Developing CarPlay Systems, Part 1

Session 722

Emily Schubert Engineering Manager, Car Experience

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CarPlay

Smarter, safer way to use your iPhone in the car

CarPlay

Smarter, safer way to use your iPhone in the car

Familiar

CarPlay

Smarter, safer way to use your iPhone in the car

Familiar

Integrated

CarPlay

Smarter, safer way to use your iPhone in the car

Familiar

Integrated

Future ready

In This Session

How CarPlay Works

Key Vehicle Requirements

Design Guidelines

Supported Apps

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

9:41

LTE

Phone

Music

Maps

Messages

Now Playing

Car Maker

Podcasts

Audiobooks

Touch

Knobs and Controls

Voice

How CarPlay Works

22°C
9:41
Phone
Radio
CD
Navi
Climate
Car
Settings

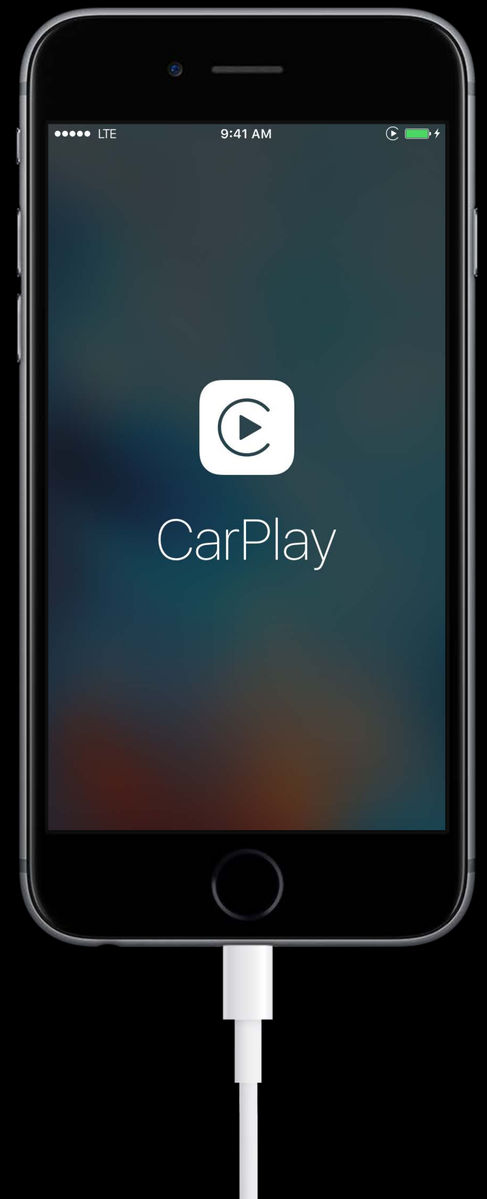
Car

iPhone

Car

22°C
9:41
Phone
Radio
CD
Navi
Climate
Car
Settings
Apple CarPlay

iPhone


LTE
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CarPlay

Car

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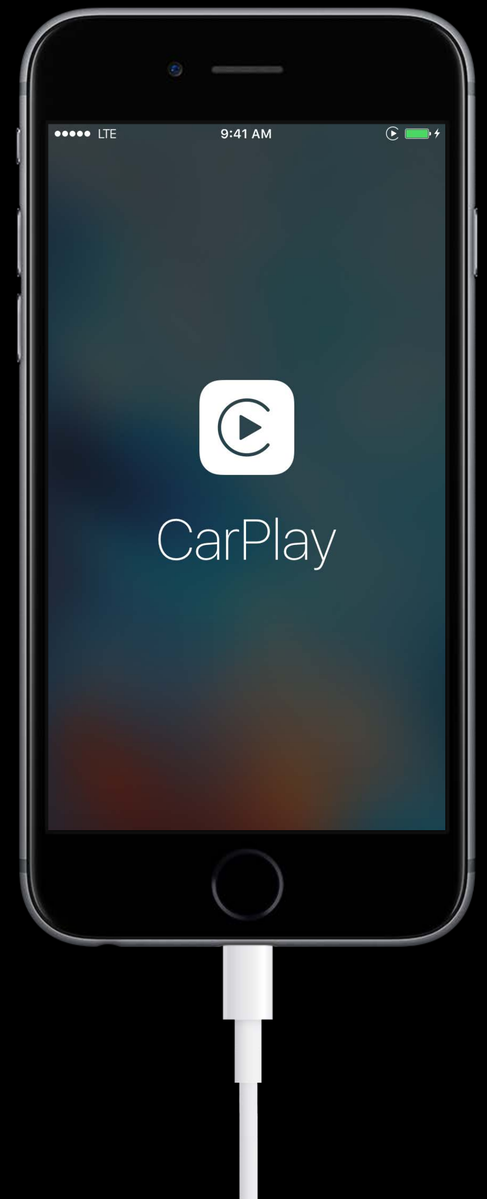
Climate
Car
Settings
Apple CarPlay

