

## Engineering Privacy for Your Users Session 709

#### Jessie Pease Privacy Engineering Julien Freudiger Privacy Engineering

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#WWDC16

"People have entrusted us with their most personal information. We owe them nothing less than the best protections that we can possibly provide."

Tim Cook White House Cybersecurity Summit, February 2015

## Great Apps Respect User Privacy

Transparency Control Consent Security Minimization Use Limitation





#### Overview

Identifiers Data Collection Transparency and Control Meaningful Choices Building Privacy into Your App

Identifiers









































#### Collect everything



Short-lived



Short-lived Random



Short-lived Random Anonymous



Favor short-lived identifiers Spotlight, Maps



Favor short-lived identifiers Spotlight, Maps

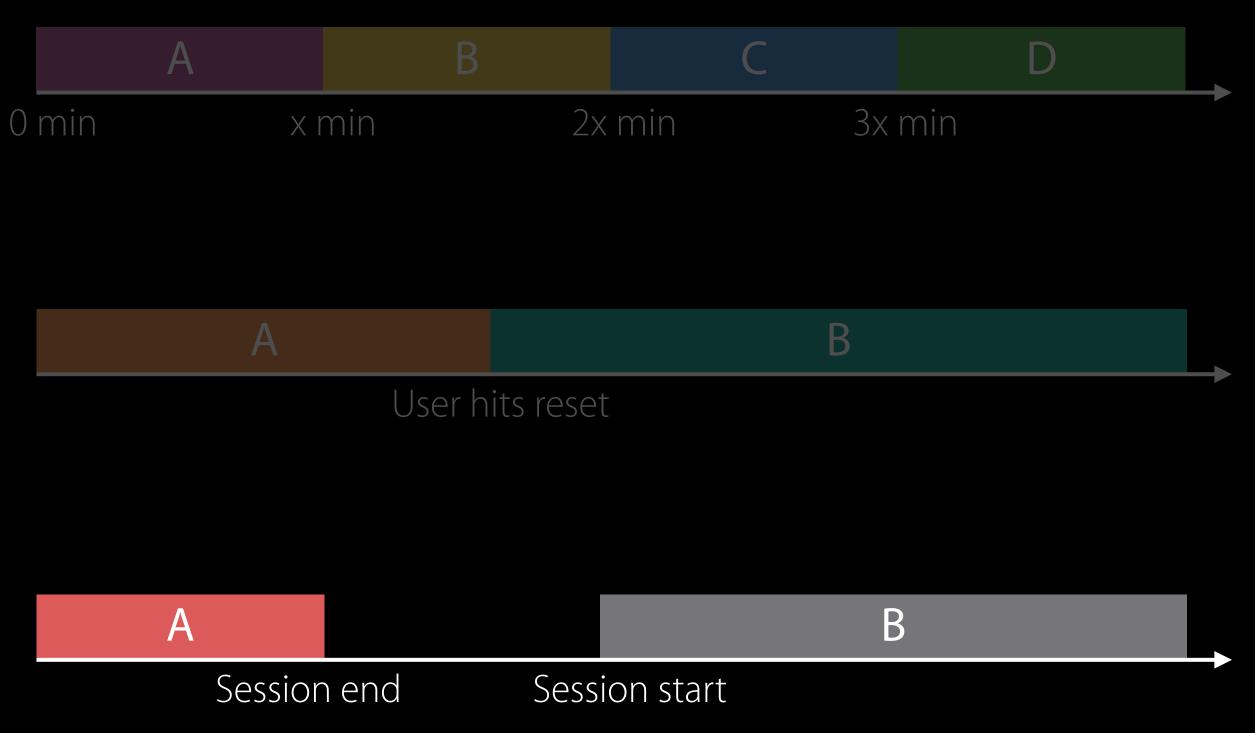
Make it easy to reset identifiers Siri, News

# A B C D 0 min x min 2x min 3x min A B User hits reset

Favor short-lived identifiers Spotlight, Maps

Make it easy to reset identifiers Siri, News

Identify sessions, not users



New unique identifier for each function call

let uuid = UUID()

Call 1 a275e7cc-1d37-4ee8-8861-15ab231e44d4

Call 1 a275e7cc-1d37-4ee8-8861-15ab231e44d4

Call 2 99968a76-c1af-4257-8351-a25e82887d4e

Call 1 a275e7cc-1d37-4ee8-8861-15ab231e44d4

Call 2 99968a76-c1af-4257-8351-a25e82887d4e

Call 3 2ce3a2cd-e430-47d0-a983-b445964c46ec

#### VendorID

#### Persisted by system to identify device to an app vendor

let identifierForVendor = current().identifierForVendor.uuidString

com.myCompany.app1

bd81cef8-c5b3-4413-846d-3df993c8f256

com.myCompany.app1

com.myCompany.app2

bd81cef8-c5b3-4413-846d-3df993c8f256

bd81cef8-c5b3-4413-846d-3df993c8f256

com.myCompany.app1

com.myCompany.app2

com.myOtherCompany.app1

bd81cef8-c5b3-4413-846d-3df993c8f256

bd81cef8-c5b3-4413-846d-3df993c8f256

94004a56-8849-46f7-9427-e6e91e6e060c

### Advertising ID

Persisted by system for advertising purposes

let identifierForAdvertising = shared().advertisingIdentifier.uuidString

Device

595d16cc-c0fa-455f-8e30-d17c250139f6

Device 595

Device

595d16cc-c0fa-455f-8e30-d17c250139f6

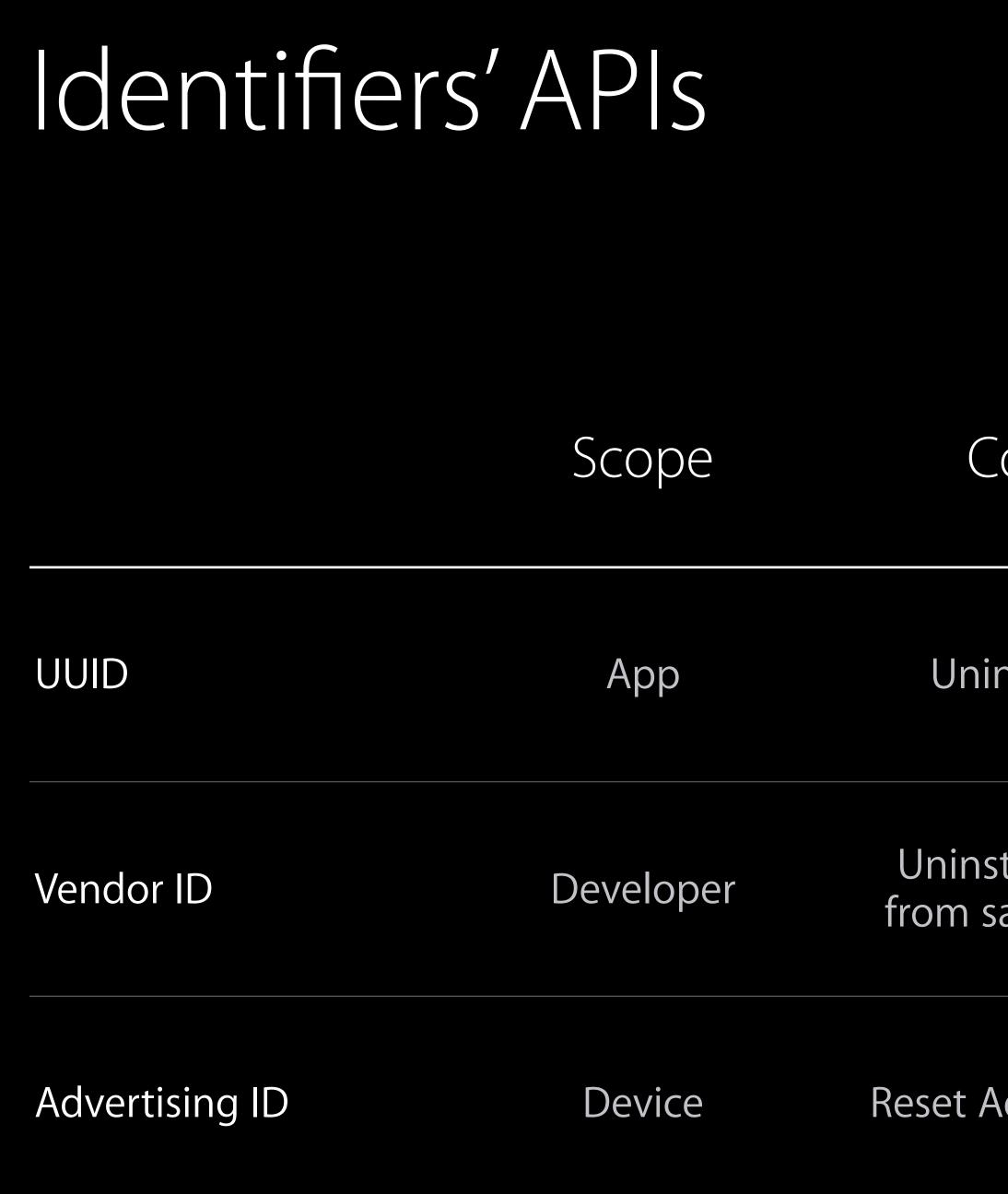
595d16cc-c0fa-455f-8e30-d17c250139f6

Device 595d16cc-c0fa-455f-8e30-d17c250139f6

Device 5950

Reset 2ce3a2cd-e430-47d0-a983-b445964c46ec

595d16cc-c0fa-455f-8e30-d17c250139f6

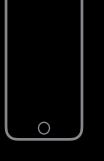


Control	Backed Up	Restored Across Devices
ninstall App	No	No
nstall all Apps same teamID	Yes	No
Advertising ID	Yes	No









