System Frameworks

#WWDC16

# How iOS Security Really Works

Session 705

Ivan Krstić Head of Security Engineering & Architecture

# Mobile Devices Today

## Unprecedented record of our lives

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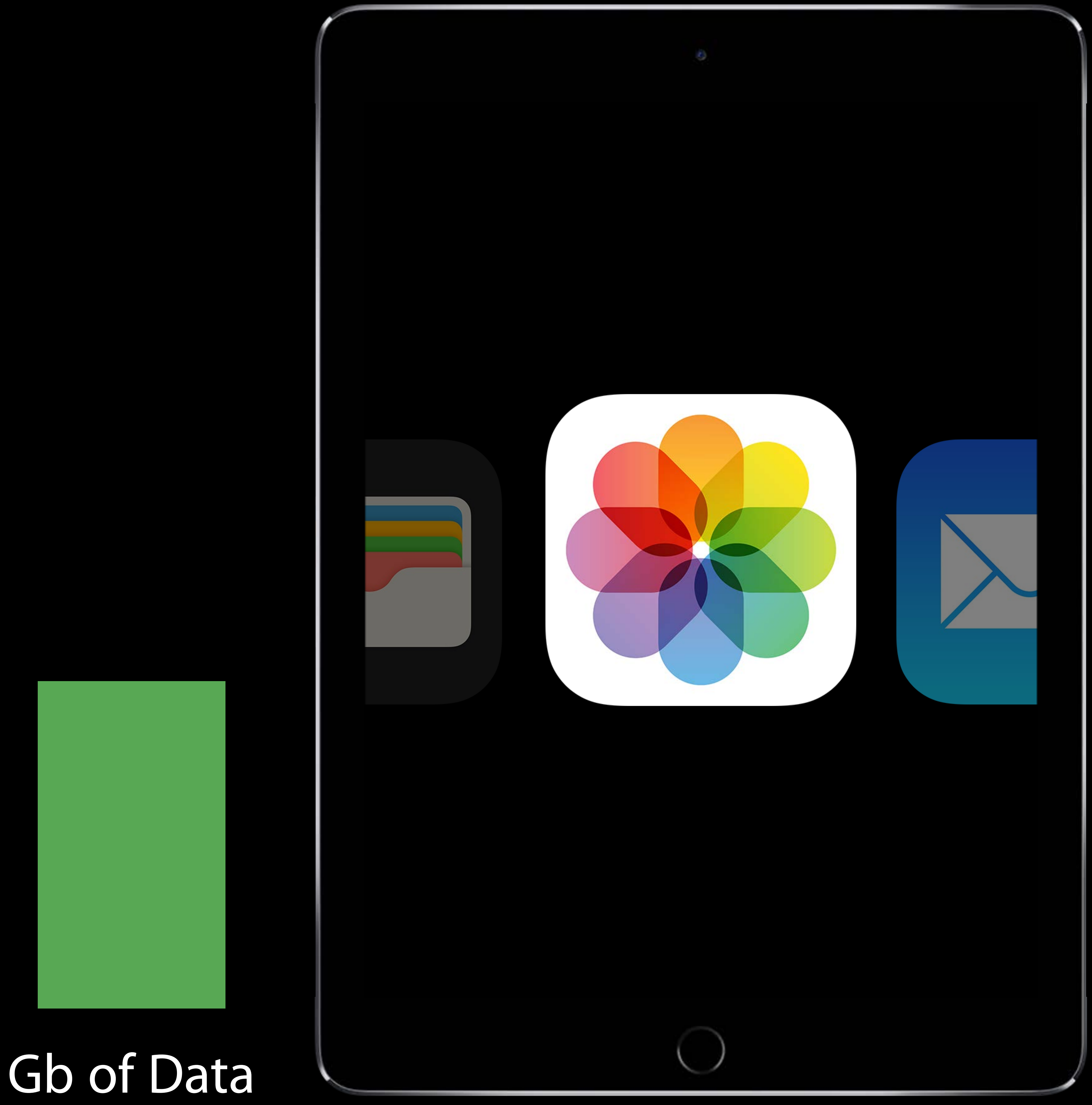
## Unprecedented record of our lives



# Mobile Devices Today

## Unprecedented record of our lives

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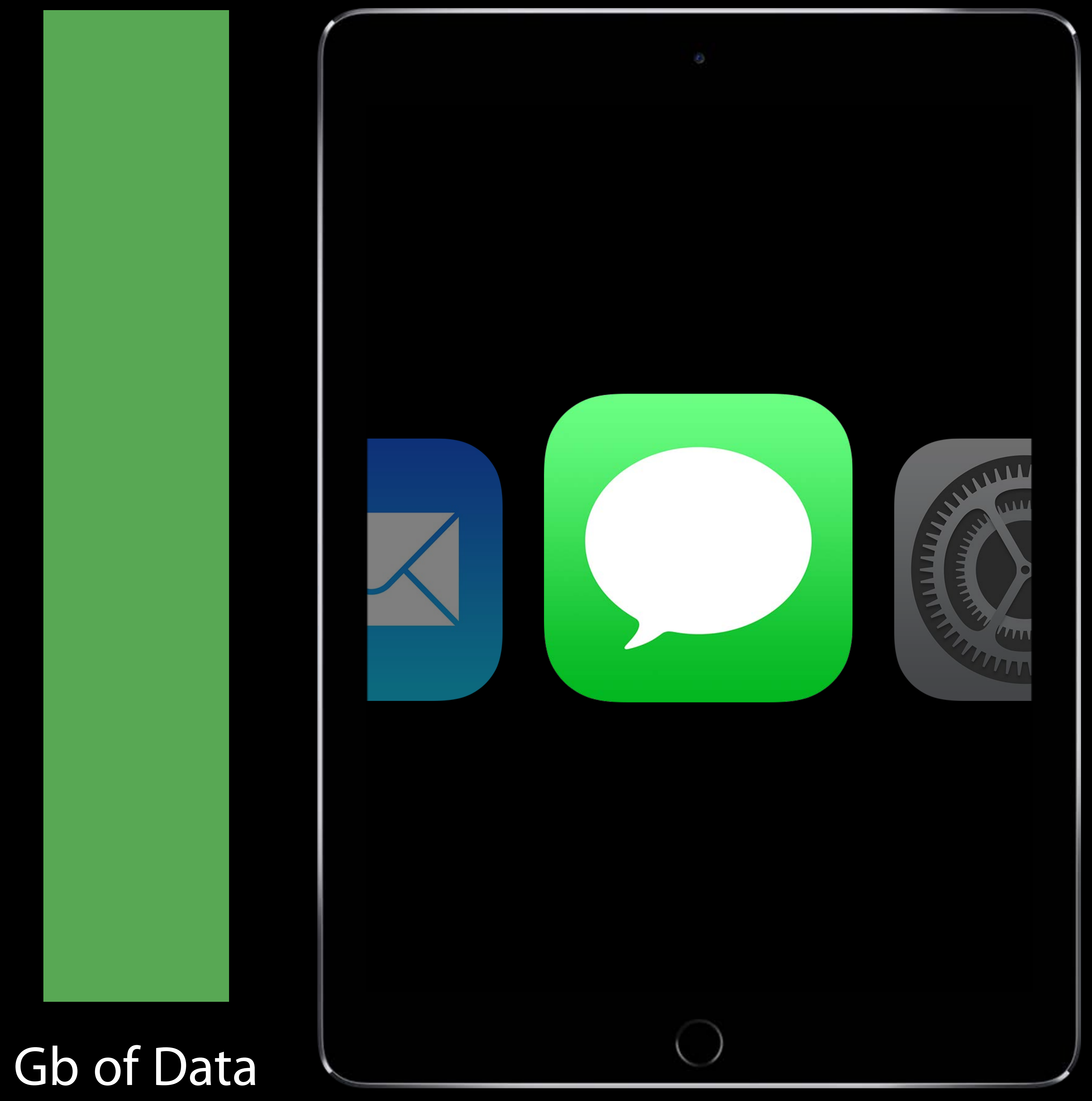