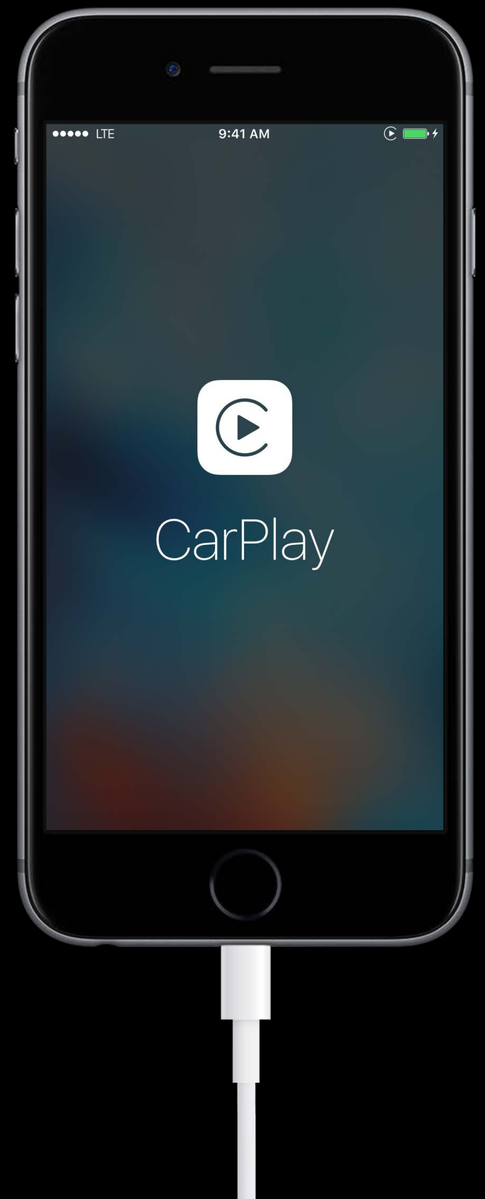
iPhone


LTE
9:41 AM
CarPlay

Car

iPhone

Communication
Protocols



Car

iPhone

Communication Protocols

Video

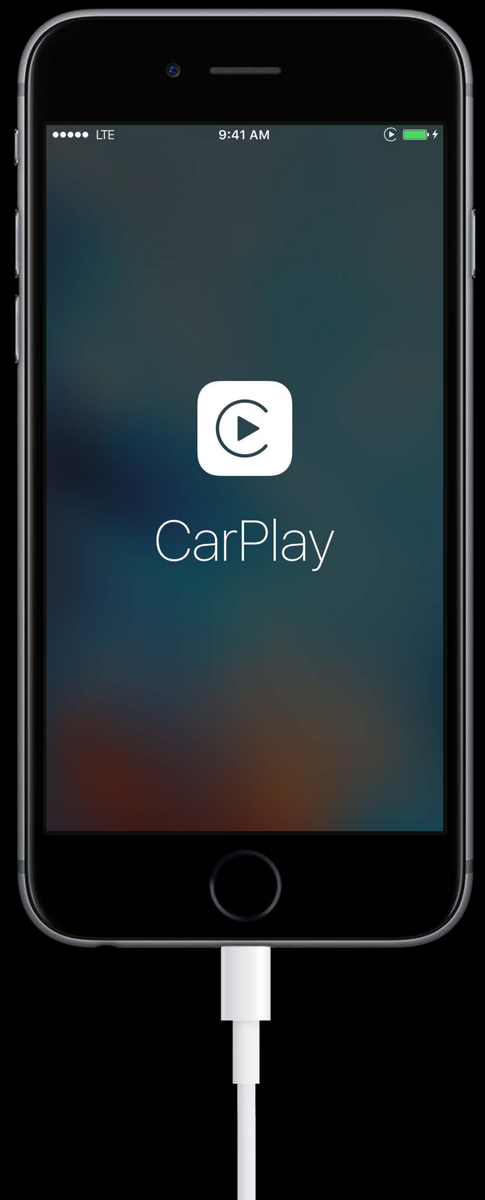
Car

iPhone

Communication Protocols

Video

Audio



Car

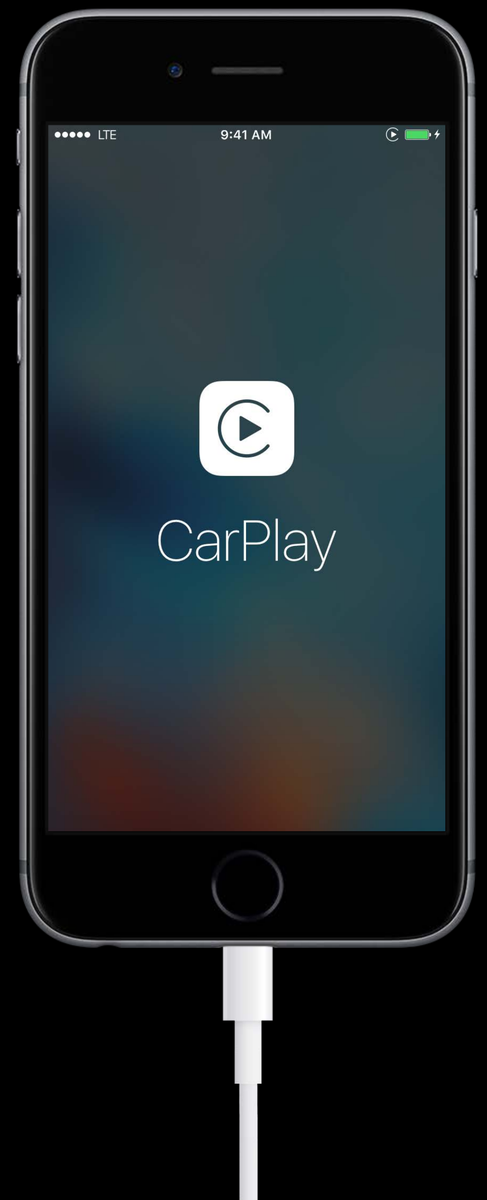
iPhone

Communication Protocols

Video

Audio

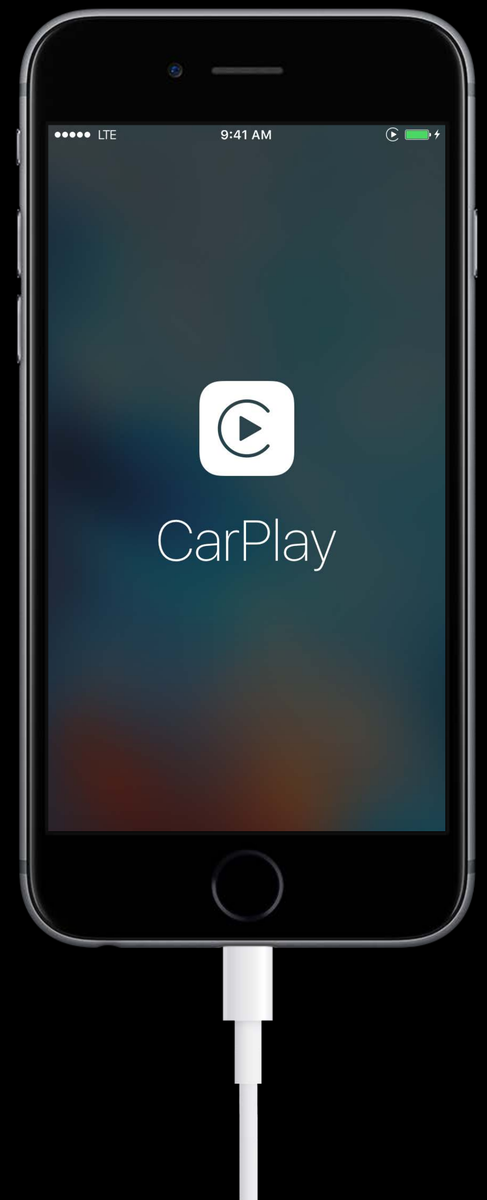
Audio



Car

iPhone

9:41
LTE
Phone
Music
Maps
Messages
Now Playing
Car Maker
Podcasts
Audiobooks


LTE
9:41 AM
CarPlay

Car

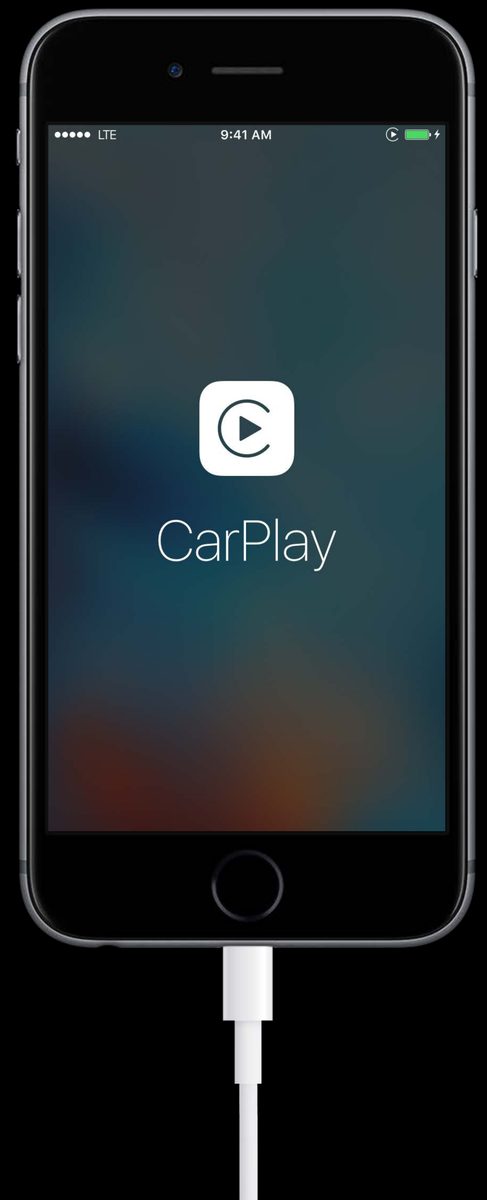
iPhone

Communication Protocols

Video

Audio

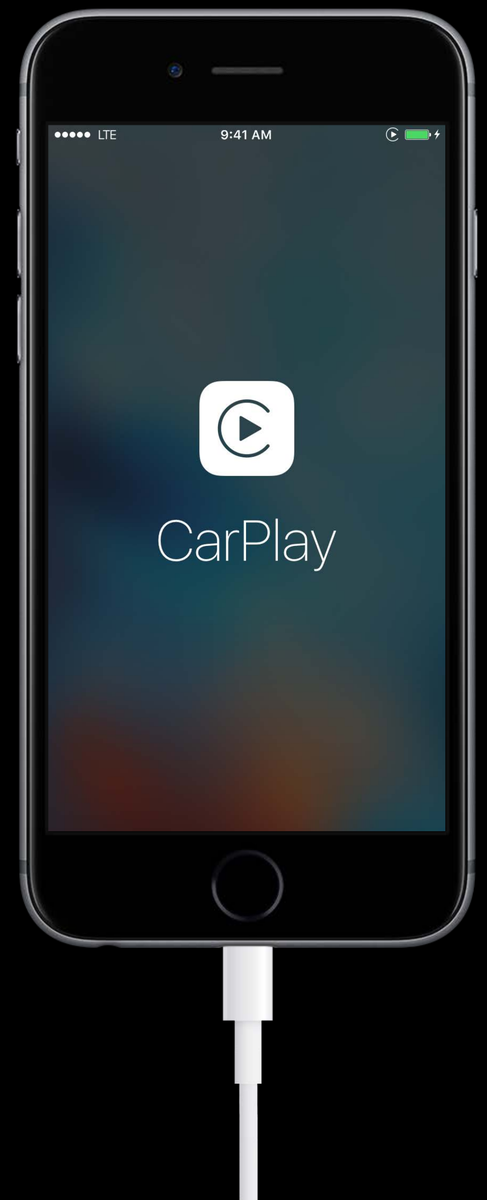
Audio



Car

Back
3 of 13
Jackie and Wilson
Hozier - Hozier
0:12
-3:31
9:41
LTE

iPhone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9:41 AM
CarPlay

Car

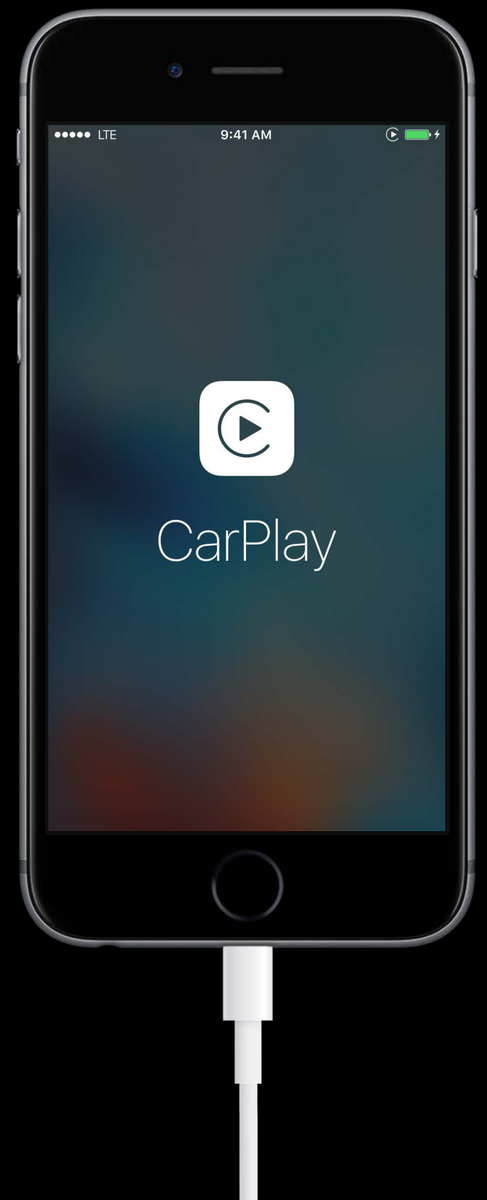
iPhone

Communication Protocols

Video

Audio

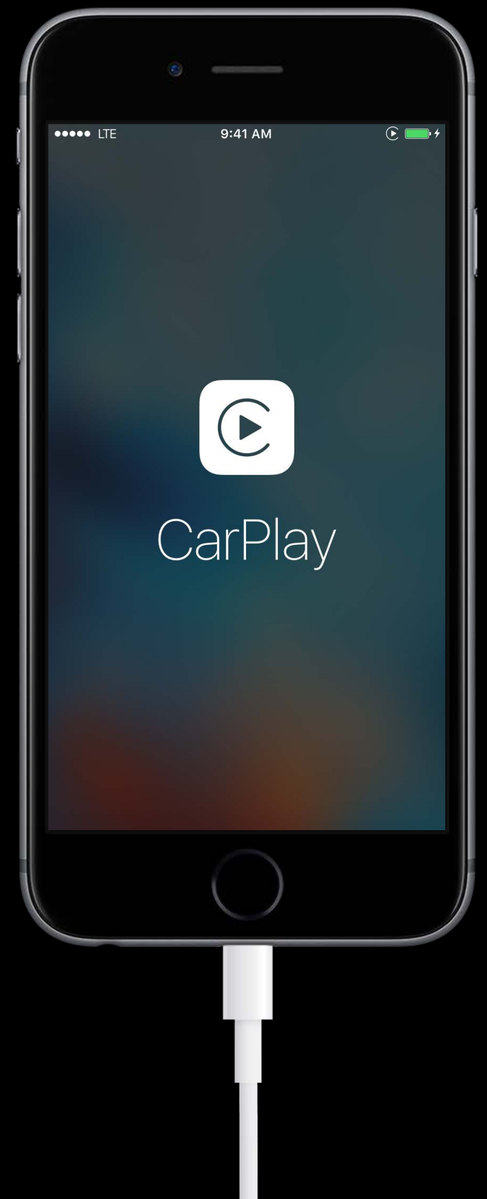
Audio



Car

22°C
9:41
Phone
Radio
CD
Navi
Climate
Car
Settings
Apple CarPlay

iPhone


LTE
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CarPlay

Car

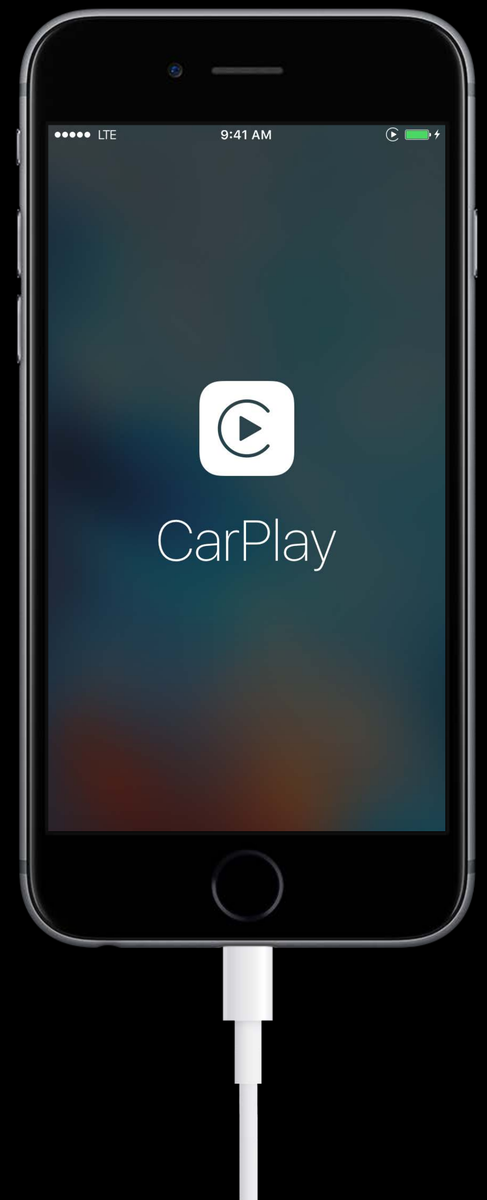
iPhone

Communication Protocols

Video

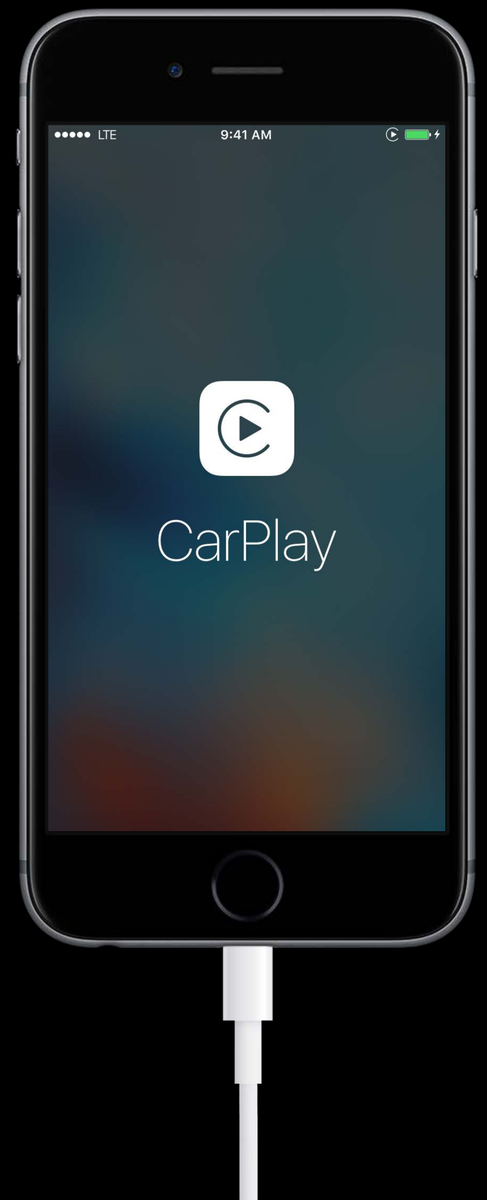
Audio

Audio



Car

iPhone



Car

iPhone

Communication
Protocols

Video

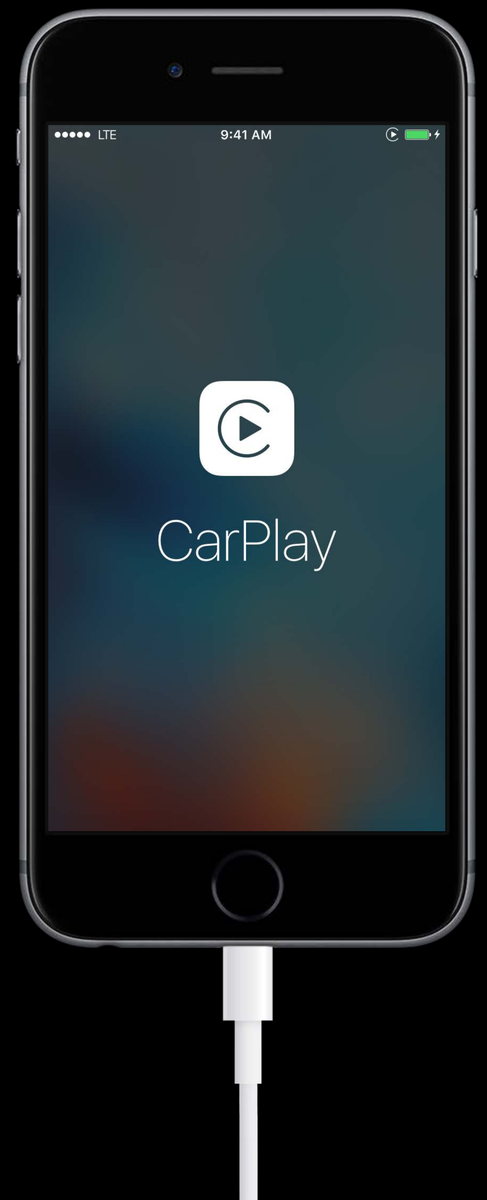
Audio

Audio

Car

iPhone

9:41
LTE
Phone
Music
Maps
Messages
Now Playing
Car Maker
Podcasts
Audiobooks


LTE
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CarPlay

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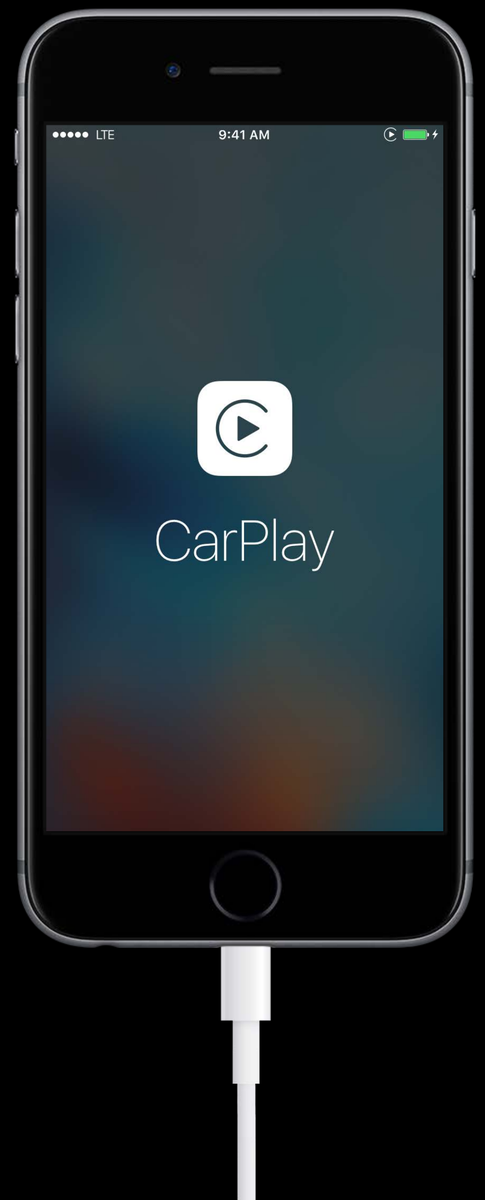
iPhone



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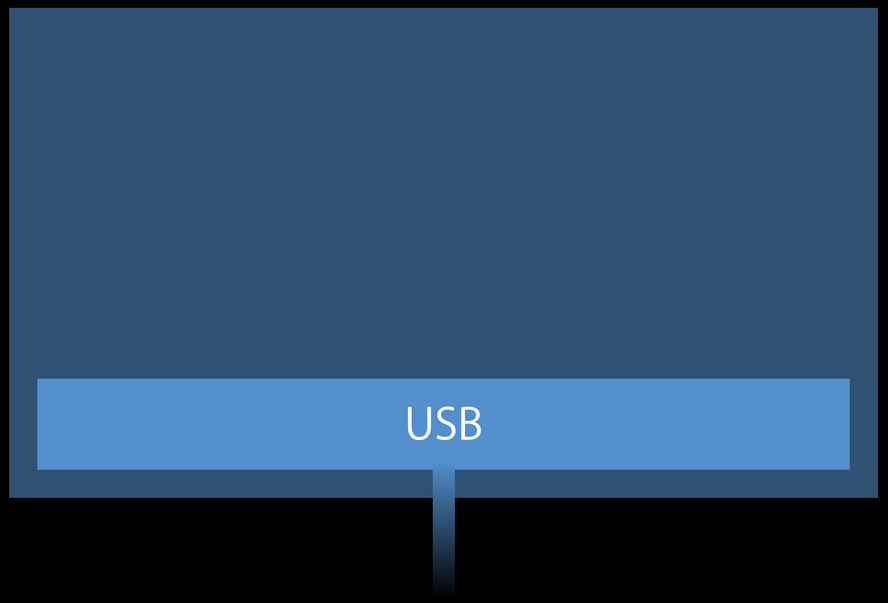
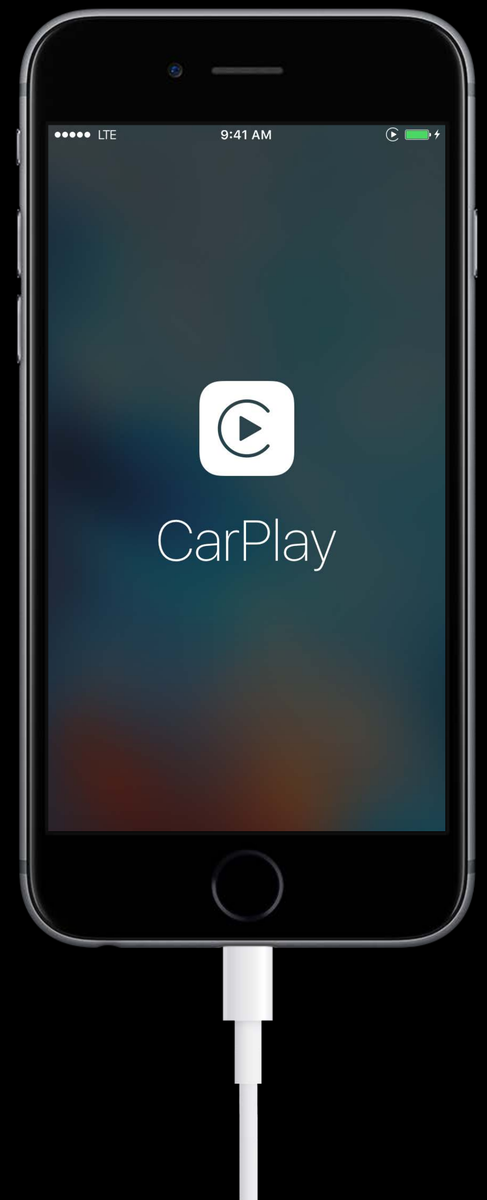