#### D1:8D:FC:AD:63:28





x min



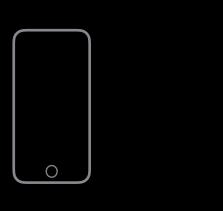


#### 2x min 3x min 72:F5:73:46:73:09 76:82:49:2B:E2:06 0C:2E:92:4E:71:B0

## x min

#### iOS and macOS





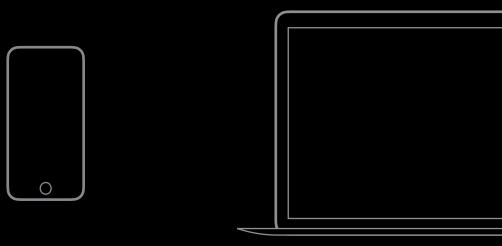




## x min

## iOS and macOS Real MAC address not always included in Wi-Fi scans







## Message App Extensions

Users identified by random UUID For each App extension For each chat





#### Marina

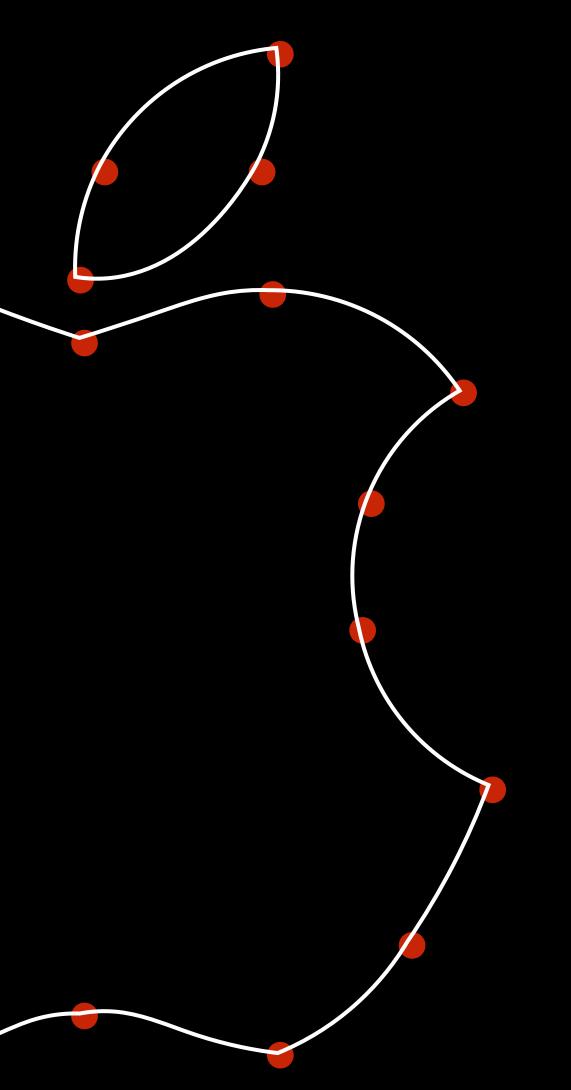
#### Tuesday 2:00PM

## Implicit Identifiers

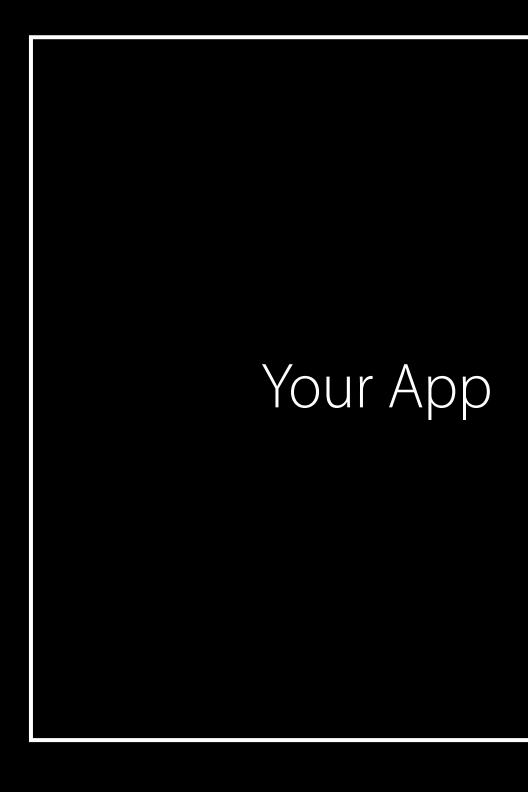
## Implicit Identifiers

# 

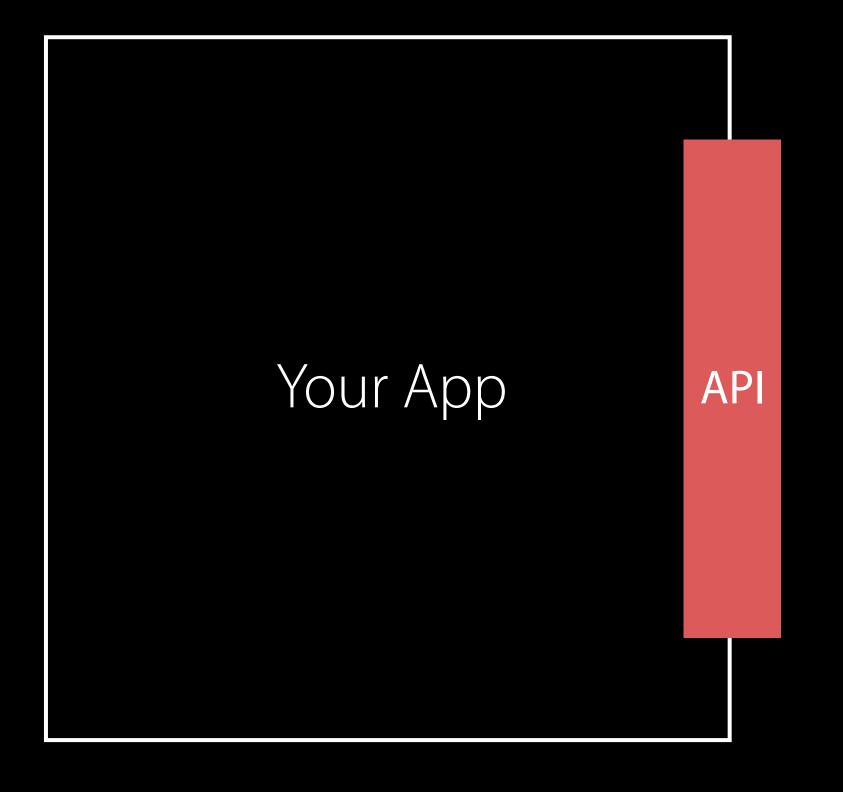
## Implicit Identifiers



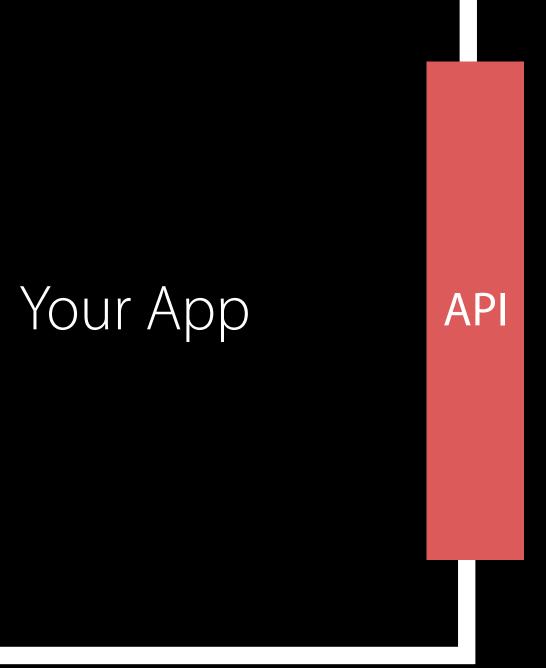
## Sandboxing



## Sandboxing



## Sandboxing



## What Does This Mean for You? Identifiers

Favor short-term identifiers Use OS-provided identifier APIs

Data Collection

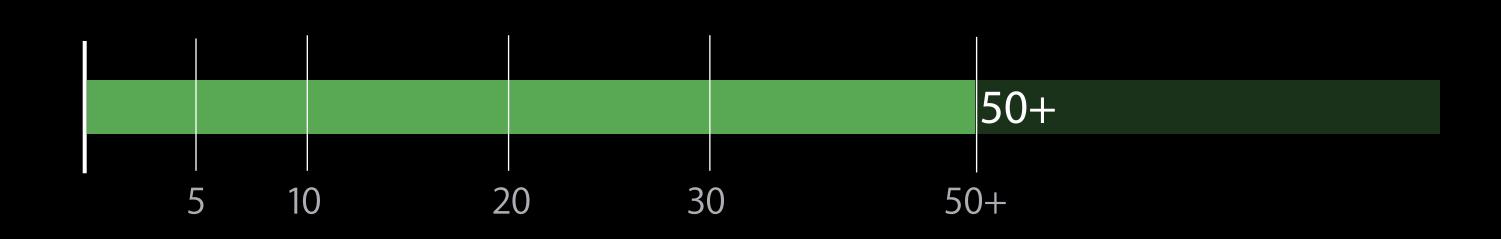
## Data Collection Best Practices

Bucket Sample Aggregate via Differential Privacy

How often does a given user open in-app Settings on a given day?

#### How often does a given user open in-app Settings on a given day?

86



### How often does a given user open in-app Settings on a given day?

10m



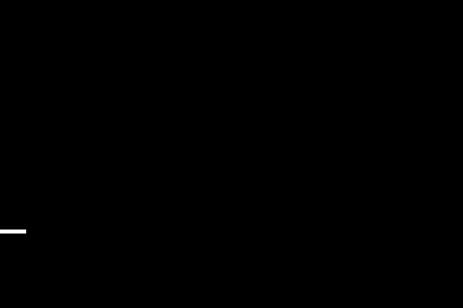
How often do my users open in-app Settings on a given day?

10m



10m

## How often do my users open in-app Settings on a given day?

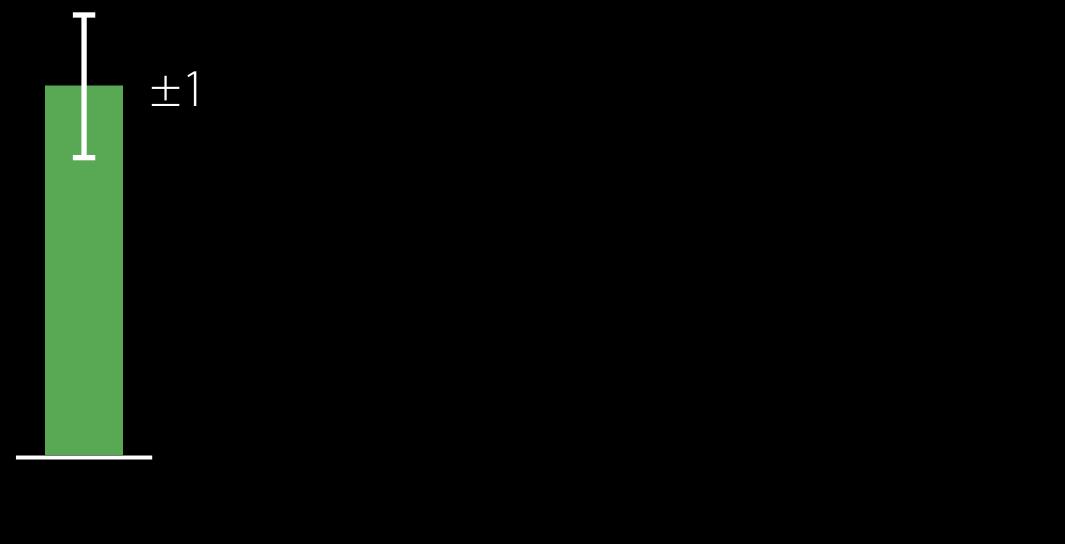




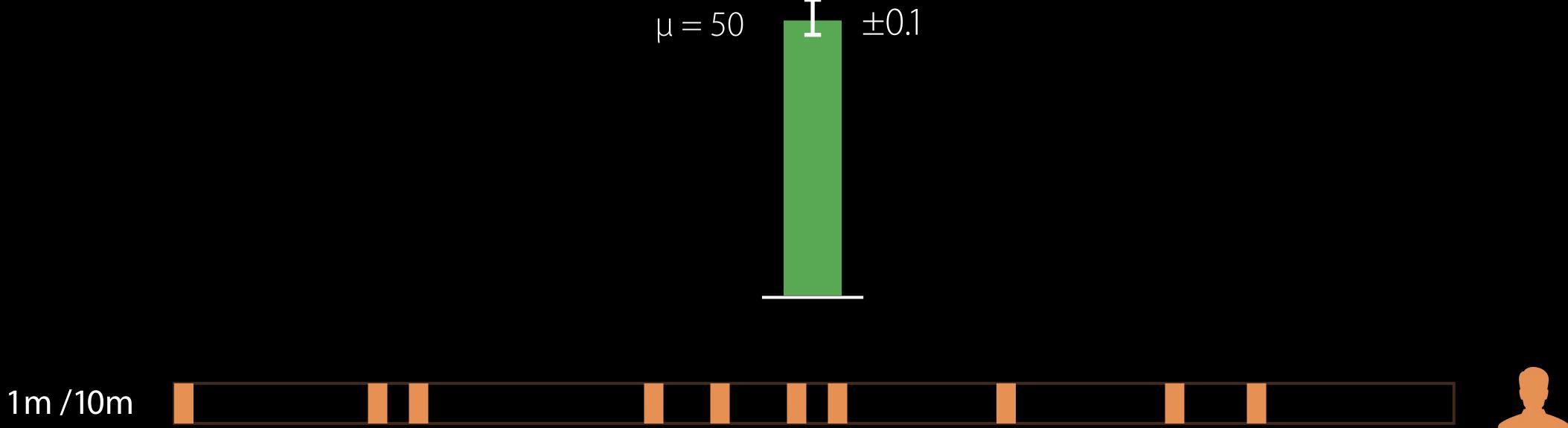
 $\mu = 50$ 



## How often do my users open in-app Settings on a given day?







## How often do my users open in-app Settings on a given day?





Learn from crowd while protecting individual privacy





Learn from crowd while protecting individual privacy Strong mathematical guarantees





Learn from crowd while protecting individual privacy Strong mathematical guarantees iOS and macOS





$$\forall i \in [n], d \in S, \left| \ln \frac{\Pr[T_i \in T | d_i = d]}{\Pr[T_i \in T | d_i = \text{NULL}]} \right| \le \epsilon$$
$$\ln \frac{\Pr[A_{client}(d) = t]}{\Pr[A_{client}(\text{null}) = t]} \right| \le \ln \left( \frac{e^{\epsilon}}{1 + e^{\epsilon}} \cdot \frac{1 + e^{\epsilon}}{1} \right) = \epsilon$$
$$\alpha = \frac{3k + 2c_{\epsilon}\sqrt{\ln(6mk/\beta)}}{\sqrt{n}} = O\left(\frac{\sqrt{\log(p/\beta)}}{\epsilon\sqrt{n}}\right)$$

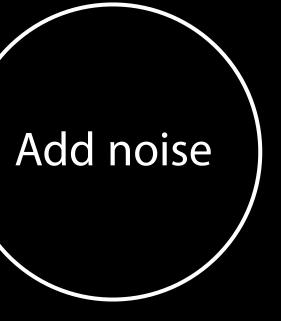
$$\alpha = \frac{3k + c_{\epsilon}\sqrt{\ln(4mk/\beta)}}{\sqrt{n}} = O\left(\frac{\sqrt{\log(p/\beta)}}{\epsilon\sqrt{n}}\right)$$

$$v_{\text{priv}} = \left\{ \left( \frac{v[j] \cdot b[j] + 1}{2} \right), \forall j \in [m] \right\}$$