# Who Might Be an Attacker

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Criminals

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Criminals

Business competitors

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Criminals

Business competitors

Service providers

# Who Might Be an Attacker

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Business competitors

Service providers

Nation states

# Who Might Be an Attacker

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Business competitors

Service providers

Nation states

Romantic partners, family, friends

# Who Might Be an Attacker

Criminals

Business competitors

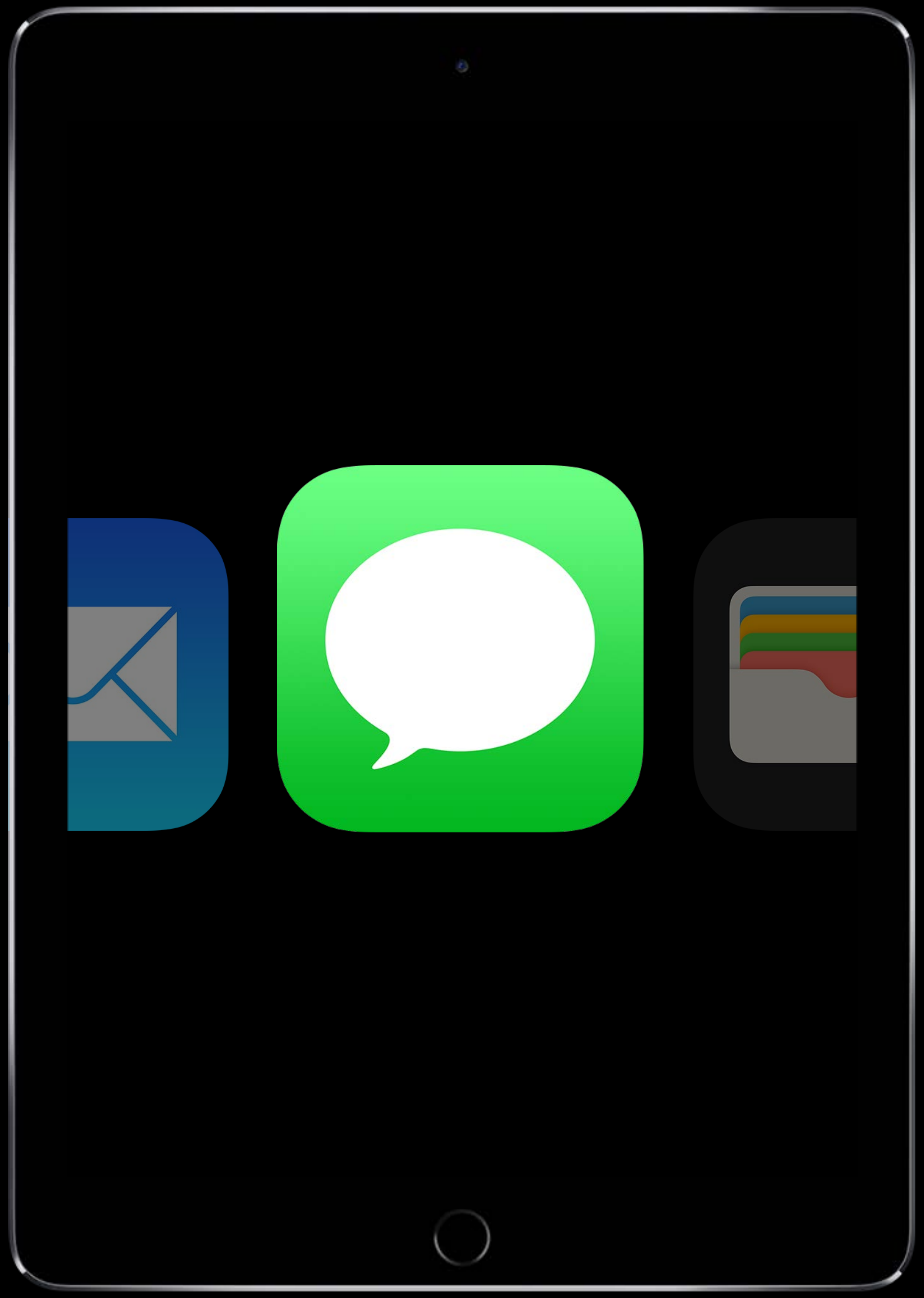
Service providers

Nation states

Romantic partners, family, friends

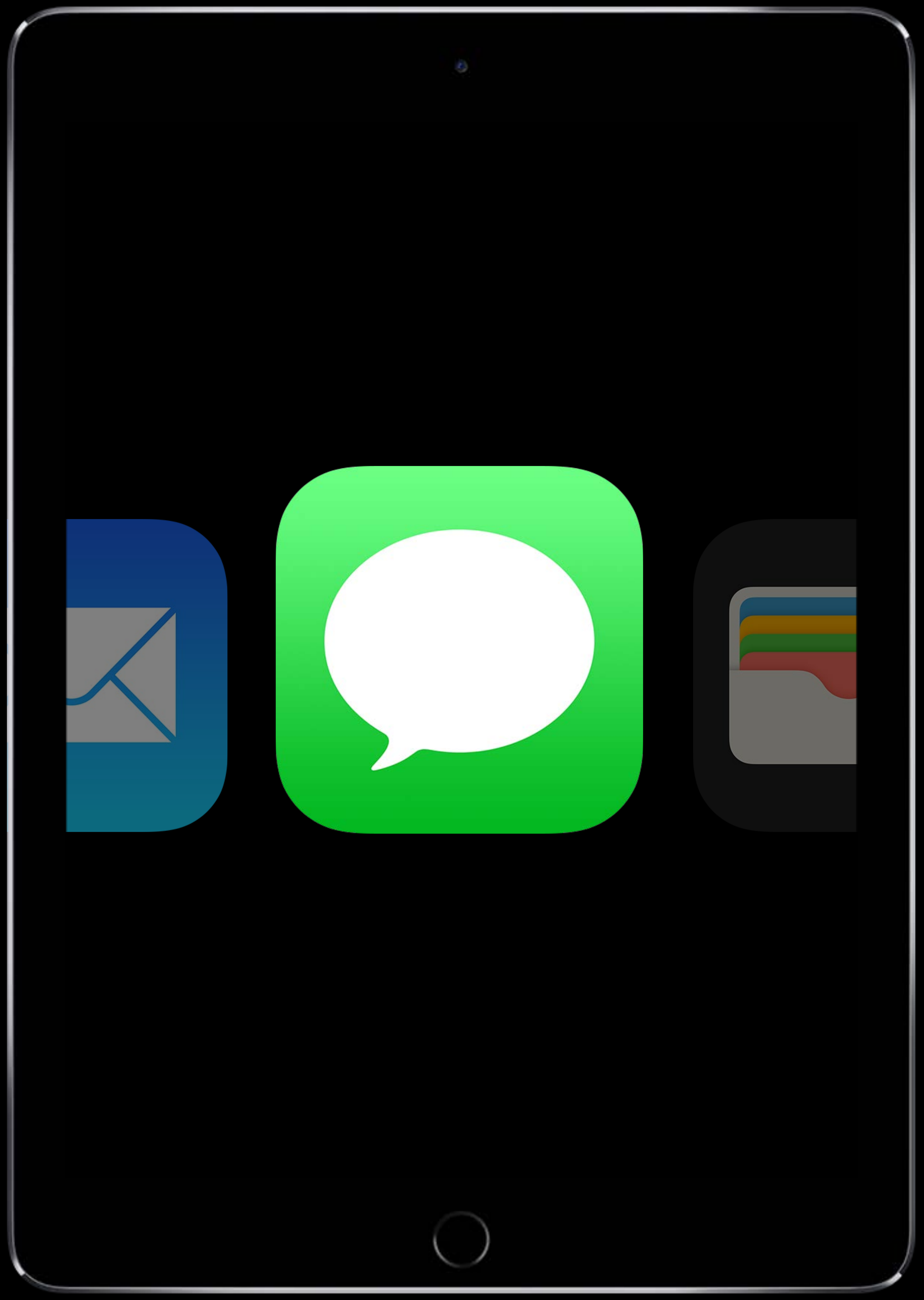
Cats

# What Do Attackers Want?



# What Do Attackers Want?

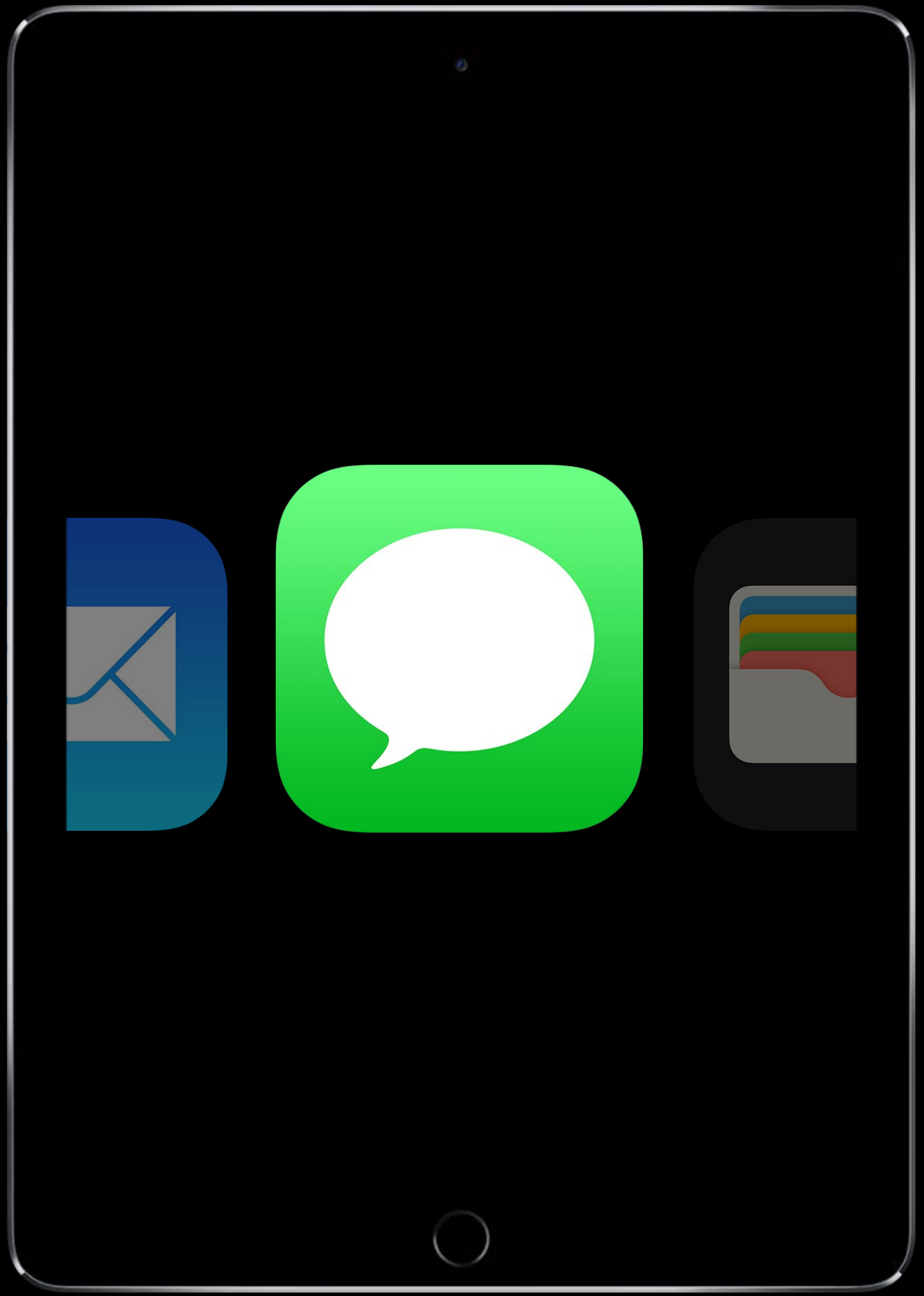
Personal stalking and surveillance



# What Do Attackers Want?

Personal stalking and surveillance

Corporate espionage

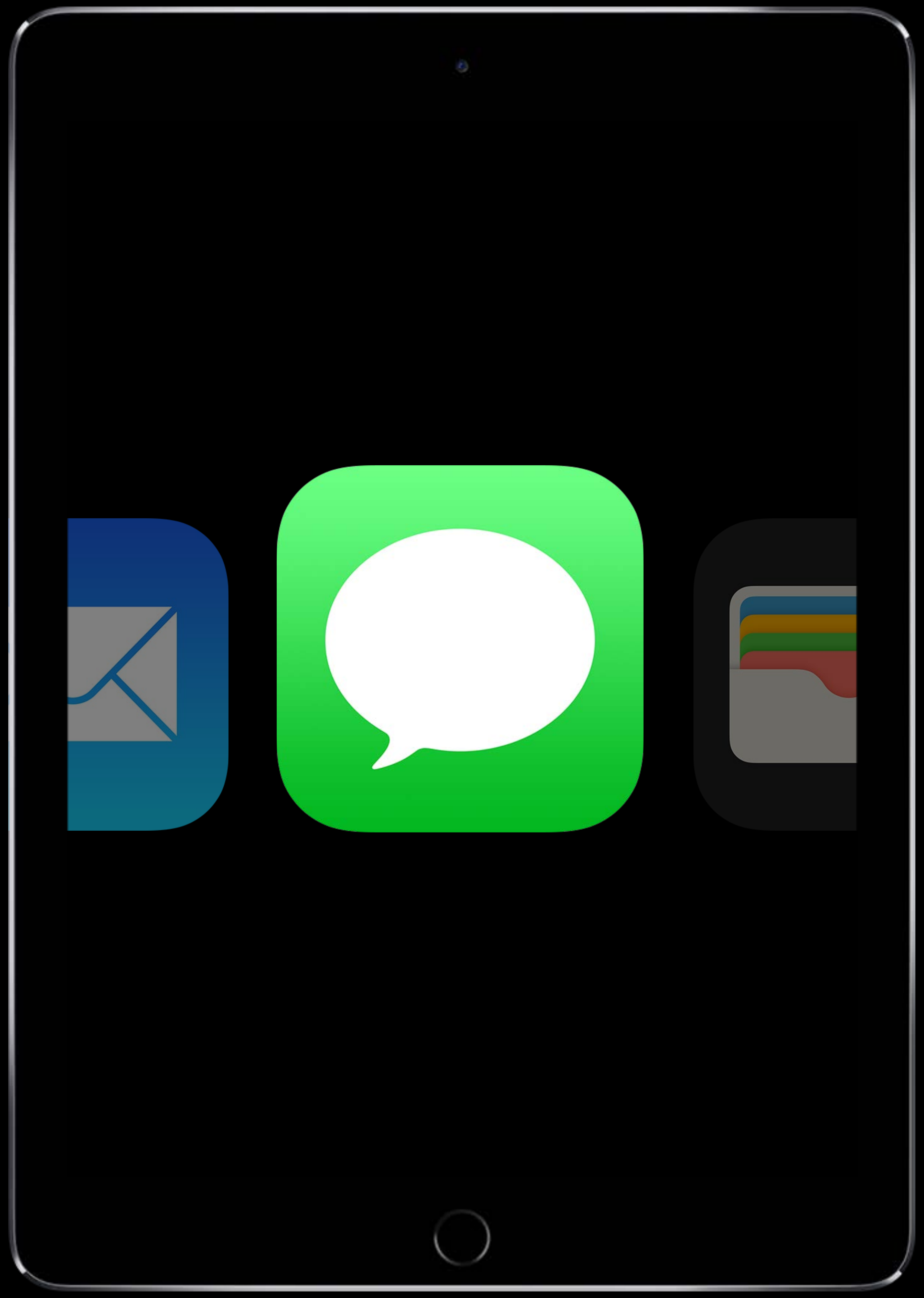


# What Do Attackers Want?

Personal stalking and surveillance

Corporate espionage

Direct financial benefit



# How Do We Know This?

We see it on other platforms

# But Not on iOS

No malware has affected iOS devices at scale

# iOS Security

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Decade-long effort to protect customers from security problems

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Decade-long effort to protect customers from security problems

Incredible scale

# iOS Security

Decade-long effort to protect customers from security problems

Incredible scale

Every single iOS security feature is designed to thwart a real security threat

# iOS Security Pillars

iOS Platform Security

Users Upgrading their Software

Developers Building Secure Apps

iOS Platform Security

Users Upgrading their Software

Developers Building Secure Apps

## Traditional Security

- physical security
- secure configuration
- installing latest patches
- password policy
- vetted apps
- mandated policies

| Traditional Security | iOS Security |
|---|---|
| physical security | security built from silicon up |
| secure configuration | secure default settings |
| installing latest patches | easy updates |
| password policy | Touch ID |
| vetted apps | App Store |
| mandated policies | ease of use |

1. Secure Boot
2. Data Protection
3. Sandboxing
4. Code Signing
5. Touch ID

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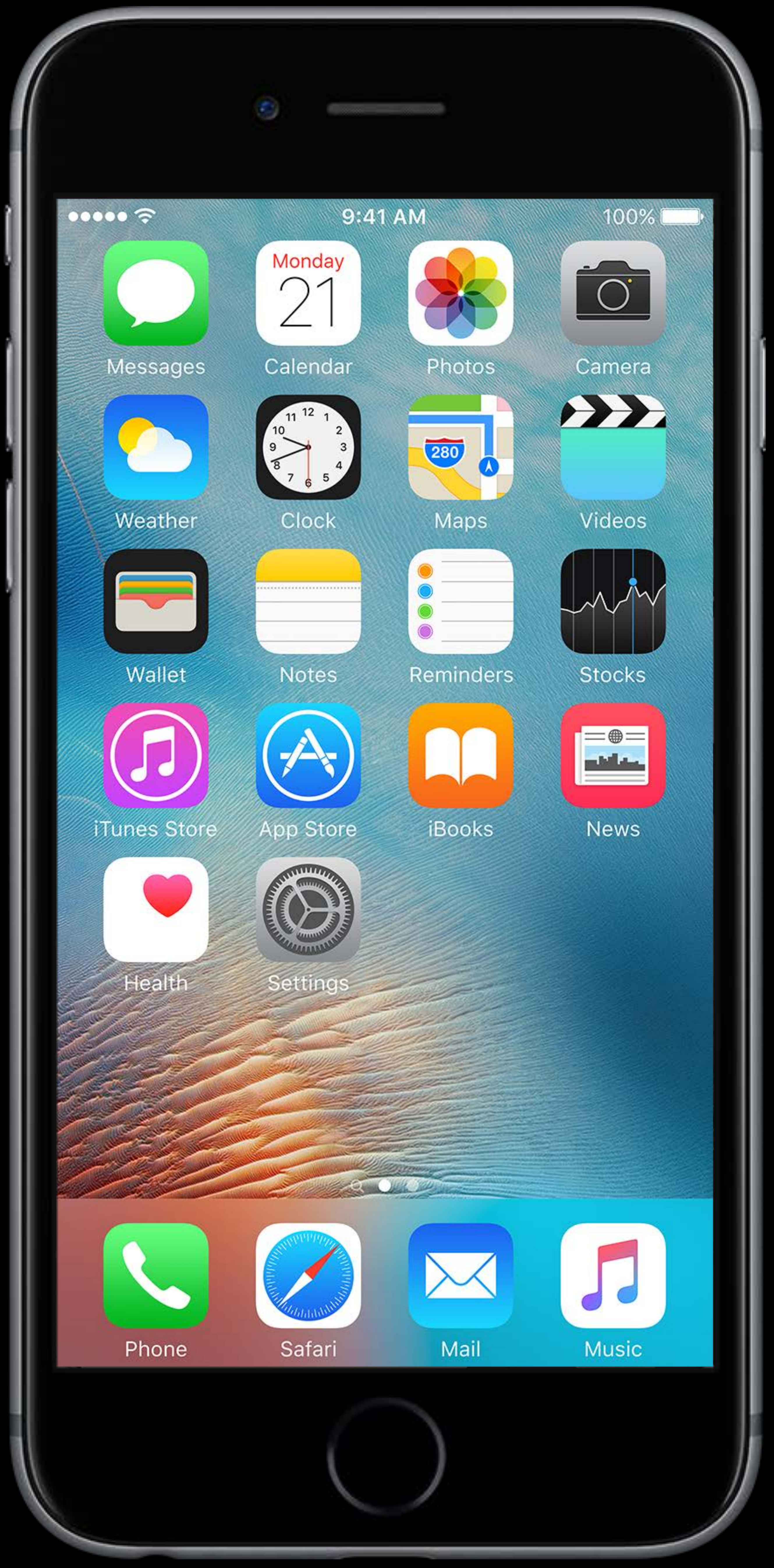
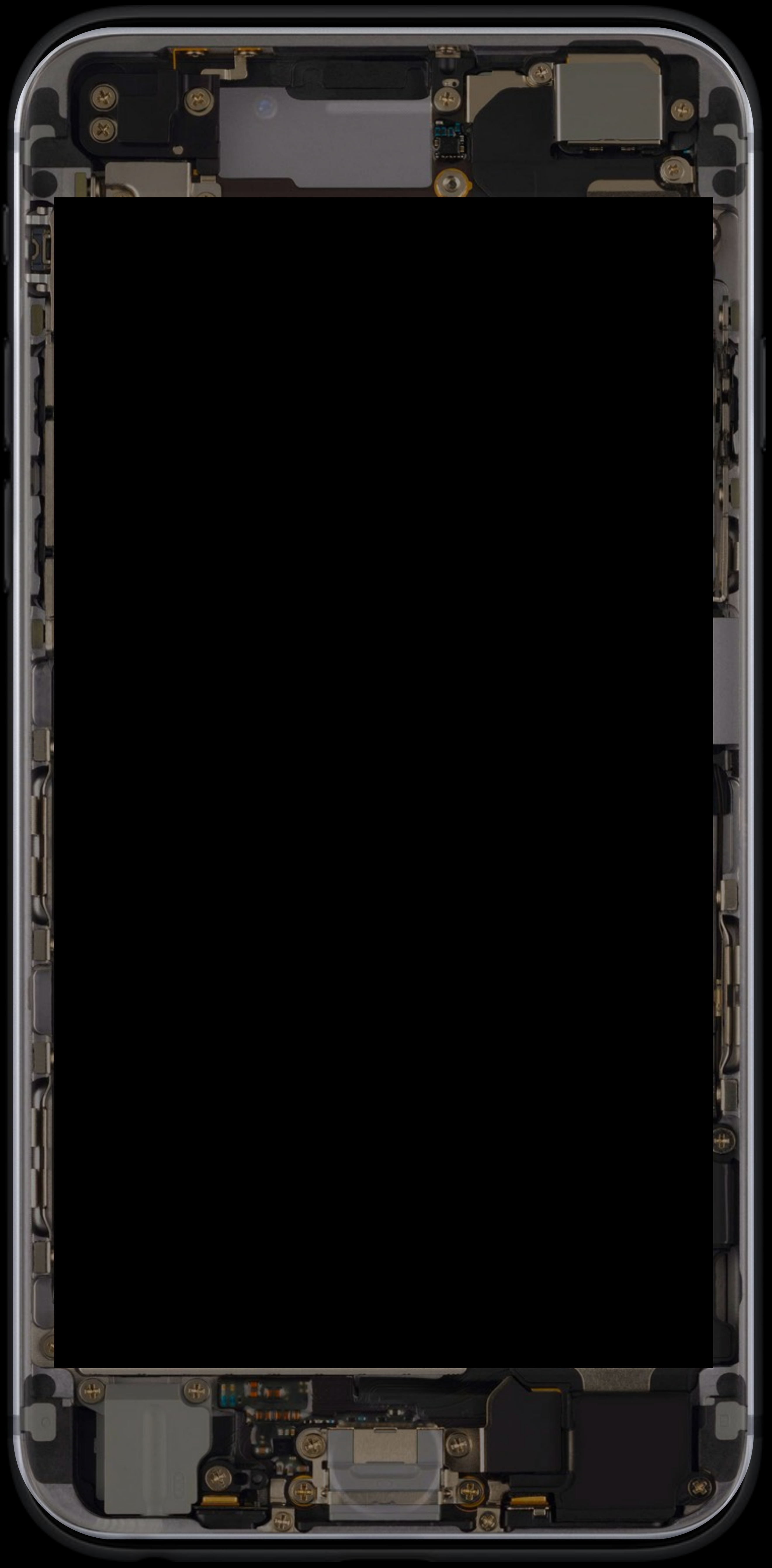
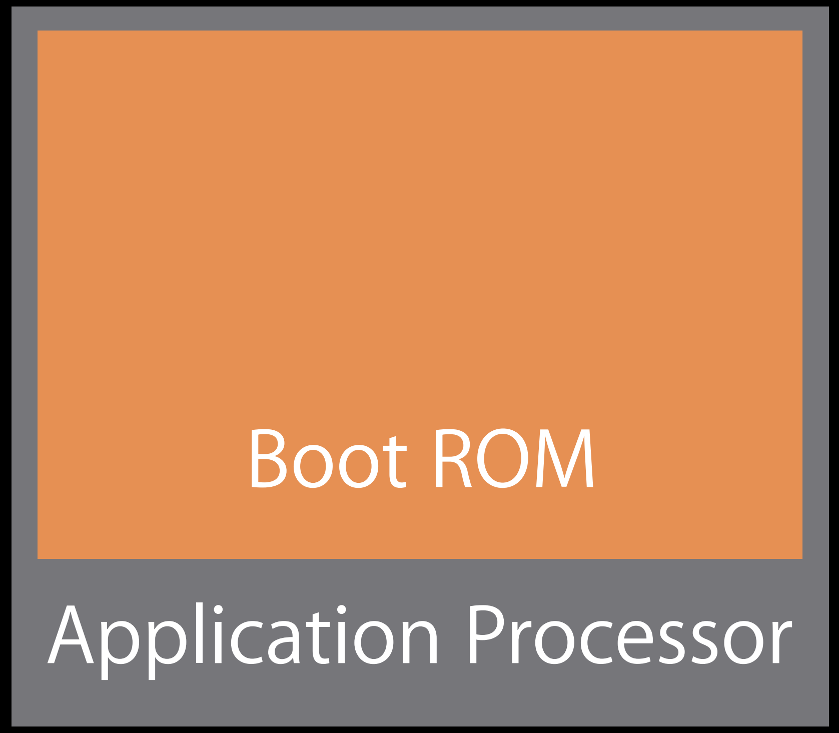

9:41 AM
100%
Monday
21
Messages
Calendar
Photos
Camera
280
Weather
Clock
Maps
Videos
Wallet
Notes
Reminders
Stocks
iTunes Store
App Store
iBooks
News
Health
Settings
Phone
Safari
Mail
Music