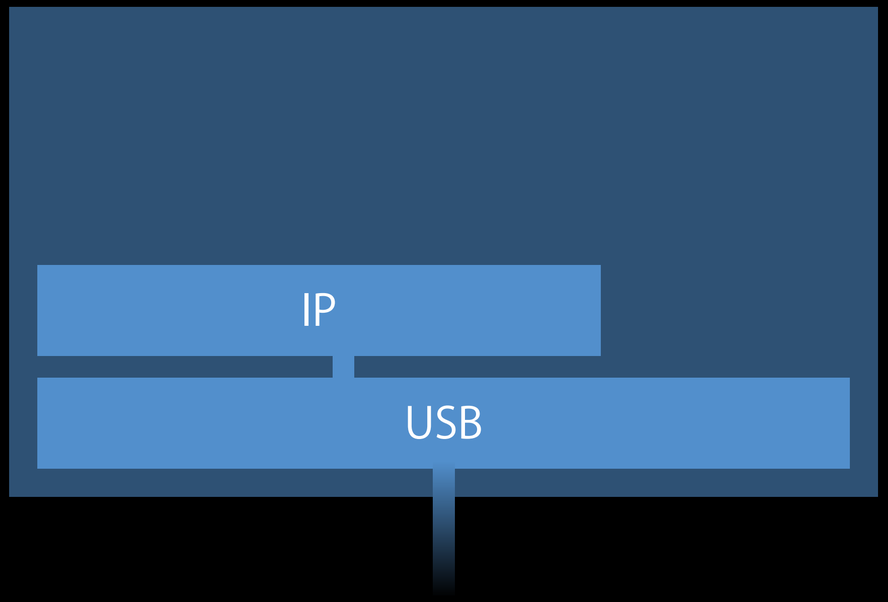
Wired Connection to iPhone

iPhone



Car

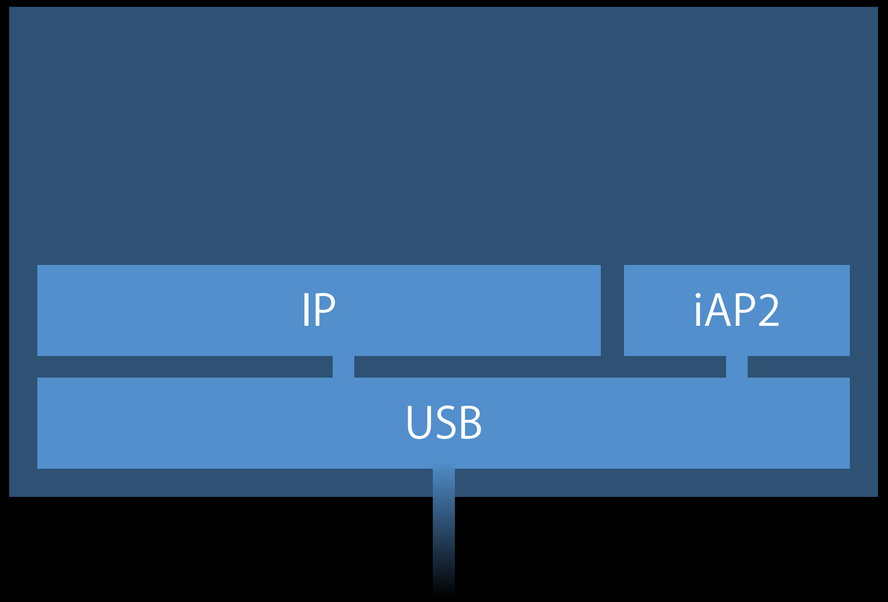
iPhone



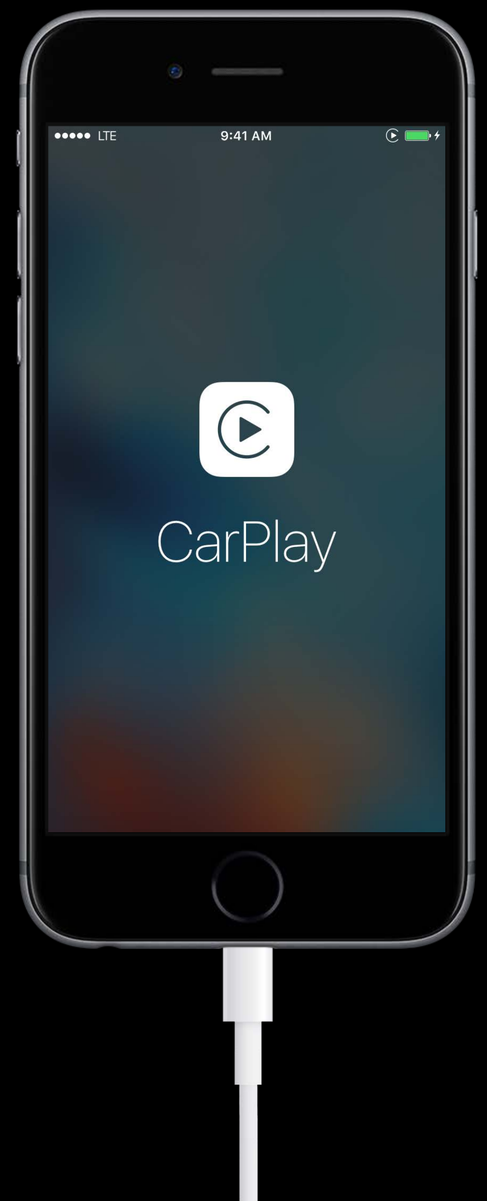
Wired Connection to iPhone

Car

iPhone



Wired Connection to iPhone



Car

Sensors
and
Metadata

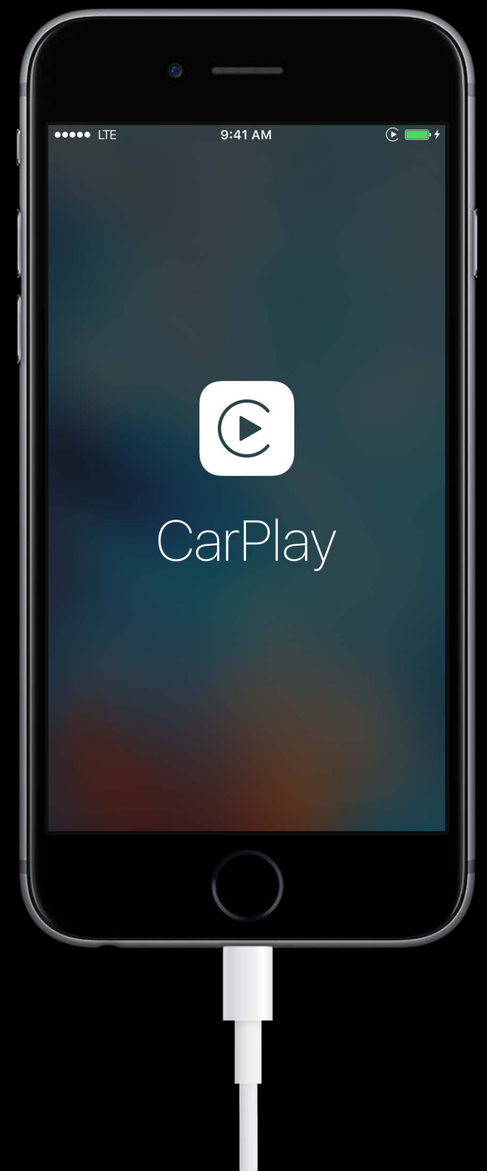
IP

iAP2

USB

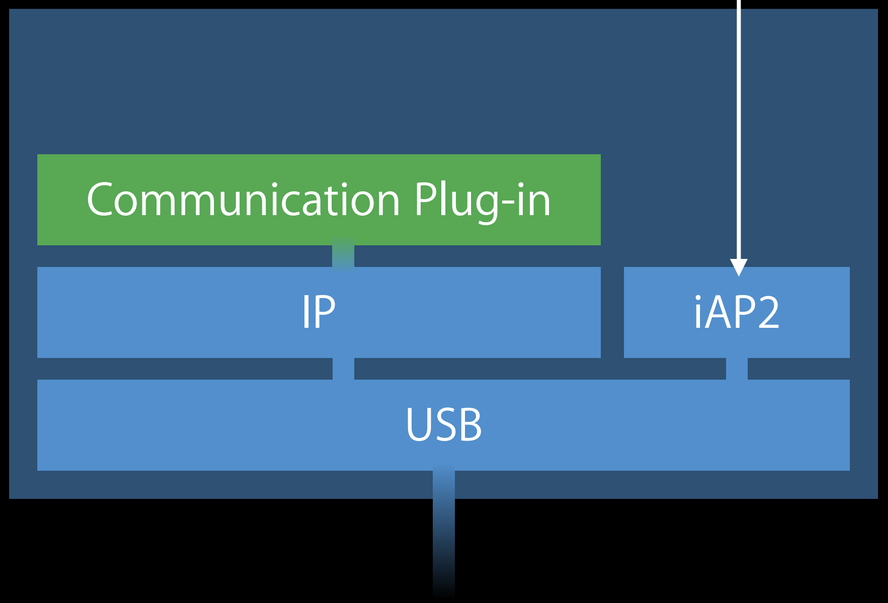
Wired Connection to iPhone

iPhone



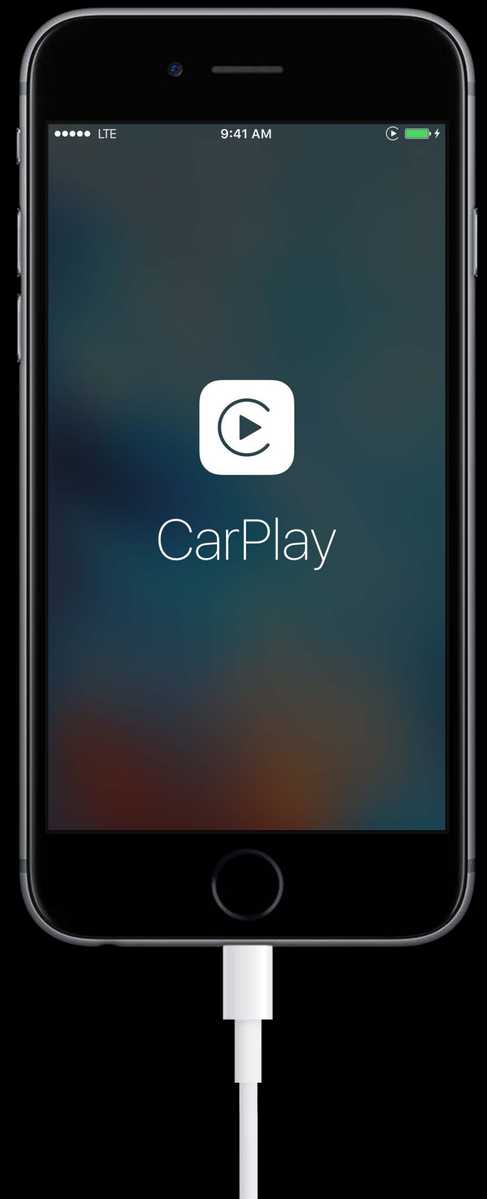
Car

Sensors
and
Metadata



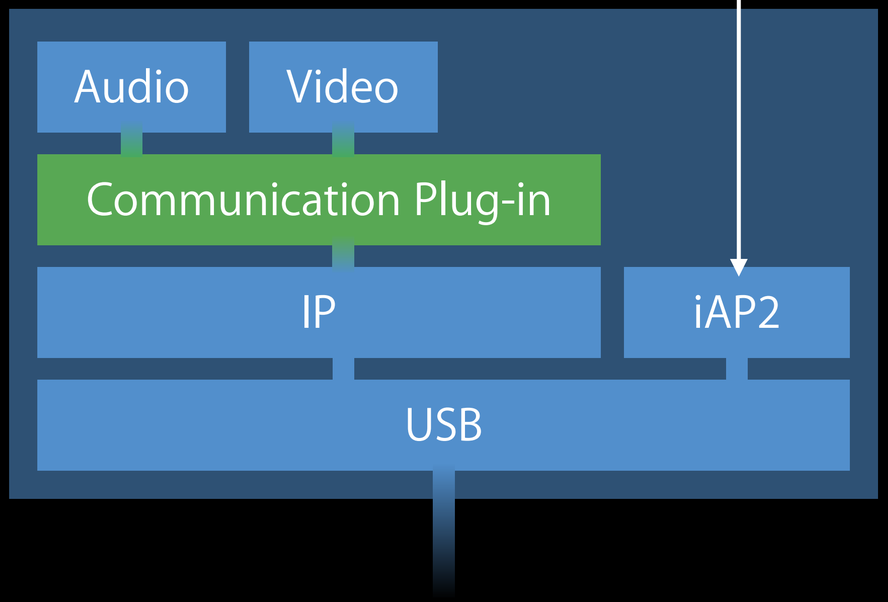
Wired Connection to iPhone

iPhone



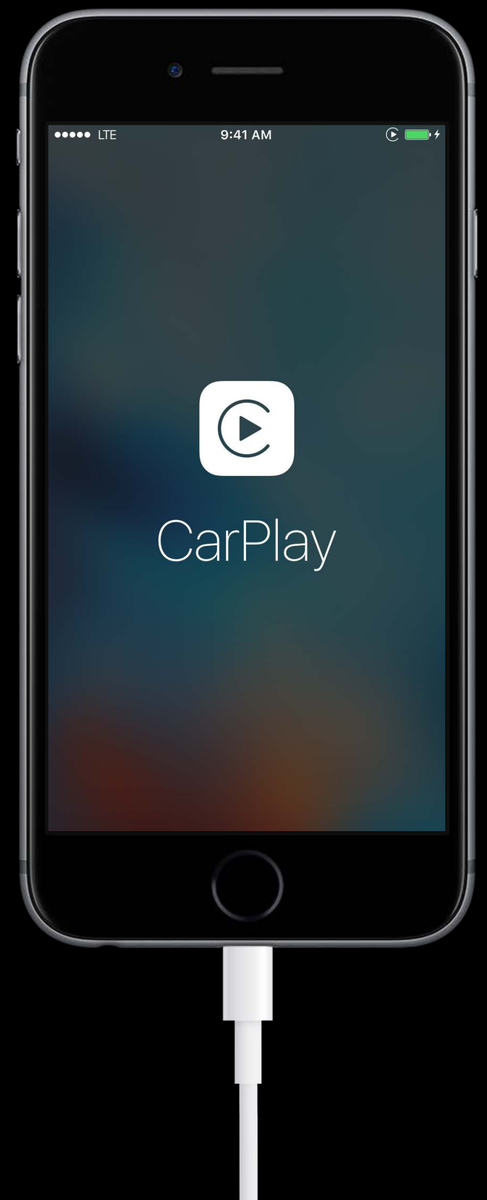
Car

Sensors and Metadata

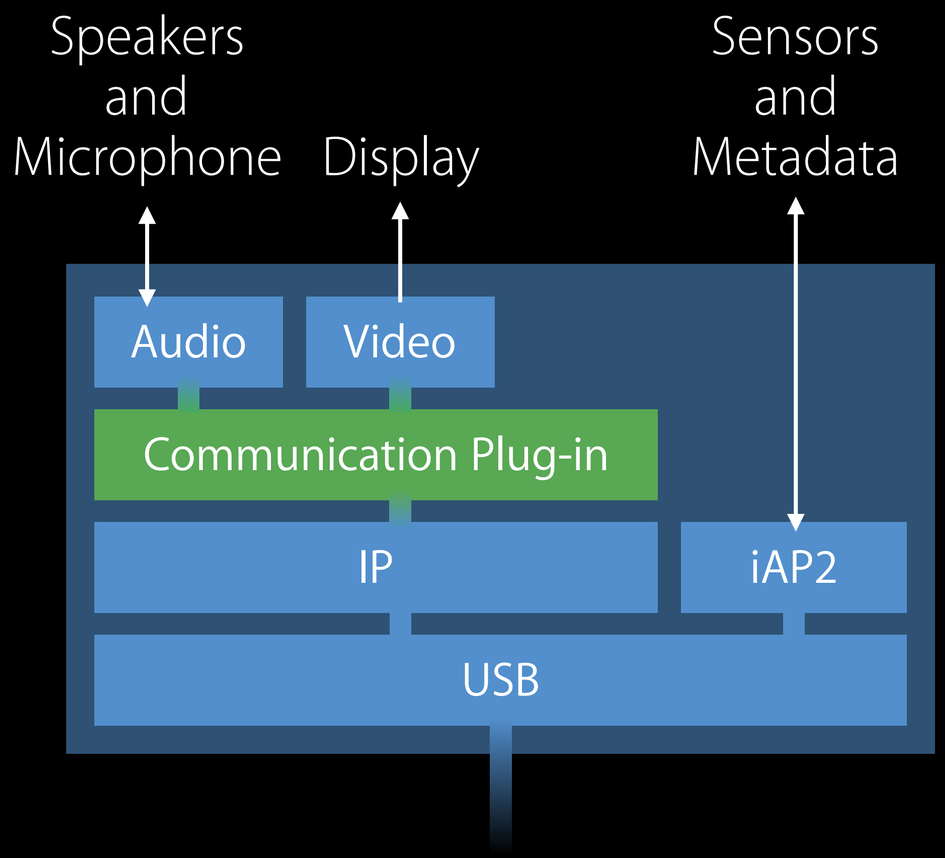


Wired Connection to iPhone

iPhone

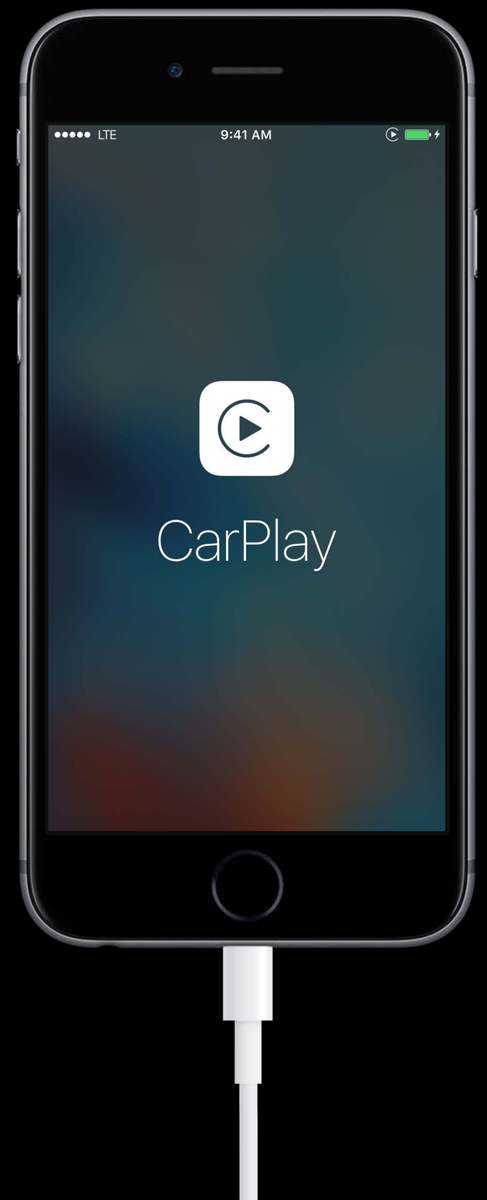


Car



Wired Connection to iPhone

iPhone



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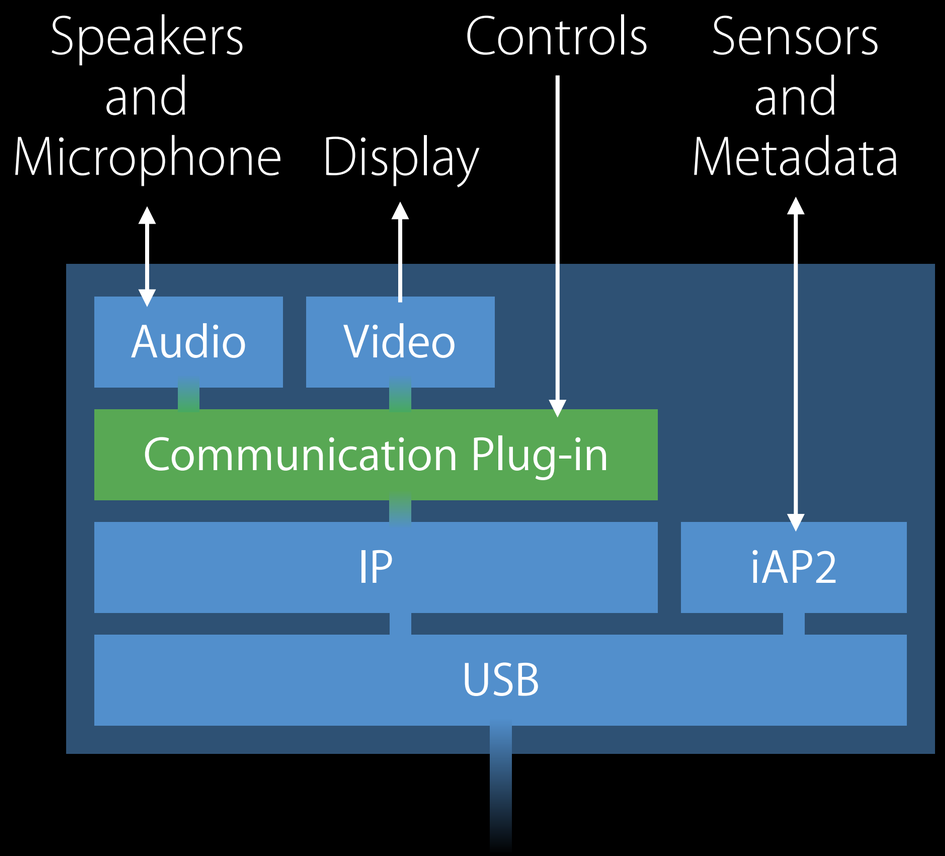
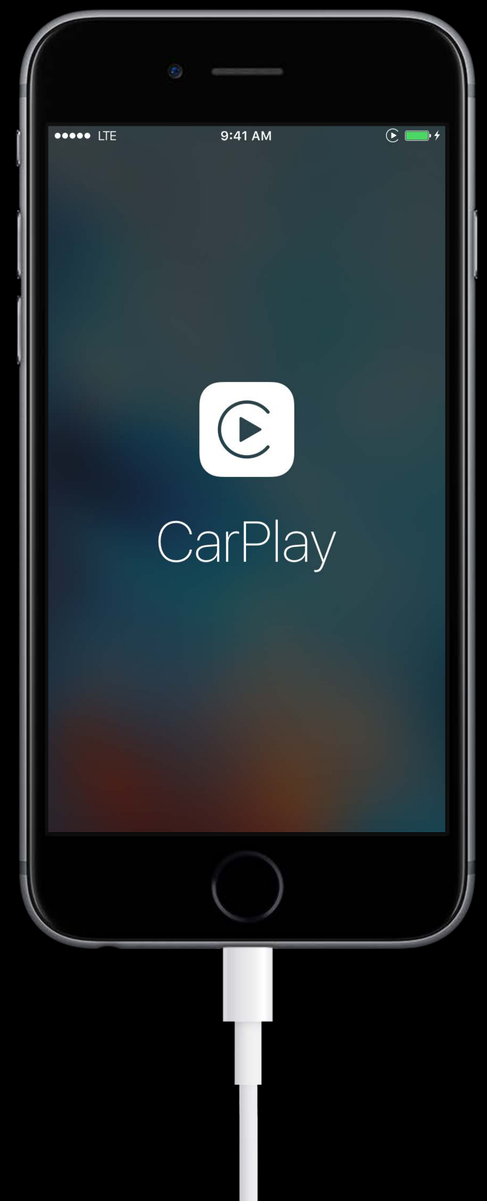


