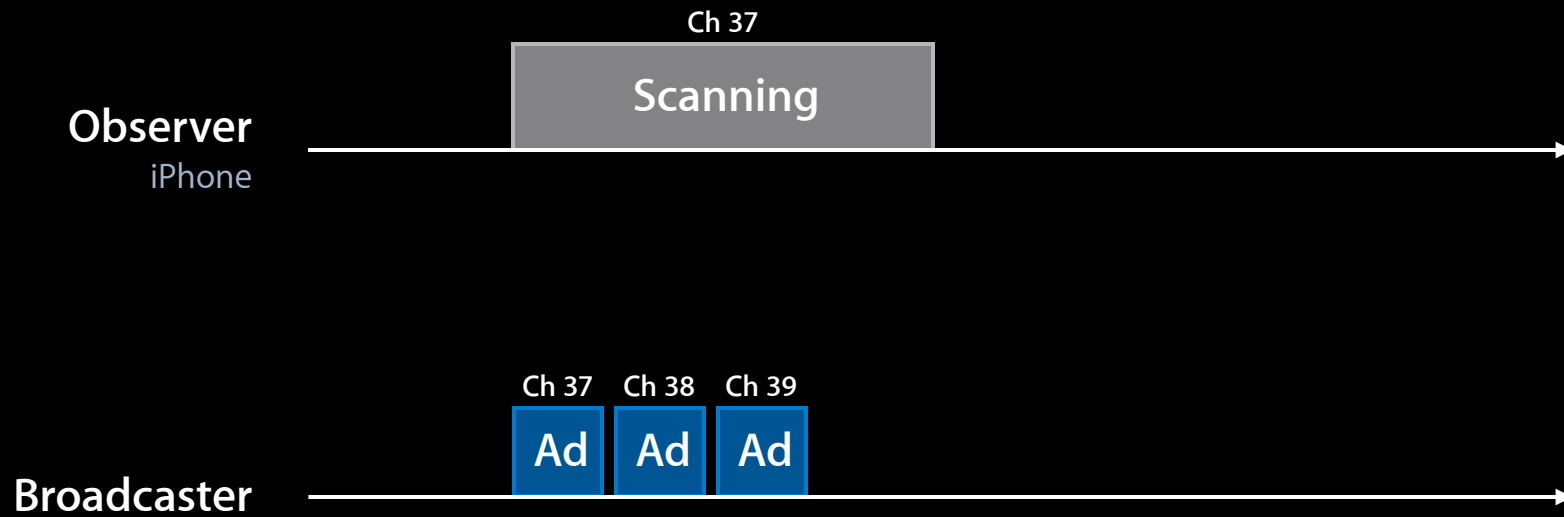
Broadcaster



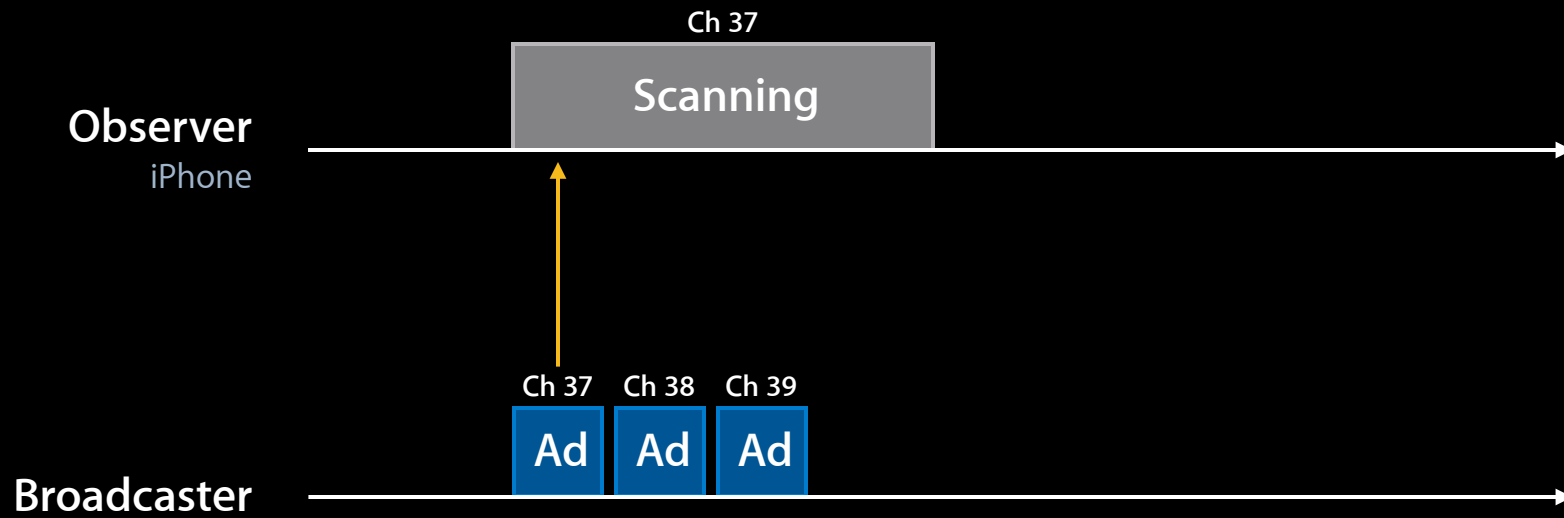
Advertising on Multiple Channels



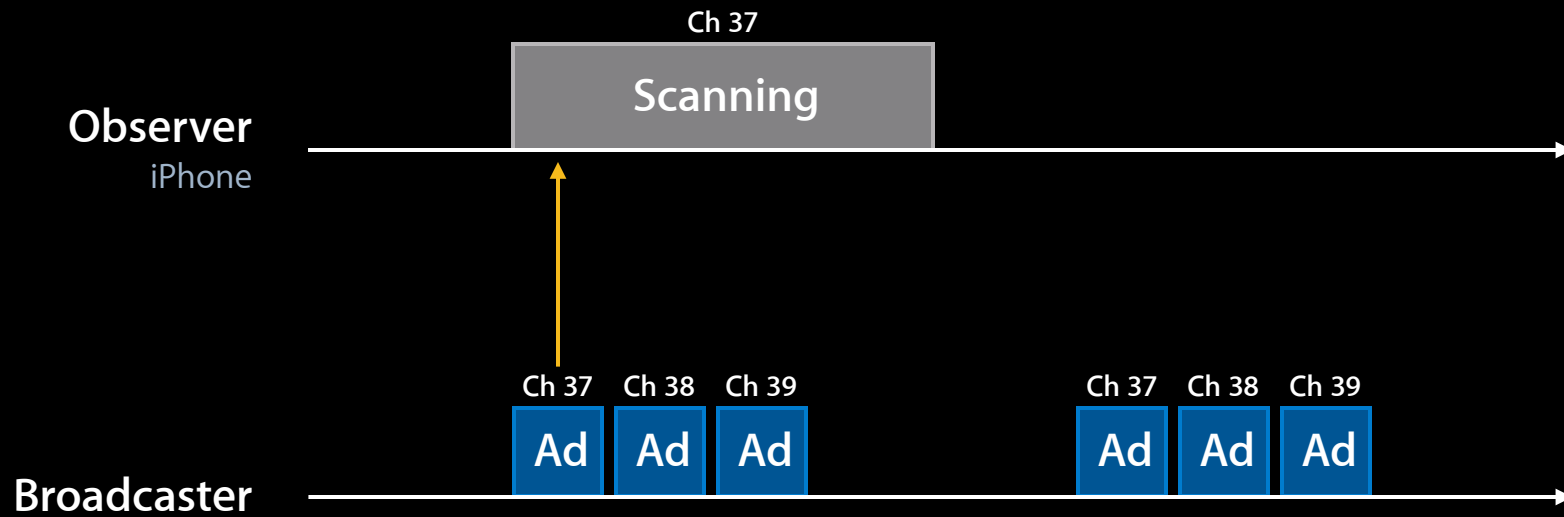
Advertising on Multiple Channels



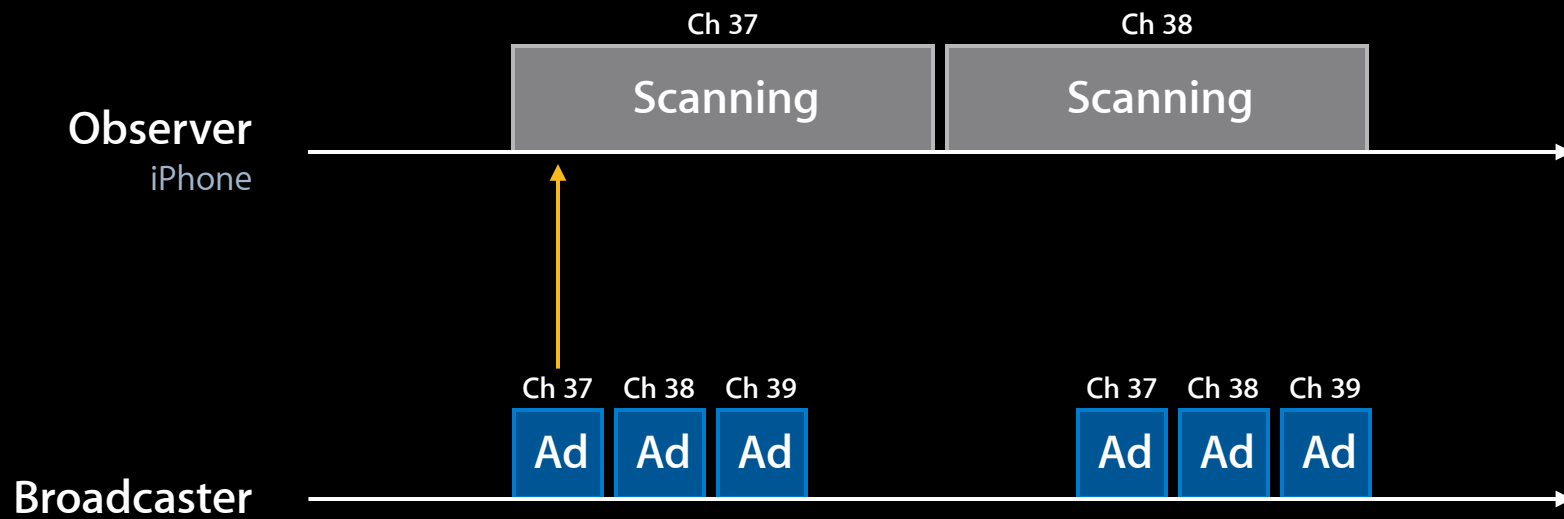
Advertising on Multiple Channels