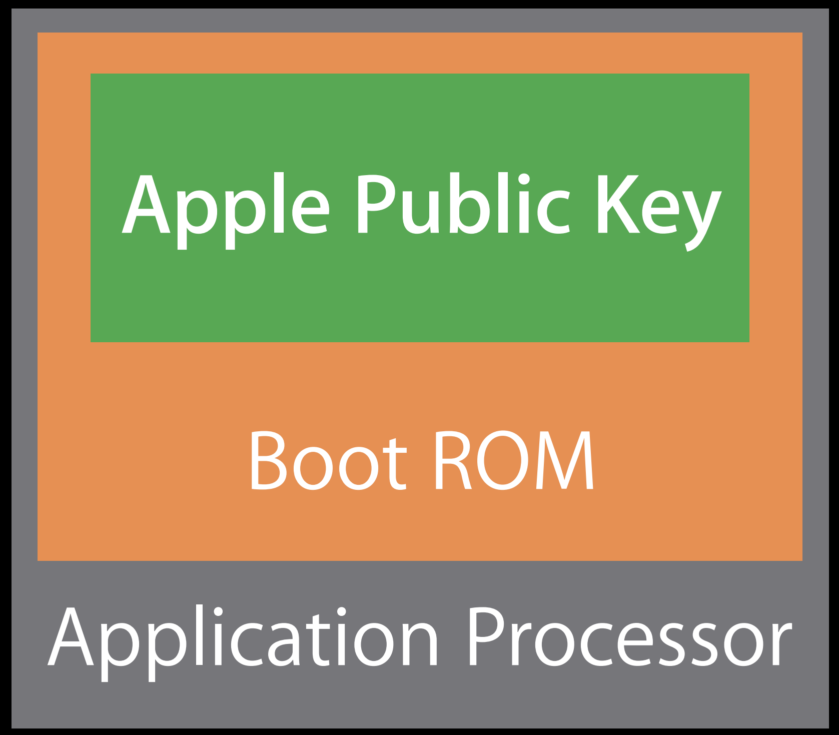
Trust built from silicon up

Application Processor



Boot ROM

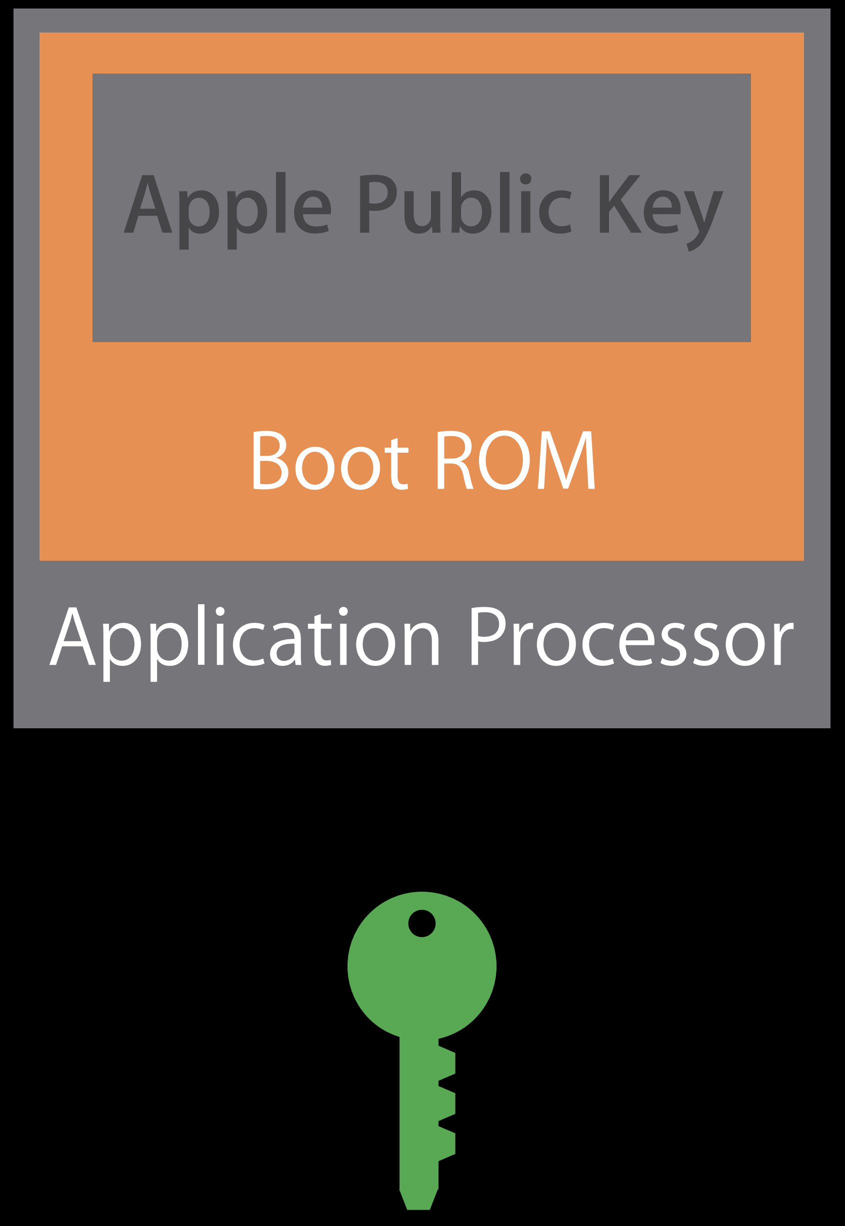
Application Processor



Apple Public Key

Boot ROM

Application Processor

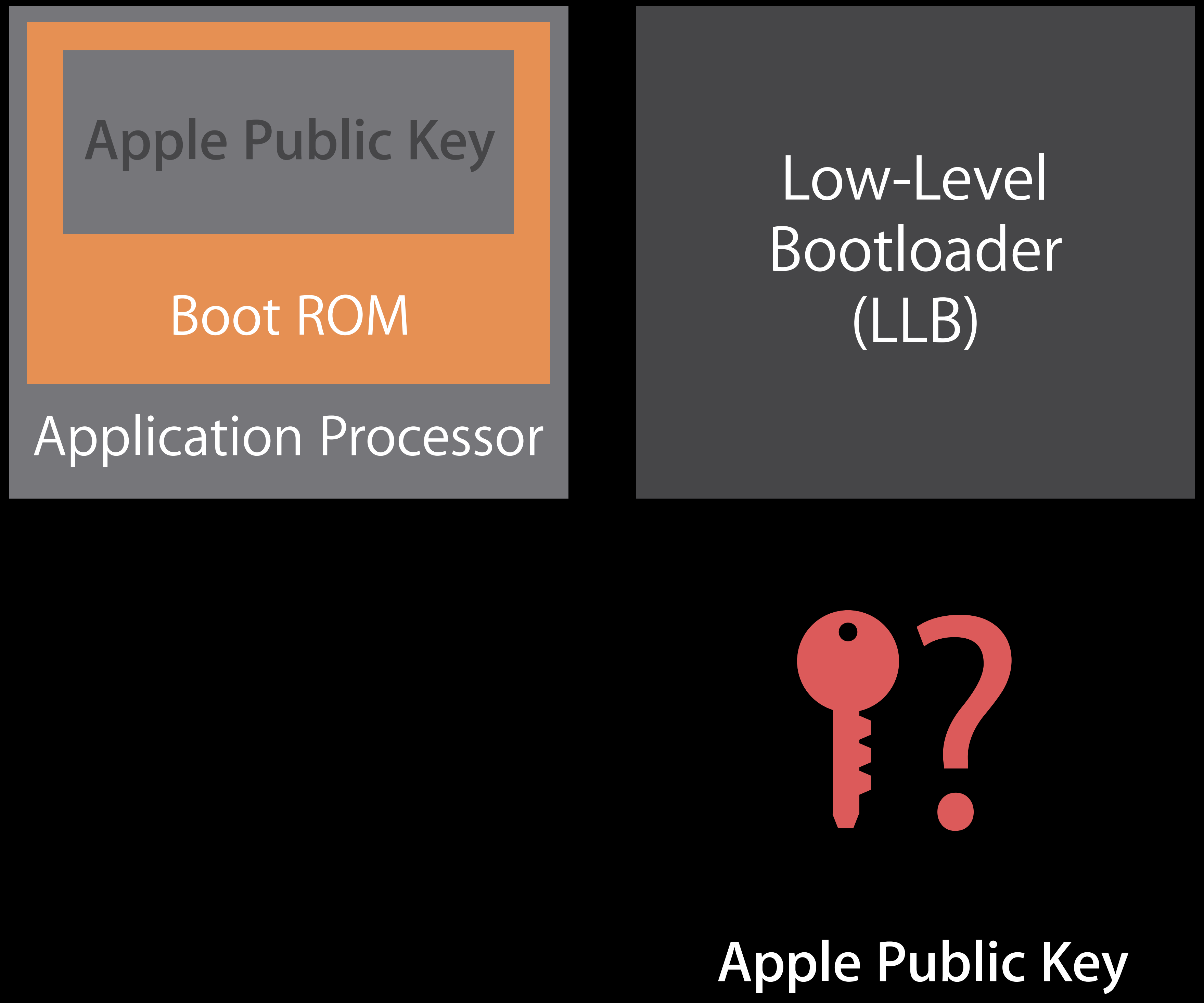


Apple Public Key

Boot ROM

Application Processor

Apple Public Key



Apple Public Key

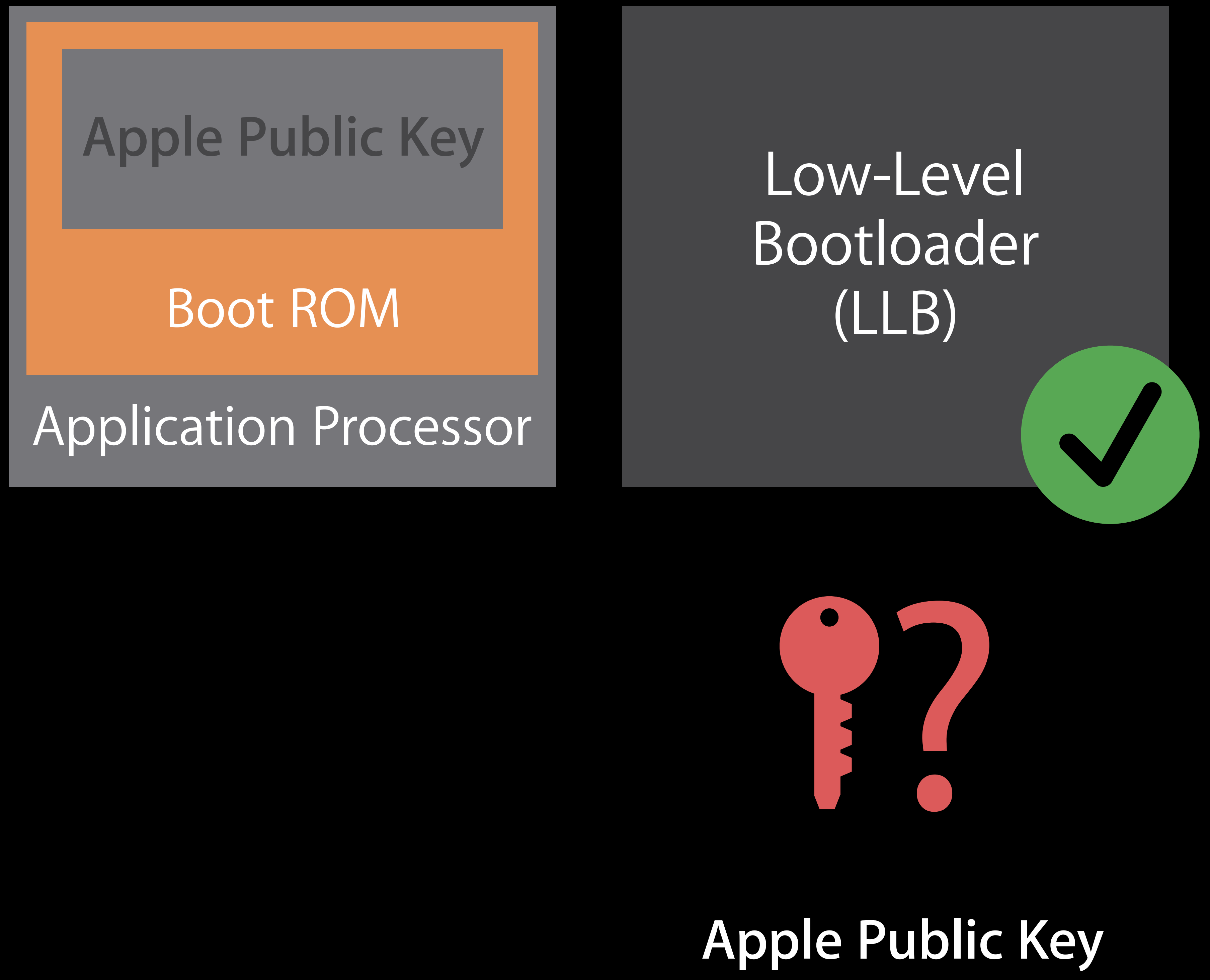
Boot ROM

Application Processor

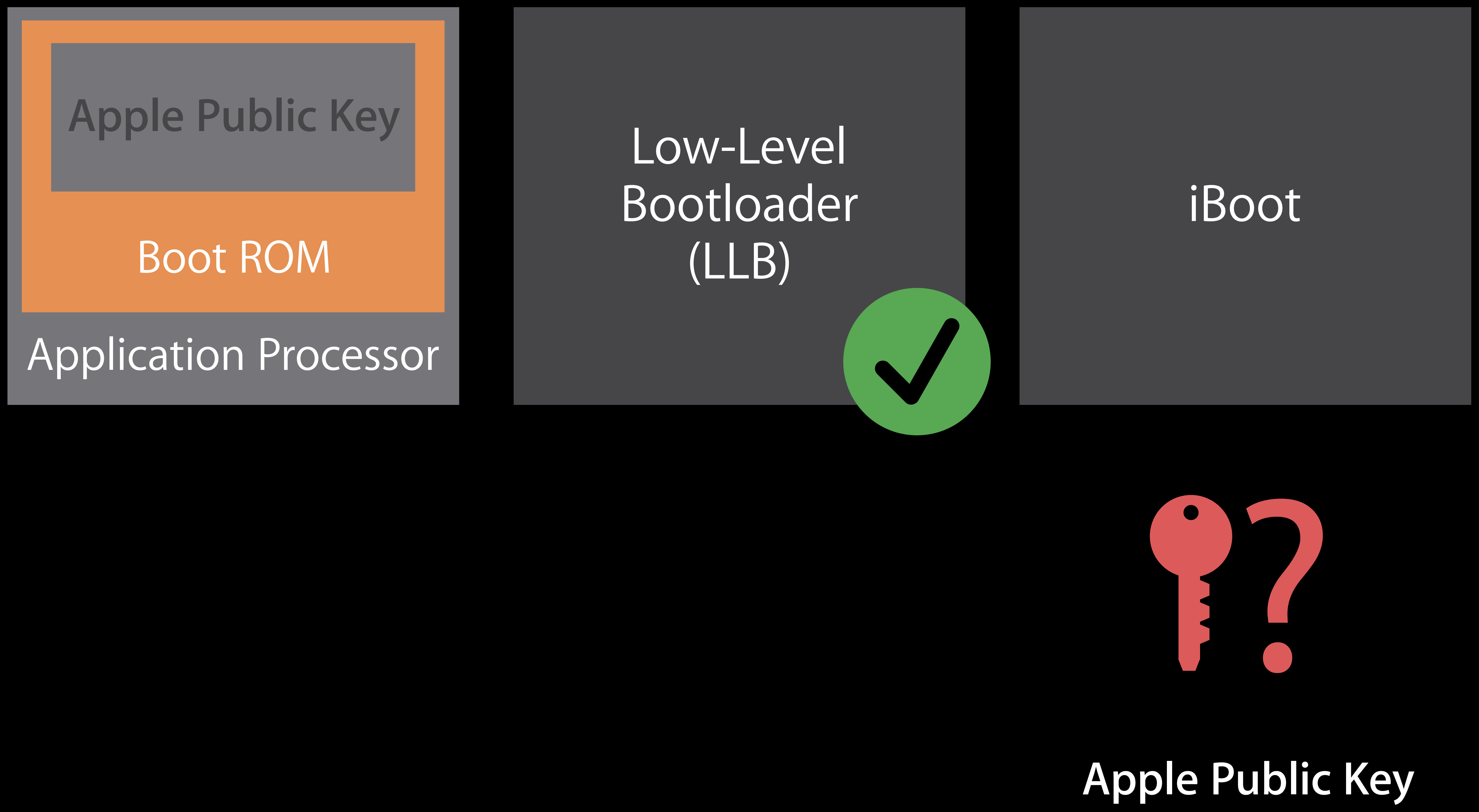
Low-Level
Bootloader
(LLB)

?