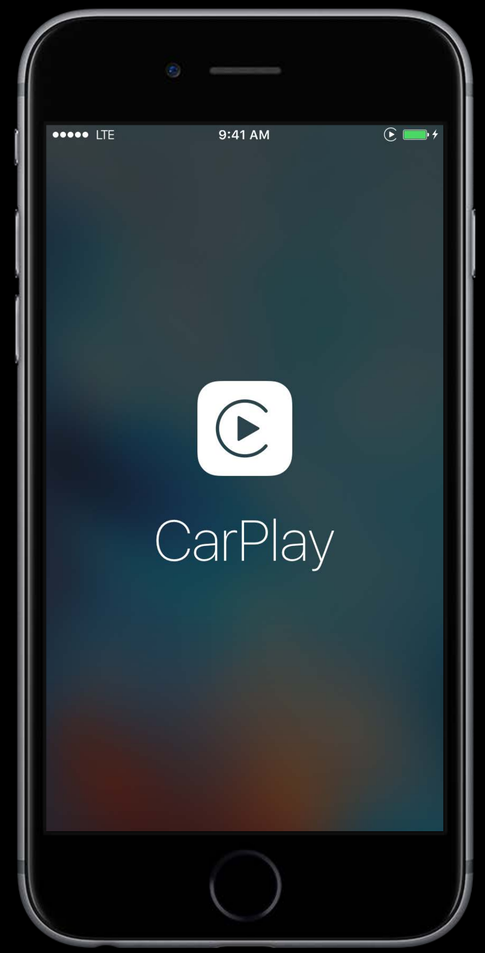
Wired Connection to iPhone

iPhone



Car

iPhone



Car

iPhone

Wi-Fi and Bluetooth

Wireless Connection to iPhone

Car

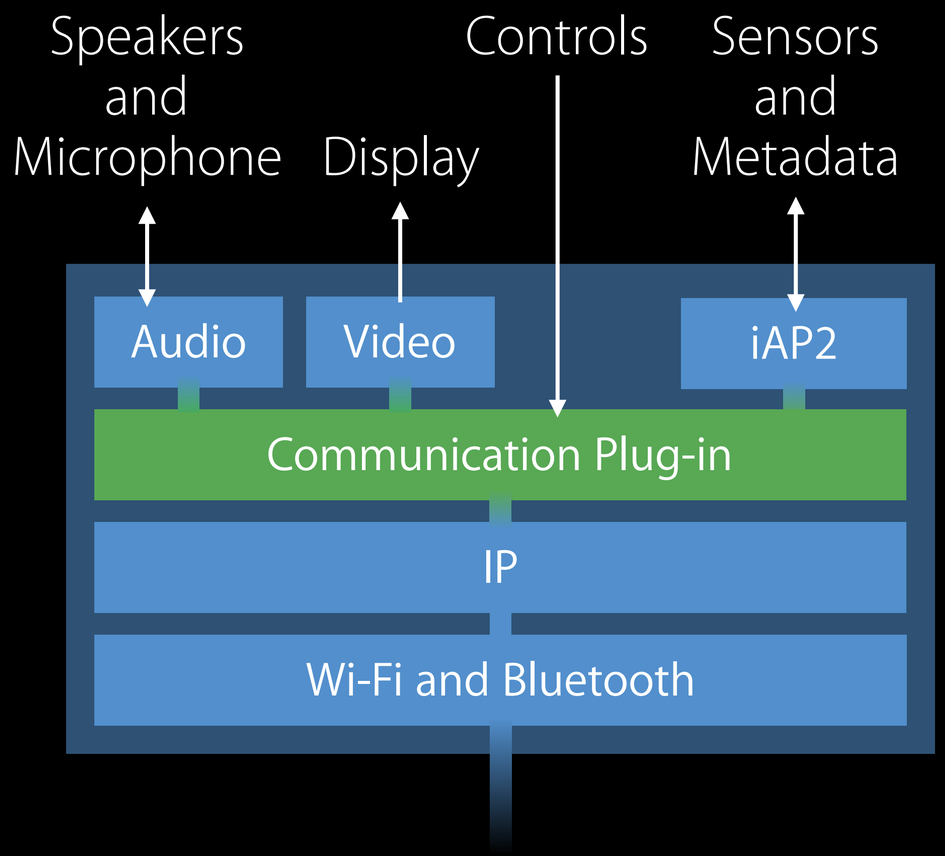
iPhone

IP

Wi-Fi and Bluetooth

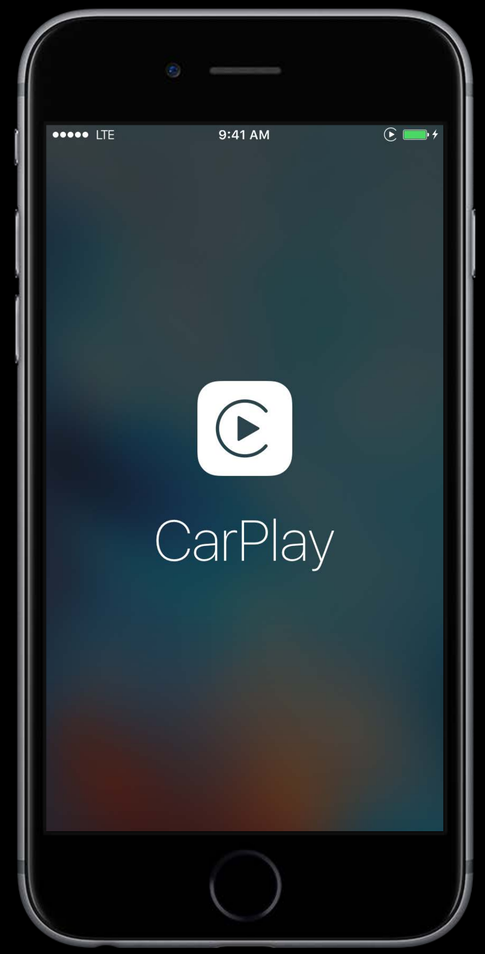
Wireless Connection to iPhone

Car



Wireless Connection to iPhone

iPhone



Key Vehicle Requirements

Key Vehicle Requirements

High Resolution Display

Speakers and Microphone

User Input

Sensors

Connection to iPhone

Key Vehicle Requirements

High Resolution Display

Speakers and Microphone

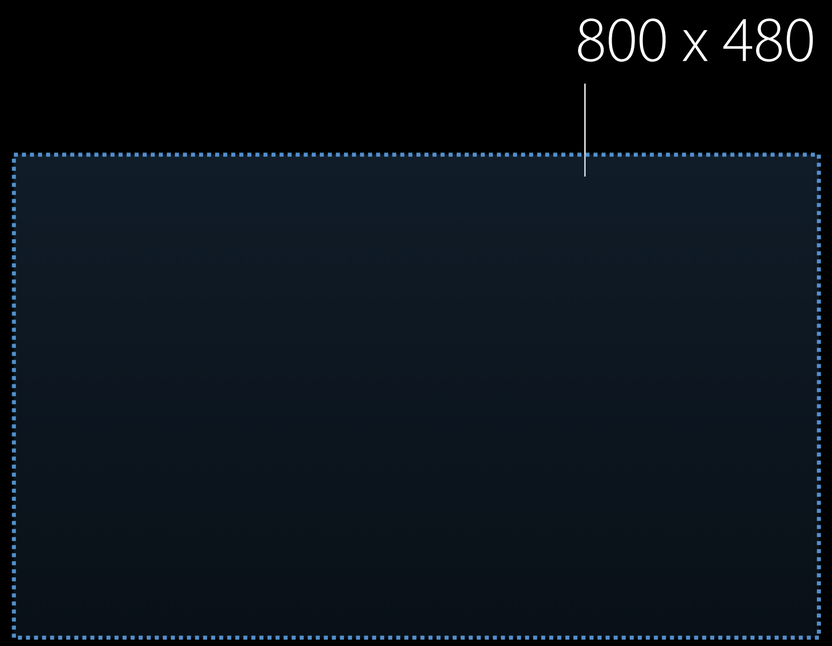
User Input

Sensors

Connection to iPhone

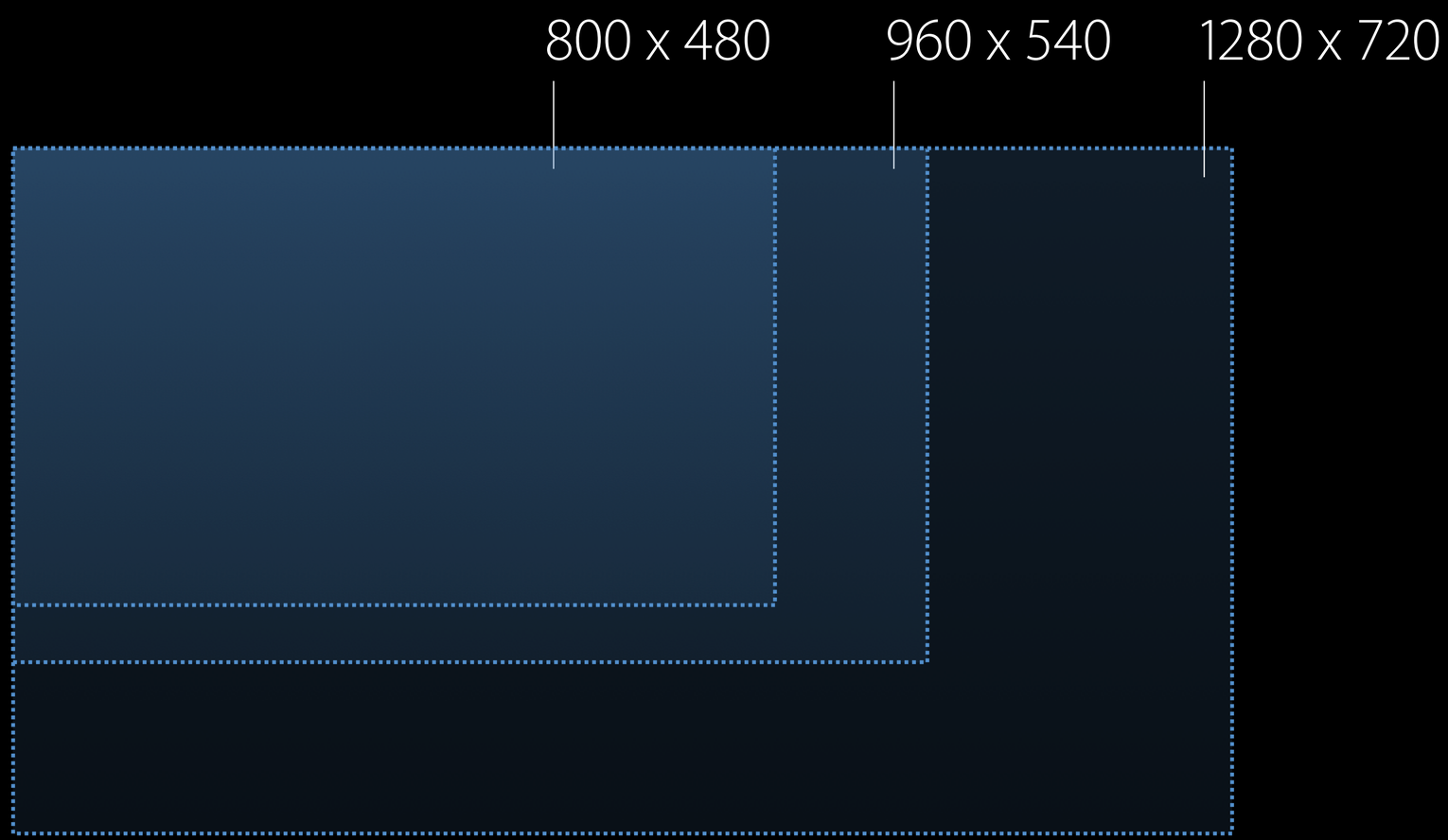
Standard Display Resolutions

Standard Display Resolutions

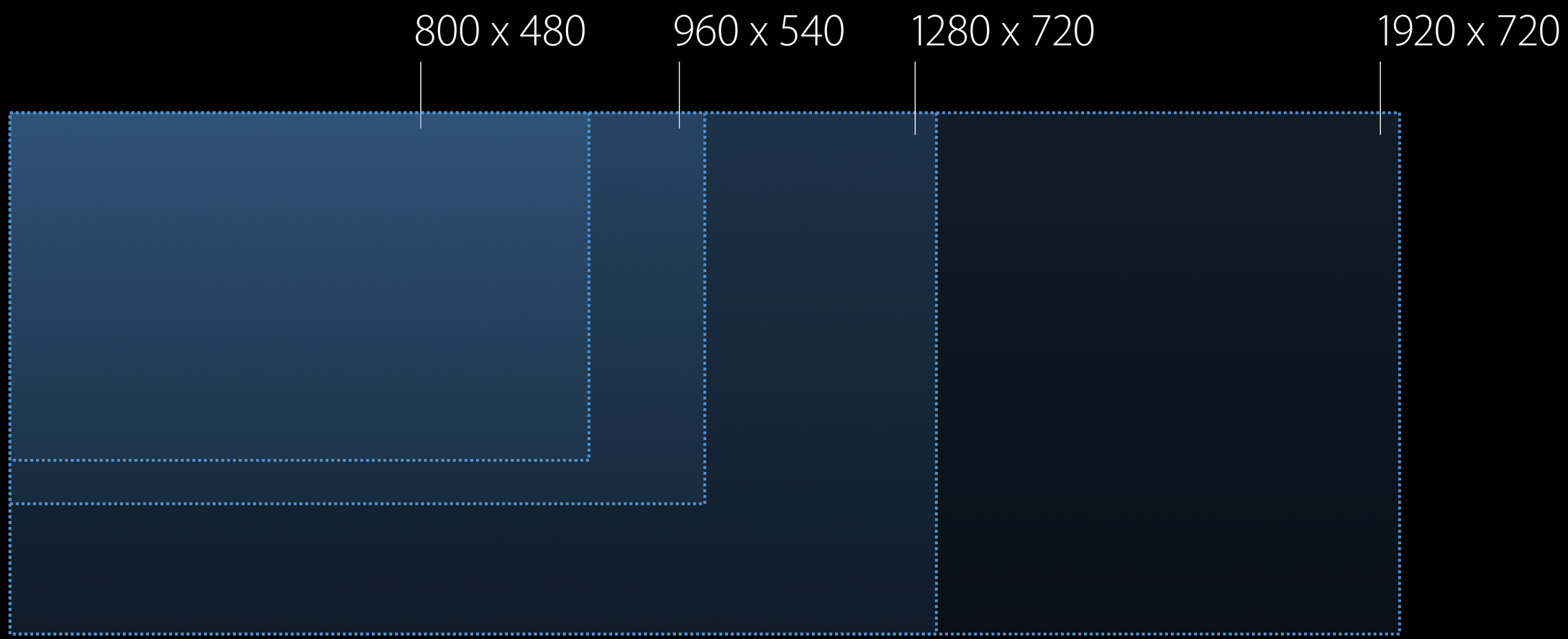


Standard Display Resolutions

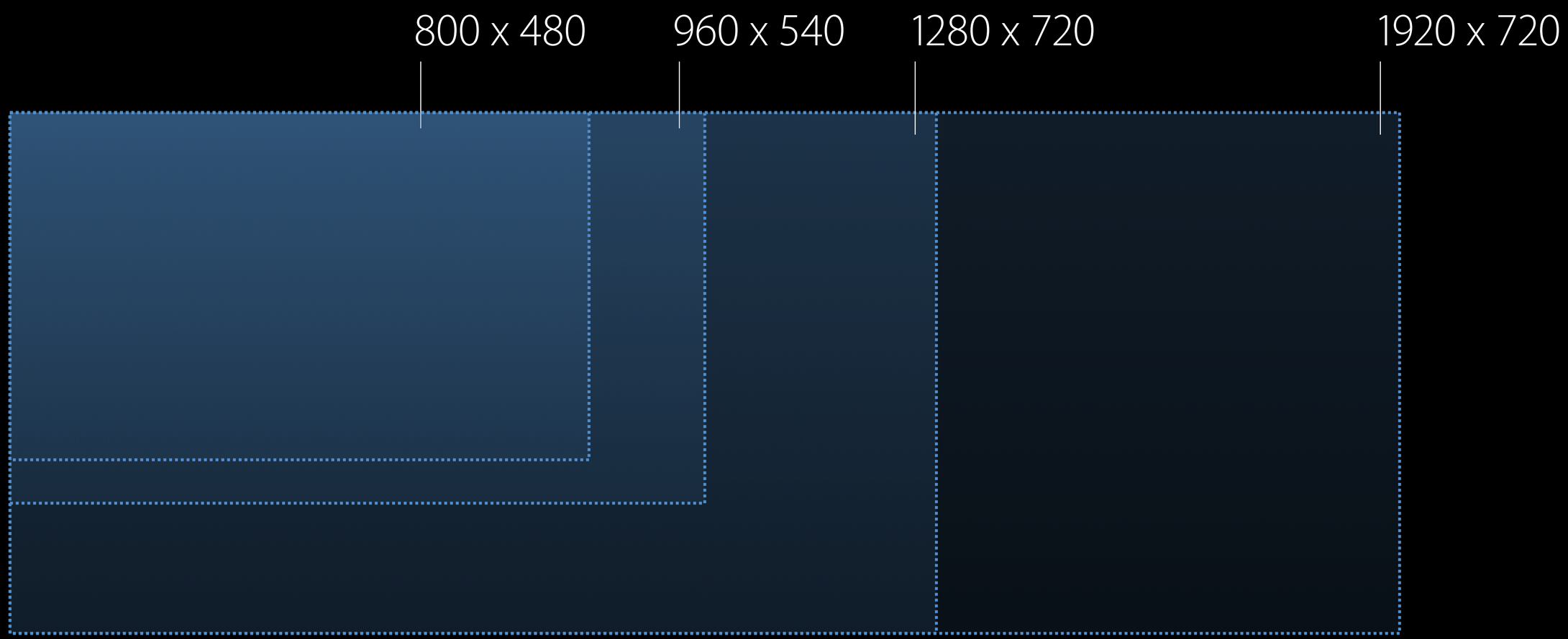
Standard Display Resolutions



Standard Display Resolutions



Pixel Density



Pixel Density

Adjusted to similar physical display sizes

800 x 480

960 x 540

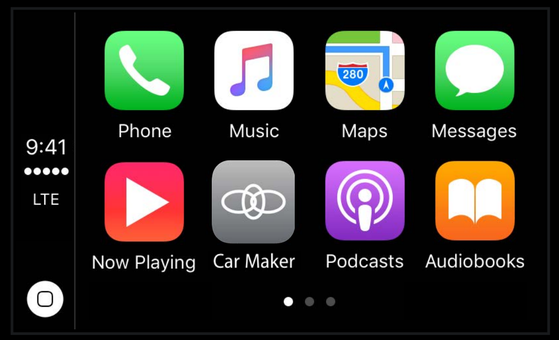
1280 x 720

1920 x 720

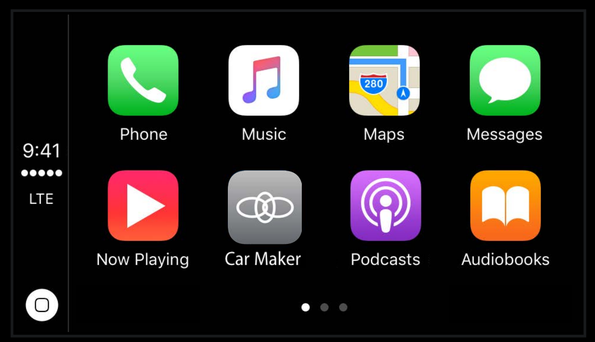
Pixel Density

Adjusted to similar physical display sizes

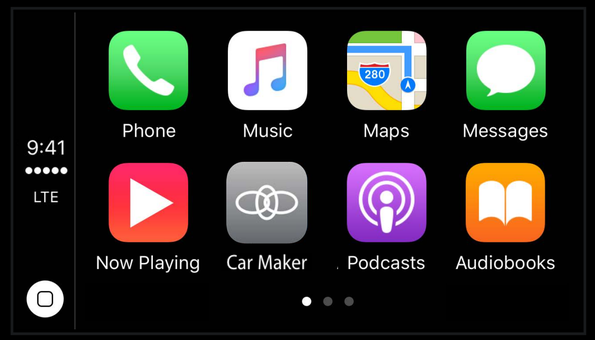
800 x 480



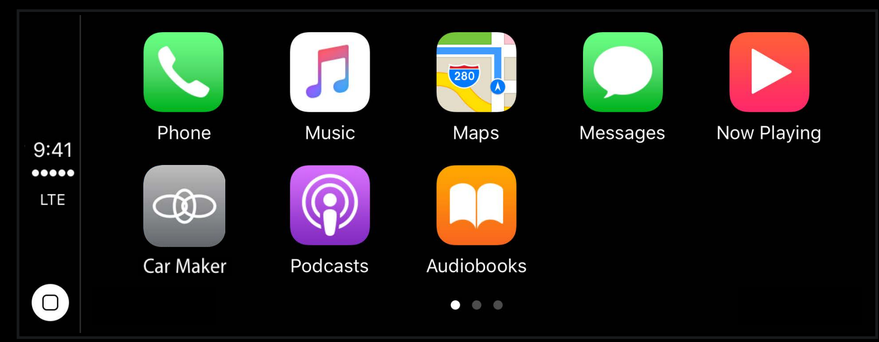
960 x 540



1280 x 720



1920 x 720



High Resolution Display

Contact Apple for non-standard resolutions

Aftermarket systems

- Minimum physical display size is 6 inches

Automaker systems

- Automakers' responsibility to select the appropriate physical display size

Additional Display Requirements

24-bit color

30 Hz refresh rate (60 Hz recommended)

Hardware support for H.264 video decoding

- High Profile 3.1