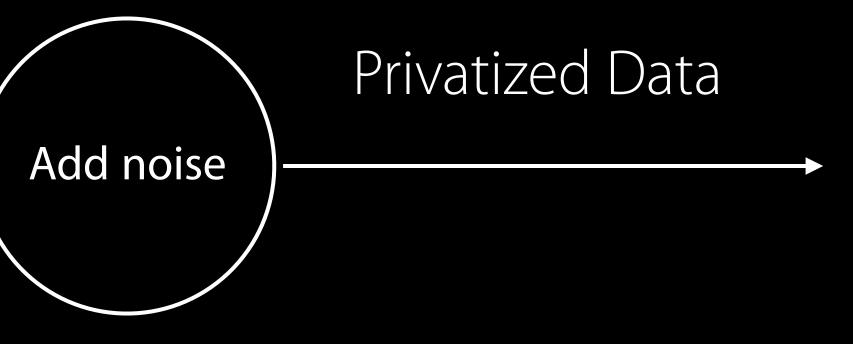
## ldea

#### Data



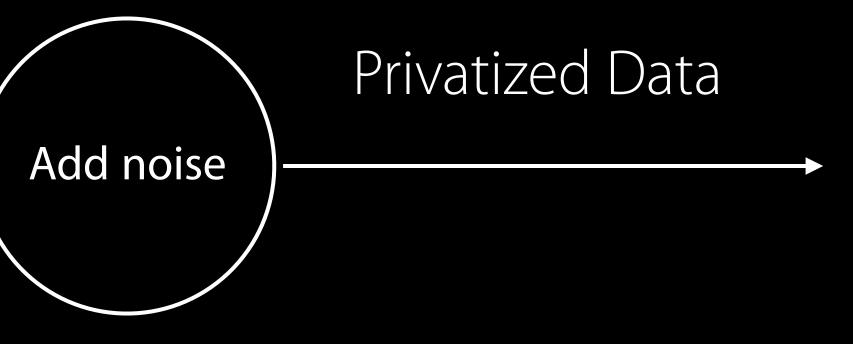






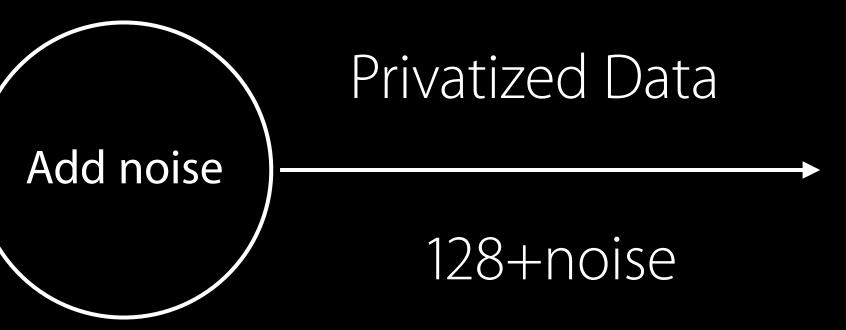


#### 128 hours



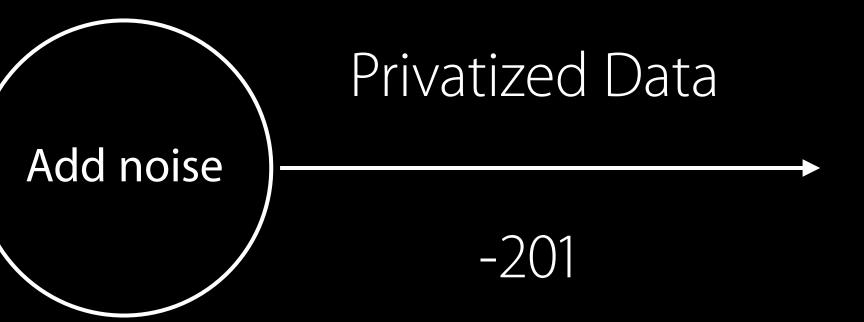


#### 128 hours





#### 128 hours



## How Does Noise Work?

Original value

Compute projection

## How Does Noise Work?

Original value

Compute projection



### 128

## How Does Noise Work?

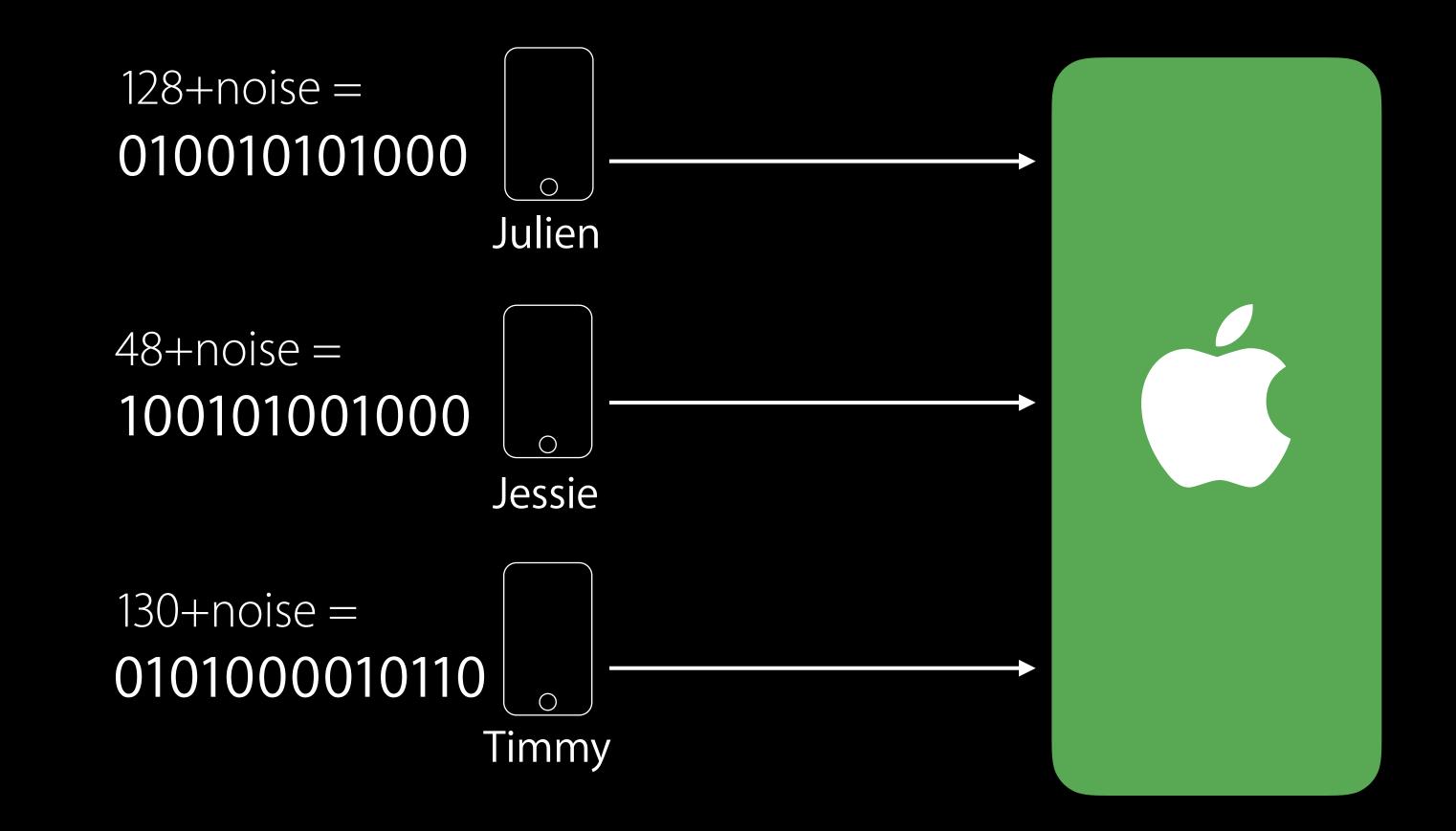
Original value

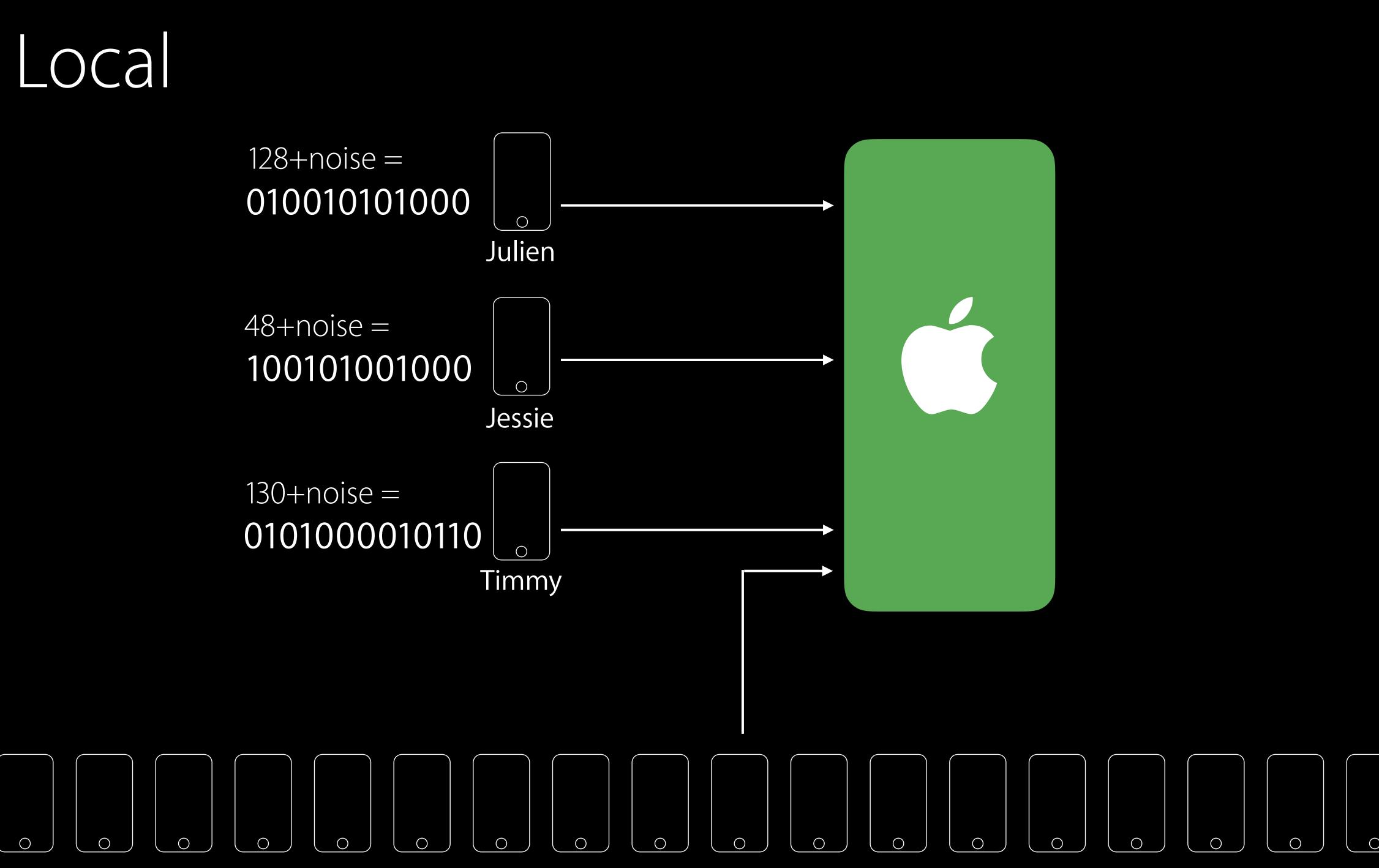
Compute projection

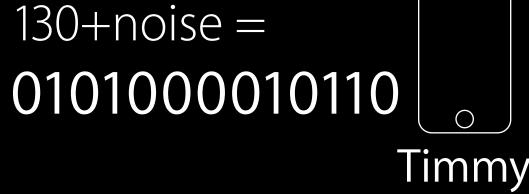


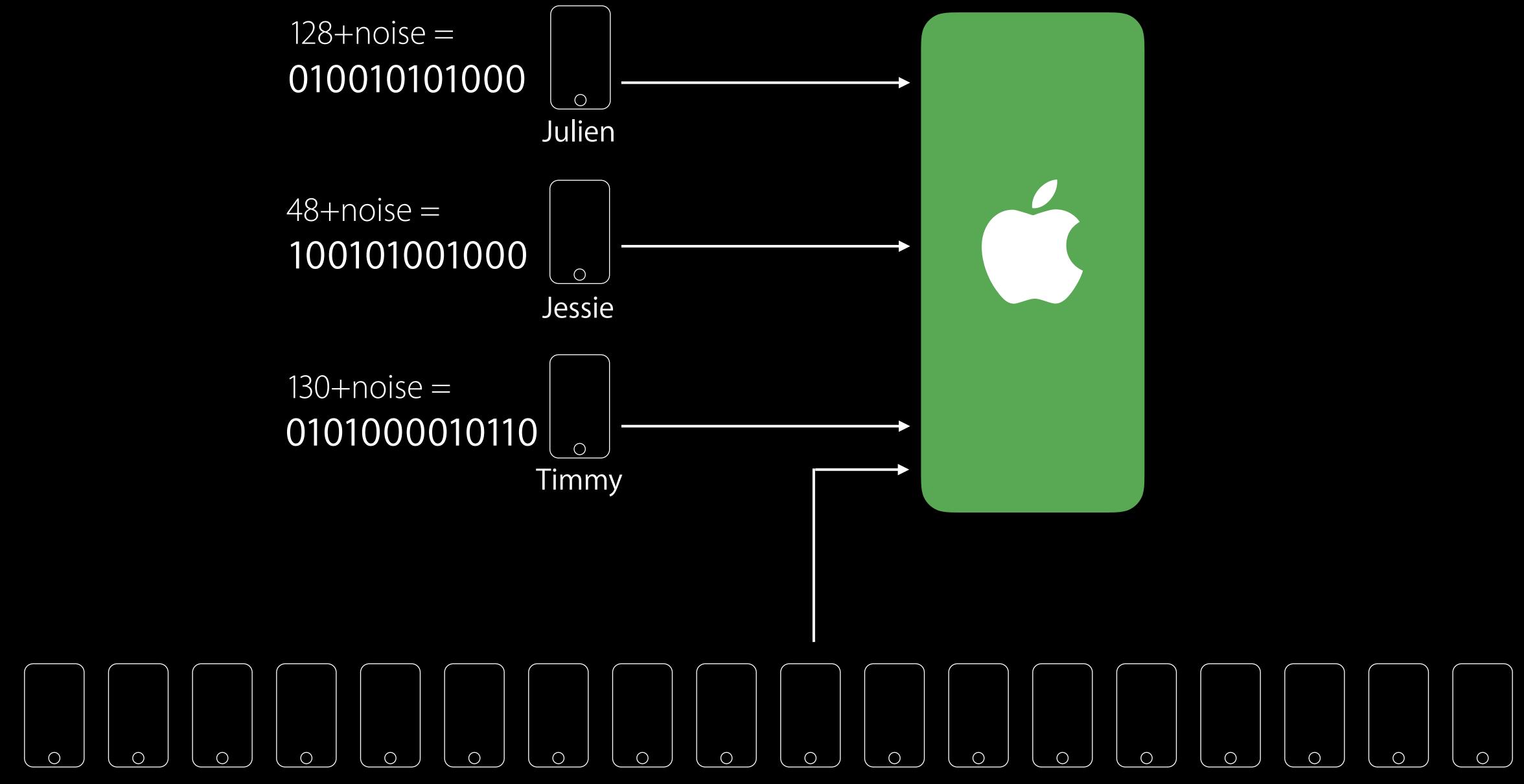
## 0001010100000001100

## [COC9]









## 

# 

### 

# Average = 41 hours

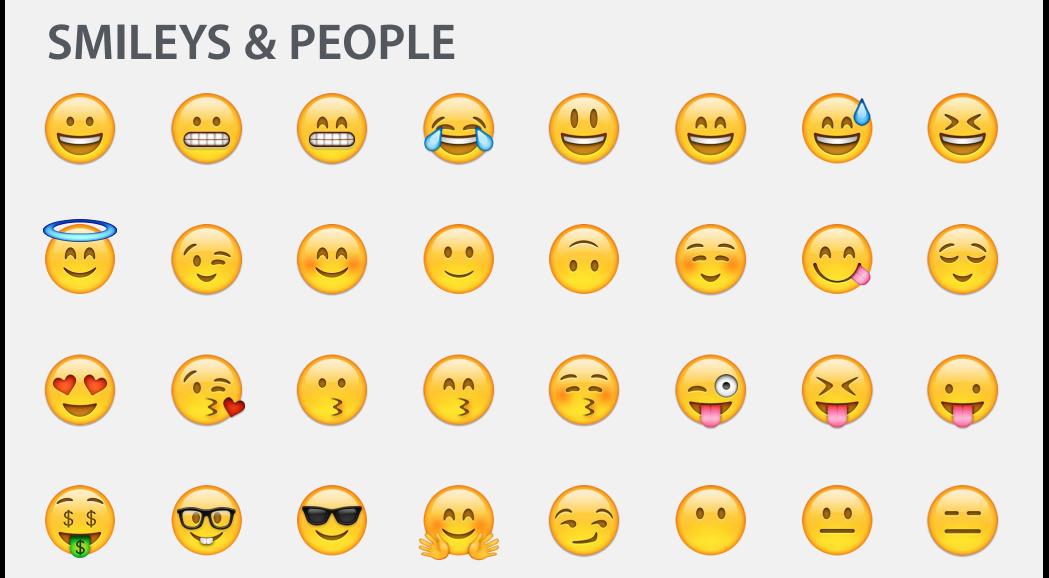
## So What? Learn popular items privately

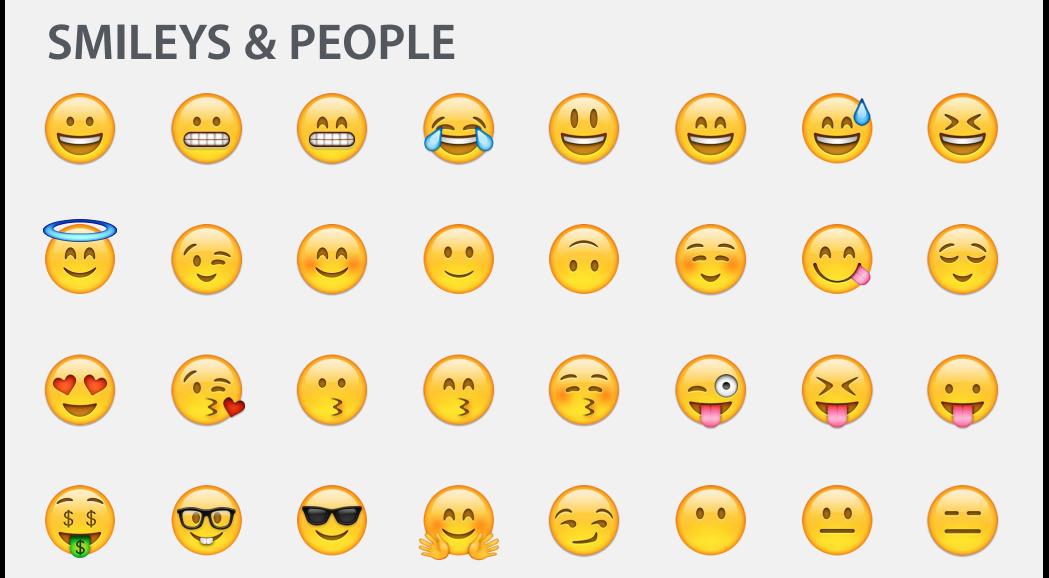
Average Presence of certain attributes Frequencies