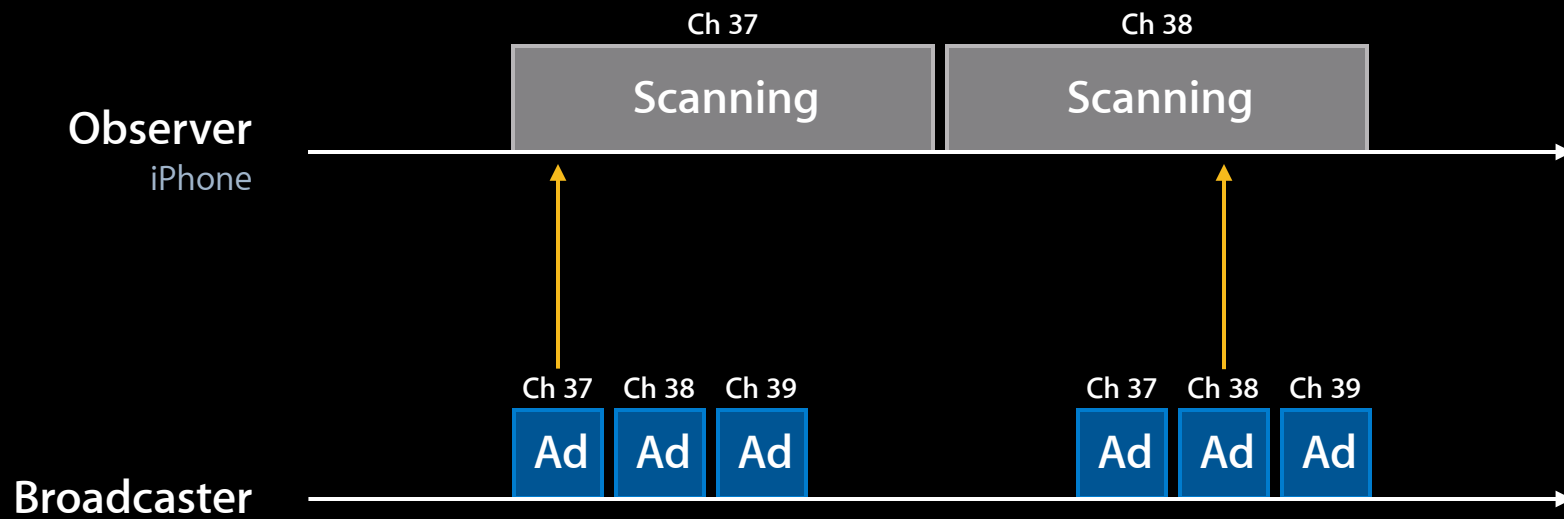
Advertising on Multiple Channels



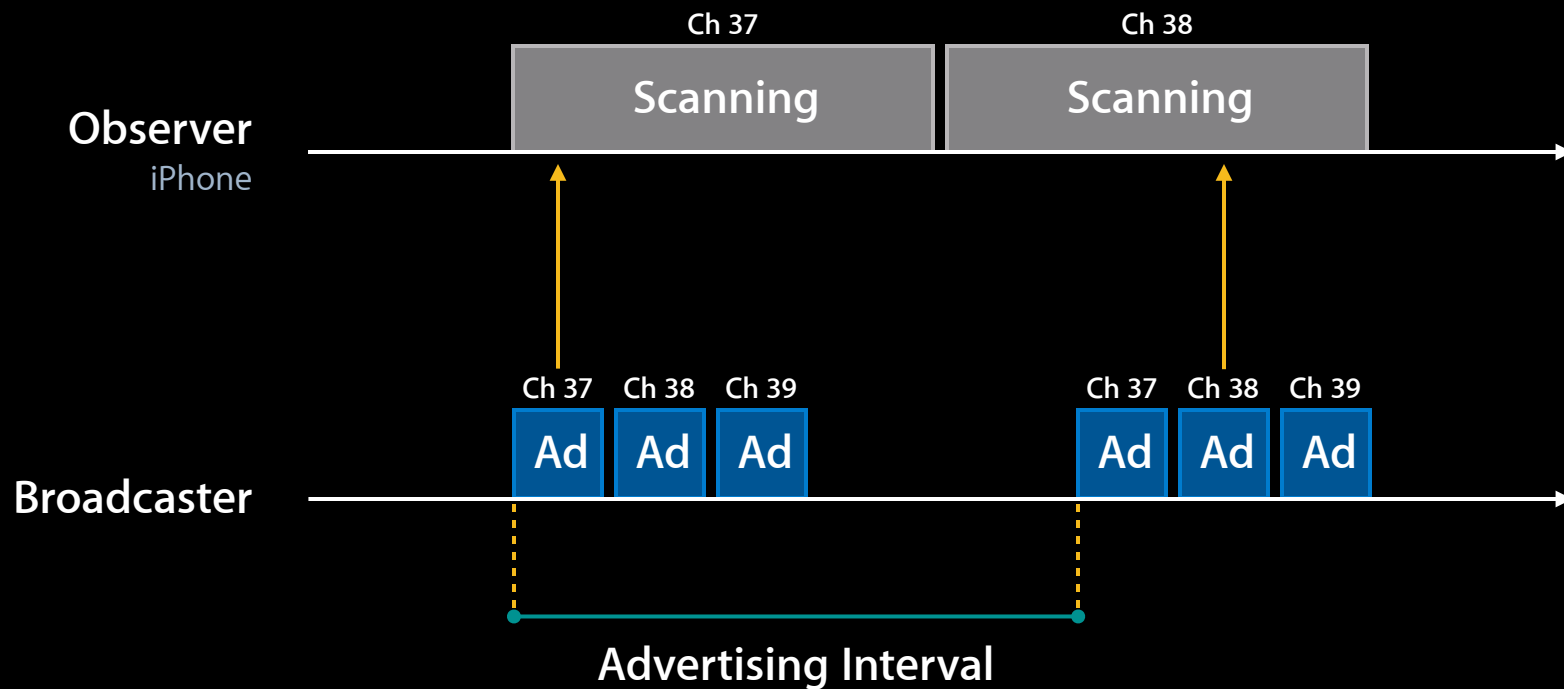
Advertising on Multiple Channels



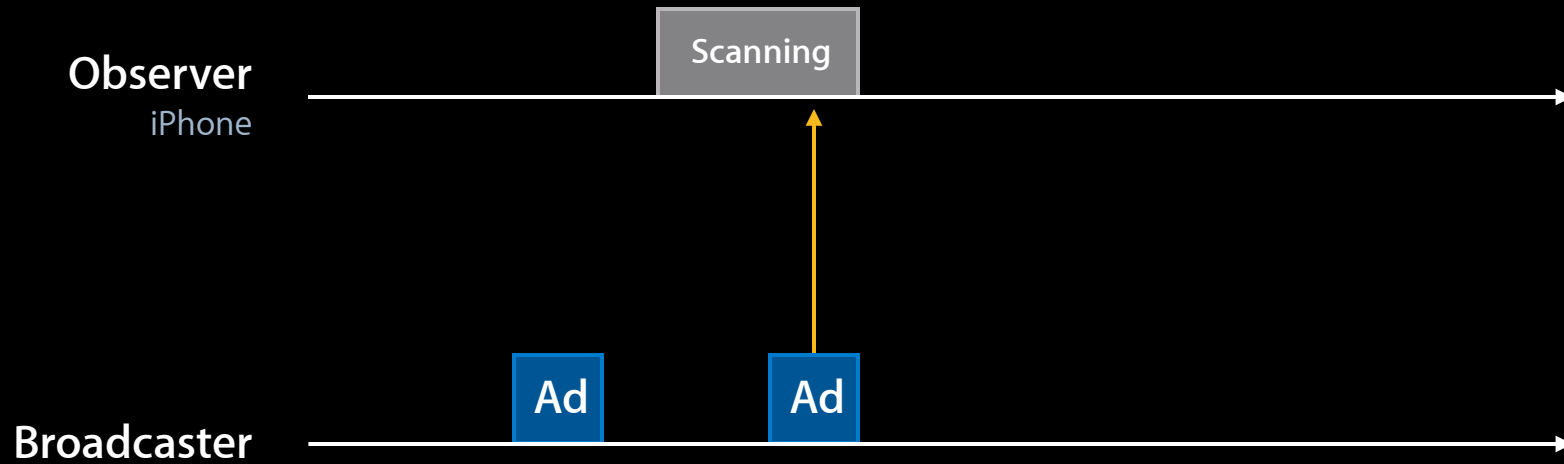
Advertising on Multiple Channels



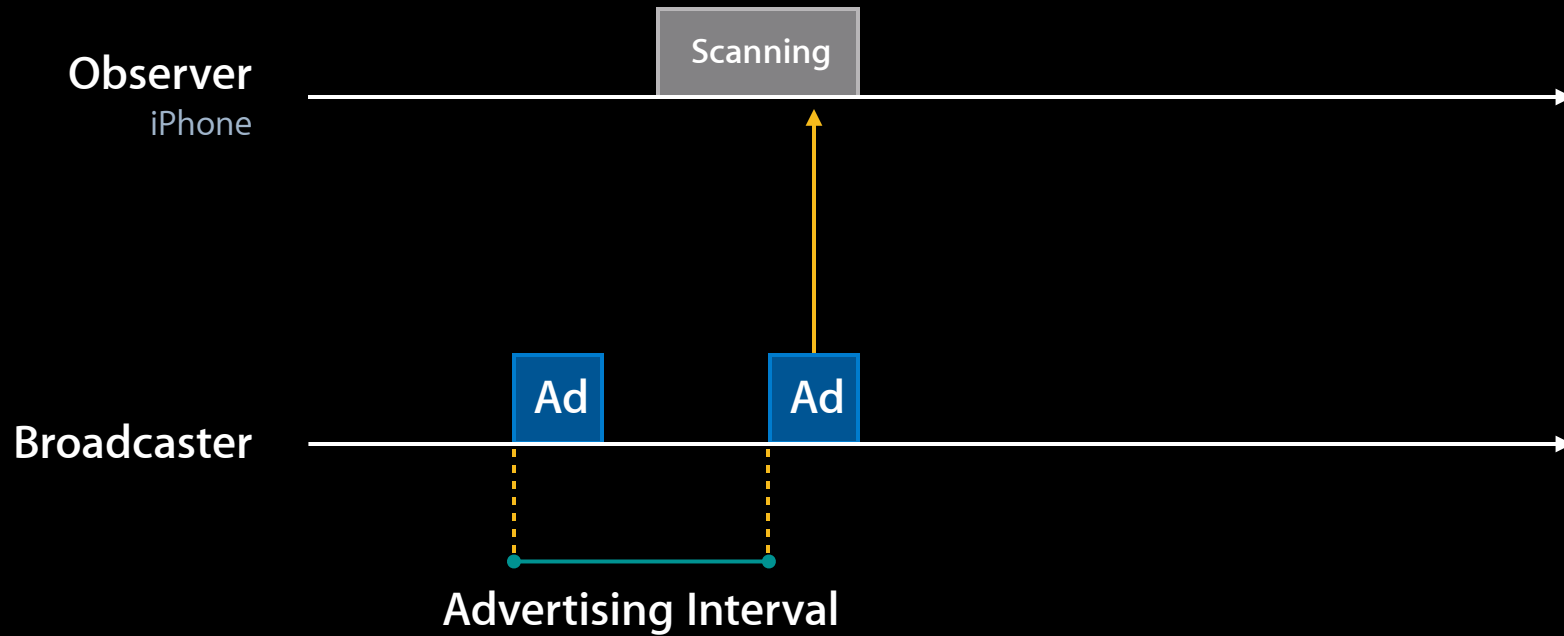
Advertising on Multiple Channels