- Full range flag

Key Vehicle Requirements

High Resolution Display

Speakers and Microphone

User Input

Sensors

Connection to iPhone

Key Vehicle Requirements

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Speaker and Microphone Requirements

Main audio

- Used for media, telephony, and Siri
- Output up to 48 kHz, 16 bit, stereo
- Input at least 24 kHz, 16 bit, mono

Alternate audio

- Used for notifications
- Must always be mixed with main audio
- 44.1 kHz or 48 kHz, 16 bit, mono or stereo

Speaker and Microphone Requirements

Wired CarPlay

- LPCM

Wireless CarPlay

- AAC-LC for media
- OPUS or AAC-ELD for all other audio

Key Vehicle Requirements

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Key Vehicle Requirements

High Resolution Display

Speakers and Microphone

User Input

Sensors

Connection to iPhone

Touch

Knobs and Controls

Voice

Touch

Knobs and Controls

Voice

Touchscreen

Direct interaction with user interface

Car sends x and y coordinates

Single touch

60 Hz refresh rate

High-fidelity or low-fidelity touch

Touchscreen

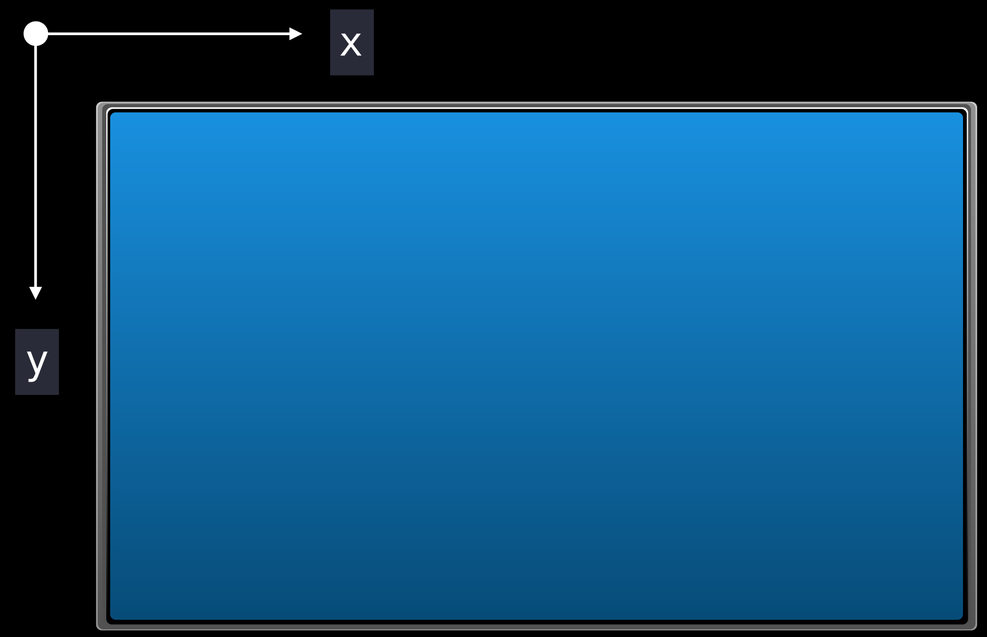
Direct interaction with user interface

Car sends x and y coordinates

Single touch

60 Hz refresh rate

High-fidelity or low-fidelity touch



High-Fidelity Touch

Allows swipe gestures with finger tracking for scrolling

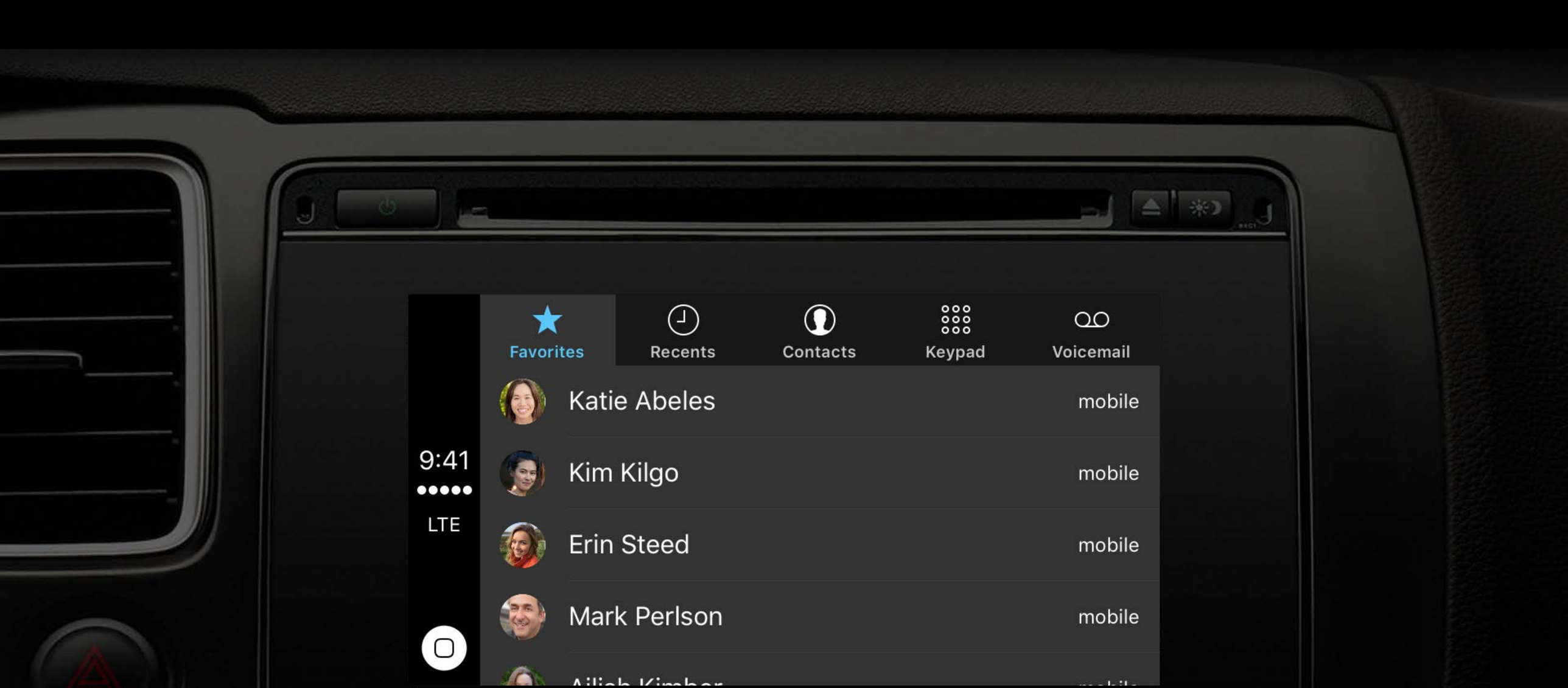
Requires high performance system

High-Fidelity Touch

Allows swipe gestures with finger tracking for scrolling

Requires high performance system

Less than 140 ms latency from touch input to display update


Favorites
Recents
Contacts
Keypad
Voicemail
Katie Abeles
mobile
9:41
Kim Kilgo
mobile
LTE
Erin Steed
mobile
Mark Perlson
mobile