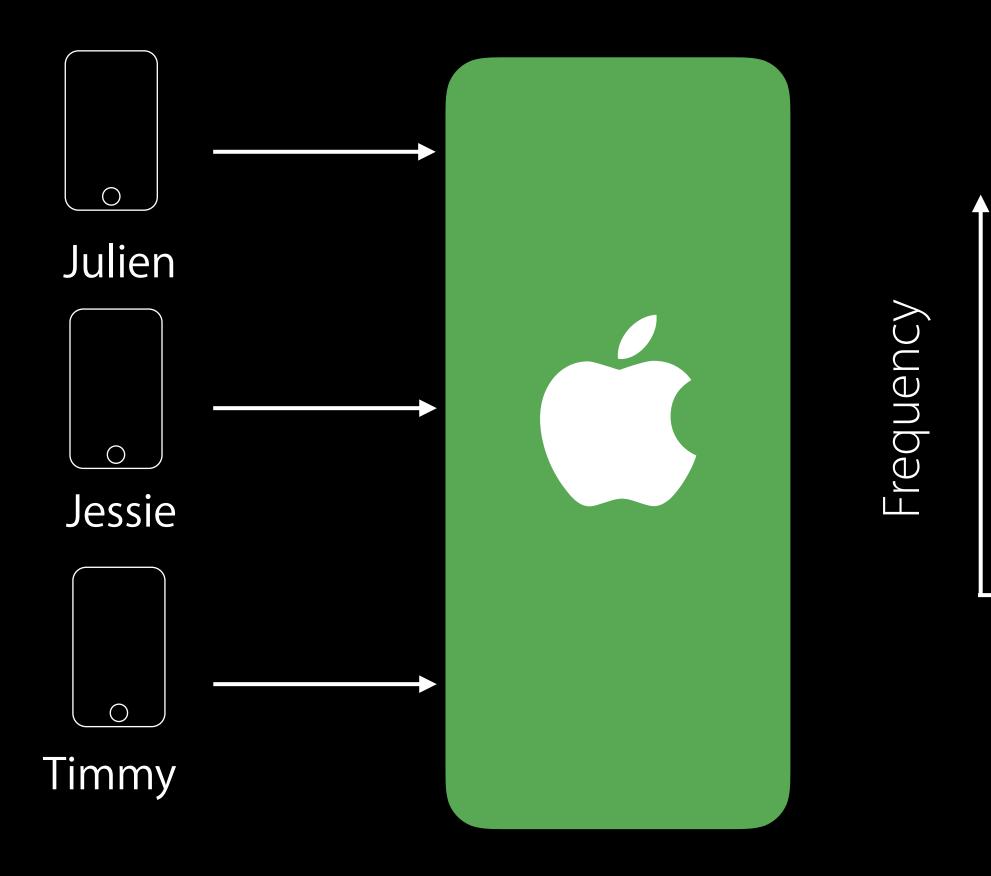


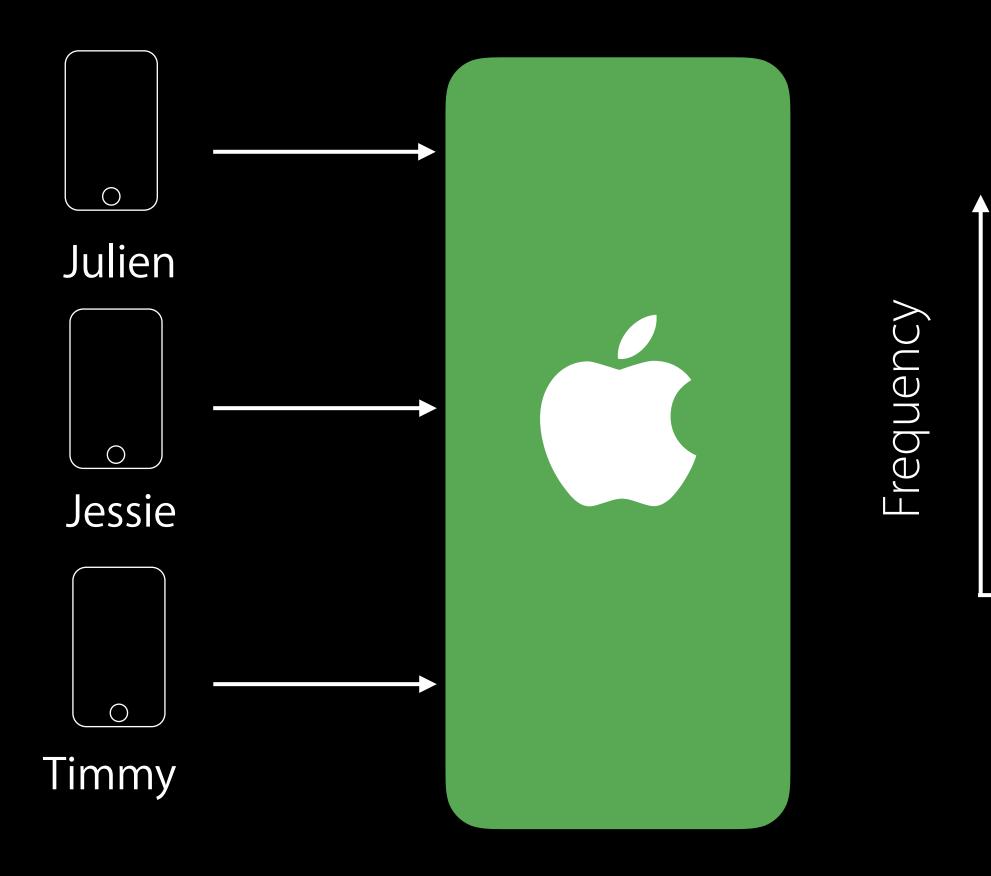
## Differential Privacy Over Time Privacy budget

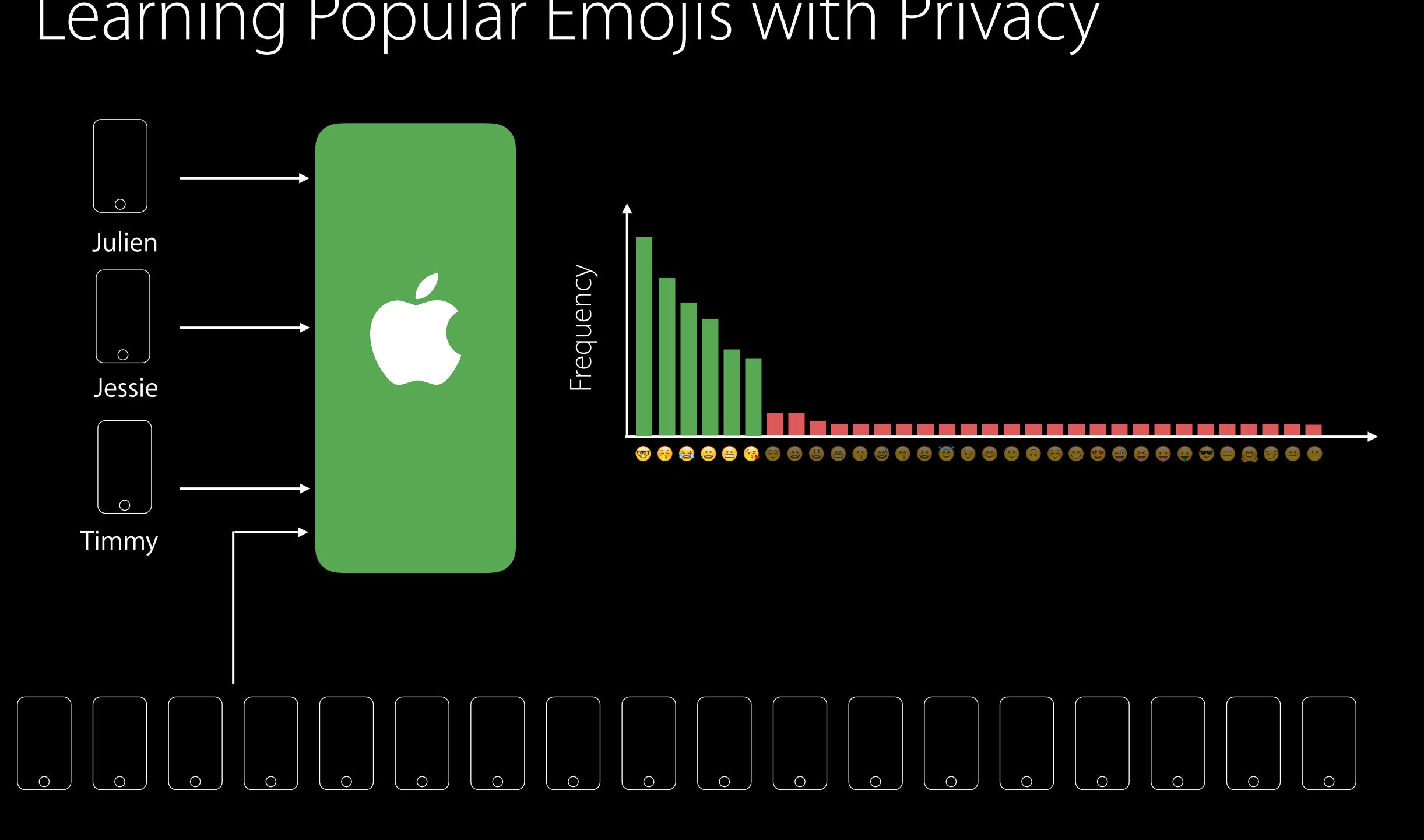
- Restrict the number of submissions made during a period No identifiers
- Periodically delete donations from server



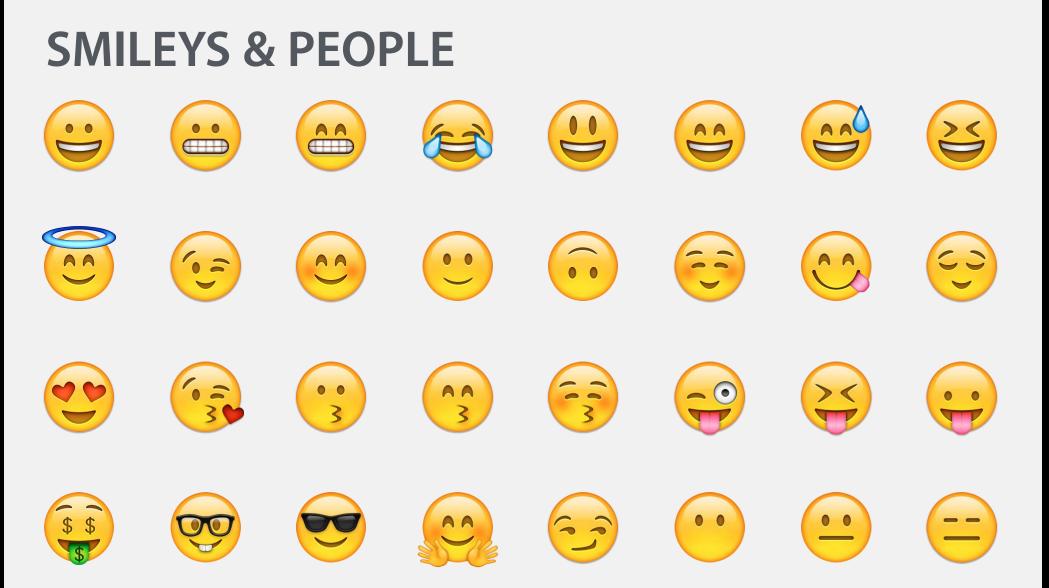




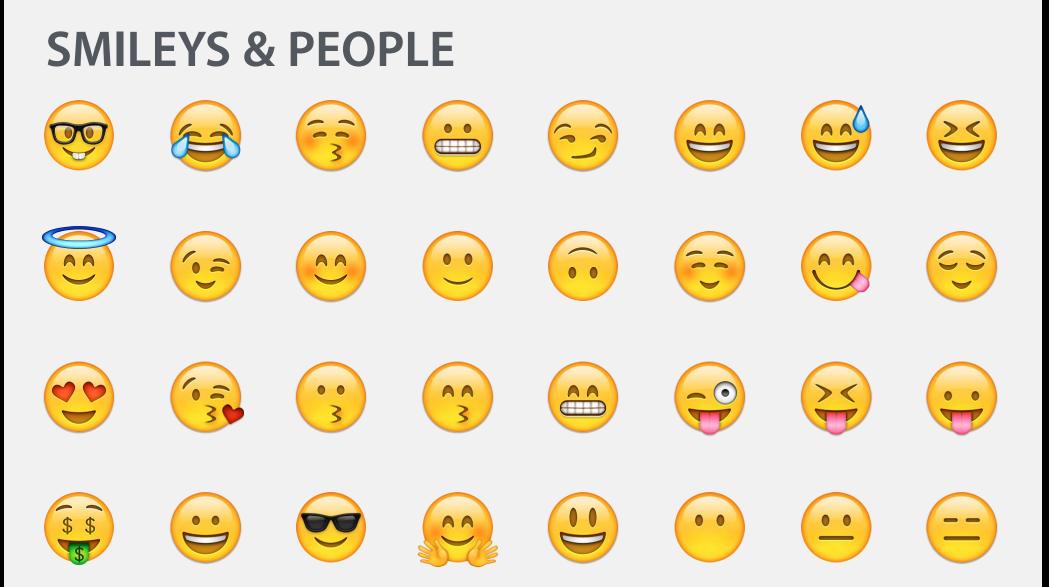




## Crowd-Driven Insight with Privacy



## Crowd-Driven Insight with Privacy



## Use Cases

## Use Cases

Emojis Popular emojis

New words Popular words unknown to QuickType dictionary

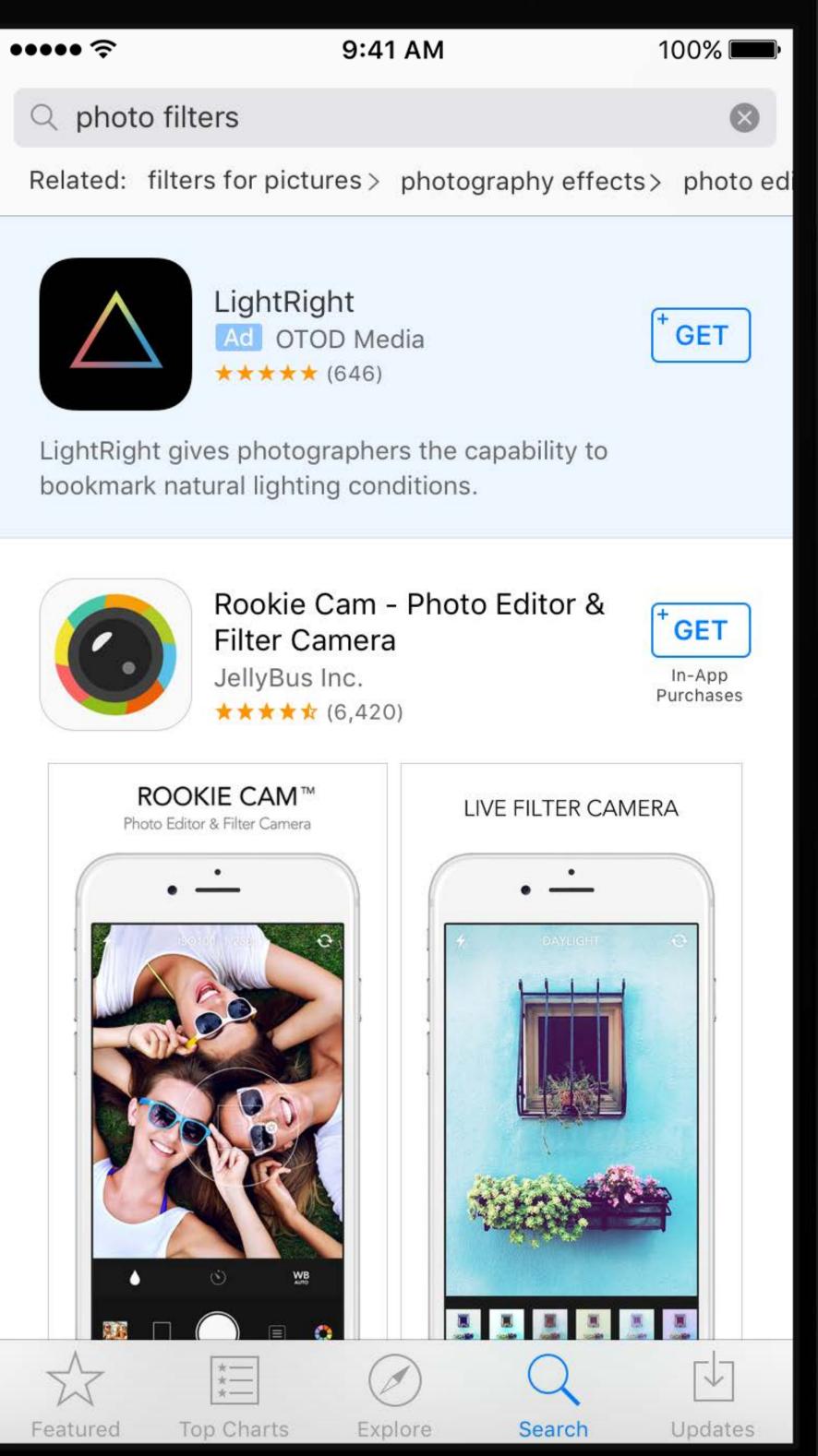
Deeplinks (iOS) Popular deeplinks within apps marked as "eligible for public indexing"