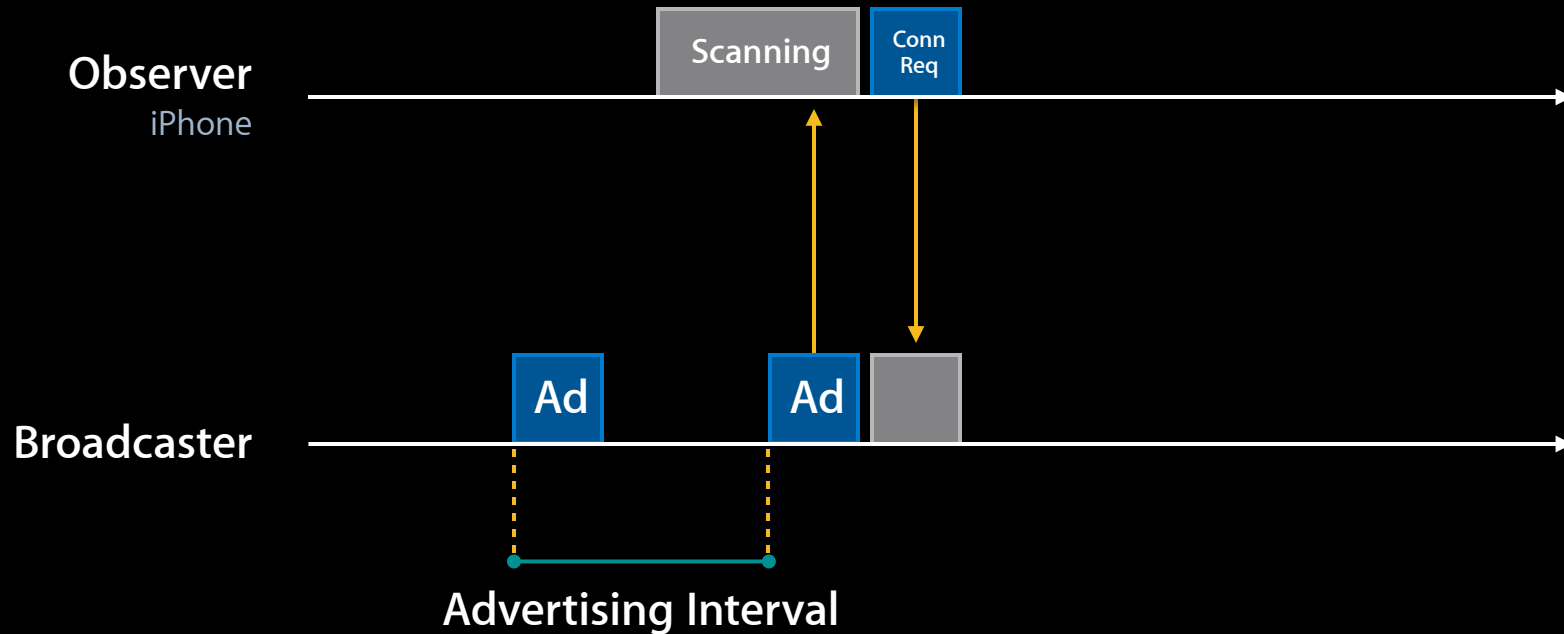
Setting Up a Connection



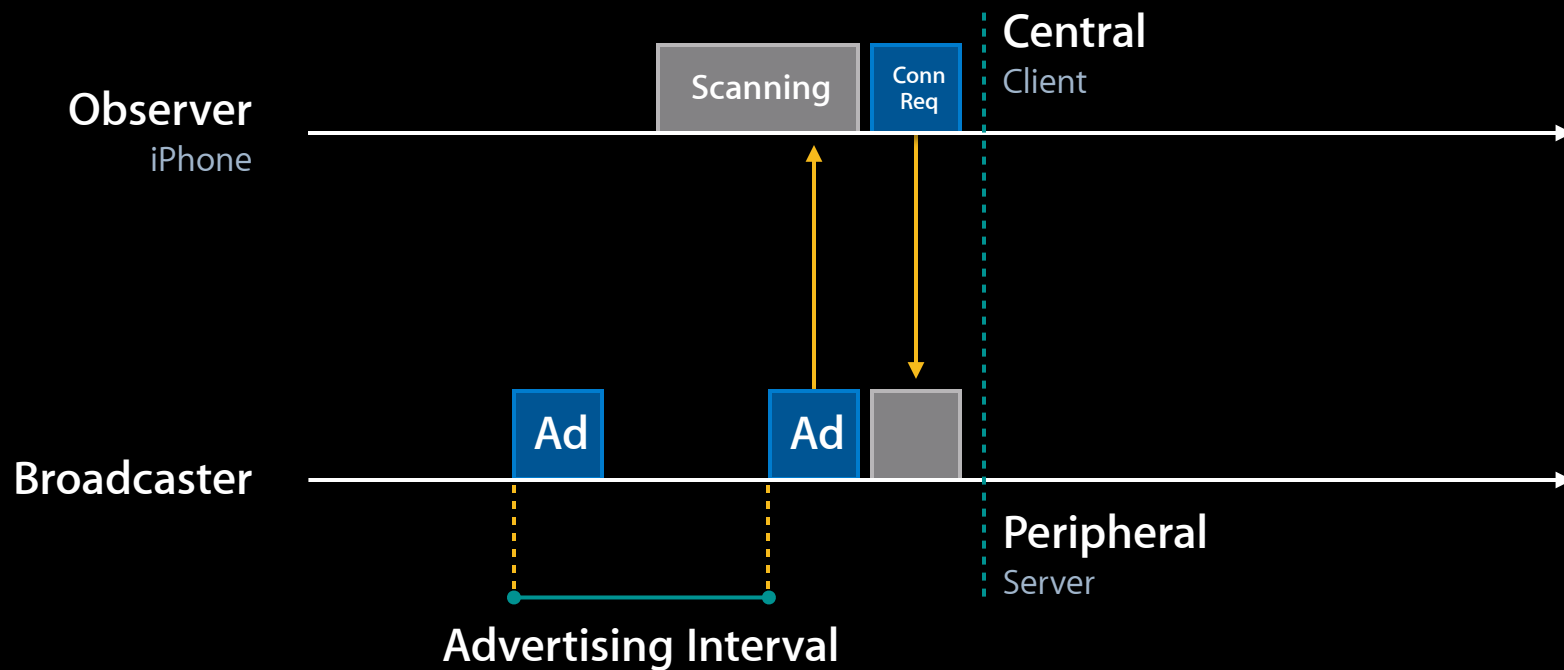
Setting Up a Connection



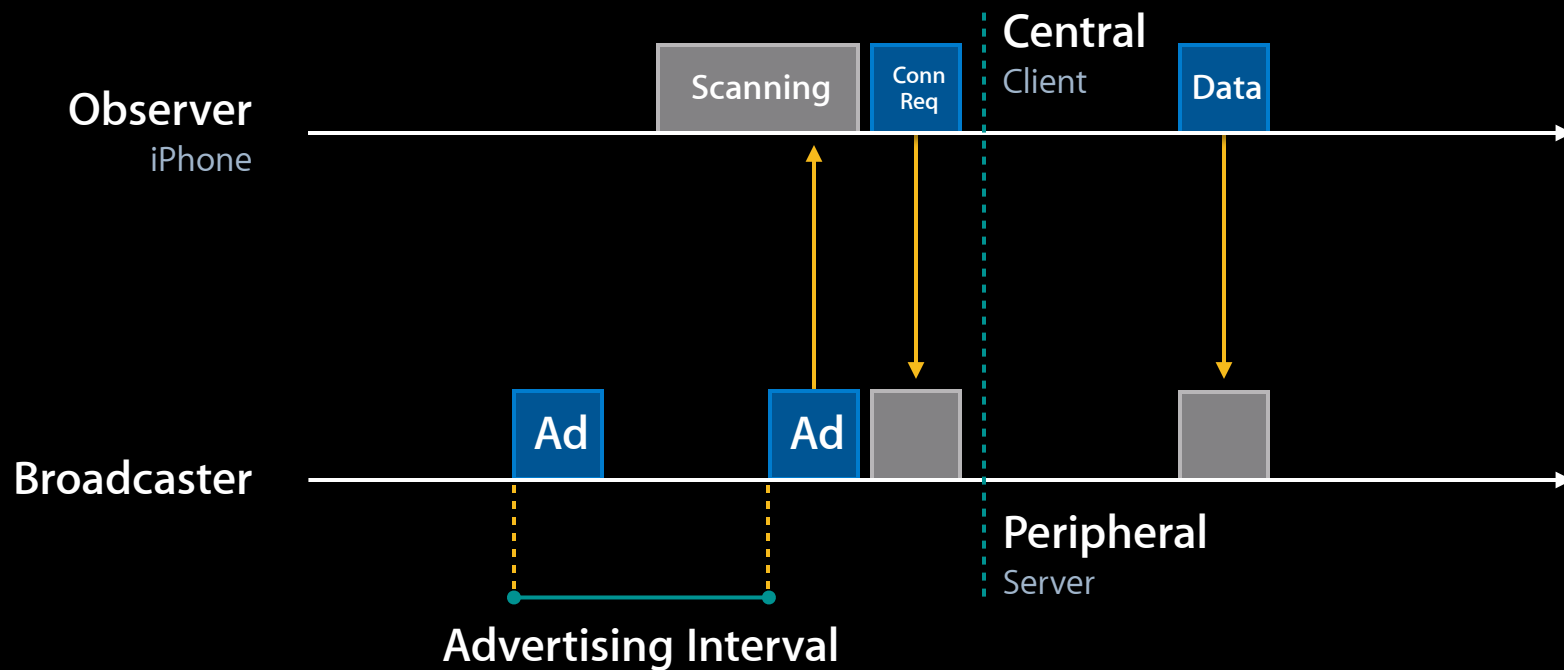
Setting Up a Connection



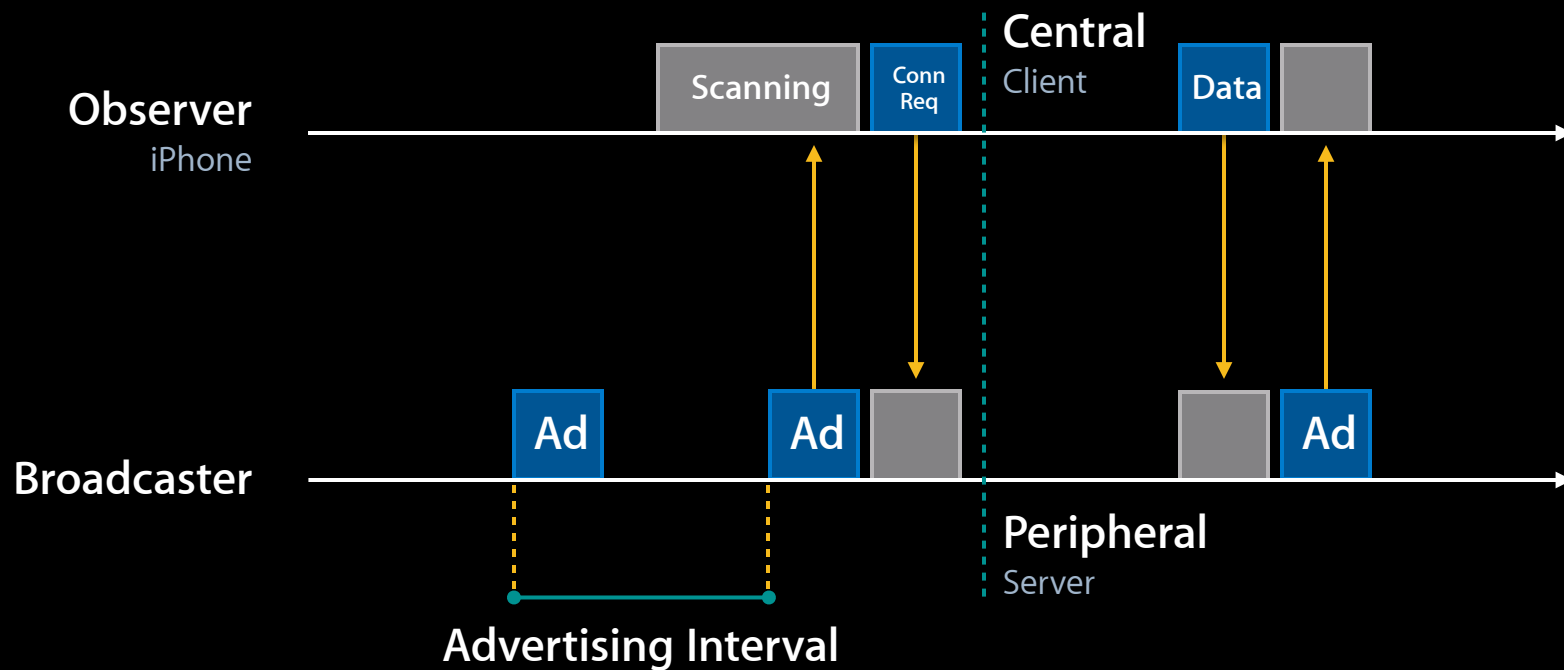
Setting Up a Connection



Setting Up a Connection



Setting Up a Connection