9:41

LTE

Favorites | Recents | Contacts | Keypad | Voicemail

Ailish Kimber	mobile
Kevin Frank	FaceTime
Natalia Maric	mobile
Tamsin Vantress	mobile

Low-Fidelity Touch

CarPlay user interface optimized for single touch interactions

Recommended for resistive touch screens

Favorites
Recents
Contacts
Keypad
Voicemail
Katie Abeles mobile
Kim Kilgo mobile
Erin Steed mobile
Mark Perlson mobile
9:41
LTE

Favorites
Recents
Contacts
Keypad
Voicemail

9:41
LTE

Ailish Kimber mobile
Kevin Frank FaceTime
Natalia Maric mobile
Tamsin Vantress mobile

Touch

Knobs and Controls

Voice

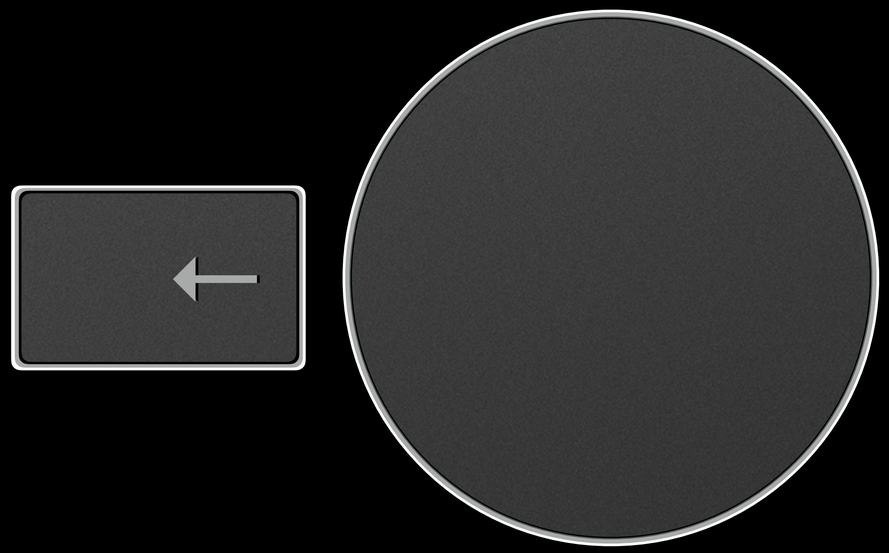
Touch

Knobs and Controls

Voice

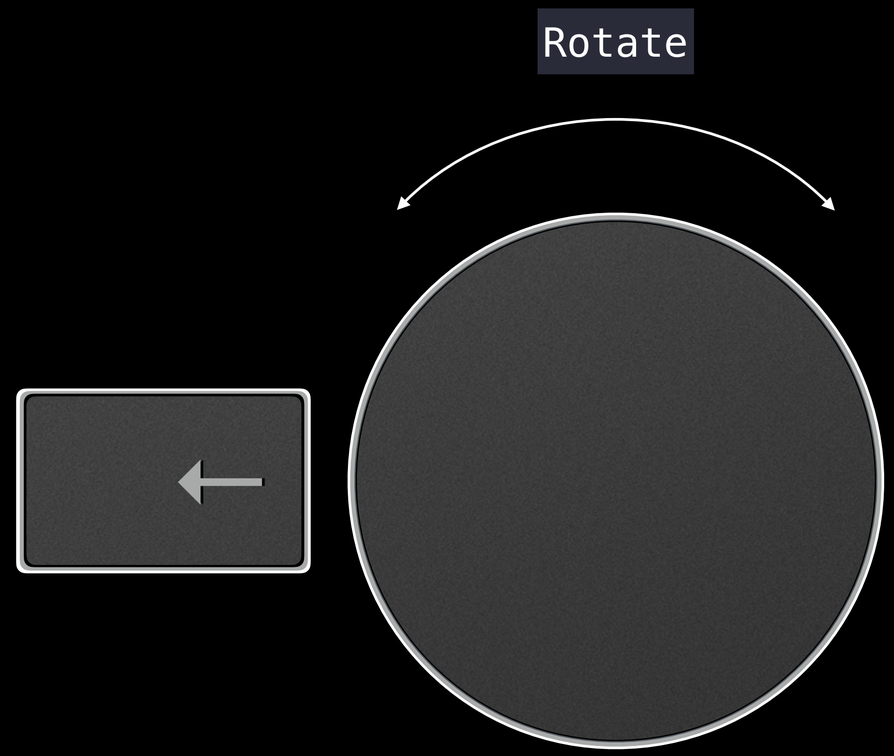
Knobs and Controls

Rotating knob



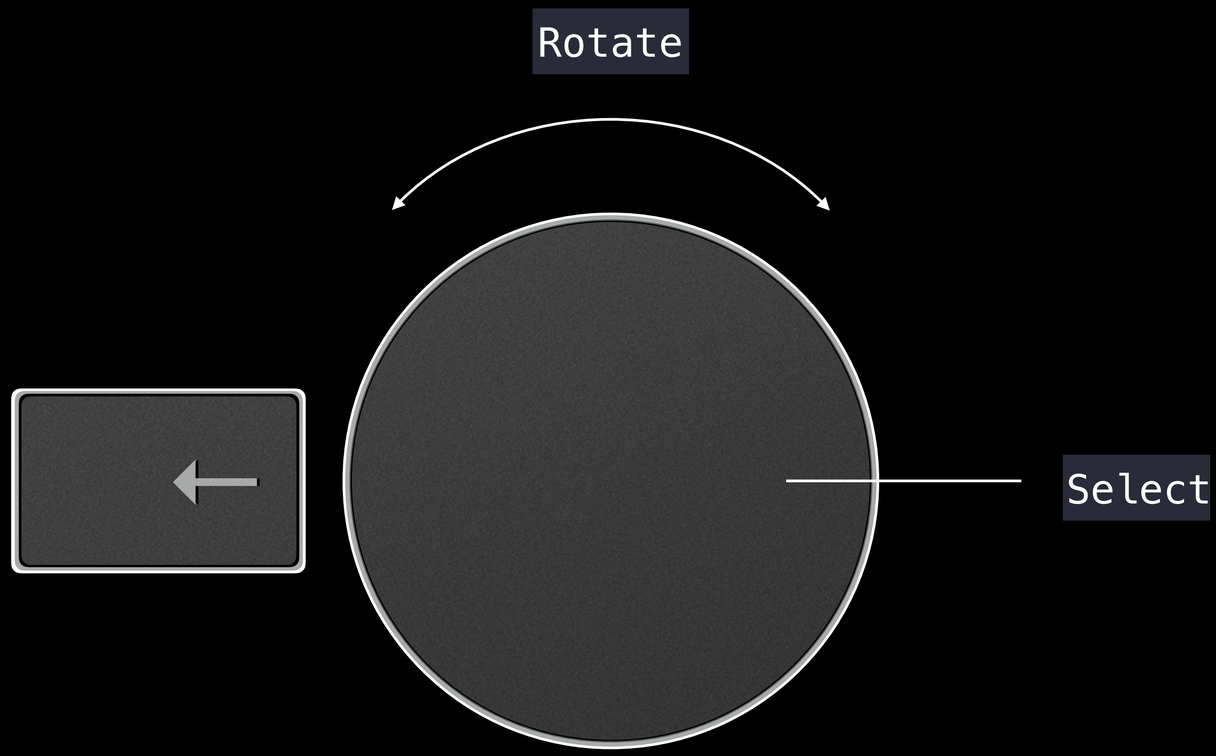
Knobs and Controls

Rotating knob



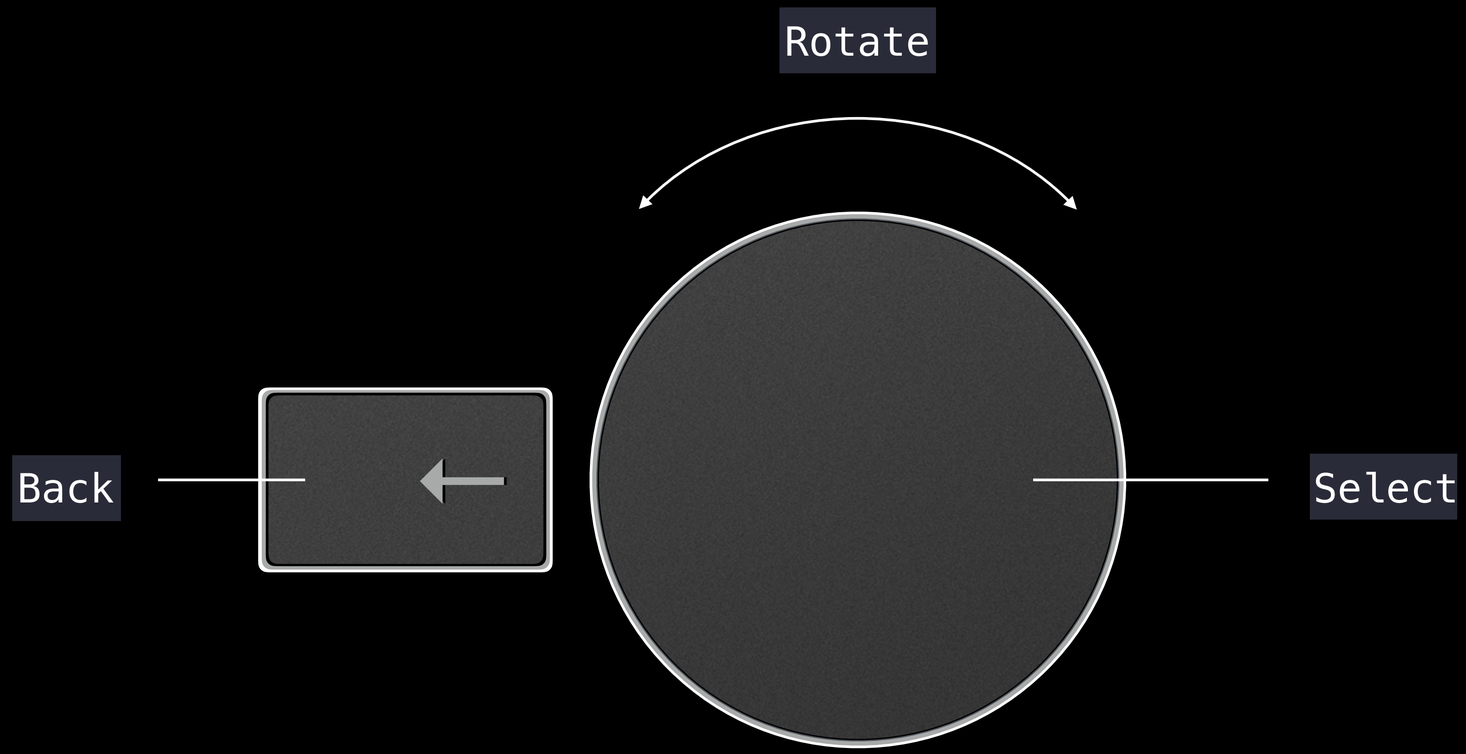
Knobs and Controls

Rotating knob



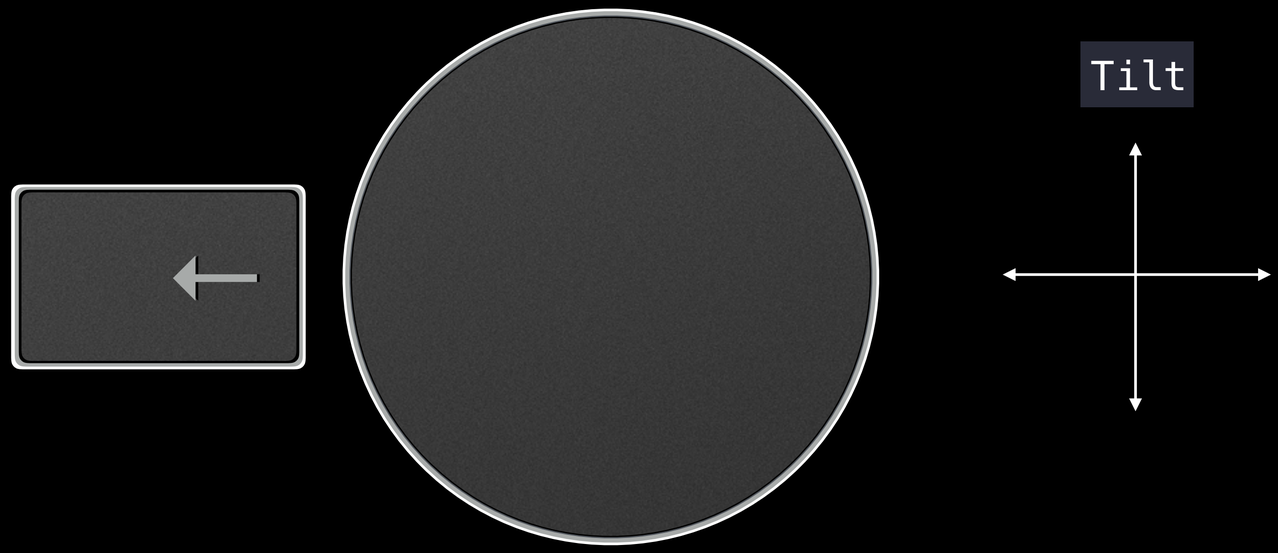
Knobs and Controls

Rotating knob



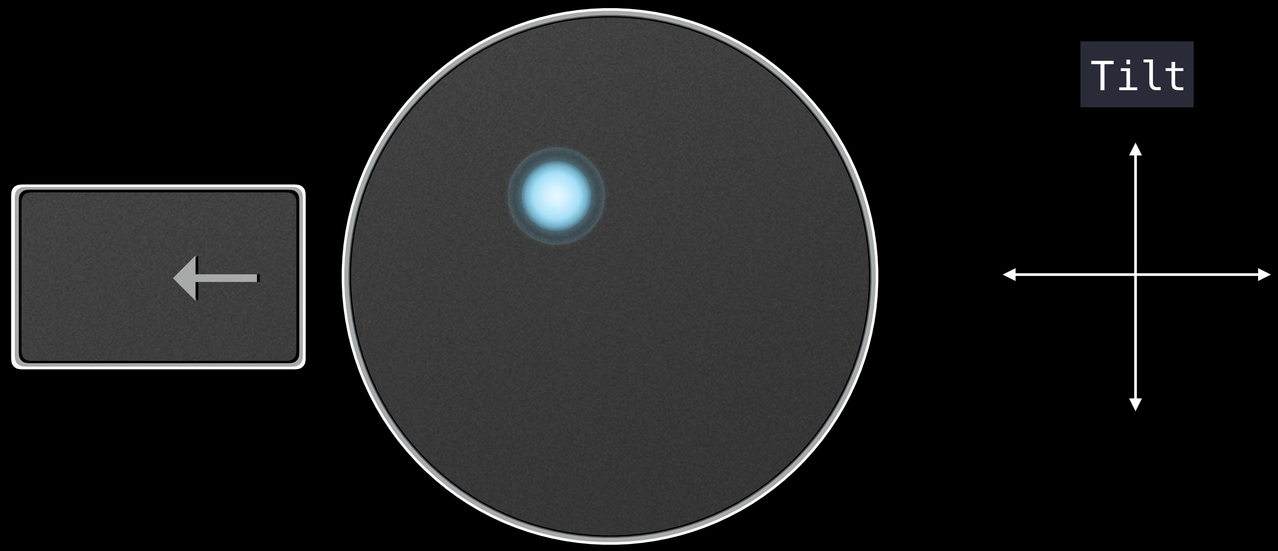
Knobs and Controls