Lookup Hints in Notes Popularly highlighted hints

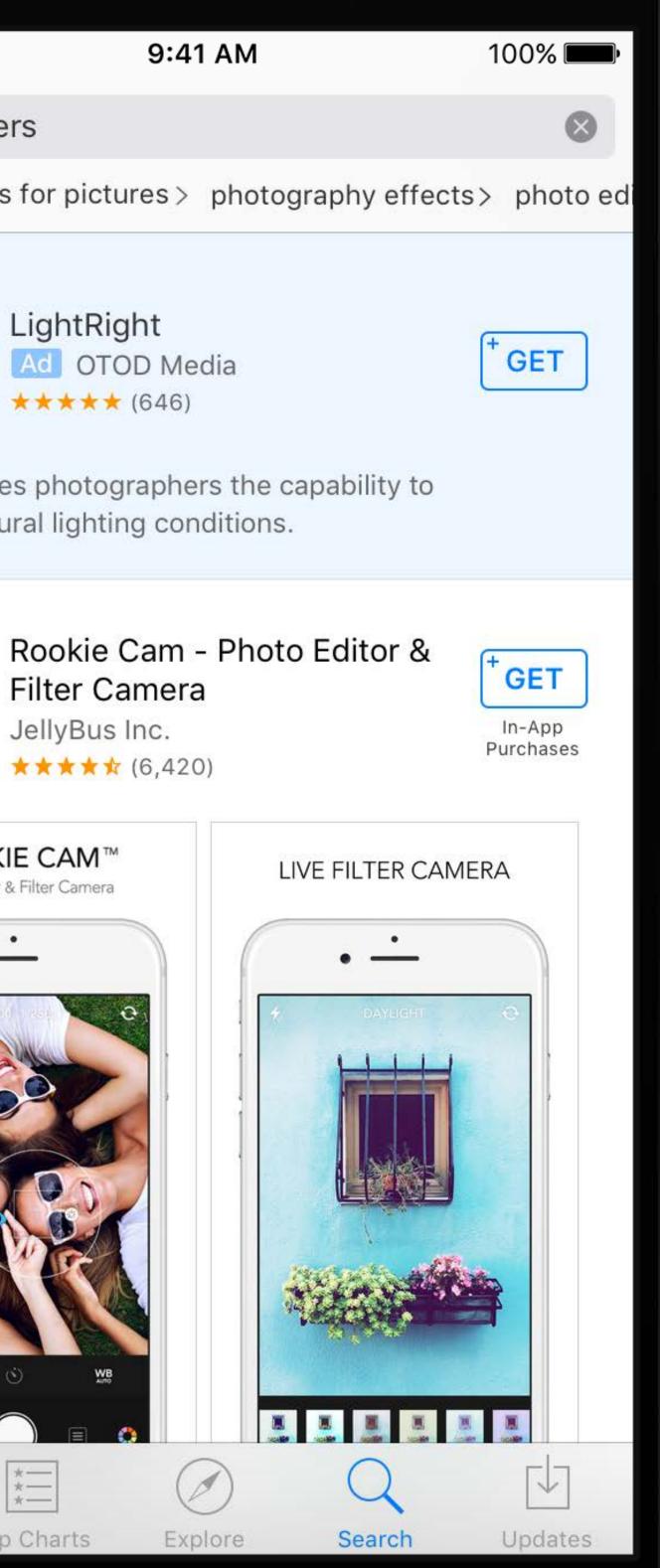
## What Does this Mean for You? Data collection via Differential Privacy

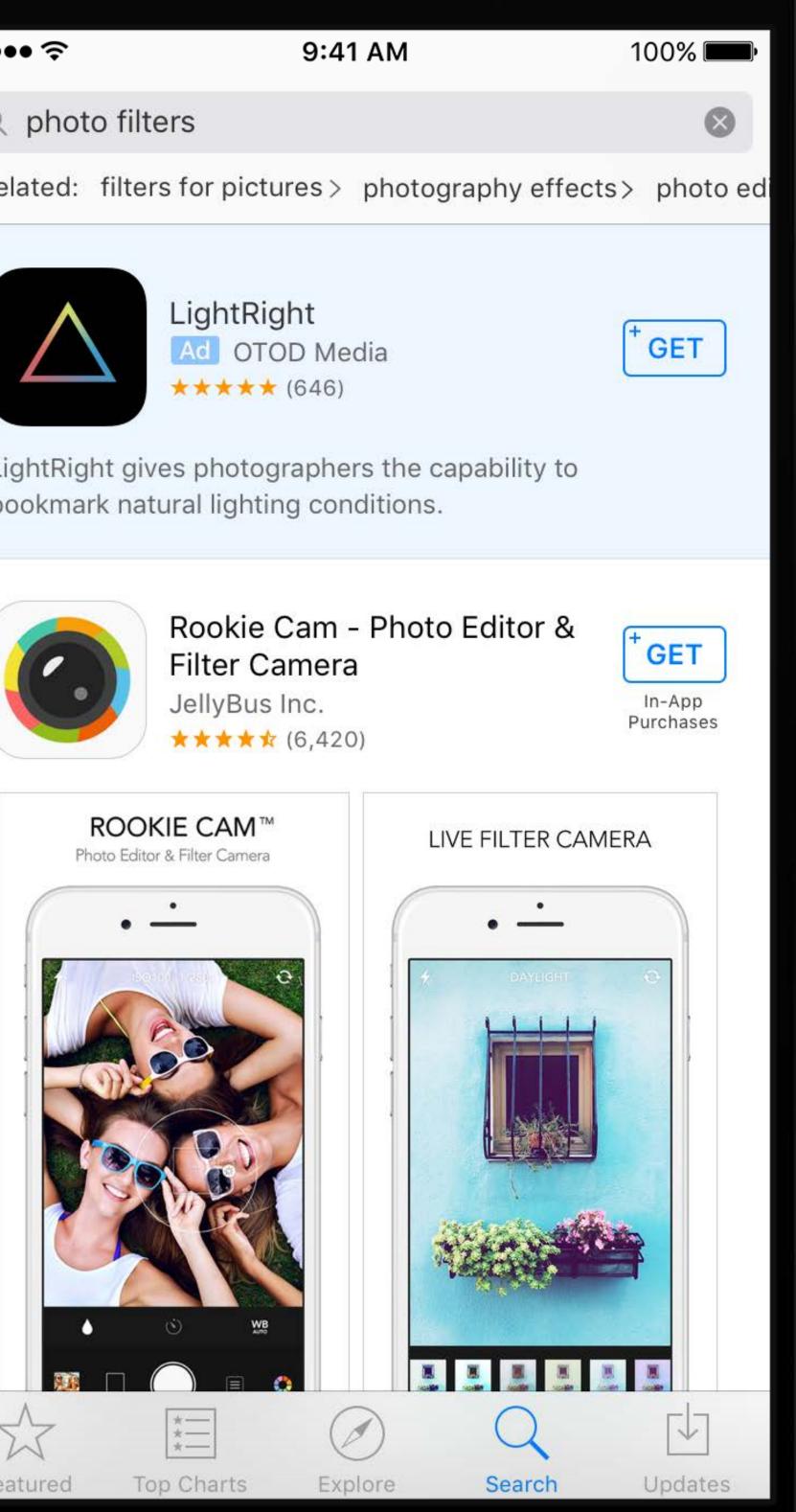
Crowd-driven insight at scale Protects individuals No identifiers <u>No raw</u> measurements

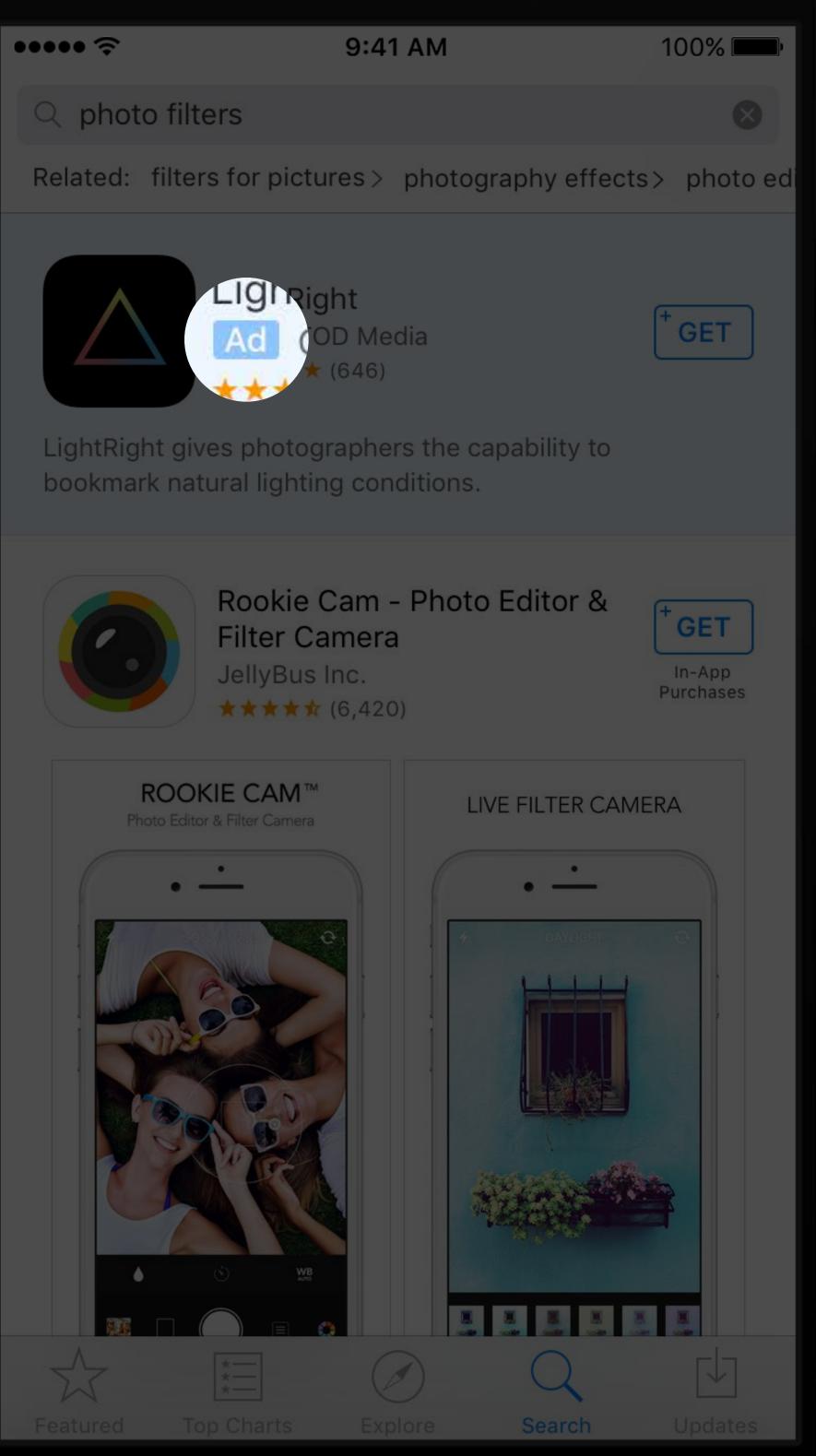
Transparency and Control

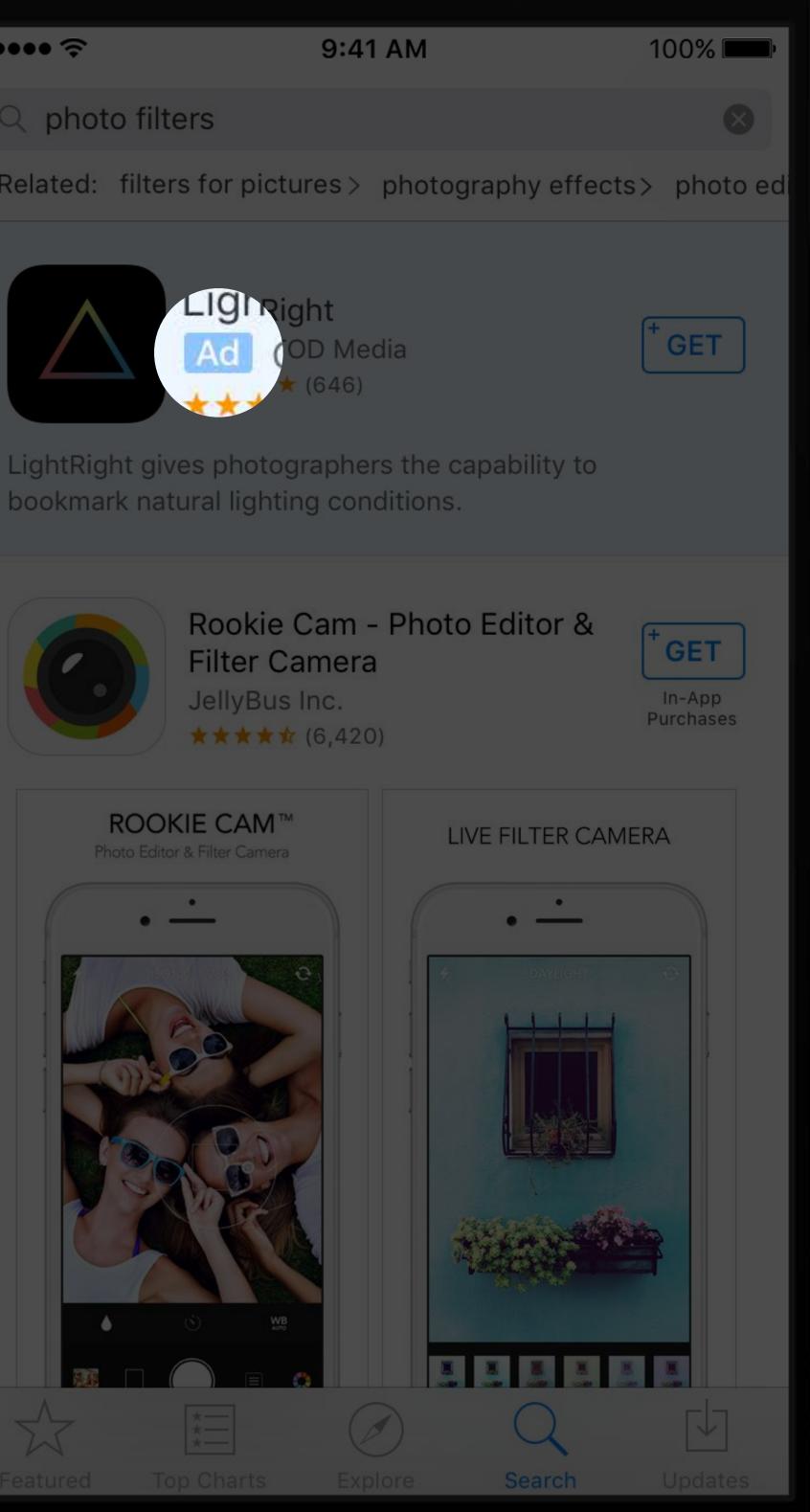




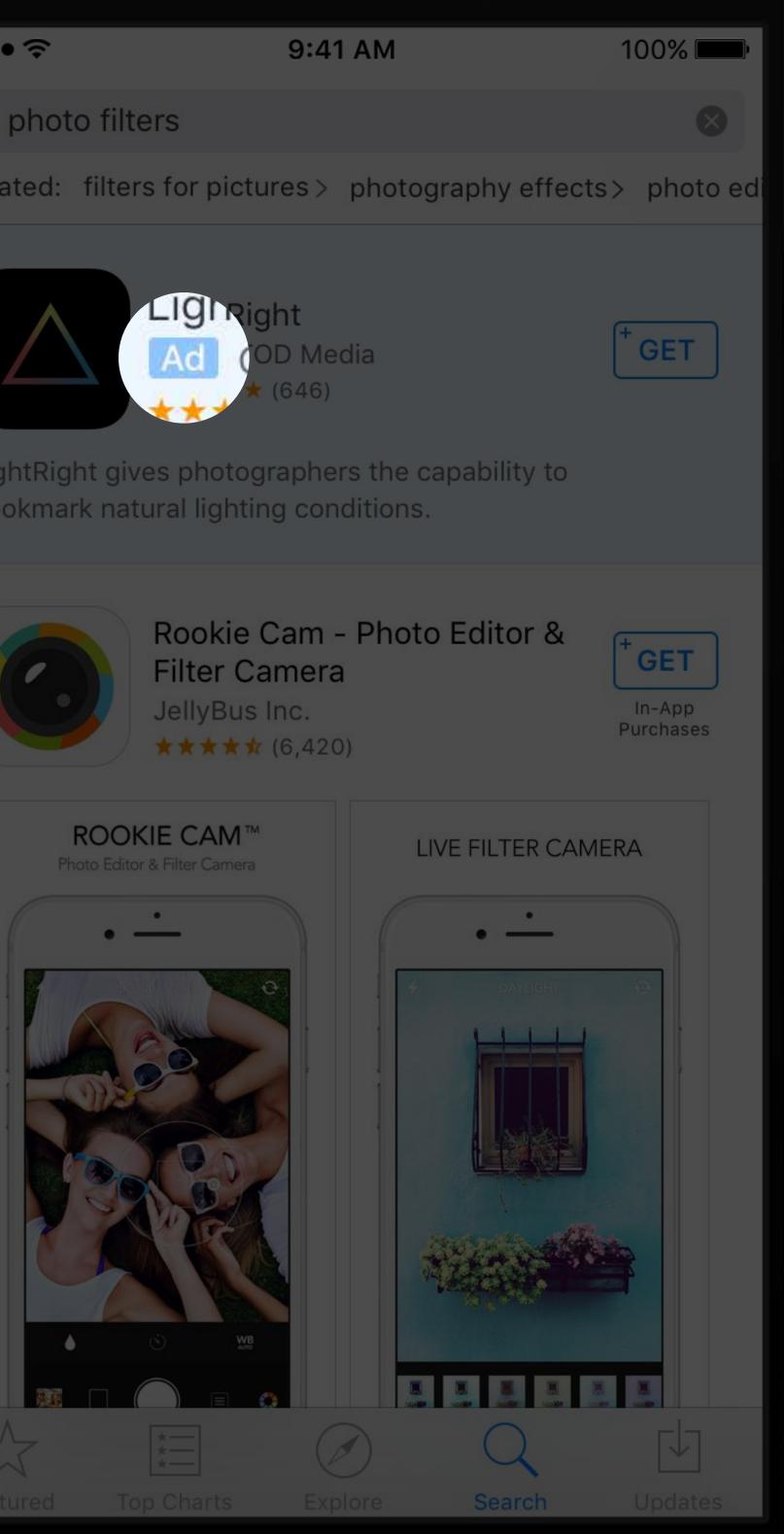












Ads in the App Store are presented based on their relevance to your search. This ad was displayed because you also meet some of the criteria listed below. No personally identifiable information is provided to third parties.