Connection Interval

Central
Client



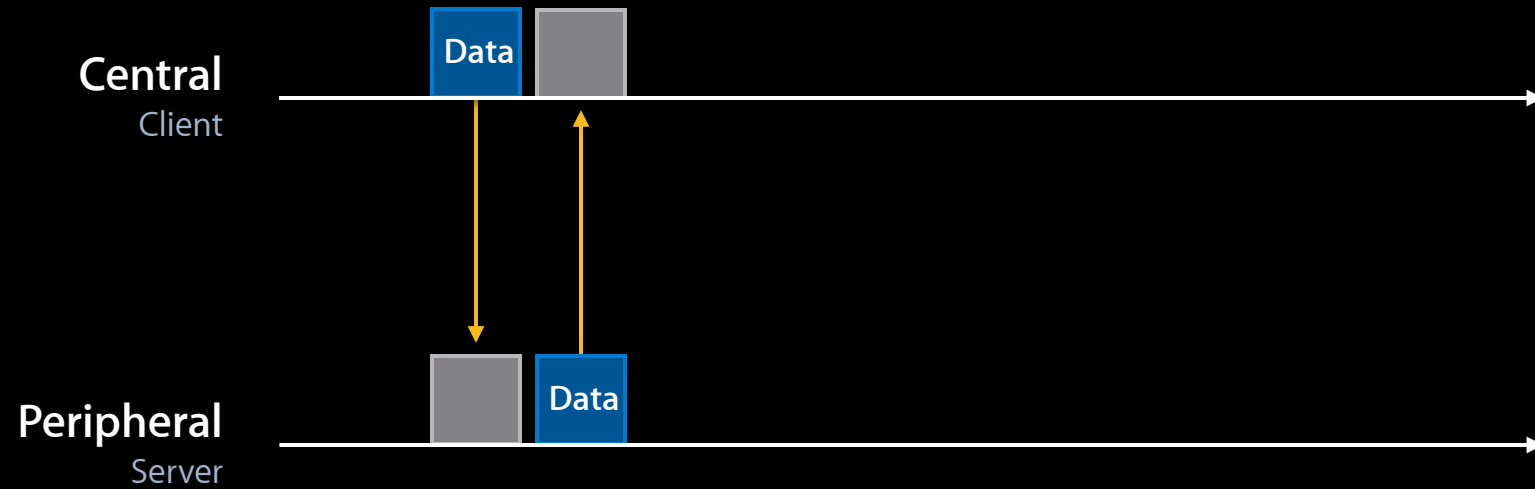
Peripheral
Server



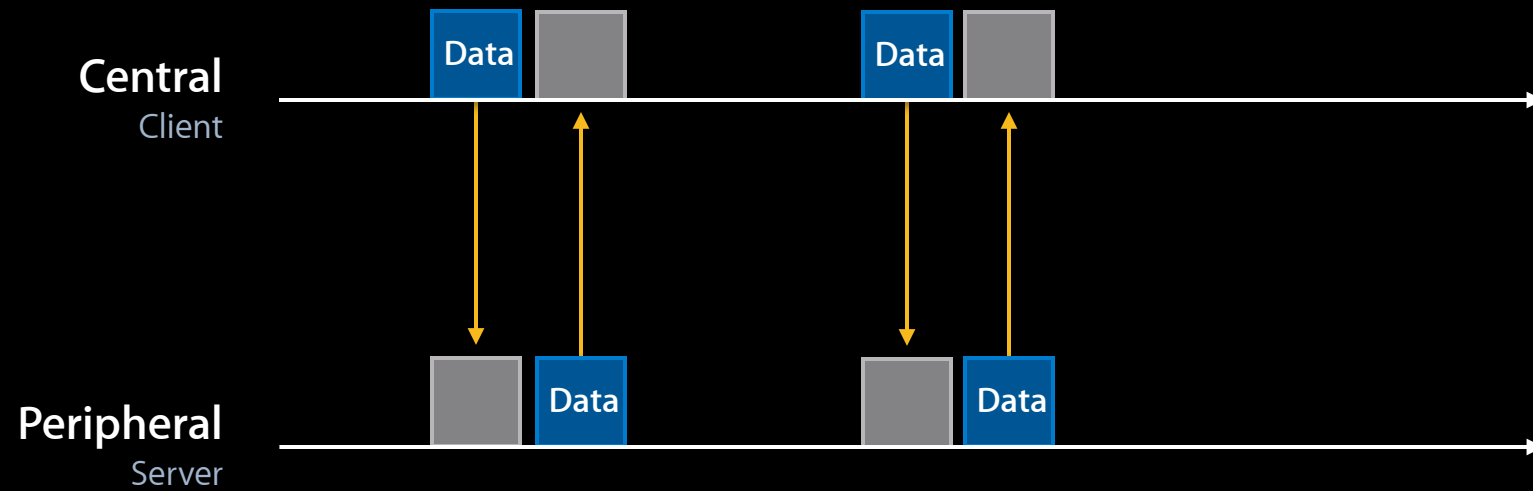
Connection Interval



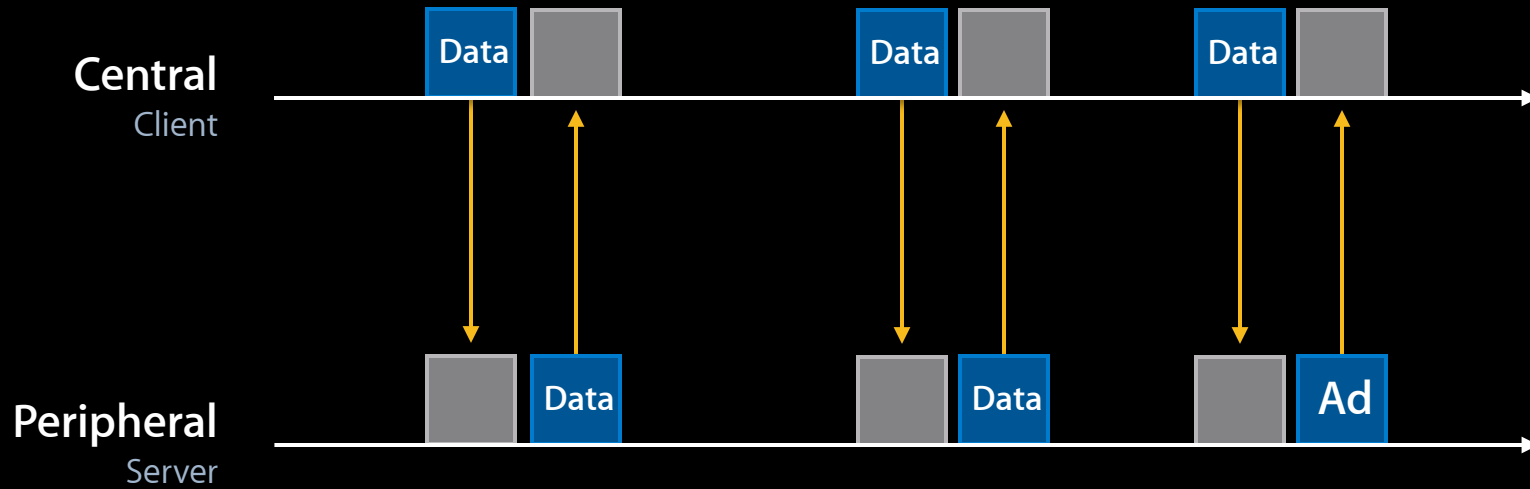
Connection Interval



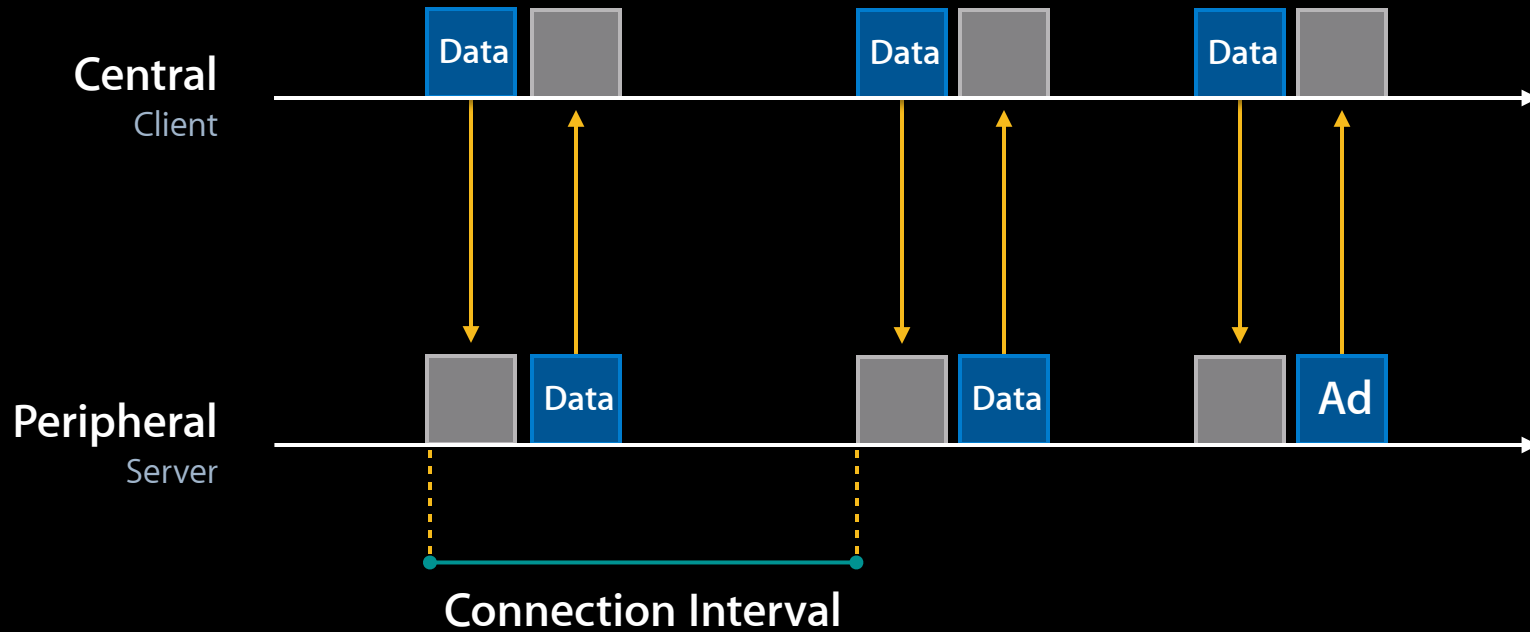
Connection Interval