Apple Public Key



Apple Public Key
Boot ROM
Application Processor
Low-Level Bootloader (LLB)
✓
?
Apple Public Key



Apple Public Key

Boot ROM

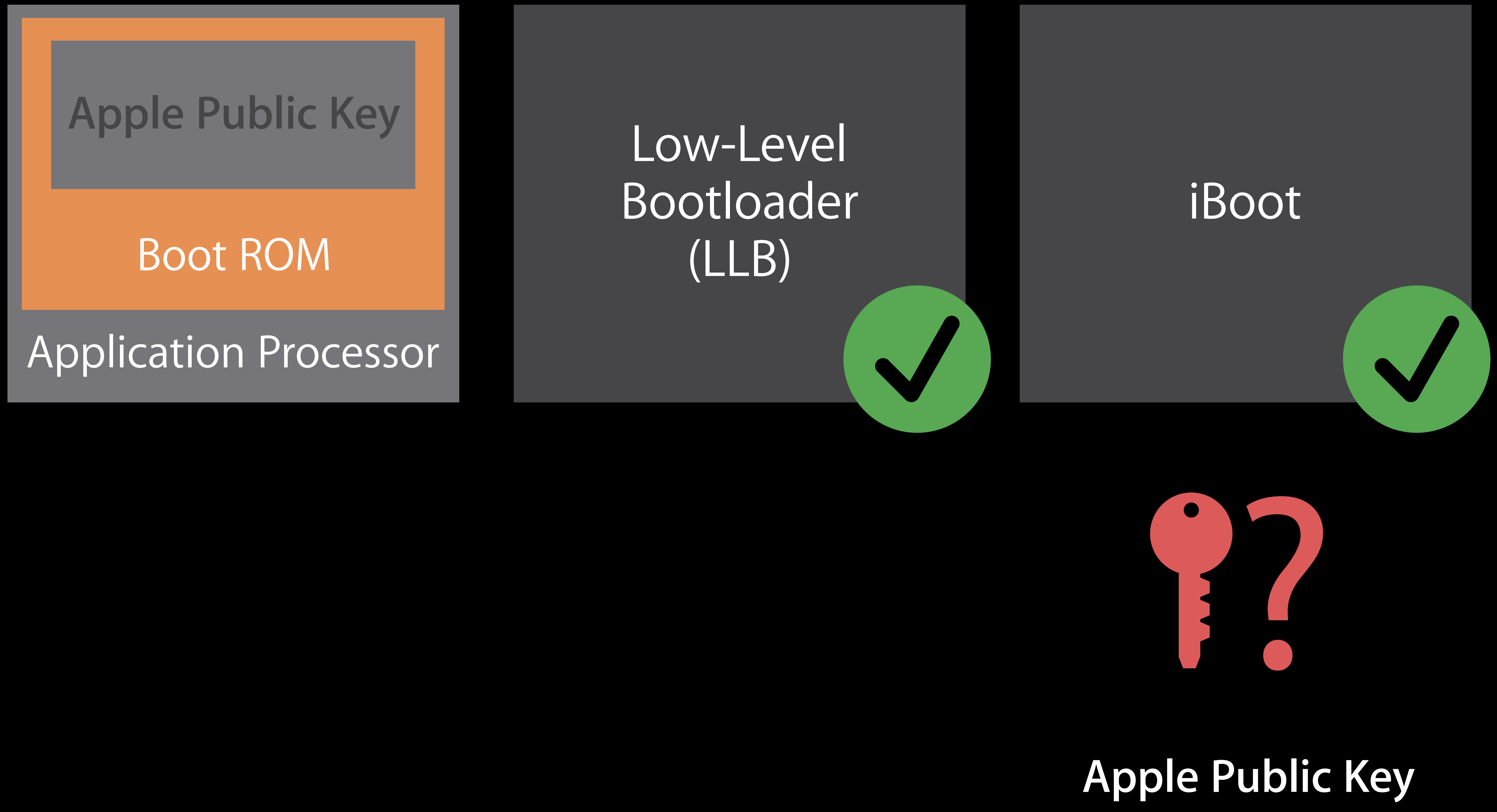
Application Processor

Low-Level Bootloader (LLB)

✓

iBoot

Apple Public Key



Apple Public Key

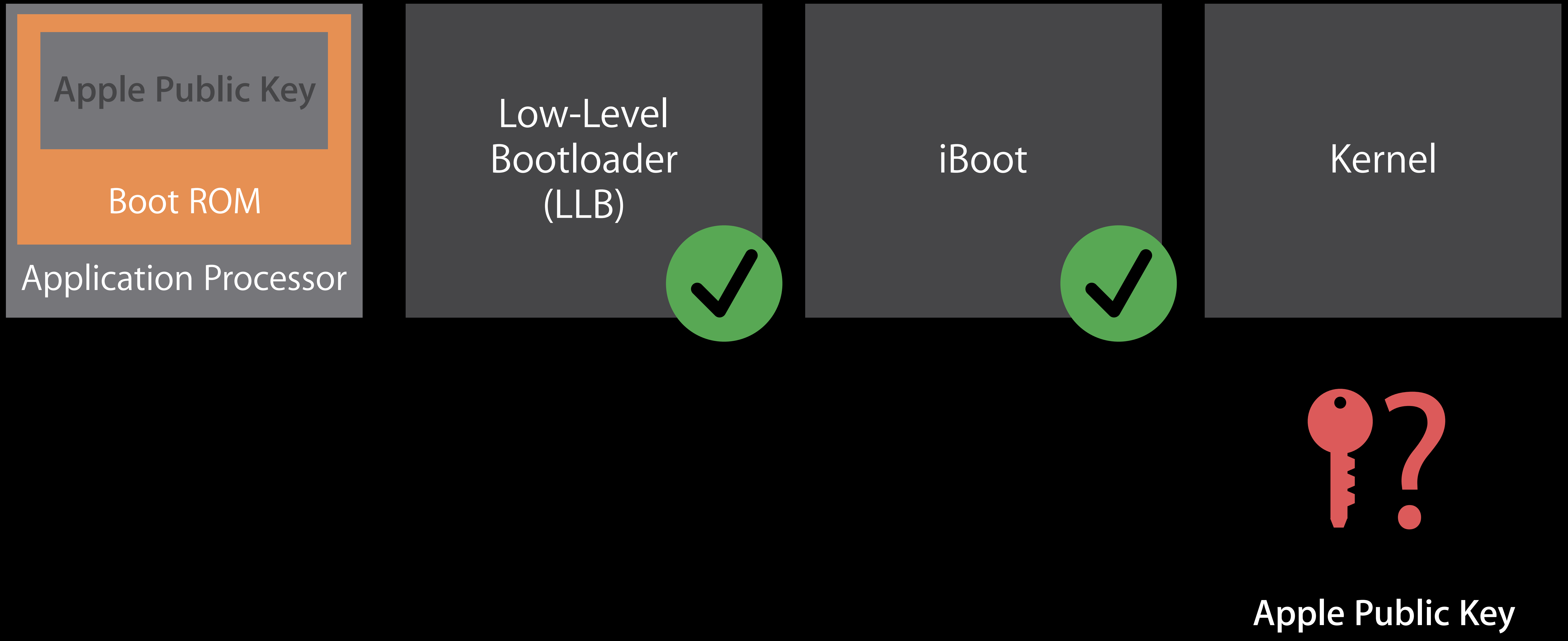
Boot ROM

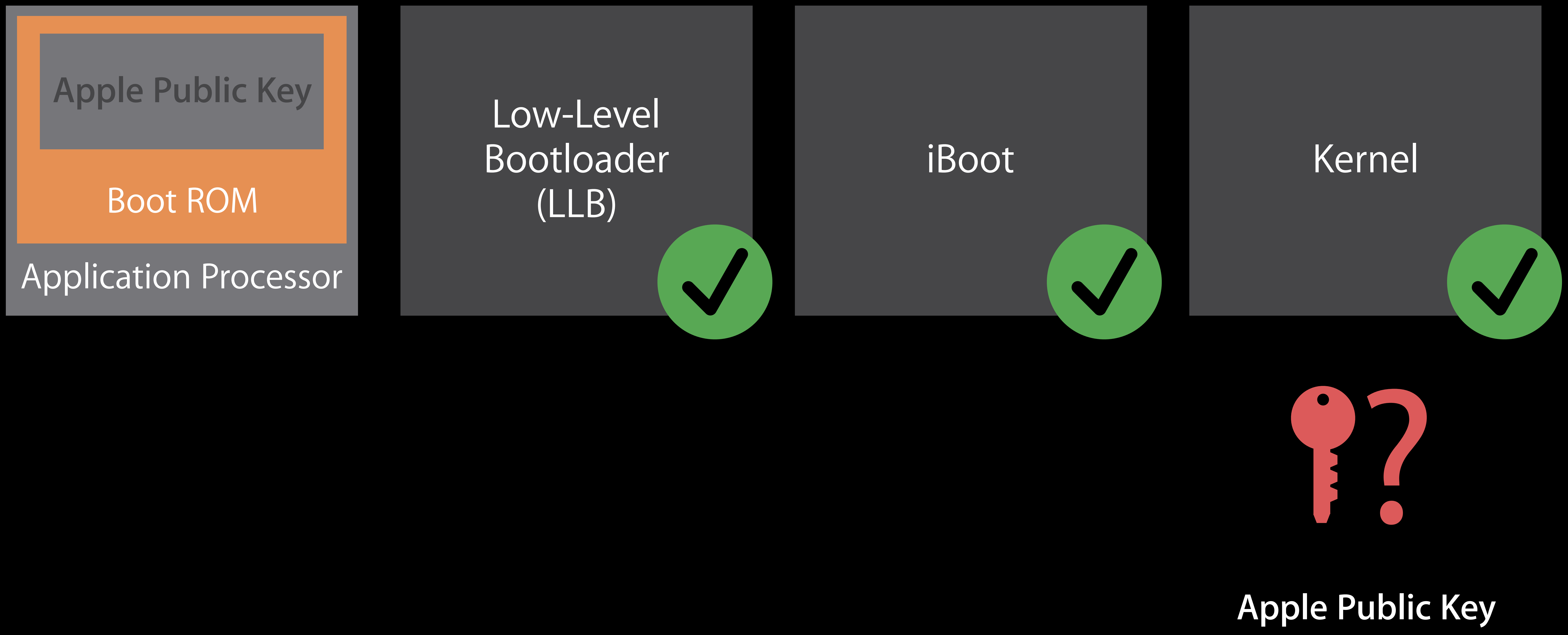
Application Processor

Low-Level Bootloader (LLB) ✓

iBoot ✓

Apple Public Key


Apple Public Key
Boot ROM
Application Processor
Low-Level Bootloader (LLB)
✓
iBoot
✓
Kernel
?
Apple Public Key



Apple Public Key

Boot ROM

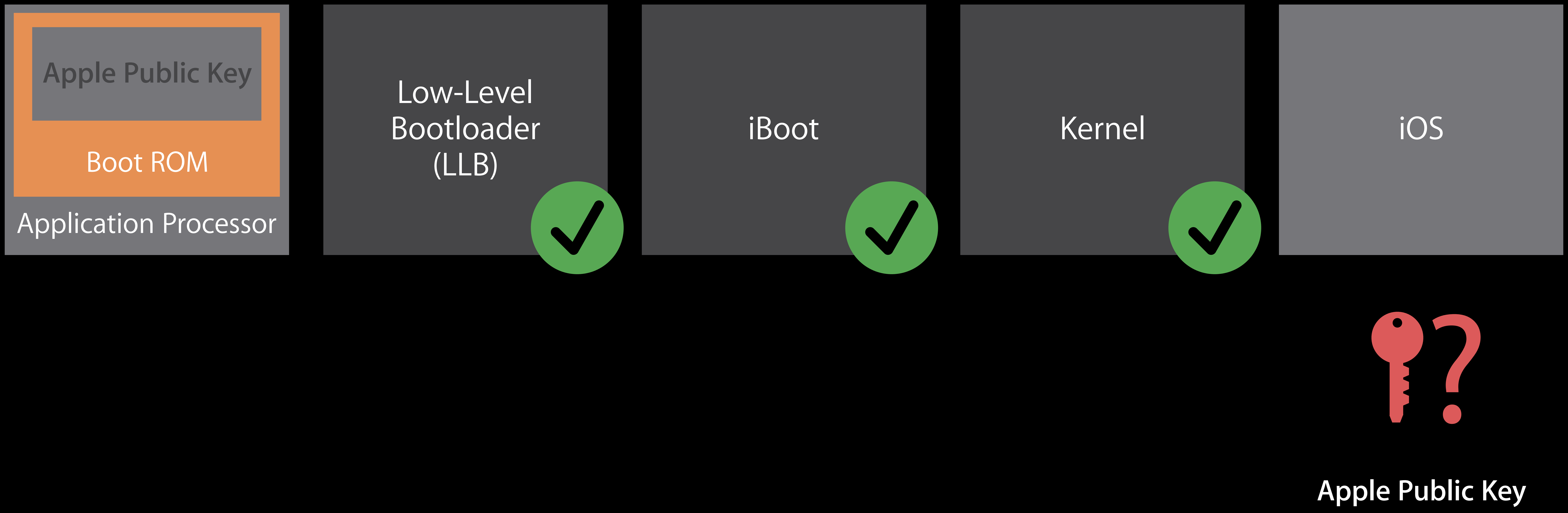
Application Processor

Low-Level Bootloader (LLB) ✓

iBoot ✓

Kernel ✓

Apple Public Key



Apple Public Key

Boot ROM

Application Processor

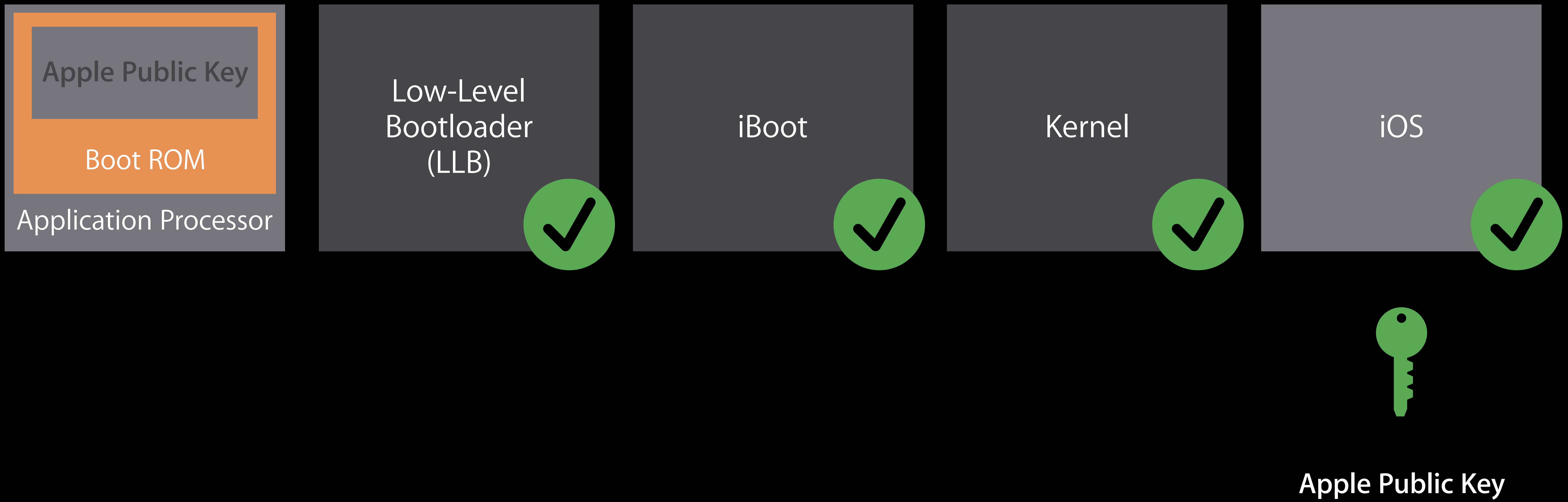
Low-Level Bootloader (LLB) ✓

iBoot ✓

Kernel ✓

iOS

Apple Public Key


Apple Public Key

Boot ROM

Application Processor

Low-Level Bootloader (LLB) ✓

iBoot ✓

Kernel ✓

iOS ✓

Apple Public Key

# Trusting Secure Boot

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Keys are securely provisioned and managed by Apple

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Keys are securely provisioned and managed by Apple

Software updates are authorized individually for each device

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2. Data Protection
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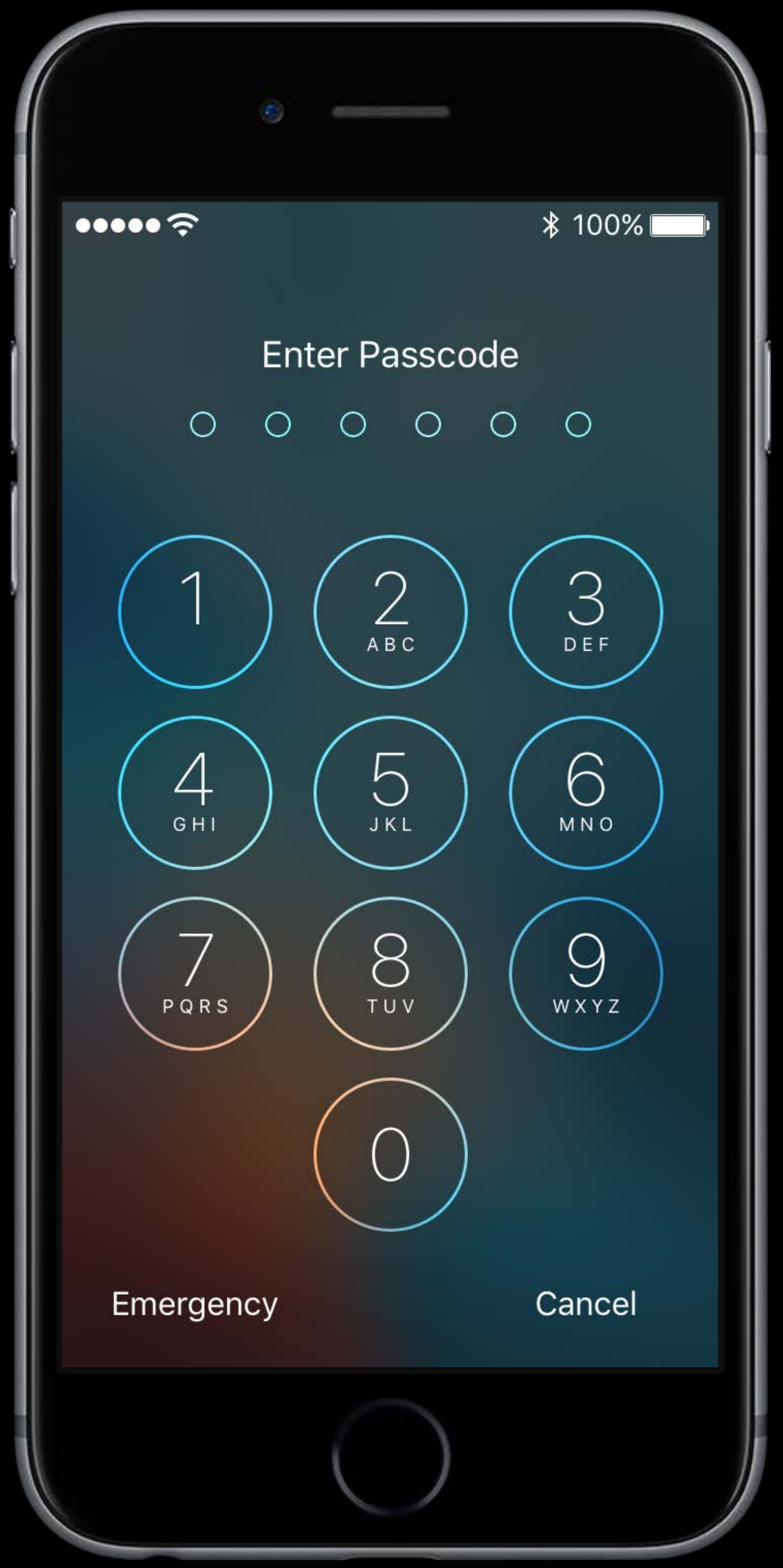
# Data Protection