Multi-axis rotating knob



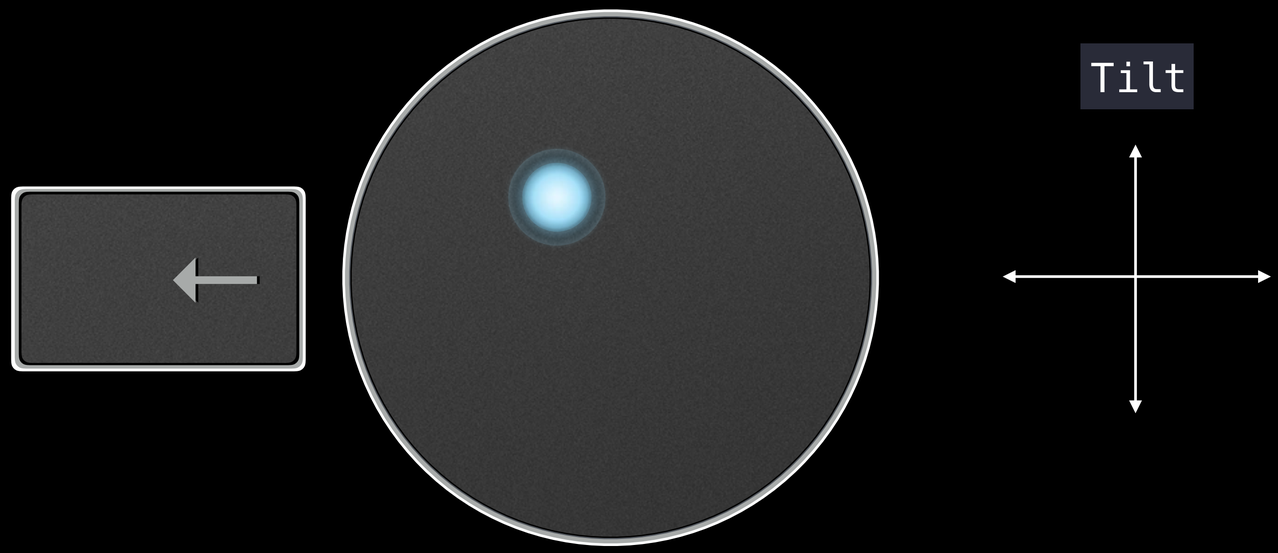
Knobs and Controls

Multi-axis rotating knob



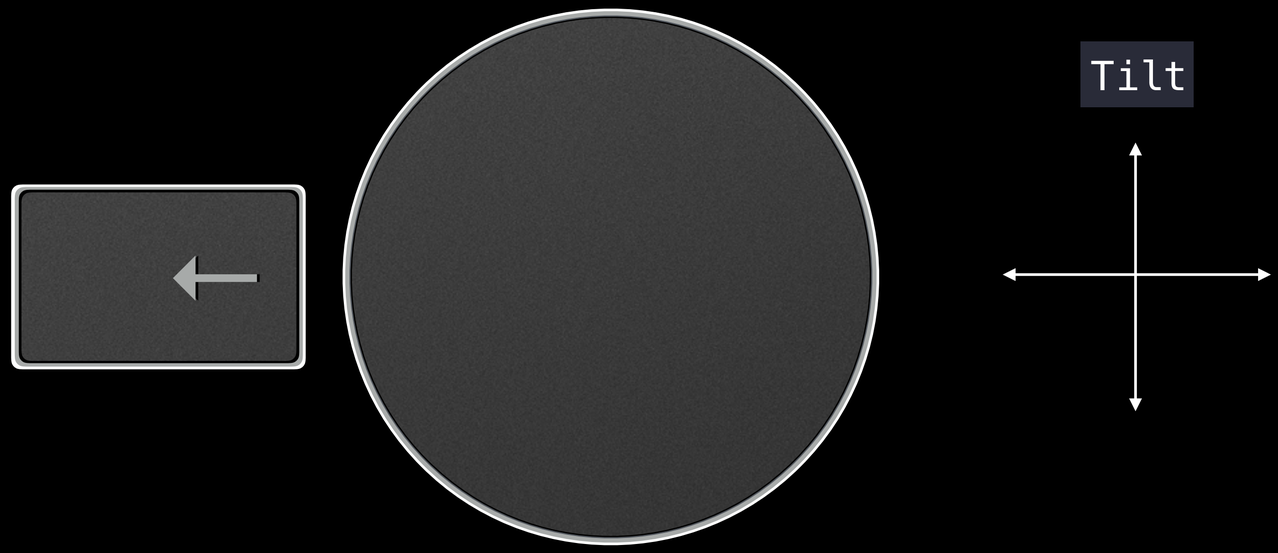
Knobs and Controls

Multi-axis rotating knob



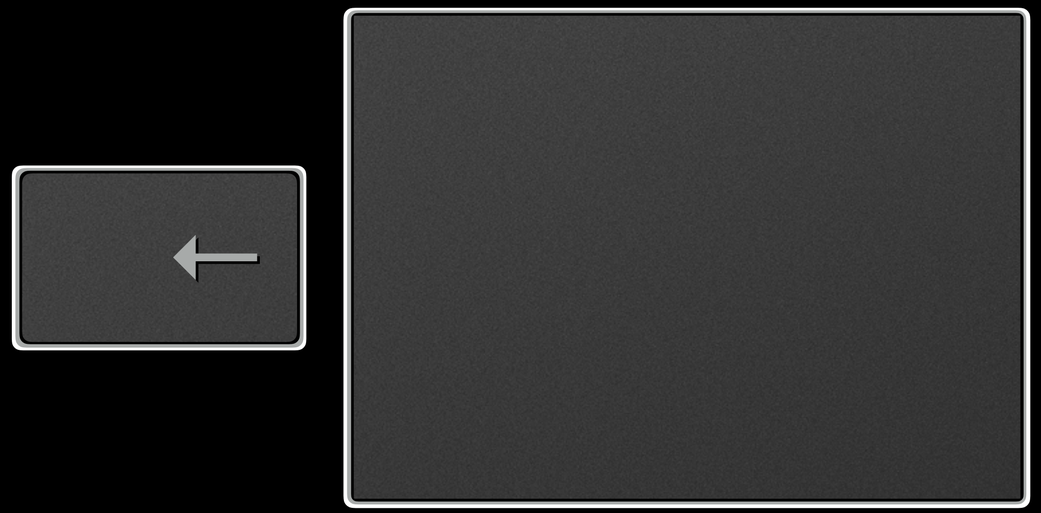
Knobs and Controls

Multi-axis rotating knob



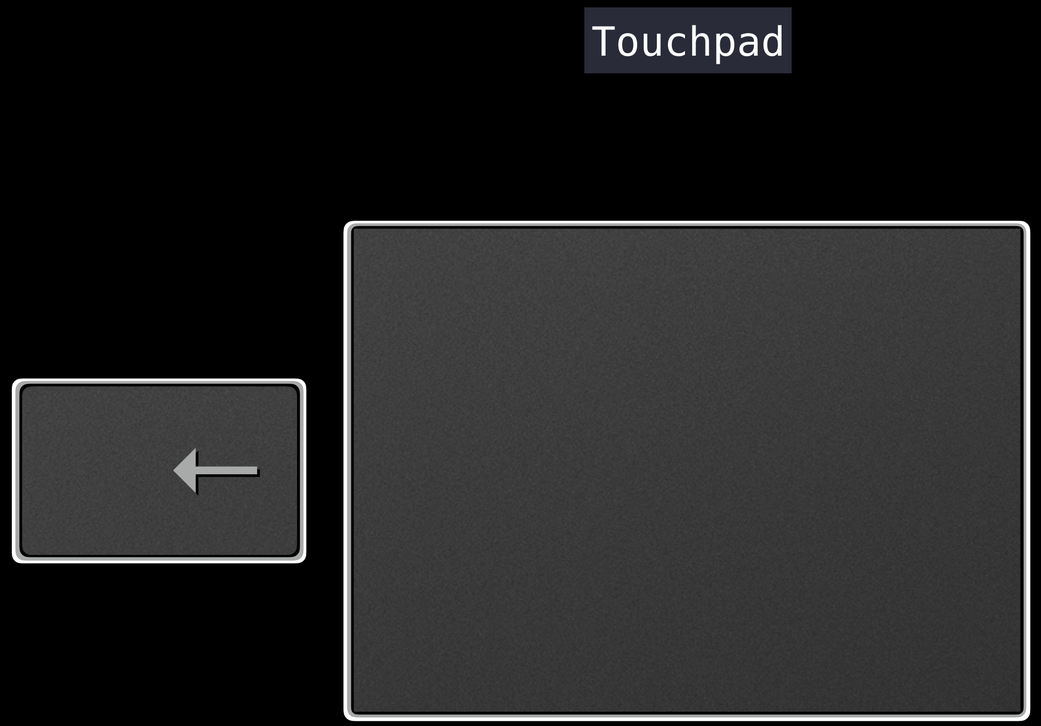
Knobs and Controls

Touchpad



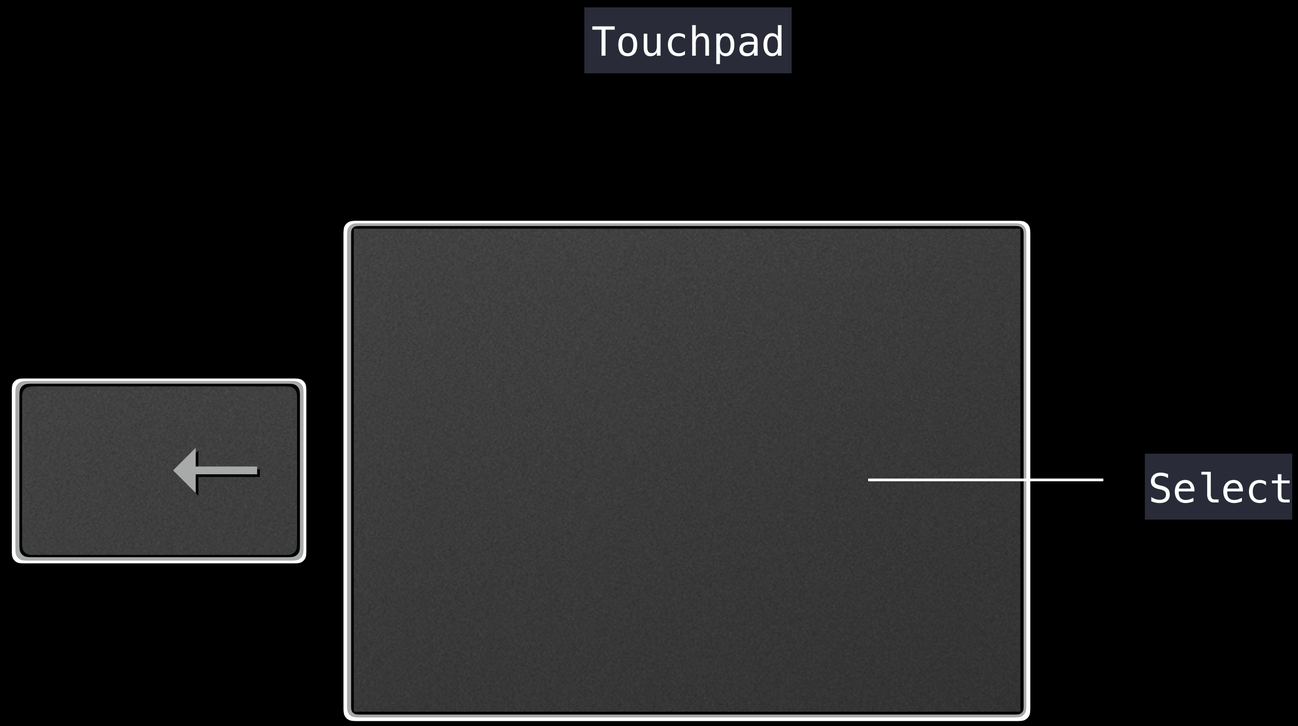
Knobs and Controls

Touchpad



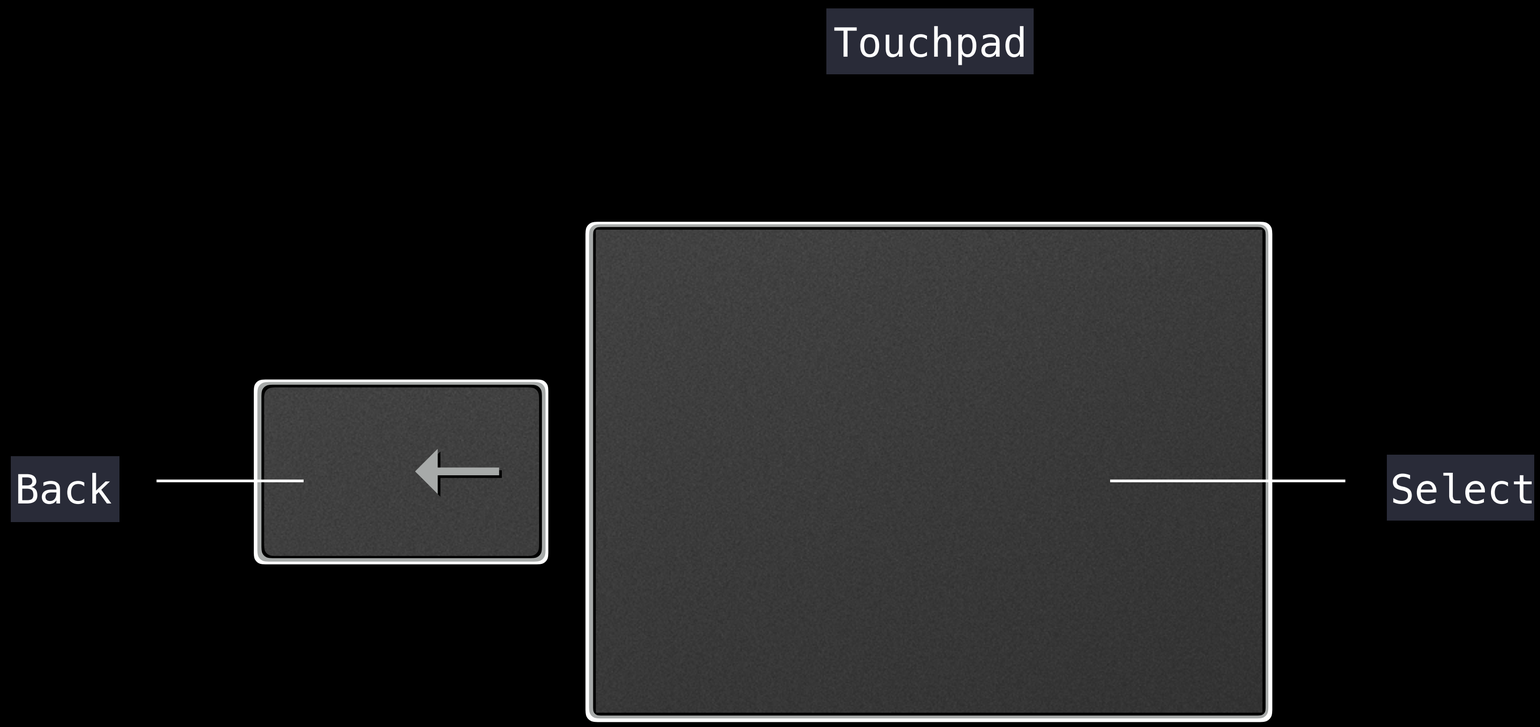
Knobs and Controls

Touchpad



Knobs and Controls

Touchpad



Knobs and Controls

Required features

- Rotating knob or touchpad
- Back
- Select

Optional features

- Multi-axis rotating knob controller
- Character gesture recognition
- Play, pause, previous/next track, home, delete
- Telephony keys

Multiple User Inputs

All combinations are supported

CarPlay automatically adjusts its user interface to match user inputs

Touchscreen examples

- Touchscreen only
- Touchscreen and rotating knob
- Touchscreen, rotating knob and touchpad