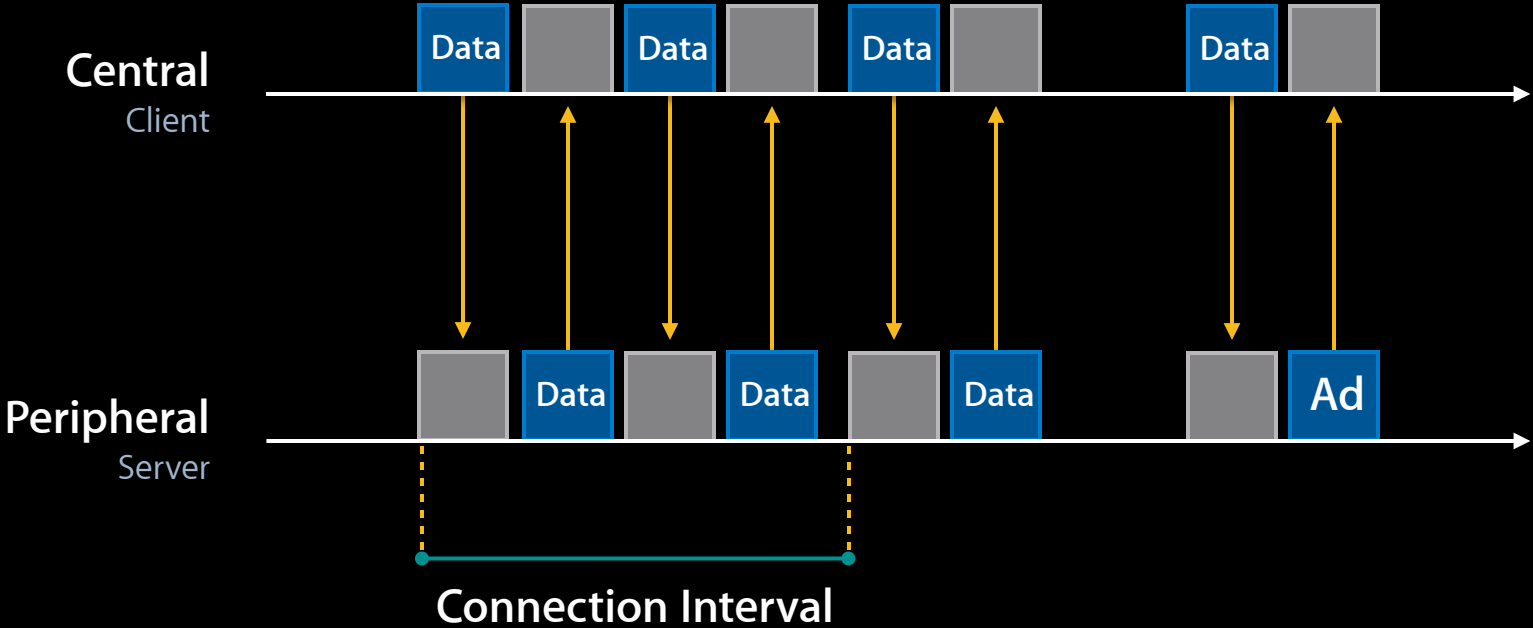
Connection Interval



Connection Interval

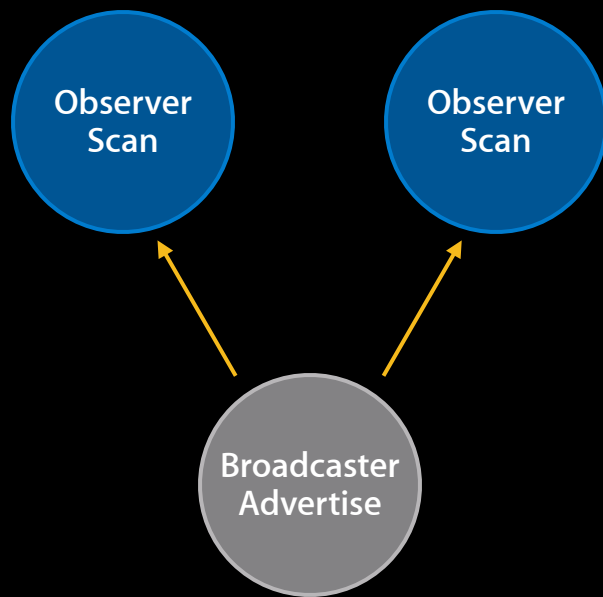


Connection Interval

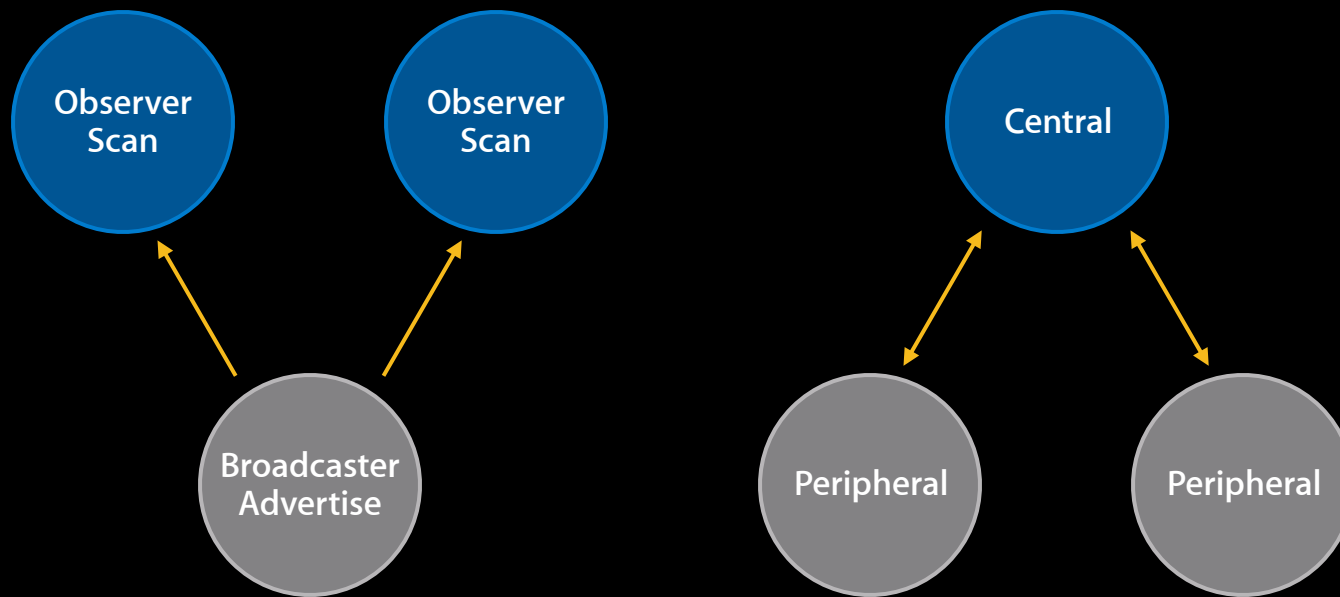


Topology

Topology



Topology



Services and Characteristics



Services and Characteristics



Server



Services and Characteristics



Server

Service
Heart Rate Monitor

Services and Characteristics



Server

Service

Heart Rate Monitor

Characteristic

Heart Rate Measurement

Characteristic

Body Sensor Location

Characteristics

Characteristics

Characteristic

Type

Value

Properties

Client Configuration

...