# Data Protection

User data is encrypted at rest with keys derived from the passcode

# Data Protection

User data is encrypted at rest with keys derived from the passcode

Entangled with hardware key in SEP

# Data Protection

# Data Protection

SEP refuses to unlock after more than 10 incorrect passcode attempts

# Data Protection

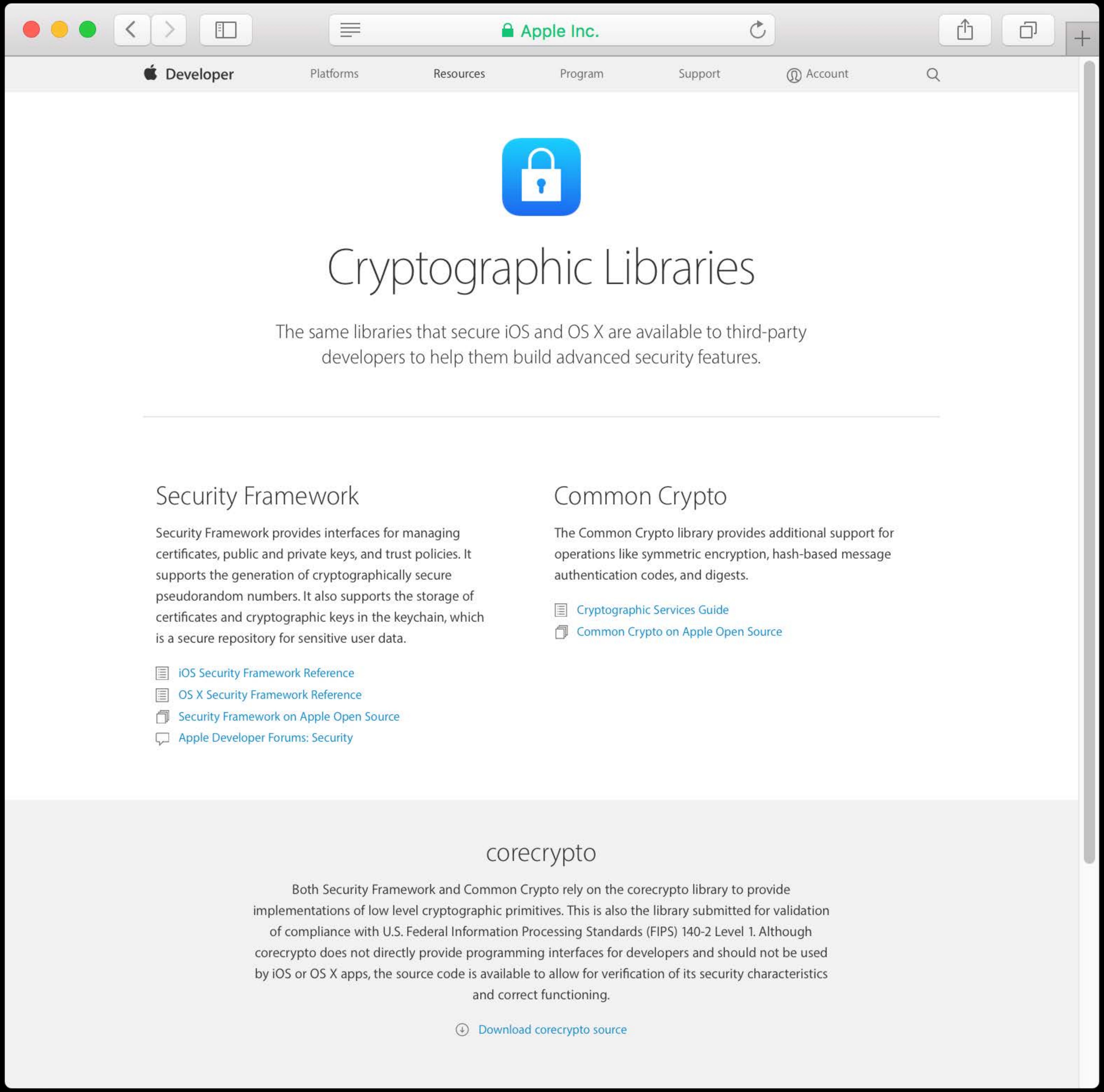
SEP refuses to unlock after more than 10 incorrect passcode attempts

‘Erase Data’ only controls erasure, not ability to unlock

Standard algorithms

Internal security audits

3rd-party code review



# Cryptographic Libraries

The same libraries that secure iOS and OS X are available to third-party developers to help them build advanced security features.

## Security Framework

Security Framework provides interfaces for managing certificates, public and private keys, and trust policies. It supports the generation of cryptographically secure pseudorandom numbers. It also supports the storage of certificates and cryptographic keys in the keychain, which is a secure repository for sensitive user data.

- iOS Security Framework Reference
- OS X Security Framework Reference
- Security Framework on Apple Open Source
- Apple Developer Forums: Security

## Common Crypto

The Common Crypto library provides additional support for operations like symmetric encryption, hash-based message authentication codes, and digests.

- Cryptographic Services Guide
- Common Crypto on Apple Open Source

## corecrypto

Both Security Framework and Common Crypto rely on the corecrypto library to provide implementations of low level cryptographic primitives. This is also the library submitted for validation of compliance with U.S. Federal Information Processing Standards (FIPS) 140-2 Level 1. Although corecrypto does not directly provide programming interfaces for developers and should not be used by iOS or OS X apps, the source code is available to allow for verification of its security characteristics and correct functioning.

Download corecrypto source

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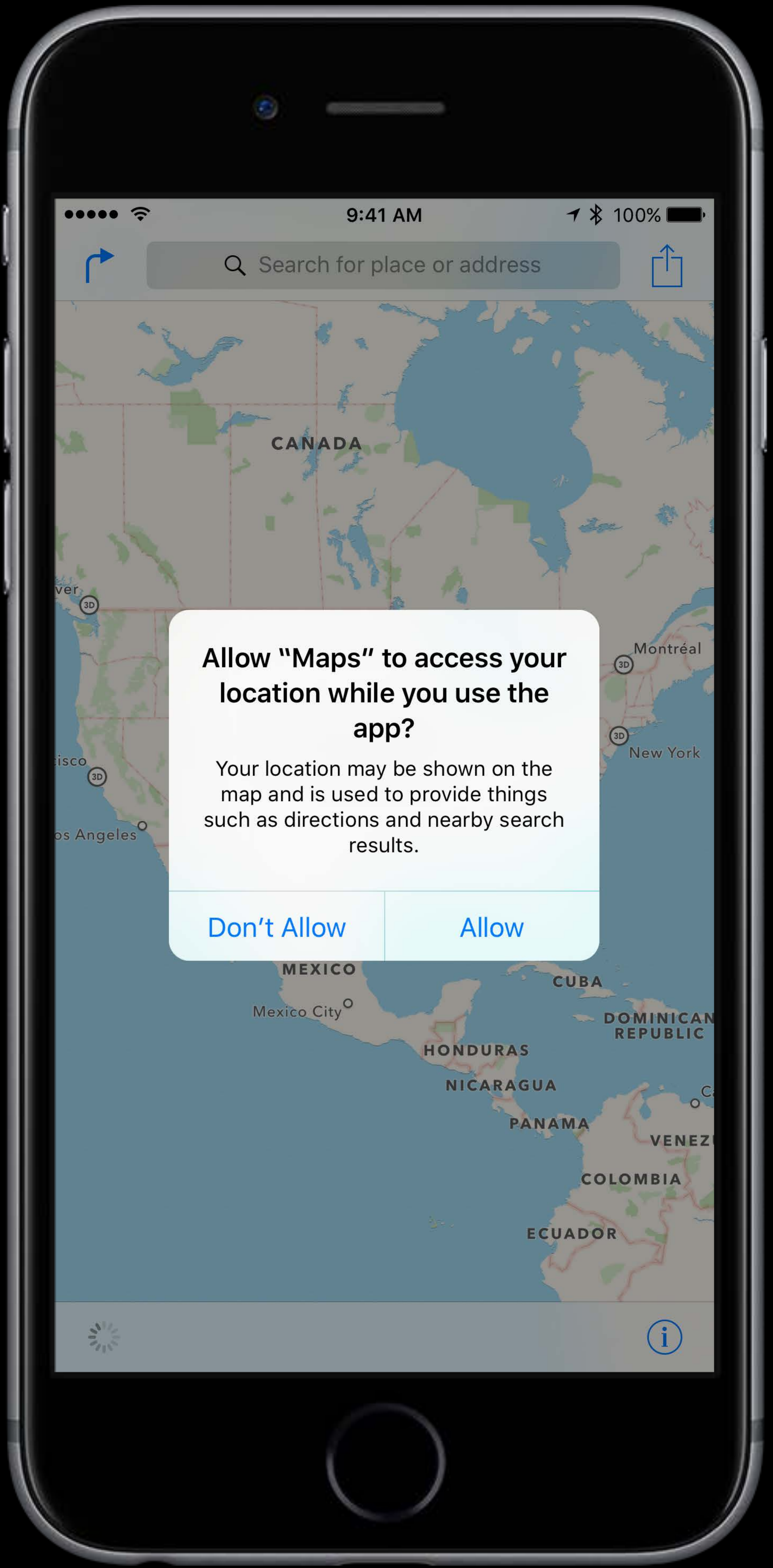
Isolating data between apps



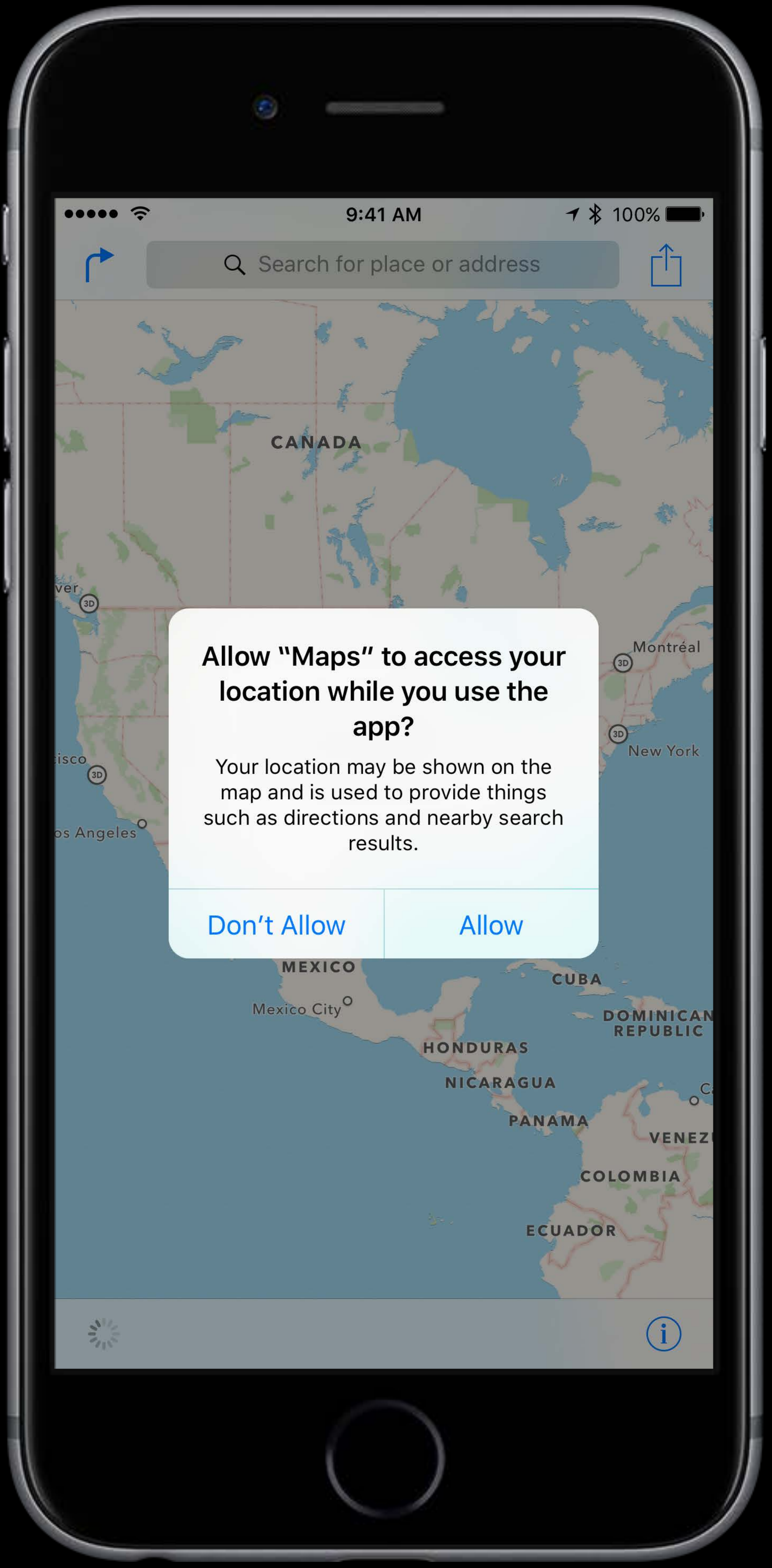
**Allow "Maps" to access your location while you use the app?**

Your location may be shown on the map and is used to provide things such as directions and nearby search results.

Transparency

Consent

Control



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4. **Code Signing**
5. Touch ID