Account Information Inferred from the data you provided for your Apple ID.

Age Range

Gender

Location

**Device Information** Information about your device's connectivity, time setting, type, language, and location (if the Location-Based iAds system service is on) may be used to deliver ads.

To limit Ad Tracking, reset your Advertising Identifier

9:41 AM	
About This Ad	

100% 🔳

Done

18-34 Male 95129

Ads in the App Store relevance to your sea because you also me below. No personally provided to third par

Account Information Inferred from the dat Apple ID.

Age Range

Gender

Location

**Device Information** Information about your device's connectivity, time setting, type, language, and location (if the Location-Based iAds system service is on) may be used to deliver ads.

To limit Ad Tracking, reset your Advertising Identifier

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**Device Information** Information about your device's connectivity, time setting, type, language, and location (if the Location-Based iAds system service is on) may be used to deliver ads.

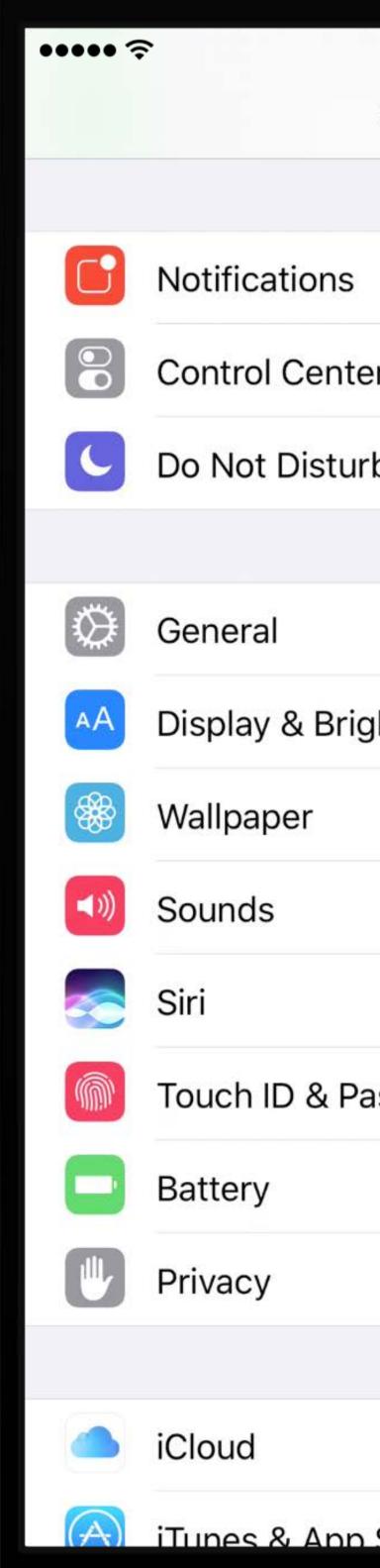
To limit Ad Tracking, reset your Advertising Identifier and view the information used by Apple to deliver more relevant ads in Apple News and the App Store, go to Settings > Privacy > Advertising.

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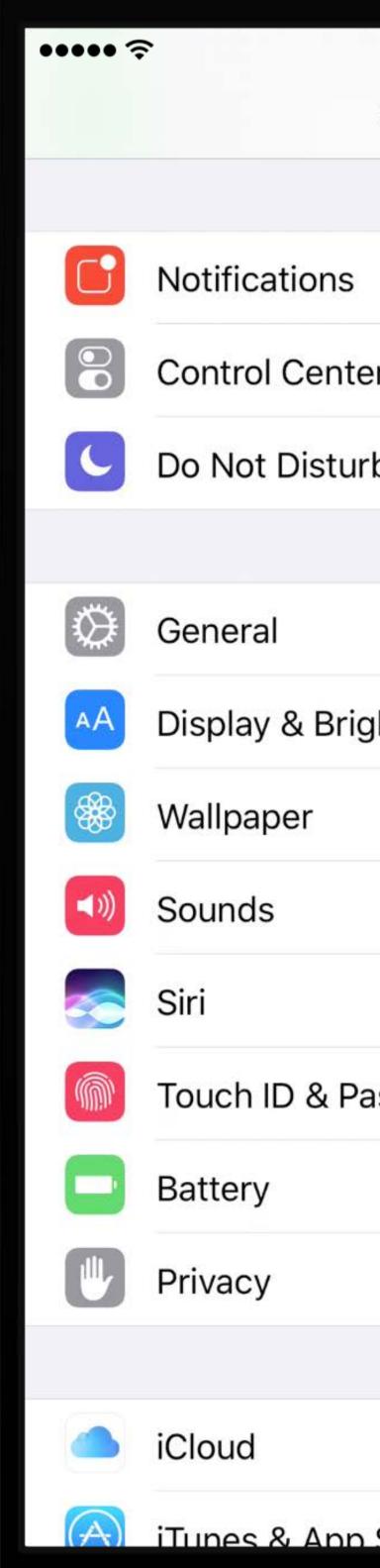
100% 🔲

Done

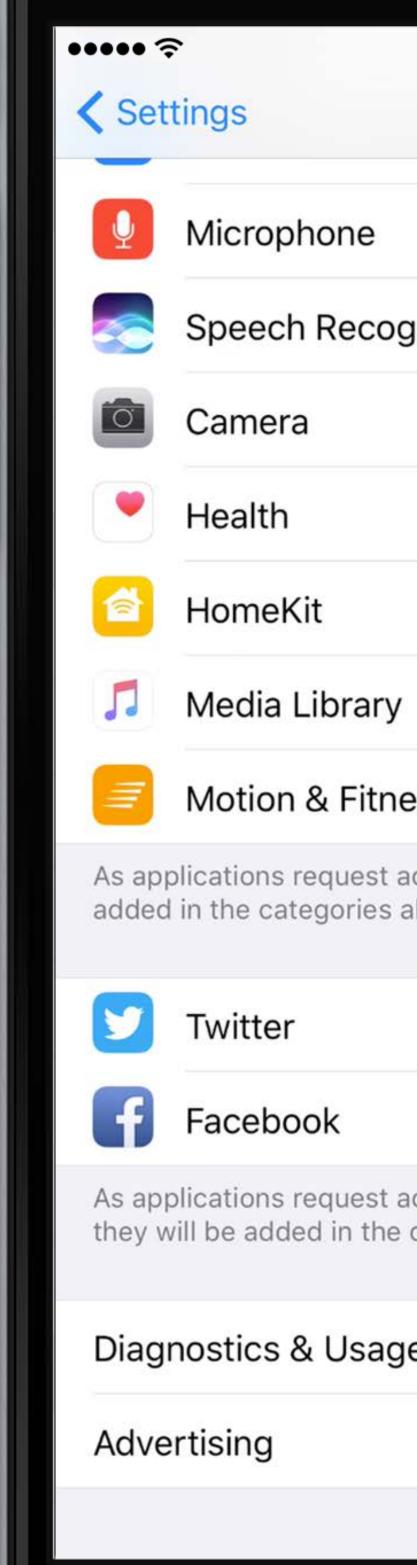
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	Male
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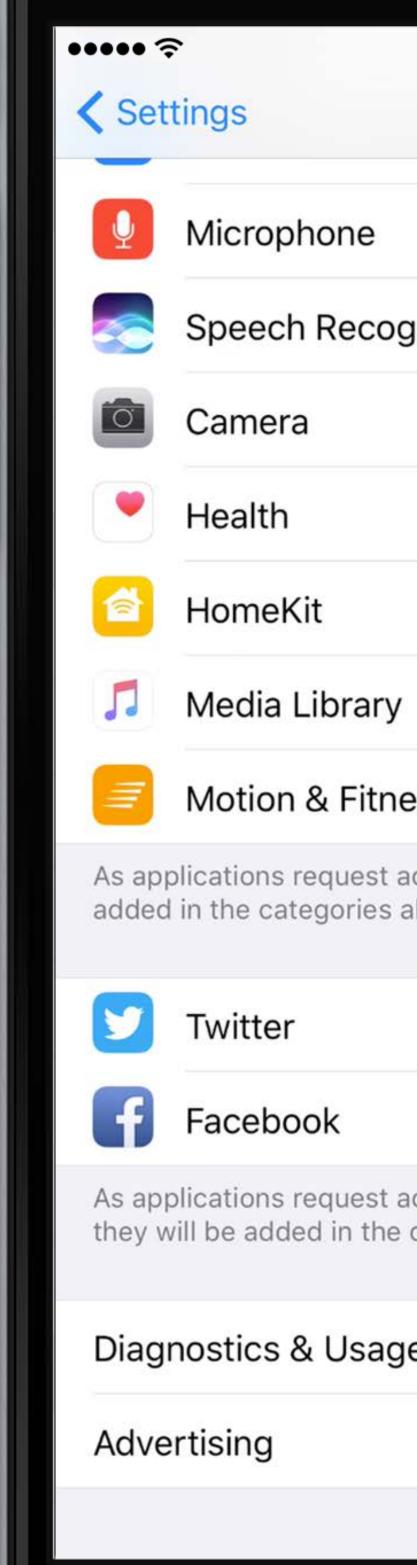
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### ••••• ? Privacy

## Advertising

ALL ADVERTISERS

### Limit Ad Tracking

### Reset Advertising Identifier...

Opt out of receiving ads targeted to your interests. You may still receive the same number of ads, but the ads may be less relevant to you.

ADVERTISING IN APPLE APPS

### **View Ad Information**

View the information used by Apple to deliver more relevant ads to you in Apple News, the App Store, and Wallet. Your personal data is not provided to third-parties.

About Advertising & Privacy...

### 9:41 AM

100% 🔳

### ••••• ? Privacy

## Advertising

ALL ADVERTISERS

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Opt out of receiving ads targeted to your interests. You may still receive the same number of ads, but the ads may be less relevant to you.

ADVERTISING IN APPLE APPS

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View the information used by Apple to deliver more relevant ads to you in Apple News, the App Store, and Wallet. Your personal data is not provided to third-parties.

About Advertising & Privacy...

### 9:41 AM

100% 🔳

The following information is associated with an anonymous identifier and is used by Apple to deliver more relevant ads in Apple News, the App Store, and Wallet. Your personal data is not provided to third parties.

**Content Categories** You have downloaded content from these iTunes Store and App Store categories.

Apps 7

Audiobooks 3

Books **0** 

Movies 3

Music 3

TV 3

Advertising Segments You are included in segments of users based on your interactions with advertisers and Apple services, including content downloads, and In-App Purchases.

### 9:41 AM

100% 🔳

### Ad Information

Done

$\checkmark$
$\checkmark$
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Advertising Segments You are included in segments of users based on your interactions with advertisers and Apple services, including content downloads, and In-App Purchases.

Customer Relationships 3

News 6

Account Information Inferred from the data you provided for your Apple ID.

Birth Year

Gender

Location

**Device Information** Information about the connectivity of your device, its time setting, type of device, the language setting, and location (if Location Services is enabled) may be used to deliver ads.

To control the information that is used to deliver ads to you, visit About Advertising & Privacy.

100% 🔳

### Ad Information

Done

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Unknown Male 95129

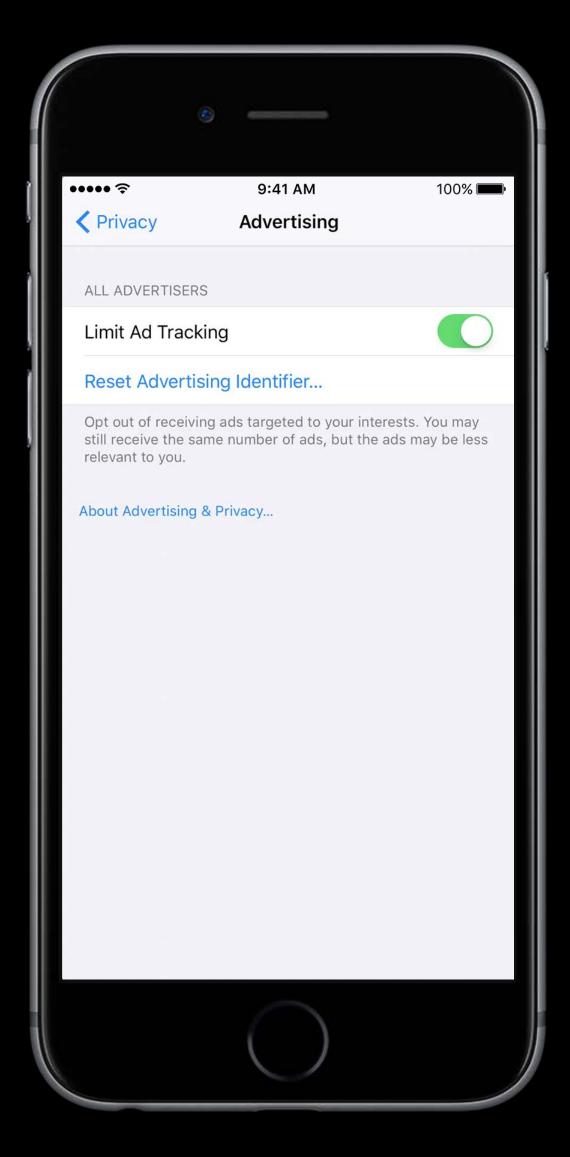
Limit Ad Tracking Disabled Random Advertising ID 7d97c5e0-2424-11e6-abc5-0002a5d5c51b