Characteristics

Characteristic

Type
Value
Properties
Client Configuration
...

← **UUID identifying the type**
Uniquely identifies the type of the value

Characteristics

Characteristic

Type
Value
Properties
Client Configuration
...

The value
Octet string with the value



Characteristics

Characteristic

Type
Value
Properties ←
Client Configuration
...

Read, write, notify
The allowed operations on the value

Characteristics

Characteristic

Type

Value

Properties

Client Configuration

...

← Notification on/off
Settings for this client

Characteristics

Characteristic

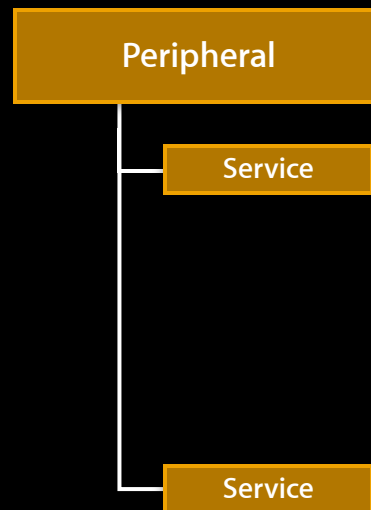
Type
Value
Properties
Client Configuration
...

Additional descriptors
More information about the characteristic

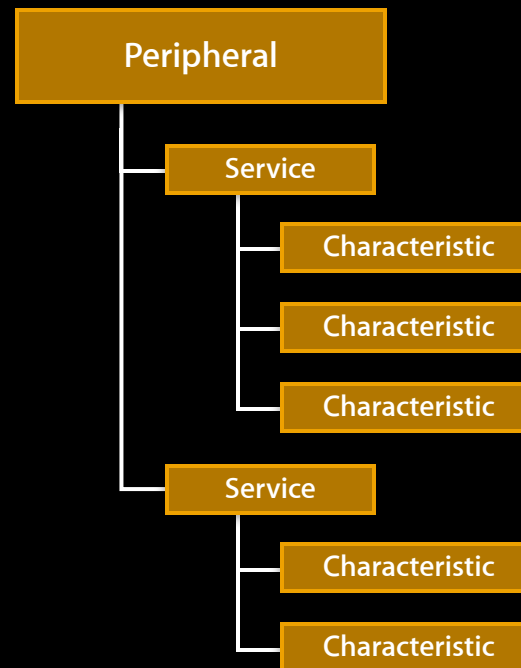
Services and Characteristics Tree

Peripheral

Services and Characteristics Tree



Services and Characteristics Tree





Introduction to Core Bluetooth

Core Bluetooth Principles



Core Bluetooth Principles

- Simple



Core Bluetooth Principles

- Simple
- Powerful



Core Bluetooth Principles

- Simple
- Powerful
- Built on the Bluetooth 4.0 standard



It's All About Your App

It's All About Your App

- No iOS hosted BT LE device management
 - One exception is paired LE devices shown in Bluetooth settings

It's All About Your App

- No iOS hosted BT LE device management
 - One exception is paired LE devices shown in Bluetooth settings
- App is responsible for all device interaction
 - Discovery
 - Connection Management
 - Data Exchange
 - Device Management