# Code Signing

# Code Signing

Attacker's first step: code execution

iOS code signing covers not just the OS, but every app that runs

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# 80

Average user unlocks per day

Easy

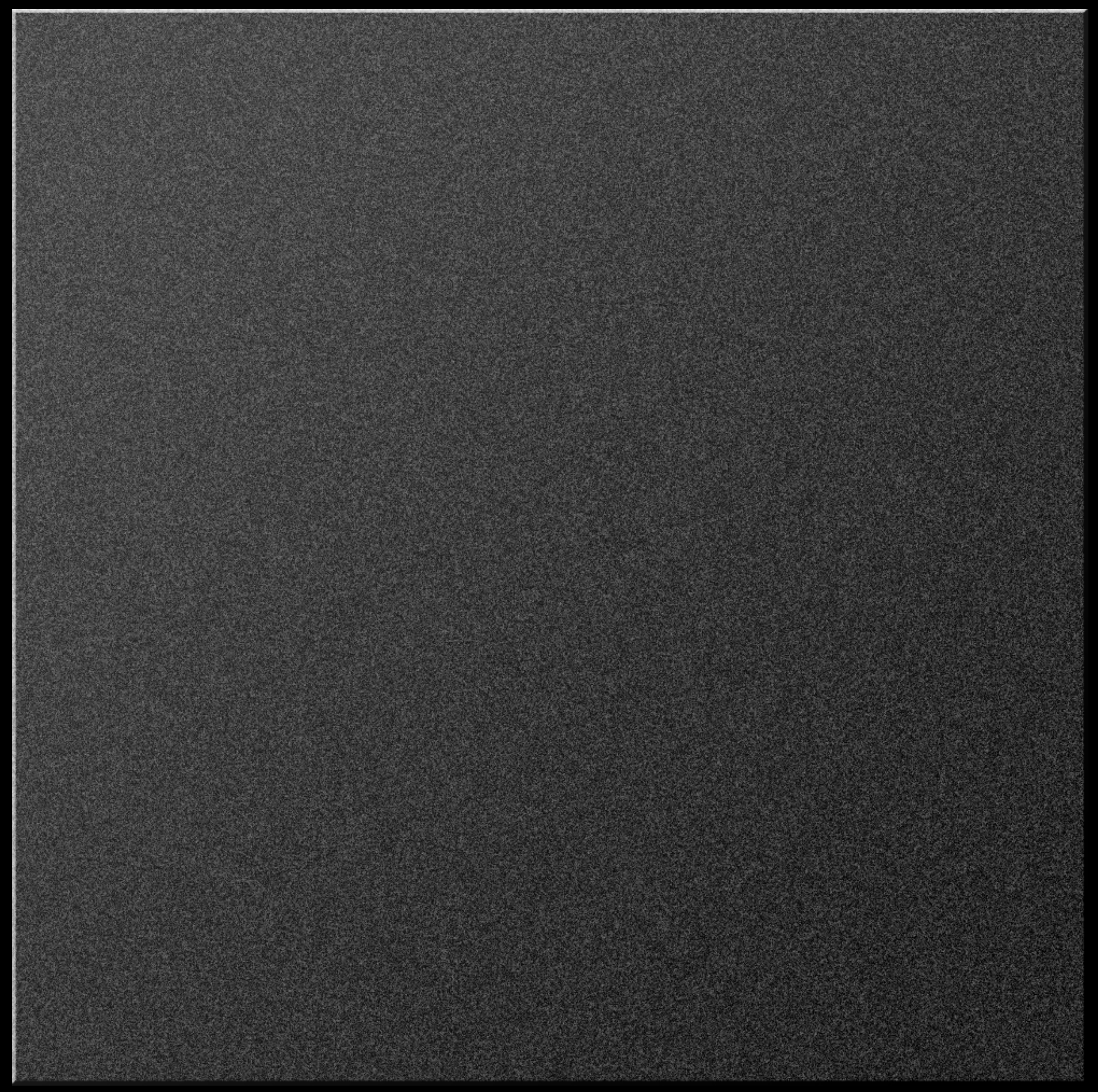
Fast

Protects user data

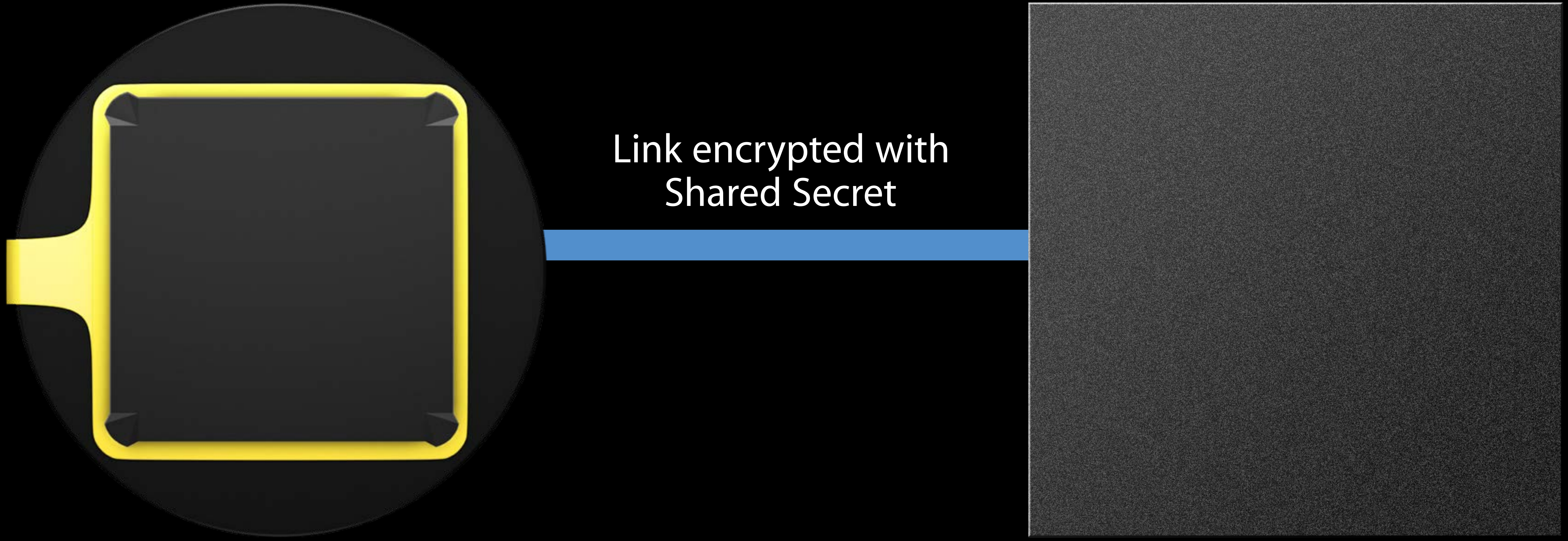
# Touch ID

Sensor

Secure Enclave



# Touch ID

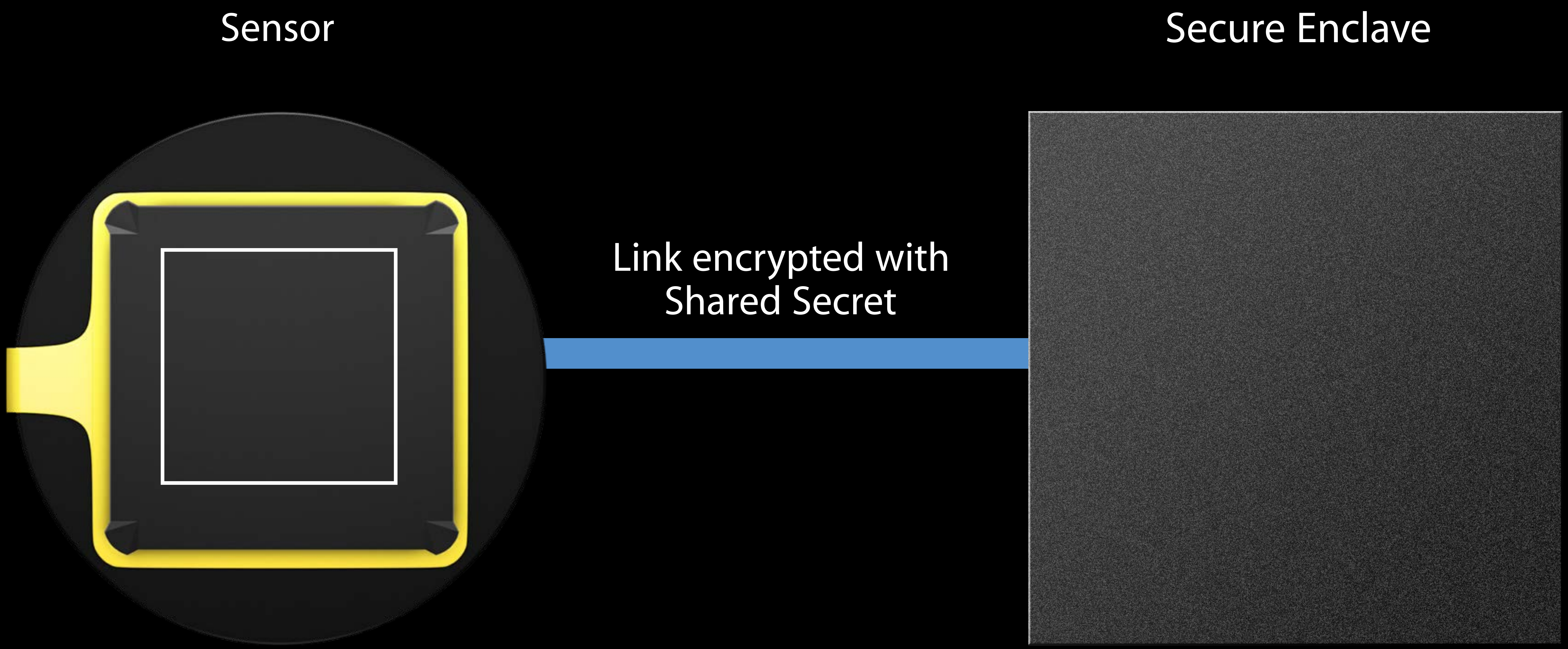


Sensor

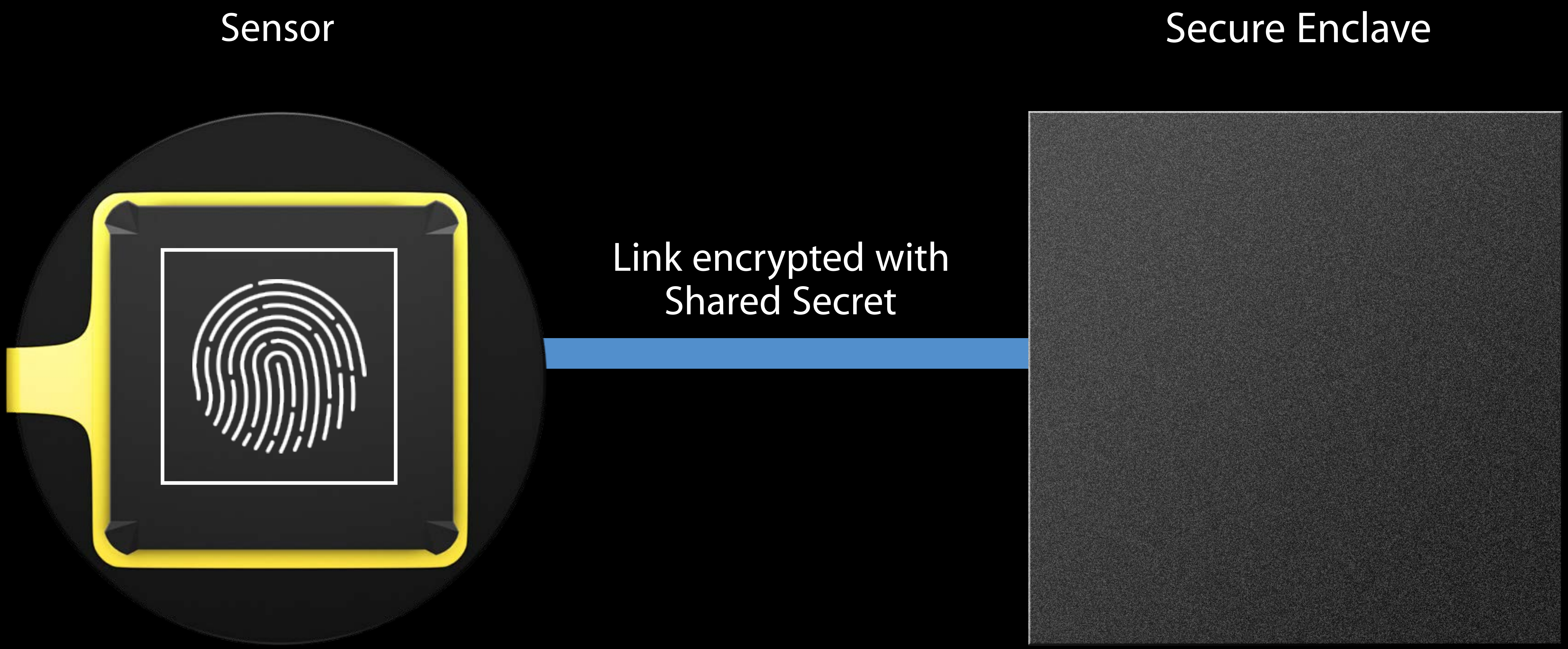
Secure Enclave

Link encrypted with Shared Secret

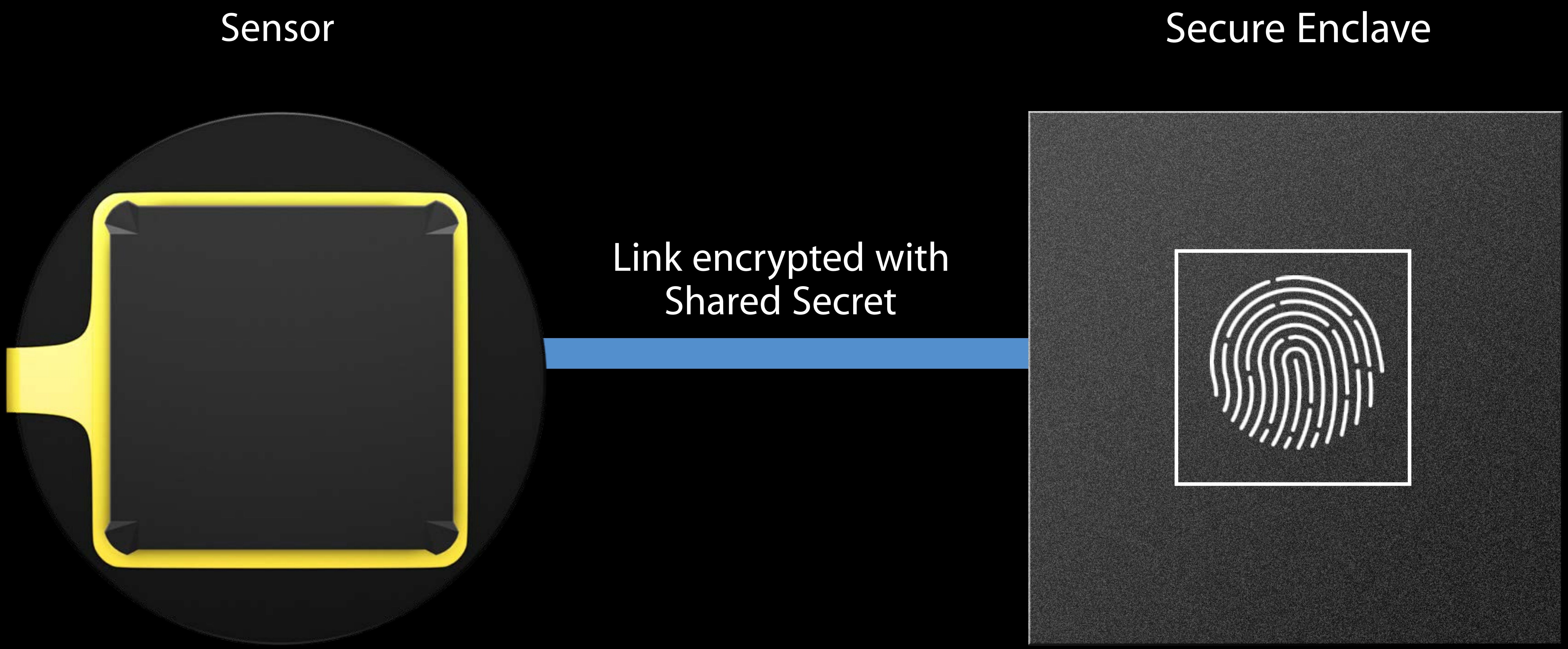
# Touch ID



# Touch ID



# Touch ID

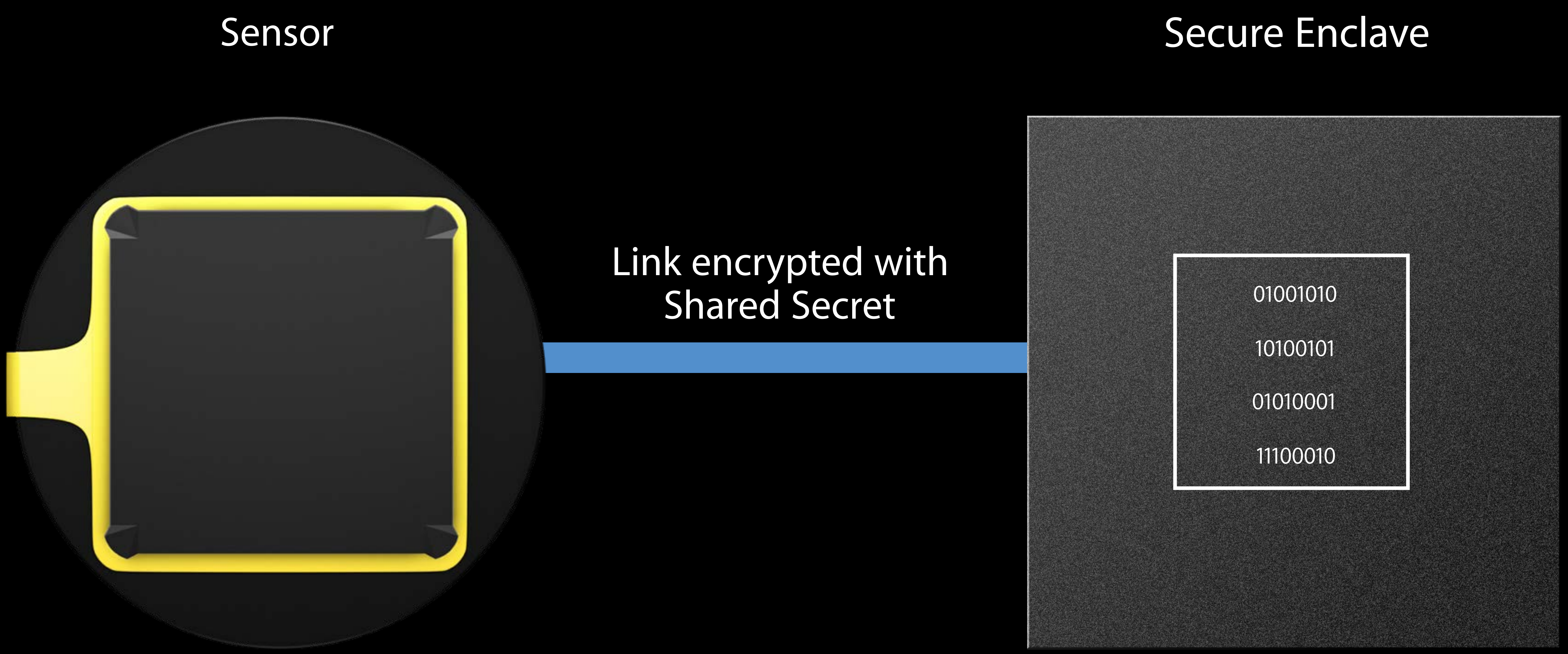


Sensor

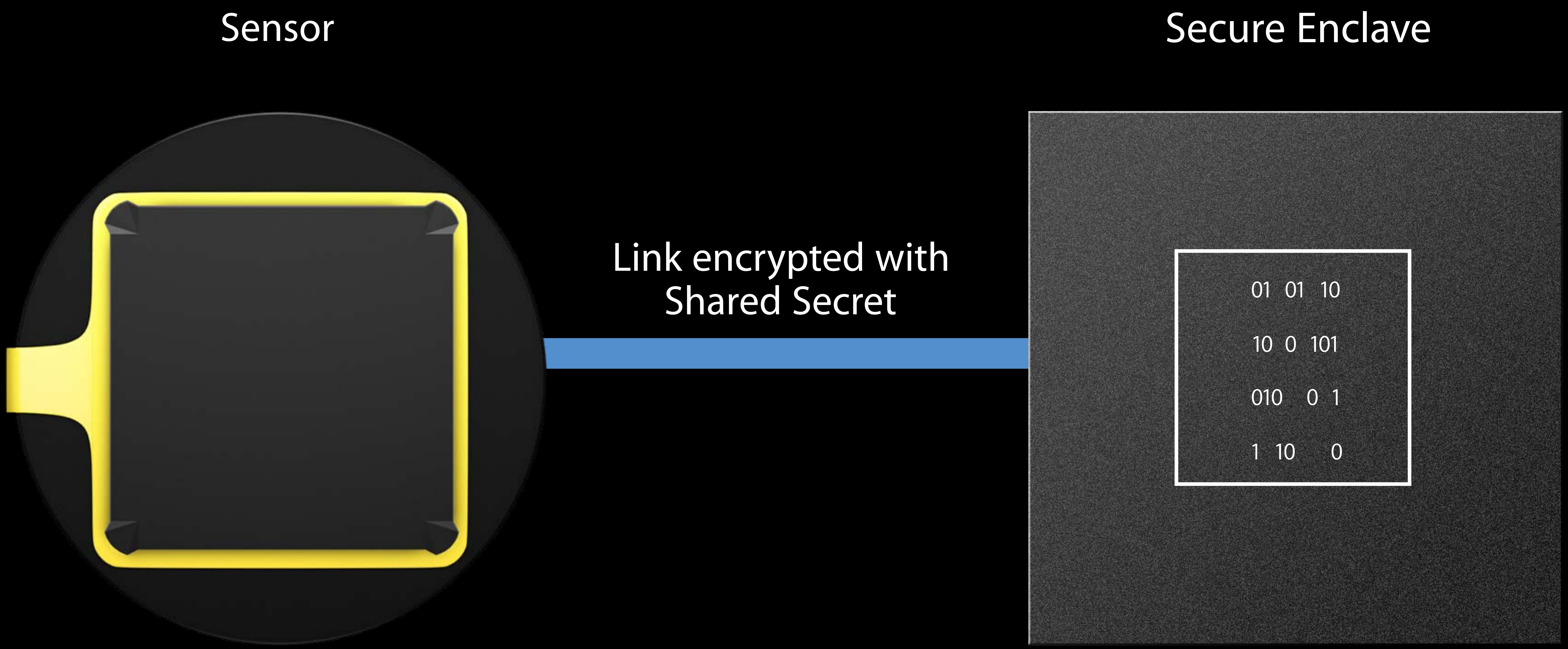
Secure Enclave

Link encrypted with Shared Secret

# Touch ID


Sensor
Secure Enclave
Link encrypted with Shared Secret
01001010
10100101
01010001
11100010