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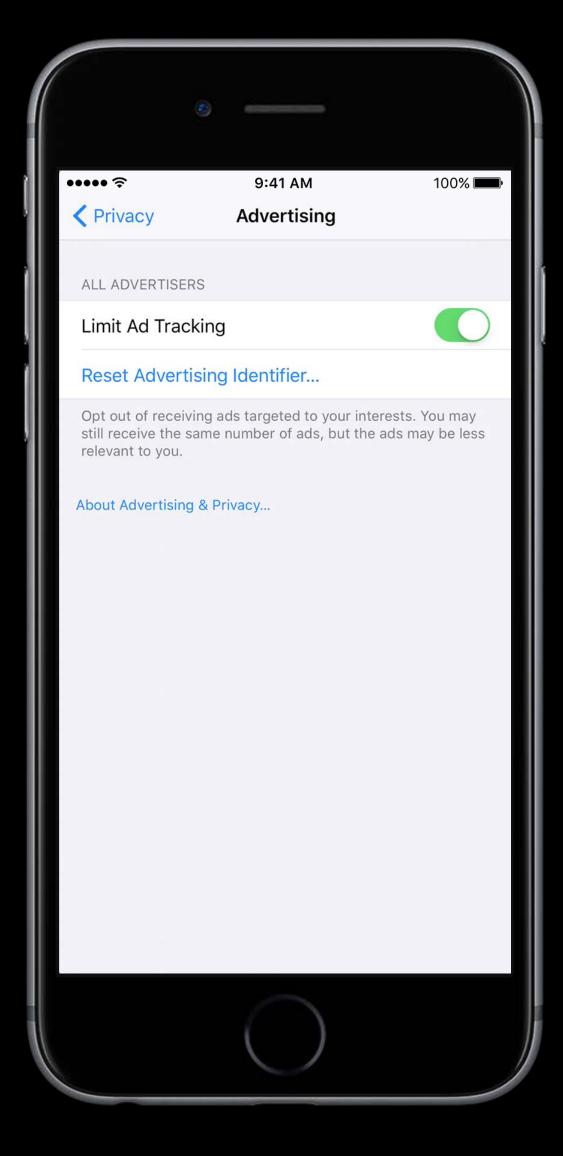
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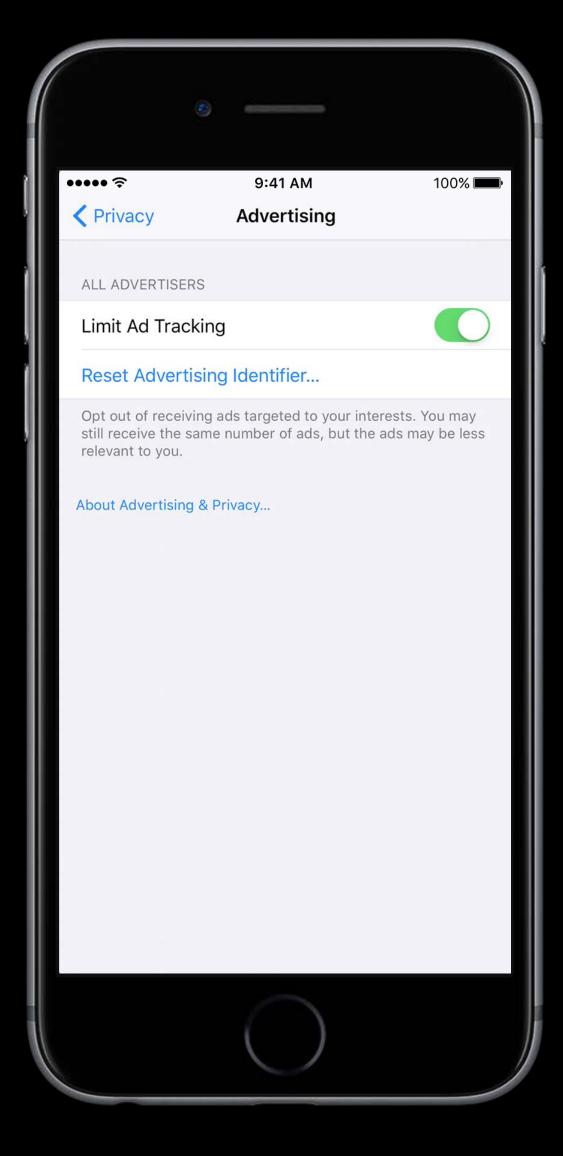
Limit Ad Tracking Disabled Random Advertising ID 7d97c5e0-2424-11e6-abc5-0002a5d5c51b



#### Limit Ad Tracking Disabled Random Advertising ID



#### Limit Ad Tracking Disabled Random Advertising ID



#### Limit Ad Tracking Disabled Random Advertising ID

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## What Does That Mean For You?

## What Does That Mean For You?

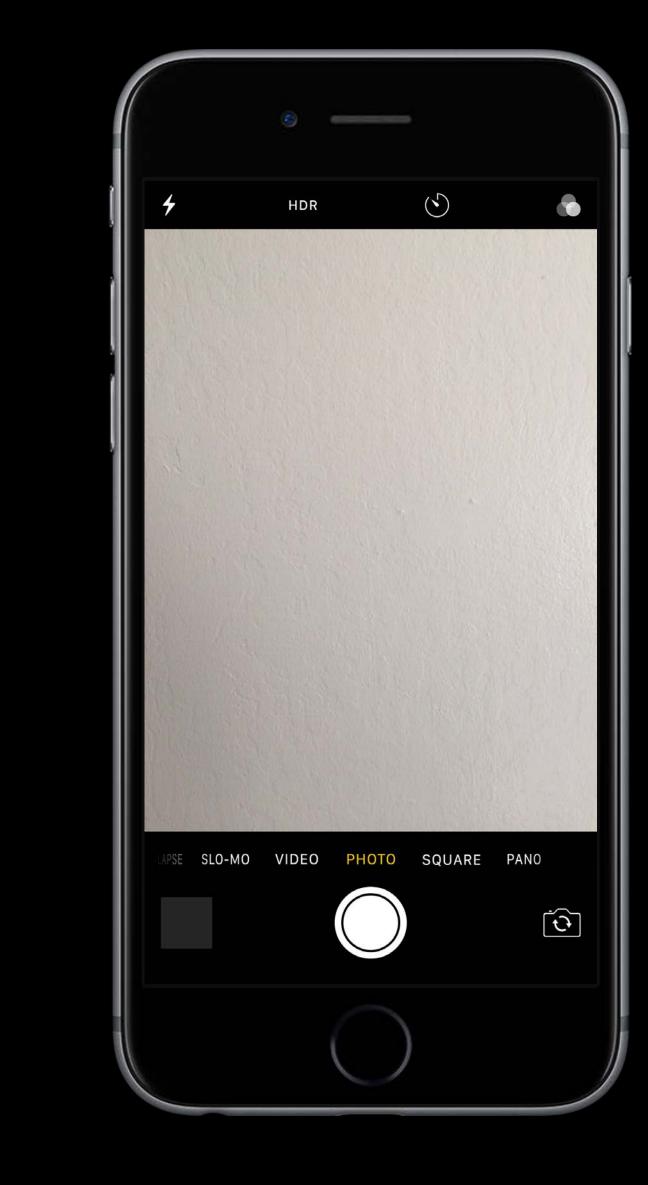
Increase in transparency for ads surfaced to users

## What Does That Mean For You?

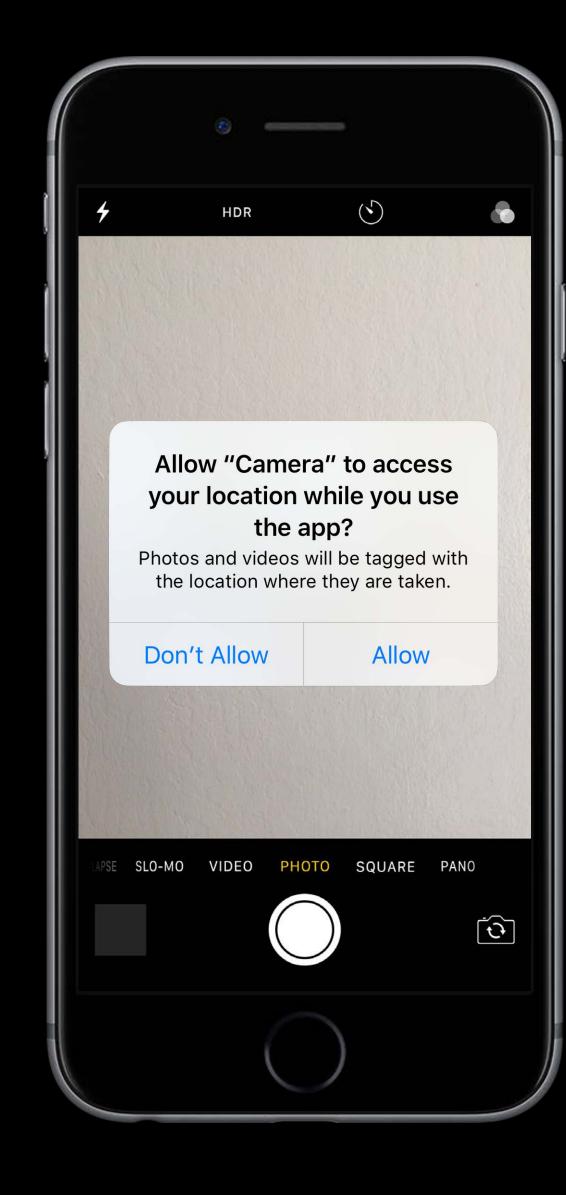
Increase in transparency for ads surfaced to users Limit Ad Tracking now supported in code

Meaningful Choices Empowering users to make good privacy decisions

### Consent Alerts



#### Consent Alerts



New Consent Alerts

Apple Music Subscriber status



Apple Music Subscriber status

SKCloudServiceController.requestCapabilitie
NSError?) -> Void)



#### SKCloudServiceController.requestCapabilities(completionHandler: (SKCloudServiceCapability,

Apple Music Subscriber status Apple Music Subscriber storefront



Apple Music Subscriber status Apple Music Subscriber storefront

SKCloudServiceController.requestStorefrontI
-> Void)



#### SKCloudServiceController.requestStorefrontIdentifier(completionHandler: (String?, NSError?)

Apple Music Subscriber statusApple Music Subscriber storefrontAdd content to a playlist



Apple Music Subscriber statusApple Music Subscriber storefrontAdd content to a playlist

MPMediaLibrary.defaultMediaLibrary().addItemWithProductID(productID: String, completionHandler:(([MPMediaEntity], NSError?) -> Void)?)



Apple Music Subscriber statusApple Music Subscriber storefrontAdd content to a playlistRead from media library



Apple Music Subscriber statusApple Music Subscriber storefrontAdd content to a playlistRead from media library

MPMediaQuery.songs()
MPMediaQuery.playlists()
MPMediaQuery.audiobooks()
MPMediaQuery.podcasts()





SKCloudServiceController.authorizationStatus()

enum SKCloudServiceAuthorizationStatus : Int { case notDetermined case denied case restricted case authorized }



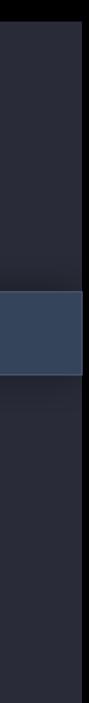


SKCloudServiceController.authorizationStatu

enum SKCloudServiceAuthorizationStatus : In case notDetermined case denied case restricted case authorized }



t {	IS()			
	t {			



SKCloudServiceController.authorizationStatus()

<pre>enum SKCloudServiceAuthorizationStatus</pre>			:	In
	case	notDetermined		
	case	denied		
	case	restricted		
	case	authorized		
}				





SKCloudServiceController.authorizationStatus()

enum SKCloudServiceAuthorizationStatus : Int { case notDetermined case denied case restricted case authorized }





SKCloudServiceController.authorizationStatus()

enum SKCloudServiceAuthorizationStatus : Int { case notDetermined case denied case restricted case authorized }





### Speech Recognition iOS 10



## Speech Recognition iOS 10

Speech transcription engine for use by apps



# Speech Recognition iOS 10

Speech transcription engine for use by apps Speech transcription done on the user's behalf



## Speech Recognition iOS 10

Speech transcription engine for use by apps Speech transcription done on the user's behalf

SFSpeechRecognizer.requestAuthorization(SFSpeechRecognizerAuthorizationStatus)





Users can make Siri requests that are completed with a third party app



Users can make Siri requests that are completed with a third party app Apps must request access to receive requests via Siri



Users can make Siri requests that are completed with a third party app Apps must request access to receive requests via Siri

INPreferences.requestSiriAuthorization()



### TV Provider iOS 10, tvOS 10



### TV Provider iOS 10, tvOS 10

Enabled television apps can request access to user subscription information



#### TV Provider iOS 10, tvOS 10

Enabled television apps can request access to user subscription information Reach out to your WWDR partner manager for more details







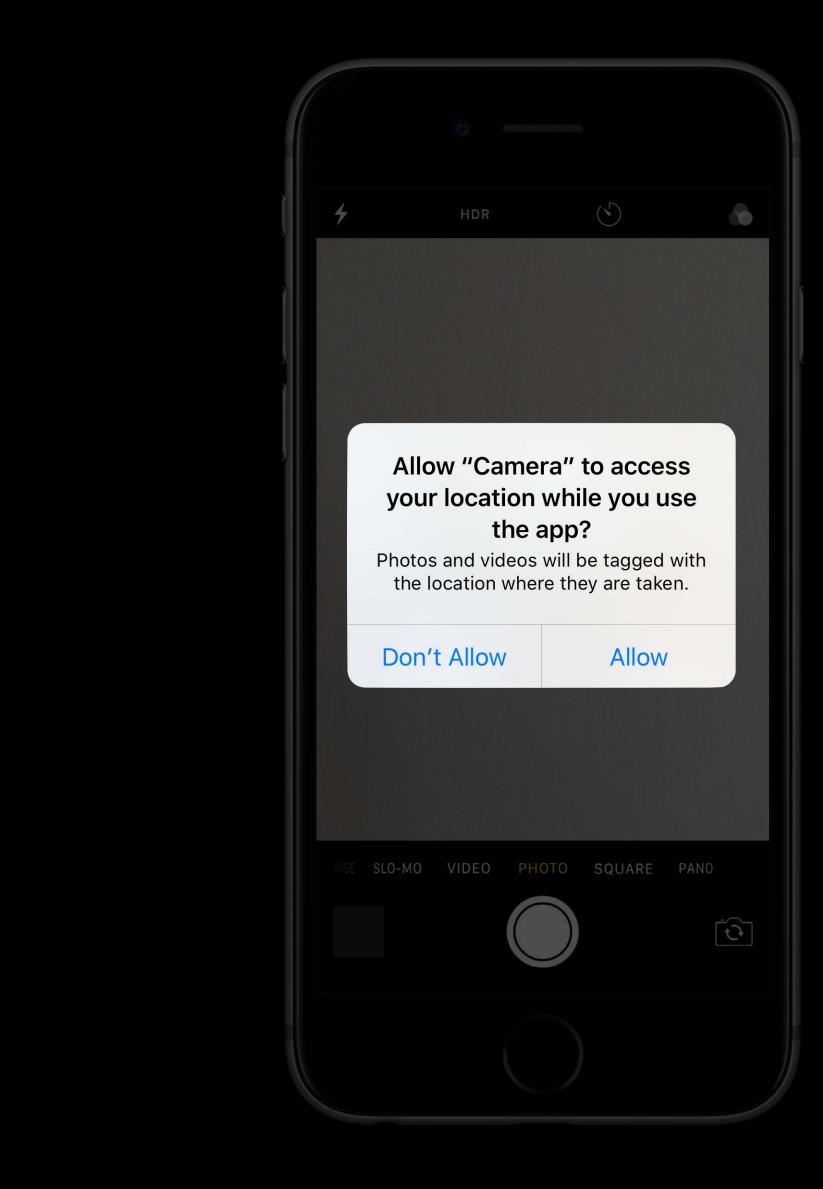
#### Photos on tvOS



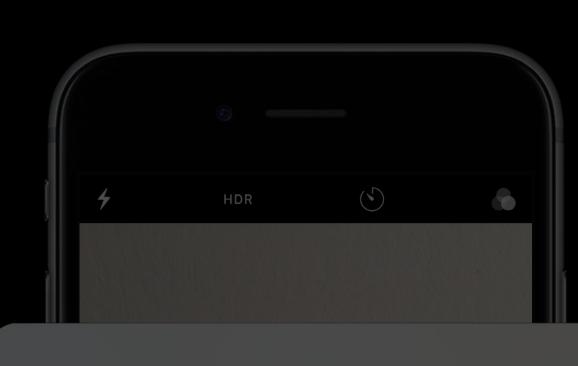
#### HomeKit on tvOS

Updates

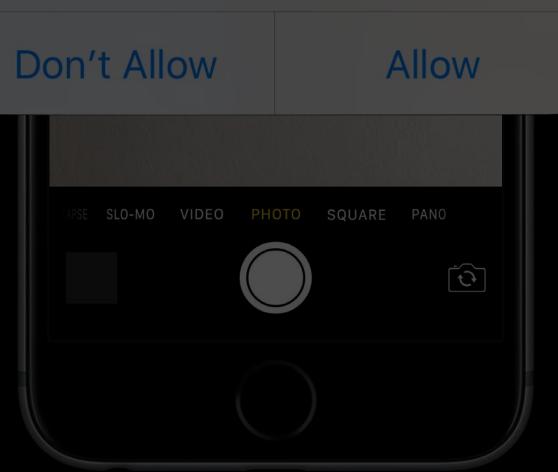
## Consent Alert Purpose String



## Consent Alert Purpose String



Photos and videos will be tagged with the location where they are taken.