Core Bluetooth Platforms

Core Bluetooth Platforms



iPhone 4S

Core Bluetooth Platforms



iPhone 4S



Mac mini

Core Bluetooth Platforms



iPhone 4S



Mac mini



iPad

Core Bluetooth Platforms



iPhone 4S



Mac mini



iPad



MacBook Air

Core Bluetooth Platforms



iPhone 4S



Mac mini



iPad

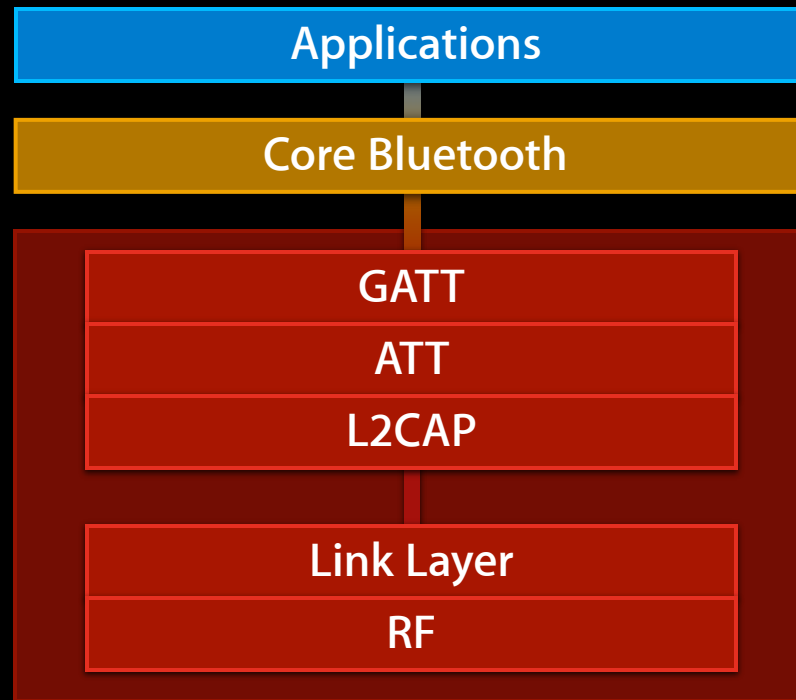


MacBook Air

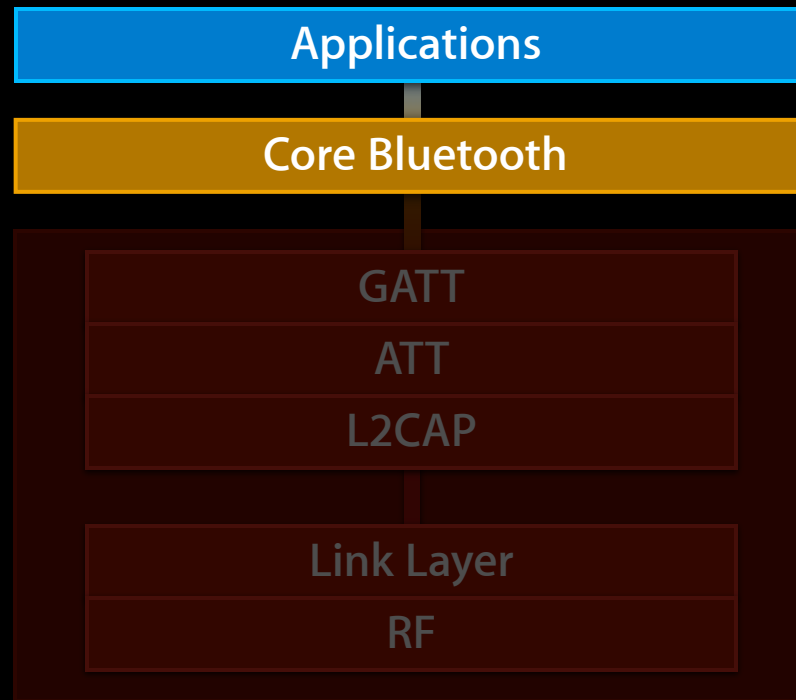


iOS Simulator

Technology Framework



Technology Framework



Key Bluetooth 4.0 Terms

Client

Wants Data

Server

Has Data



Central



Peripheral



Core Bluetooth Object Model

Core Bluetooth Object Model

Main Objects

CBCentralManager

CBPeripheral

```
graph TD; A[CBPeripheral] --- B[CBCentralManager];
```

Core Bluetooth Object Model

Main Objects

CBCentralManager

CBPeripheral

Data Objects

CBService

CBCharacteristic

Core Bluetooth Object Model

Main Objects

CBCentralManager

CBPeripheral

Data Objects

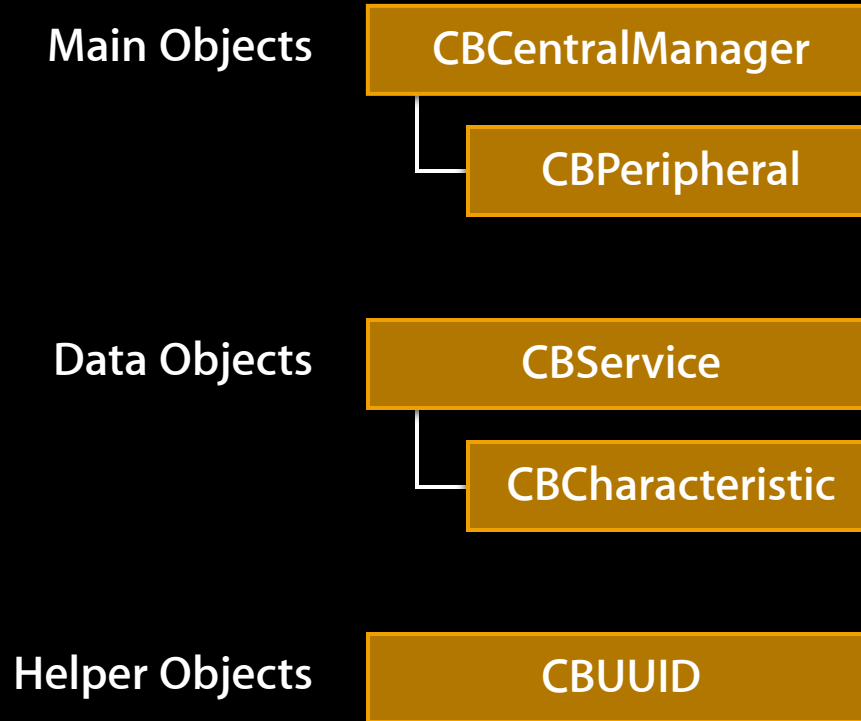
CBService

CBCharacteristic

Helper Objects

CBUUID

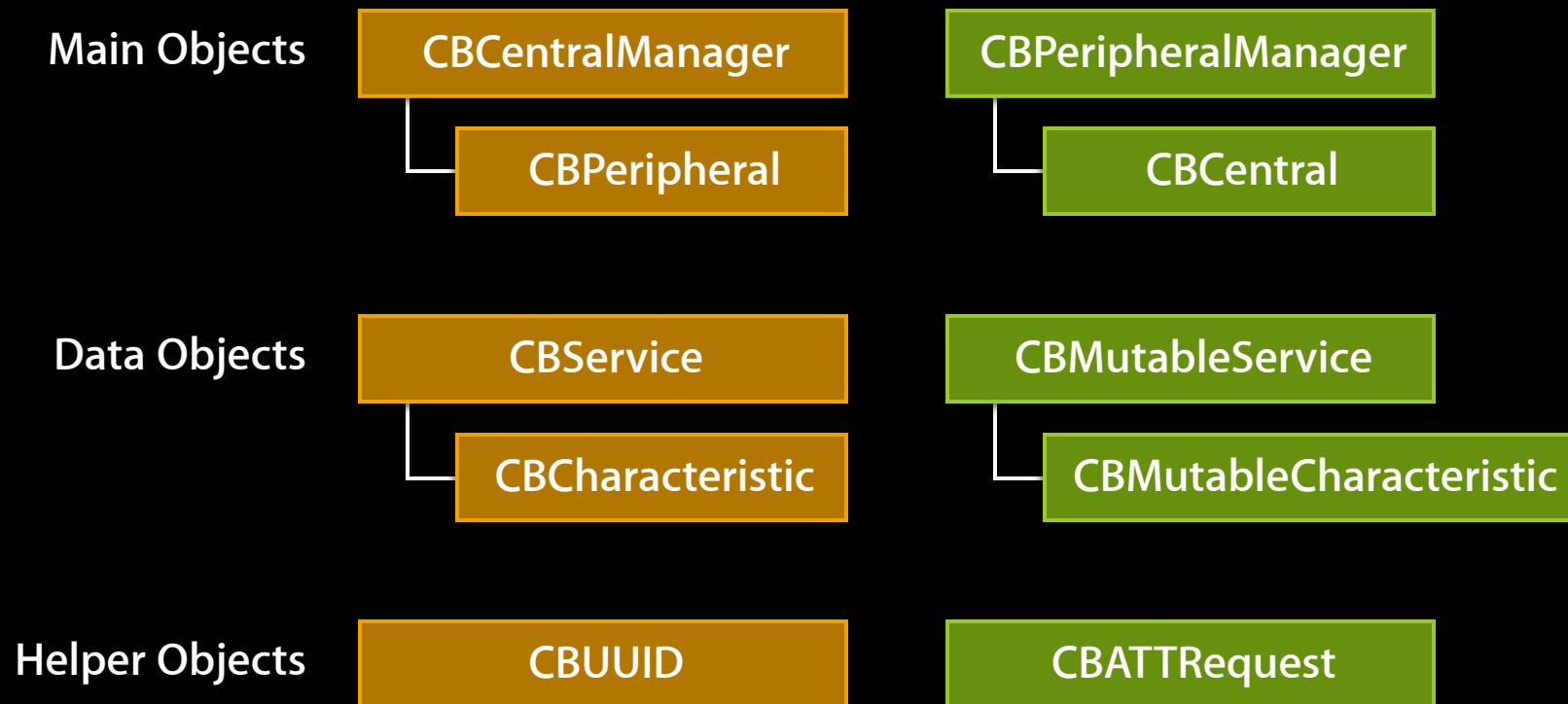
Core Bluetooth Object Model



Core Bluetooth Object Model



New in iOS 6



iOS Backgrounding Modes

iOS Backgrounding Modes

- Event-based peripherals
 - Something has happened, tell the user
 - Notifications

iOS Backgrounding Modes

- Event-based peripherals
 - Something has happened, tell the user
 - Notifications
- Session-based peripherals
 - Stream of data from peripheral with discrete Start and Stop
 - Full Access to Peripheral
 - Requires info.plist entry

Demo

Example source code available at

<http://developer.apple.com/library/mac/#samplecode/HeartRateMonitor>

Craig Dooley

OS X Bluetooth Engineer

Bluetooth Best Practices and Apple Guidelines



[http://developer.apple.com/hardwaredrivers/
BluetoothDesignGuidelines.pdf](http://developer.apple.com/hardwaredrivers/BluetoothDesignGuidelines.pdf)

More Information

Stephen Chick

iPhone Evangelist
chick@apple.com

Craig Keithley

MFi and I/O Technology Evangelist
keithley@apple.com

Developer Programs

MFi Program
<http://developer.apple.com/mfi/>

Bluetooth Mailing List

bluetooth-dev@lists.apple.com

More Information

Bluetooth Accessory Design Guidelines

<http://developer.apple.com/hardwaredrivers/>

Reporting Bugs

<http://bugreport.apple.com>

Apple Developer Forums

<http://devforums.apple.com>

Bluetooth Developer Site

<http://developer.bluetooth.org>

Related Sessions

Advanced Core Bluetooth

Russian Hill
Tuesday 2:00PM

Labs

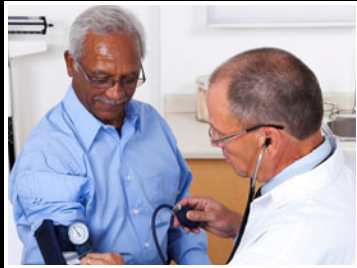
iOS Accessories Lab

Core OS Lab A
Tuesday 11:30AM

Bluetooth Lab

Core OS Lab A
Tuesday 3:15PM





Health Care



Sports/Fitness



Security



Automation



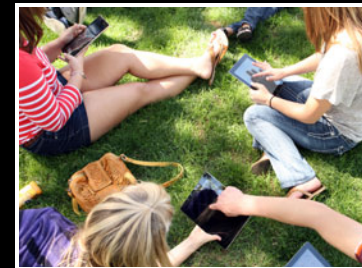
Toys



Pay Systems



Entertainment



Proximity



Health Care



Sports/Fitness



Security



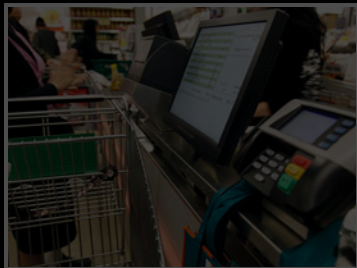
Automation



Connect the World



Toys



Pay Systems



Entertainment



Proximity

 WWDC2012