# Touch ID

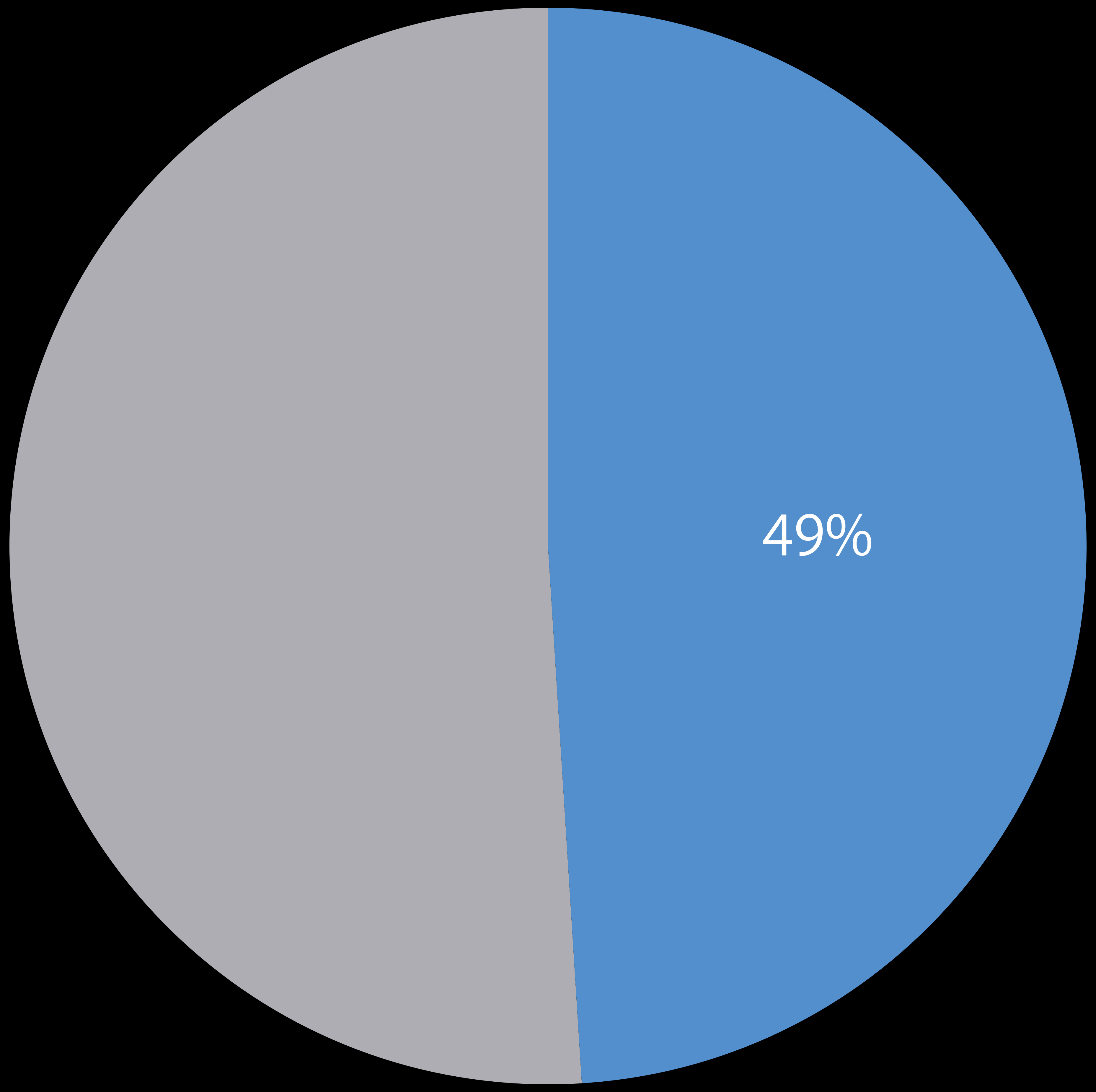


Sensor

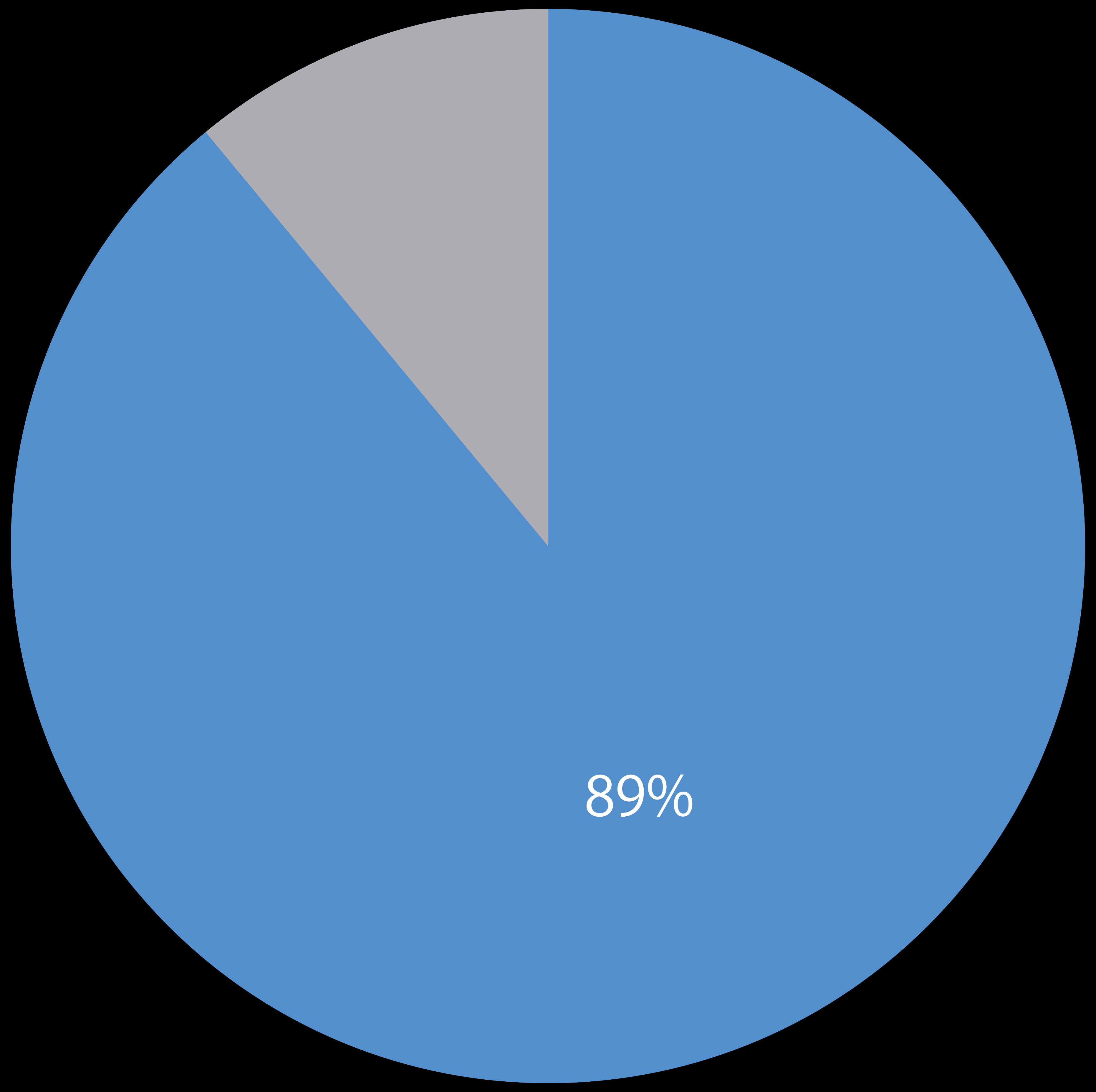
Link encrypted with Shared Secret

Secure Enclave

# Passcode usage before Touch ID



# Passcode usage after Touch ID



iOS Platform Security

Users Upgrading their Software

Developers Building Secure Apps

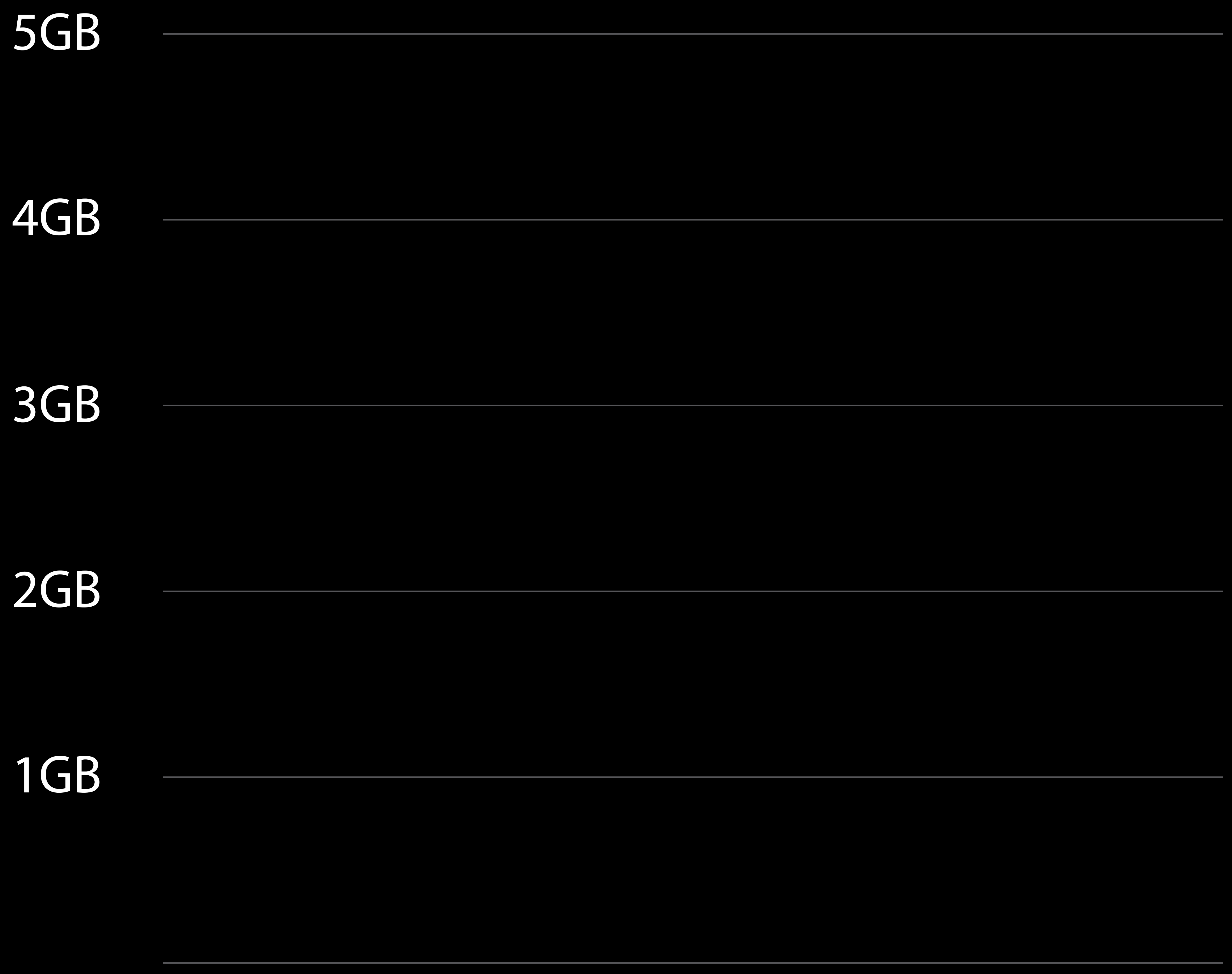
iOS Platform Security

Users Upgrading their Software

Developers Building Secure Apps

1

# Smaller install footprint



# Smaller install footprint

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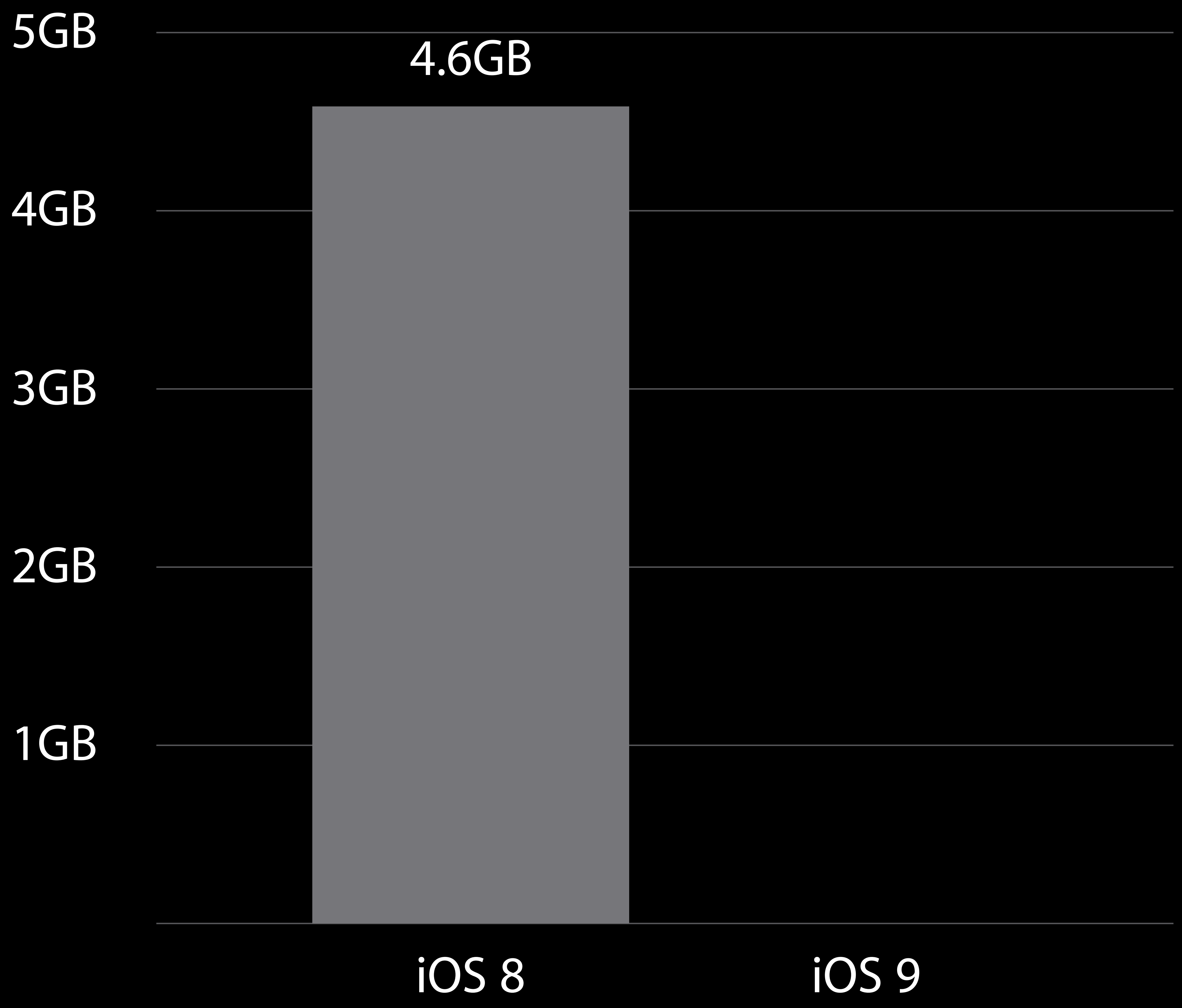
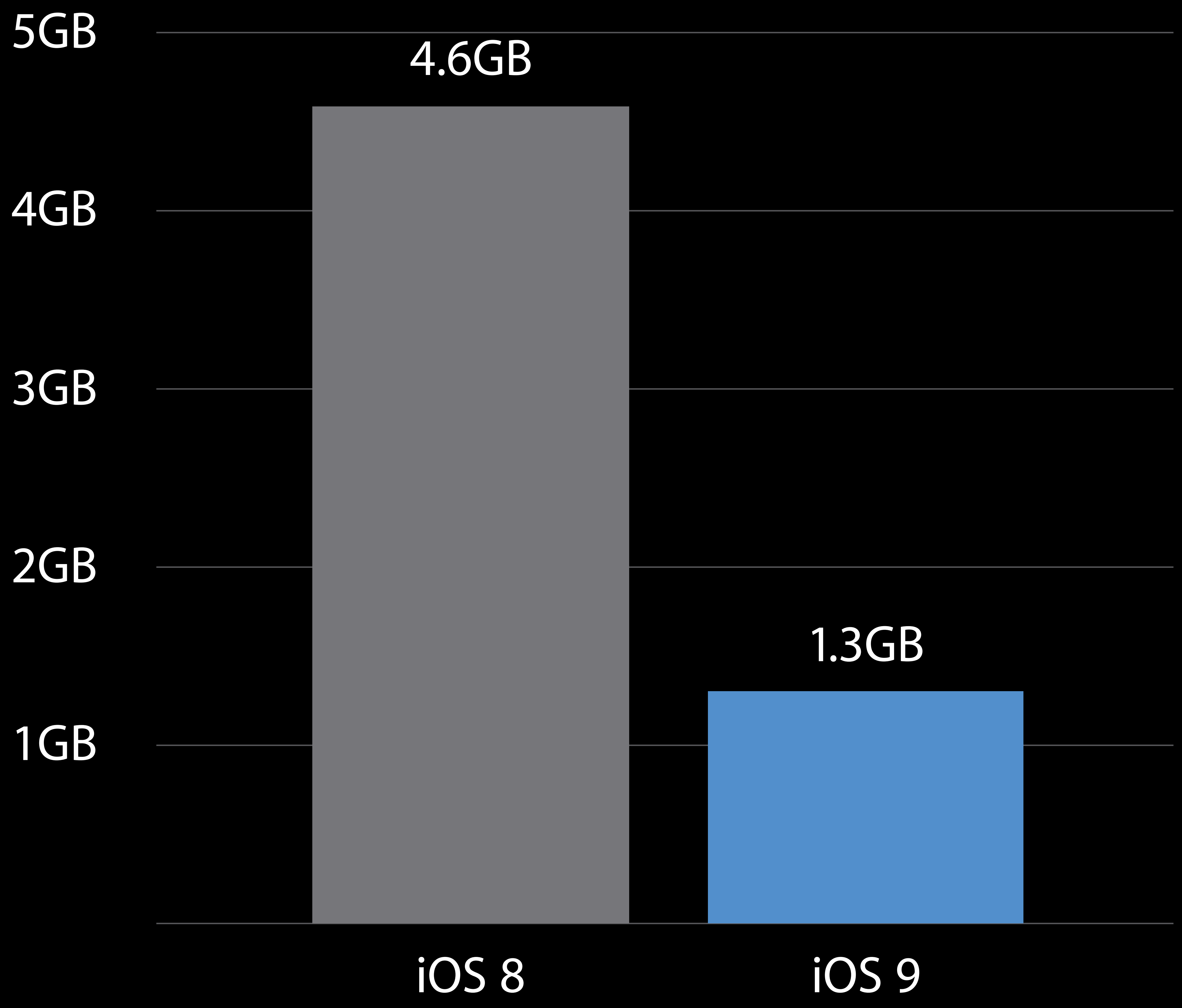
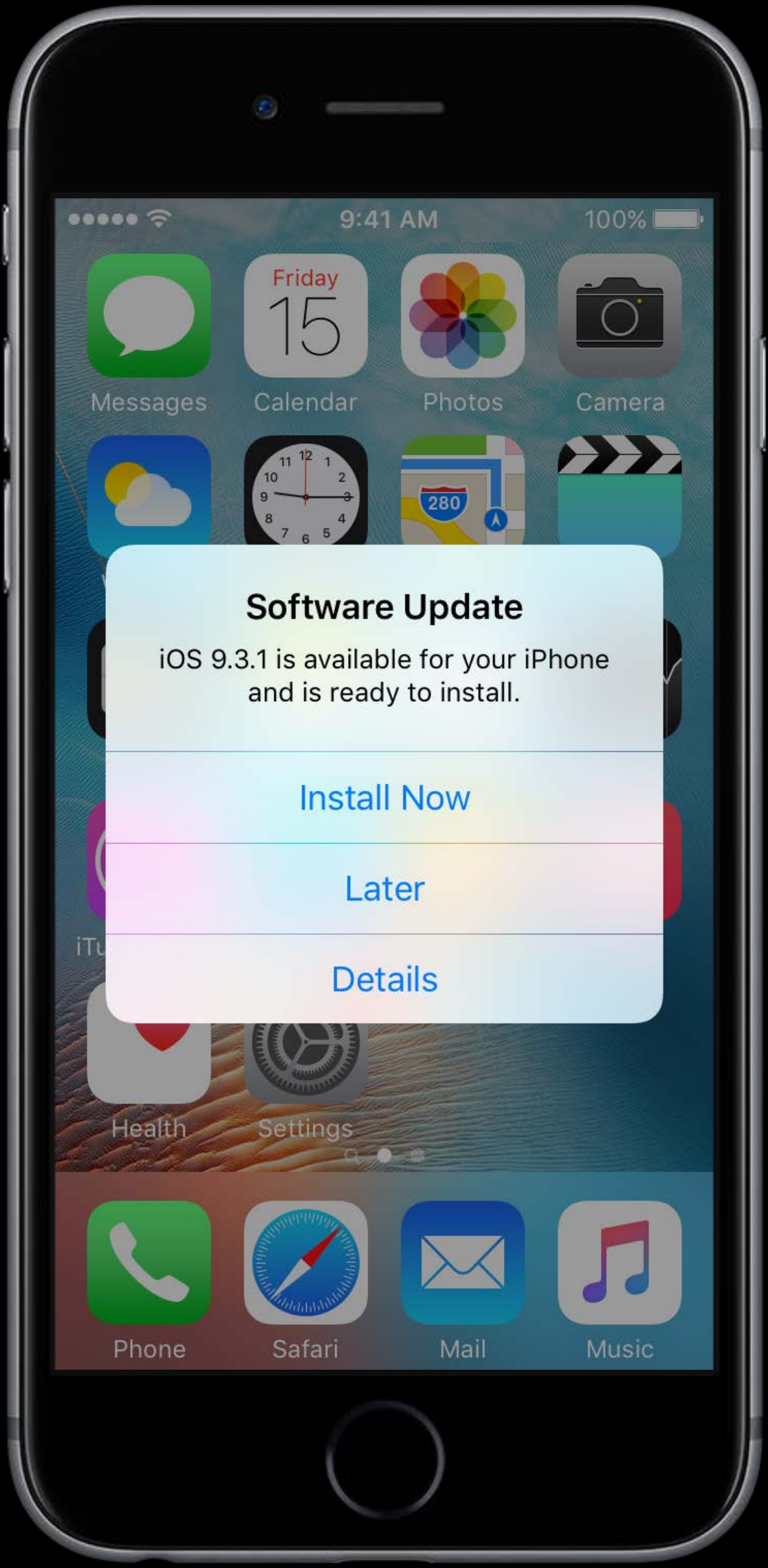


# Smaller install footprint

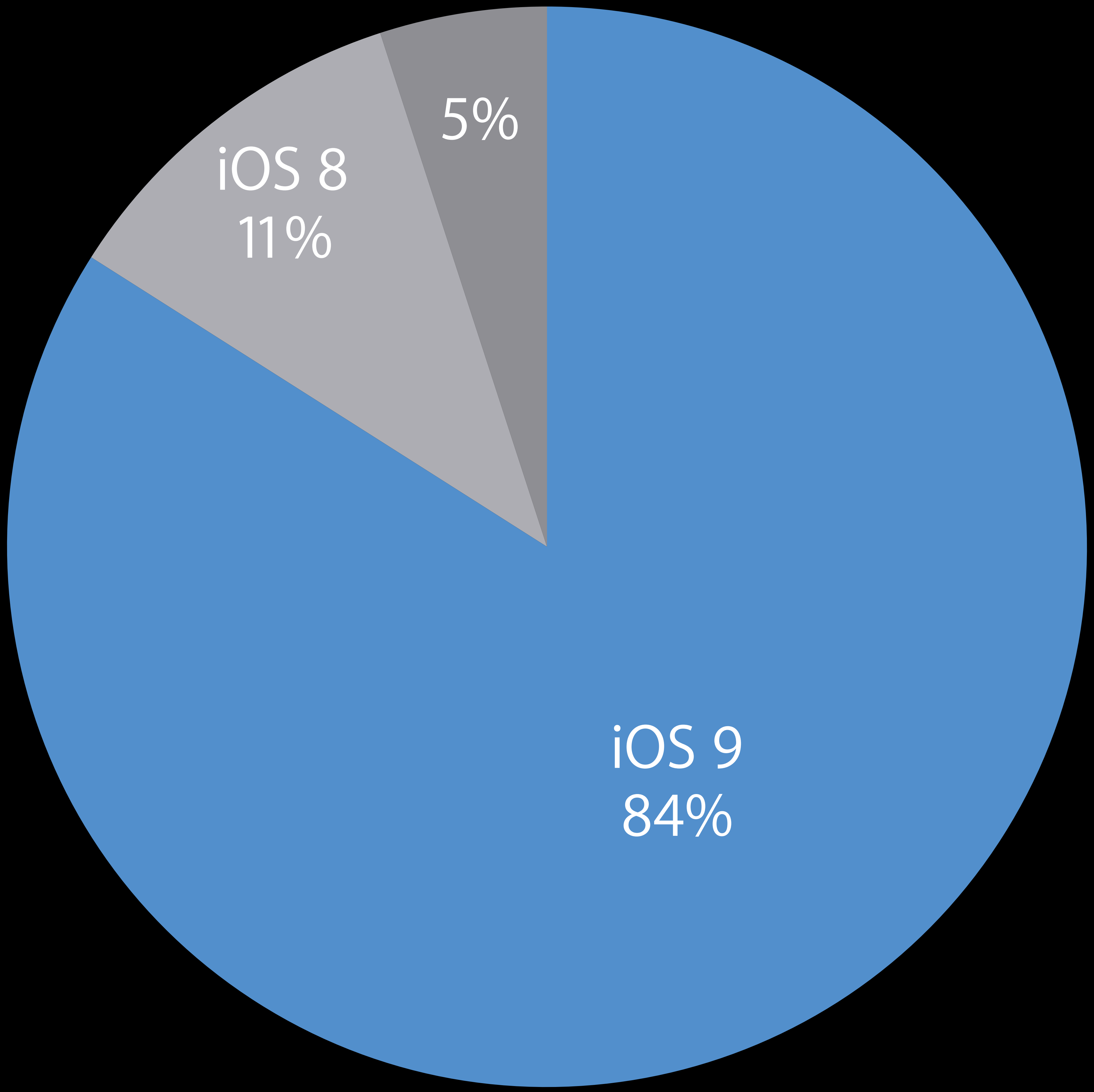




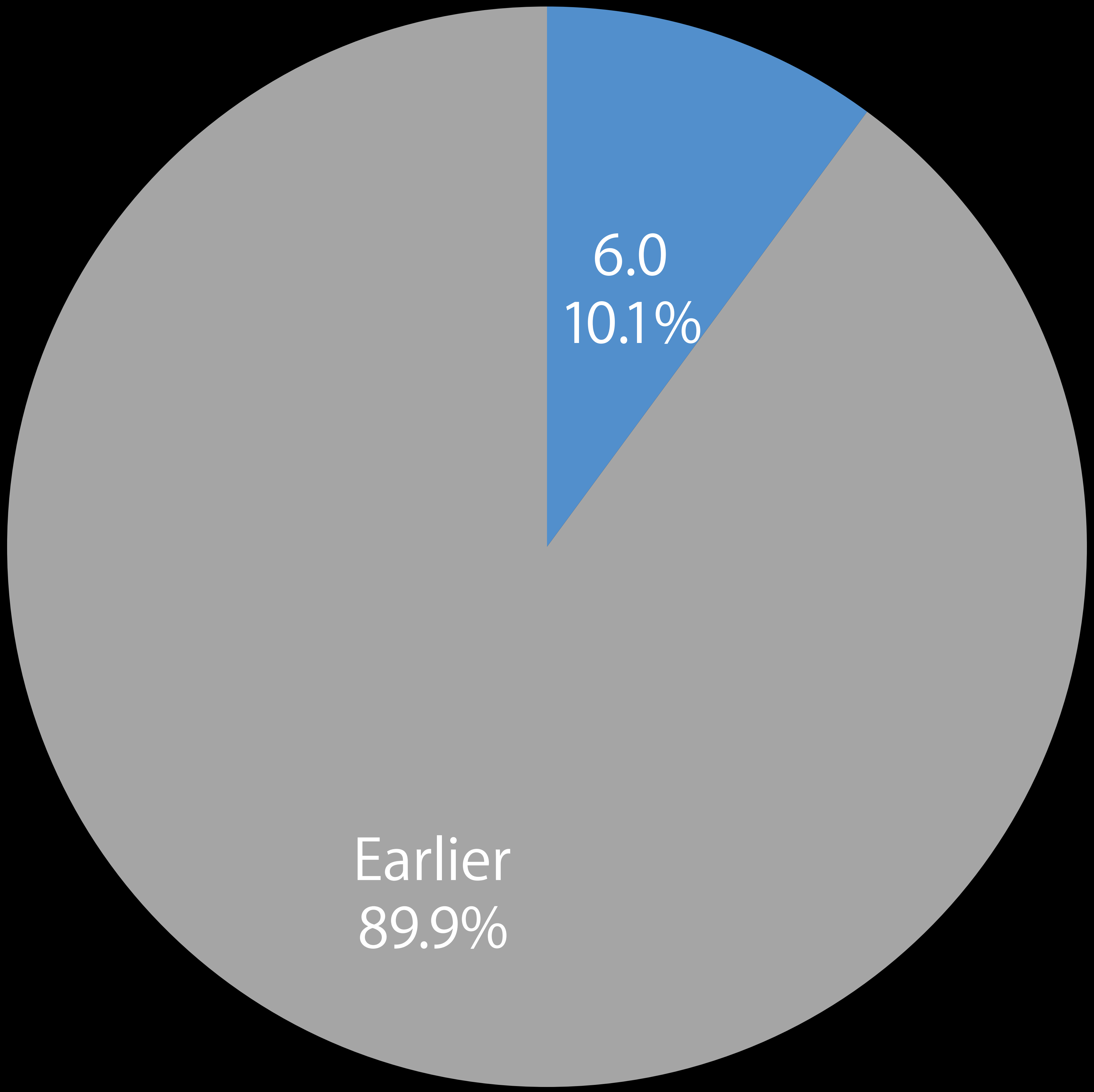
Software Update

iOS 9.3.1 is available for your iPhone and is ready to install.

# iOS Installed Base



# Android Installed Base



iOS Platform Security

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Users Upgrading their Software

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# Follow Best Practices

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Touch ID

App Transport Security

# Follow Best Practices

NEW

Touch ID

App Transport Security

- Required by App Store at end of 2016

# Follow Best Practices

NEW

Touch ID

App Transport Security

- Required by App Store at end of 2016
- TLS v1.2, with exceptions for already-encrypted bulk data like media streaming

# Know Your Code

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You are responsible for third-party code you include in your apps

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Libraries you use may undermine app security

# Know Your Code

You are responsible for third-party code you include in your apps

Libraries you use may undermine app security

Keep them current!

iOS Platform Security

Users Upgrading their Software

Developers Building Secure Apps

iOS Platform Security

Users Upgrading their Software

Developers Building Secure Apps

# How well are we doing?

No iOS malware at scale

5-10 vulnerabilities

$1 million

Security is a process,
not a destination

## More Information

https://developer.apple.com/wwdc16/705

# Related Sessions

| | | |
|---|---|---|
| What's New in Security | Nob Hill | Tuesday 5:00PM |
| Engineering Privacy for Your Users | Pacific Heights | Wednesday 4:00PM |

# Labs

| | | |
|---|---|---|
| Security & Privacy Lab 1 | Frameworks Lab C | Wednesday 9:00AM |
| Security & Privacy Lab 2 | Frameworks Lab B | Thursday 9:00AM |

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