#### Allow "Camera" to access your location while you use the app?

# Purpose String Required



#### Purpose String Required iOS 10

Contacts Calendar Reminders Photos Bluetooth Sharing Microphone Camera Location Health—Sharing

Health—Updating HomeKit Media Library Motion and Fitness CallKit Speech Recognition SiriKit TV Provider



# Purpose String Required tvOS 10

Photos Location HomeKit TV Provider





Contacts Calendars Reminders Photos Bluetooth Sharing Microphone Camera Health—Sharing Health—Updating NSContactsUsageDescription NSCameraUsageDescription

- NSCalendarsUsageDescription
- NSRemindersUsageDescription
- NSPhotoLibraryUsageDescription
- NSBluetoothPeripheralUsageDescription
- **NSMicrophoneUsageDescription**
- NSHealthShareUsageDescription
- HSHealthUpdateUsageDescription



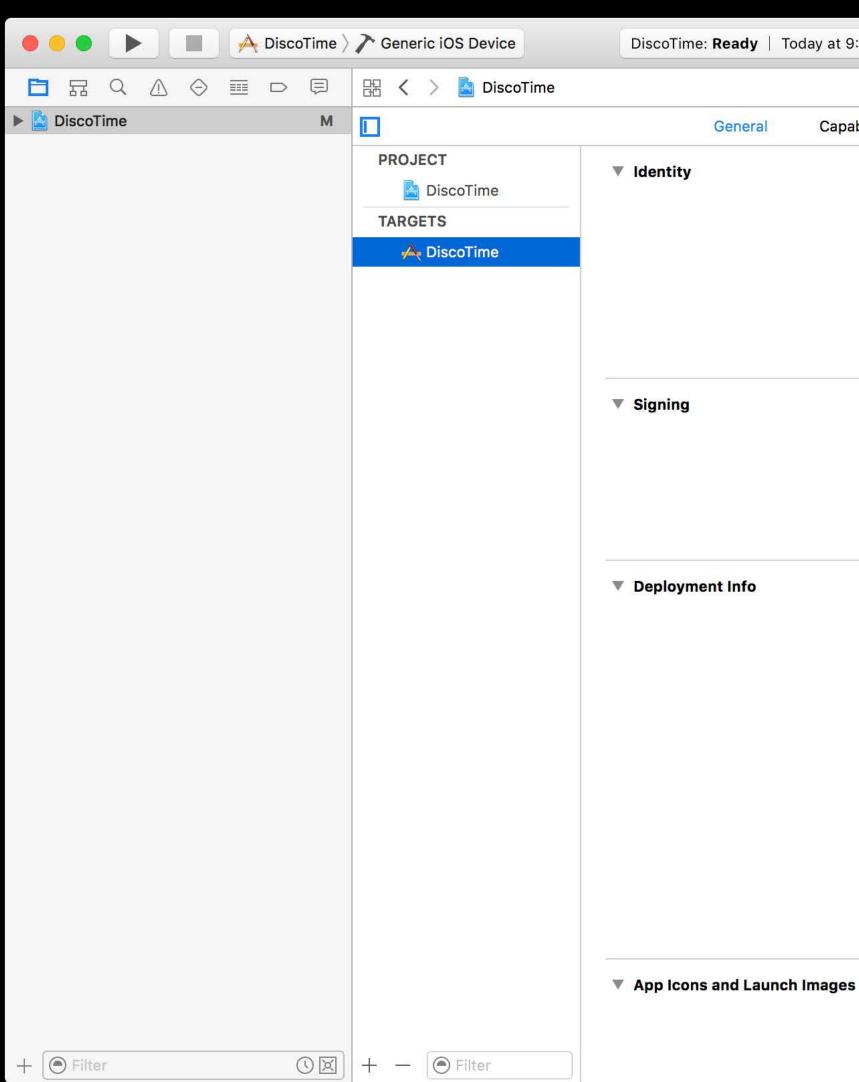


HomeKit Media Library Motion and Fitness CallKit Speech Recognition Siri Third Party TV Provider

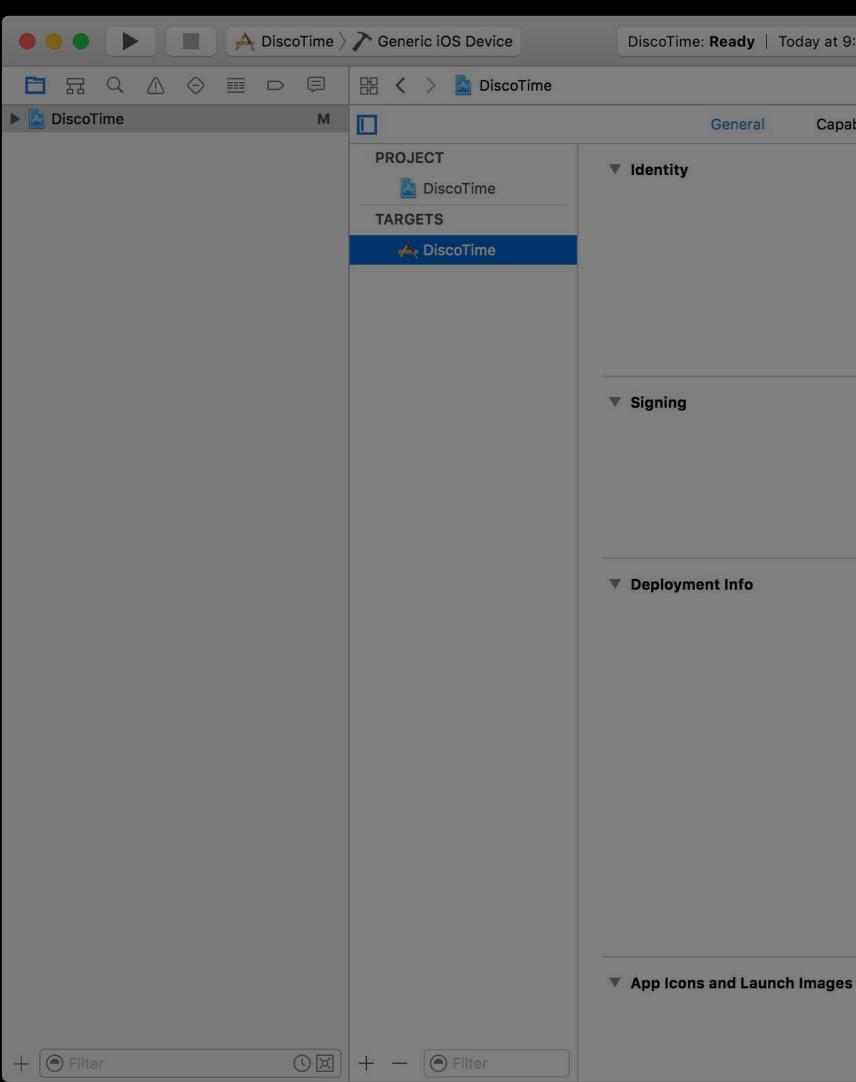
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- NSAppleMusicUsageDescription
- NSSpeechRecognitionUsageDescription
- NSVideoSubscriberAccountUsageDescription



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#### If Not, You'll Crash and



#### If Not, You'll Crash and

2016-05-12 13:40:54.161036 DiscoTime[12103:588848] This app has crashed because it attempted to access privacy-sensitive data without a usage description. The app's Info.plist must contain an NSHomeKitUsageDescription key with a string value explaining to the user how the app uses this data.



#### What Does That Mean for You?

#### What Does That Mean for You?

New Features with Privacy Settings

#### What Does That Mean for You?

New Features with Privacy Settings Declare Purpose String in info.plist

Building Privacy into Your App



Set expiration and local options of pasteboards



Set expiration and local options of pasteboards





Set expiration and local options of pasteboards

@available(i0S 10.0, \*) enum UIPasteboardOption: String { case expirationDate case localOnly }



#### Pasteboard Changes Example



Set expiration and local options of pasteboards

### NEW



Set expiration and local options of pasteboards

var image: UIImage



Set expiration and local options of pasteboards

var image: UIImage

let pasteboard = UIPasteboard.general()



Set expiration and local options of pasteboards

var image: UIImage

let pasteboard = UIPasteboard.general()

pasteboard.setItems([{UIPasteboardTypeAutomatic: "Hello, world"},



Set expiration and local options of pasteboards

var image: UIImage let pasteboard = UIPasteboard.general() pasteboard.setItems([{UIPasteboardTypeAutomatic: "Hello, world"}, {UIPasteboardTypeAutomatic: image}],



Set expiration and local options of pasteboards

var image: UIImage let pasteboard = UIPasteboard.general() pasteboard.setItems([{UIPasteboardTypeAutomatic: "Hello, world"}, {UIPasteboardTypeAutomatic: image}],

- options: {.expirationDate: Date(timeIntervalSinceNow: 120.0),



Set expiration and local options of pasteboards

var image: UIImage let pasteboard = UIPasteboard.general() pasteboard.setItems([{UIPasteboardTypeAutomatic: "Hello, world"}, {UIPasteboardTypeAutomatic: image}], .localOnly: true})

```
options: {.expirationDate: Date(timeIntervalSinceNow: 120.0),
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All named pasteboards will be defaulted to non-persistent

All named pasteboards will be defaulted to non-persistent The Find Pasteboard will yield an empty object

All named pasteboards will be defaulted to non-persistent The Find Pasteboard will yield an empty object Use shared containers instead of named pasteboards

# Core Spotlight Framework



# Core Spotlight Framework

Every user tap should not result in NSUserActivity being published





# Core Spotlight Framework

Every user tap should not result in NSUserActivity being published Do not set eligibleForPublicIndexing to true if data is sensitive user data





Widgets

### Widgets on Home screen





Evaluate sensitivity of data in widgets

Evaluate sensitivity of data in widgets Consistent and predictable data

Evaluate sensitivity of data in widgets Consistent and predictable data Data that is FileProtectionType.complete will not be available

### Find my Friends widget



### Find my Friends widget



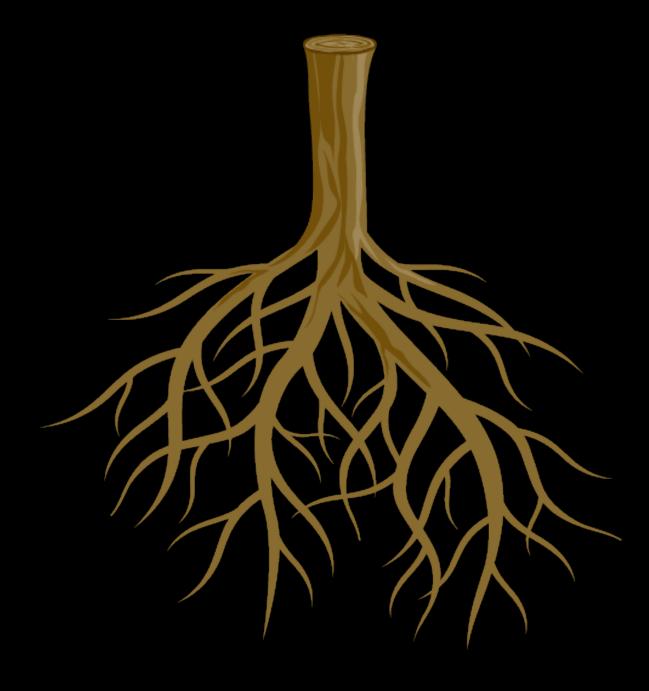
### Find my Friends widget



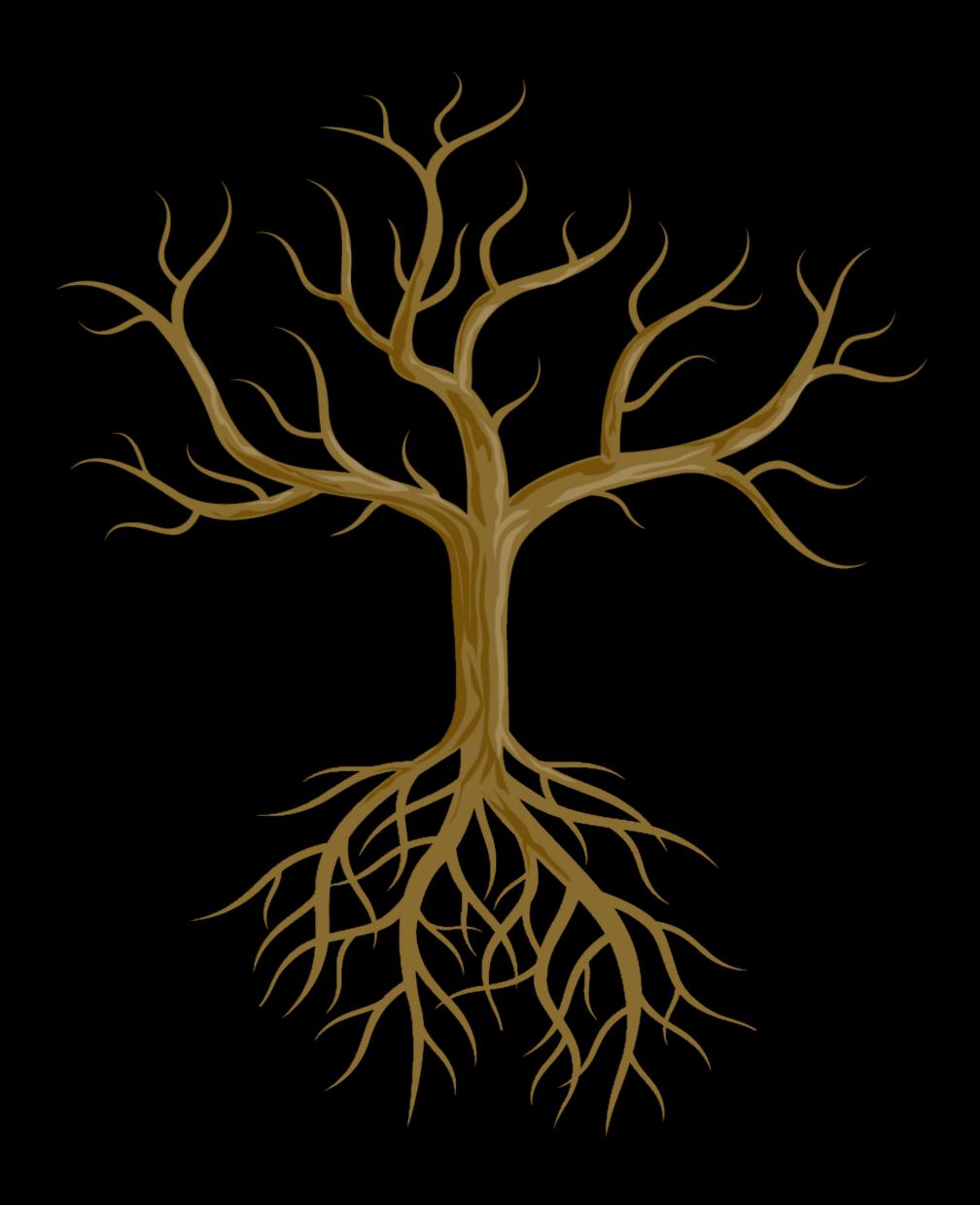
Favor short-lived identifiers



Favor short-lived identifiers Collect data in privacy friendly ways



Favor short-lived identifiers Collect data in privacy friendly ways Increase transparency and control to gain user trust



- Favor short-lived identifiers
- Collect data in privacy friendly ways
- Increase transparency and control to gain user trust
- Empower users to make good privacy decisions



- Favor short-lived identifiers
- Collect data in privacy friendly ways
- Increase transparency and control to gain user trust
- Empower users to make good privacy decisions
- Use new tools to build privacy into your app



# More Information https://developer.apple.com/wwdc16/709

### Related Sessions

How iOS Security Really Works

What's New in Security

Core Location Best Practices

Nob Hill	Tuesday 4:00PM
Nob Hill	Tuesday 5:00PM
Pacific Heights	Thursday 4:00PM



### Security & Privacy Lab 1

### Security & Privacy Lab 2

### Frameworks Lab C Wednesday 9:00AM

### Frameworks Lab B Thursday 9:00AM