Touch

Knobs and Controls

Voice

Touch

Knobs and Controls

Voice

Siri Button

Activate Siri, continue conversation, or start wireless setup

Essential to the CarPlay experience

Required to be a hard button

Allows Siri to be accessible at any time, even when CarPlay is not visible

Must support independent up/down events

Key Vehicle Requirements

High Resolution Display

Speakers and Microphone

User Input

Sensors

Connection to iPhone

Key Vehicle Requirements

High Resolution Display

Speakers and Microphone

User Input

Sensors

Connection to iPhone

Sensors

Speed information

GNSS (Global Navigation Satellite System) information

GNSS Information

Global Navigation Satellite System

Satellite-based location information

- GPS and GLONASS required
- Galileo recommended

Provide dead-reckoned information

Recommended for all CarPlay systems

Required for wireless CarPlay systems

Key Vehicle Requirements

High Resolution Display

Speakers and Microphone

User Input

Sensors

Connection to iPhone

Key Vehicle Requirements

High Resolution Display

Speakers and Microphone

User Input

Sensors

Connection to iPhone

Wired

Wireless

Wired

Wireless

Wired Connection

USB

Requires support for USB role swap

- Car functions as USB device
- iPhone functions as USB host

High throughput required

Port labeling

- Contact Apple for use of CarPlay icon

Wired

Wireless

Wired

Wireless

CarPlay Over Wireless

Two-stage process

Bluetooth

Wi-Fi

CarPlay Over Wireless

Two-stage process

Bluetooth

Wi-Fi

Bluetooth connected

CarPlay Over Wireless

Two-stage process

Bluetooth

Wi-Fi

Bluetooth connected

Car sends Wi-Fi credentials to iPhone

CarPlay Over Wireless

Two-stage process

Bluetooth

Wi-Fi

Bluetooth connected

Car sends Wi-Fi credentials to iPhone

Wi-Fi connected

CarPlay Over Wireless

Two-stage process

Bluetooth

Wi-Fi

Bluetooth connected

Car sends Wi-Fi credentials to iPhone

Wi-Fi connected

CarPlay session established over Wi-Fi

CarPlay Over Wireless

Two-stage process

Bluetooth

Wi-Fi

Bluetooth connected

Car sends Wi-Fi credentials to iPhone

Bluetooth disconnected

Wi-Fi connected

CarPlay session established over Wi-Fi

CarPlay Over Wireless

Wi-Fi

- Used for video, audio, and CarPlay protocol, including iAP2
- Wi-Fi Alliance certified access point with high throughput
- 5 GHz, 802.11ac recommended

Bluetooth

- Used for discovery and reconnection only
- Support for communication protocols (SDP, iAP2), 2.1+EDR

Design Guidelines

Donald Pitschel Human Interface

CarPlay is Designed to Use the Entire Display

9:41
LTE
Phone
Music
Maps
Messages
Now Playing
Car Maker
Podcasts
Audiobooks

22°C
9:42
9:41
LTE
Phone
Music
Maps
Messages
Now Playing
Car Maker
Podcasts
Audiobooks

22˚C
9:42
9:41
LTE
Phone
Music
Maps
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22˚C
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Audiobooks

22°C
9:42
9:41
LTE
Phone
Music
Maps
Messages
Now Playing
Car Maker
Podcasts
Audiobooks

22°C
9:42
9:41
LTE
Phone
Music
Maps
Messages
Now Playing
Car Maker
Podcasts
Audiobooks

Not recommended

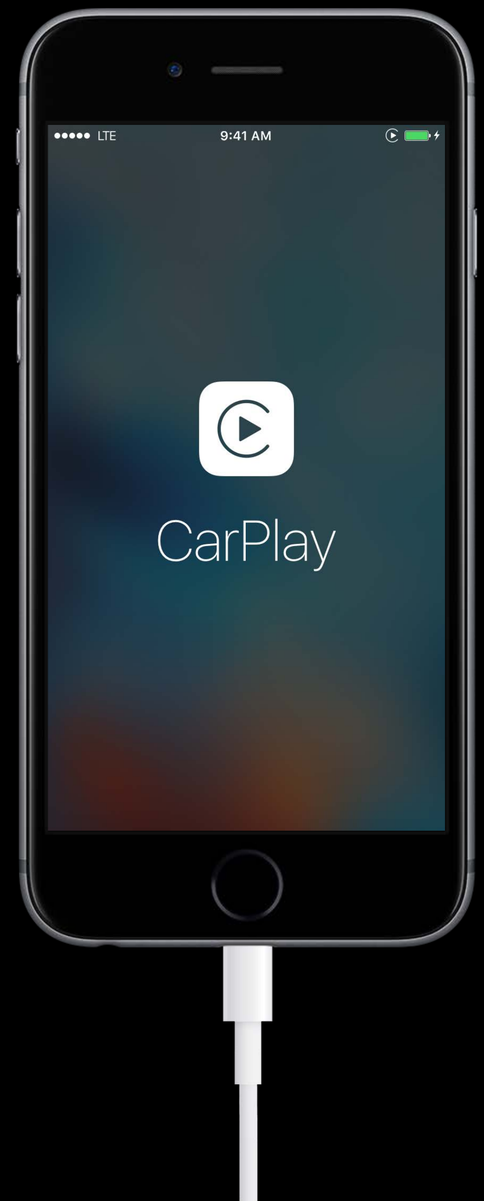
9:41
LTE
Phone
Music
Maps
Messages
Now Playing
Car Maker
Podcasts
Audiobooks

Starting CarPlay

Connecting to iPhone for the First Time

Connecting to iPhone for the First Time

Connecting to iPhone for the First Time



Connecting to iPhone for the First Time

Immediately show CarPlay on the car's display

Don't show prompts or notifications

Connecting to iPhone Again

Connecting to iPhone Again

Should always feel like a continuation of the previous CarPlay session

- If CarPlay was last shown, CarPlay should be shown again
- If iPhone audio was last playing, iPhone audio should play again

Connecting to iPhone Again

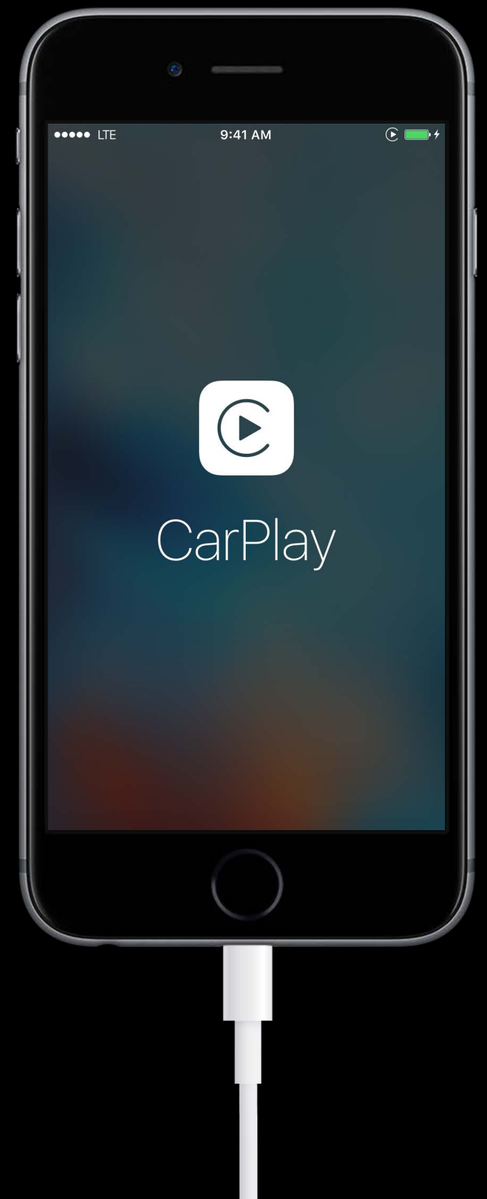
Should always feel like a continuation of the previous CarPlay session

- If CarPlay was last shown, CarPlay should be shown again
- If iPhone audio was last playing, iPhone audio should play again

Always preserve the “last user mode”

Connecting to a Known iPhone

If CarPlay was last used in the car

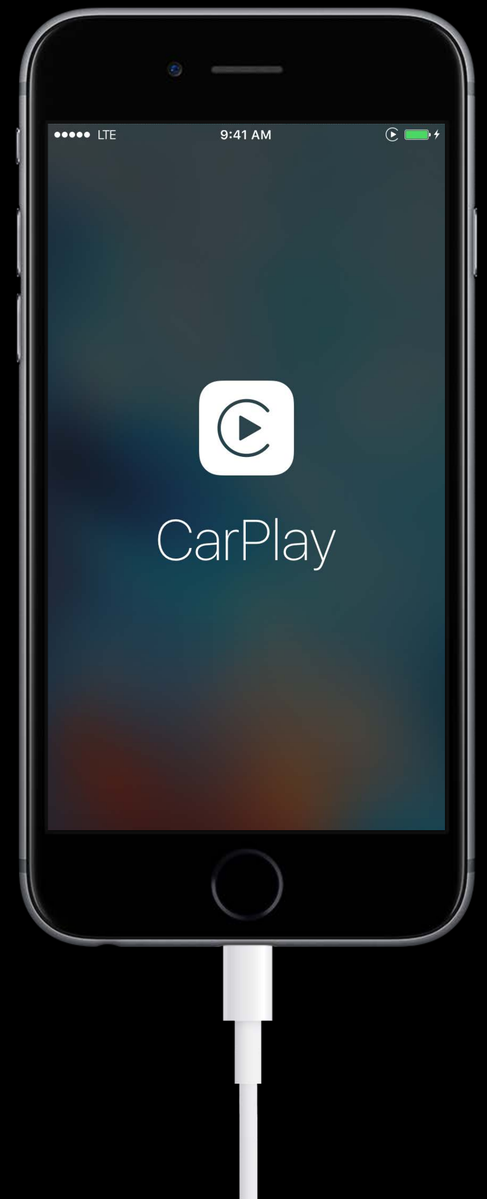


Connecting to a Known iPhone

If CarPlay was last used in the car

Connecting to a Known iPhone

If CarPlay was last used in the car



Connecting to a Known iPhone

If CarPlay was last used in the car

If CarPlay was last shown,
CarPlay should be shown again

If iPhone audio was playing,
iPhone audio should play again

Connecting to a Known iPhone

If the car's user interface was last used in the car

Connecting to a Known iPhone

If the car's user interface was last used in the car

Connecting to a Known iPhone

If the car's user interface was last used in the car

Connecting to a Known iPhone

If the car’s user interface was last used in the car

If CarPlay was not last shown, remain in the car’s user interface

If iPhone audio was playing, iPhone audio should play again

Switching to and from the CarPlay Display

9:41
LTE
Phone
Music
Maps
Messages
Now Playing
Car Maker
Podcasts
Audiobooks

22°C
9:41
Phone
Radio
CD
Navi
Climate
Car
Settings
Apple CarPlay

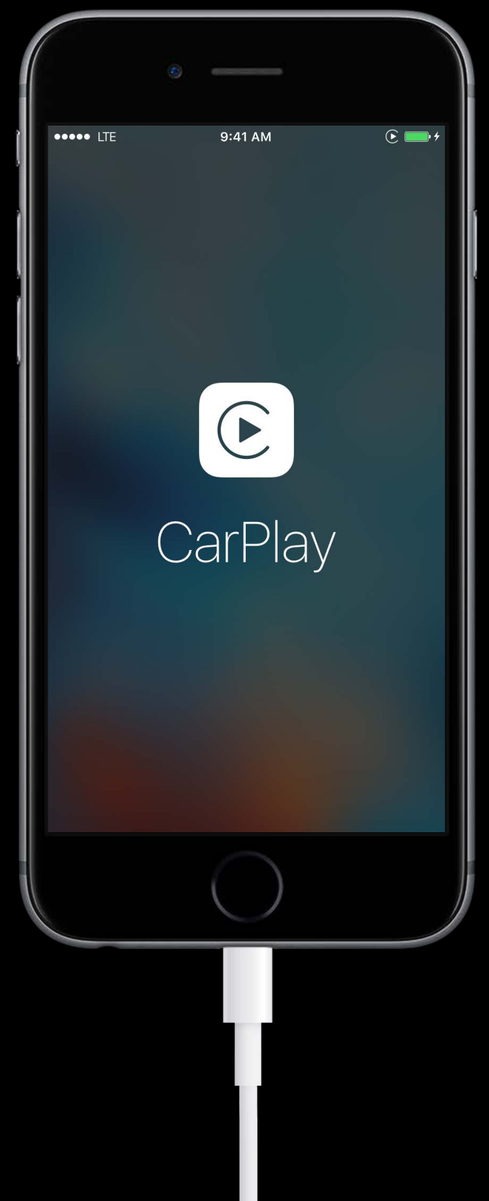
9:41
LTE
Phone
Music
Maps
Messages
Now Playing
Car Maker
Podcasts
Audiobooks

22°C
9:41
Phone
Radio
CD
Navi
Climate
Car
Settings
Apple CarPlay

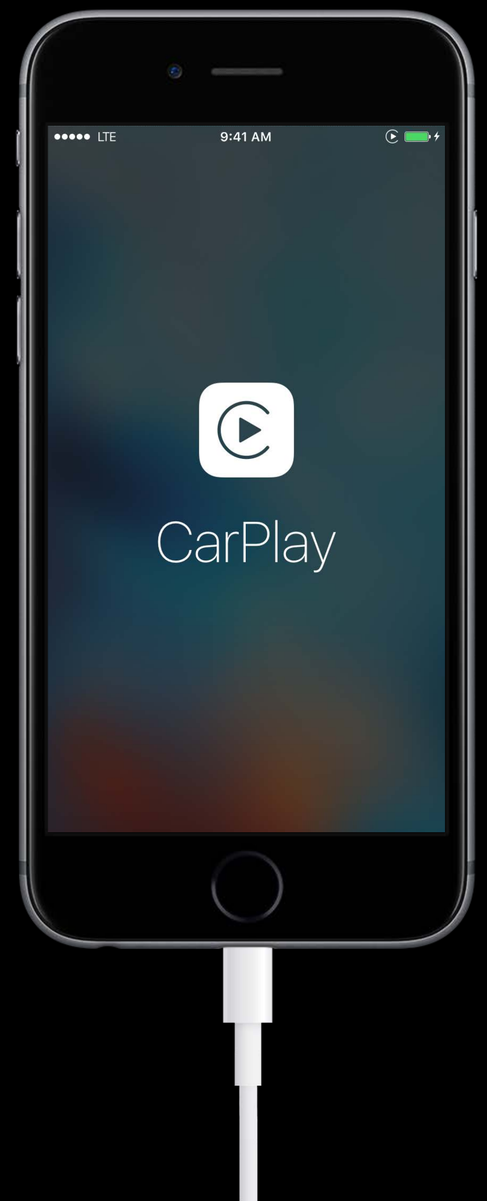
22°C
9:41
Phone
Radio
CD
Navi
Climate
Car
Settings
Apple CarPlay

Apple CarPlay Button

Apple CarPlay Button

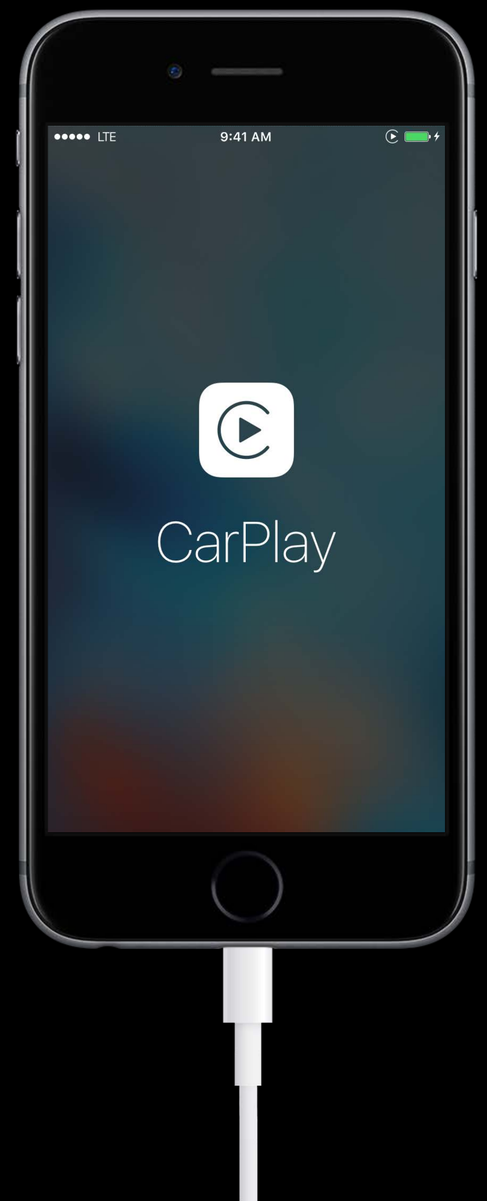


Apple CarPlay Button



Apple CarPlay Button

Apple CarPlay Button



Apple CarPlay Button

Apple CarPlay Button

Apple CarPlay Button

Apple CarPlay Button

Appears on car's home screen when iPhone is connected

Disappears or is disabled when iPhone is disconnected

Apple CarPlay Button Variations

22°C
9:41
Phone
Radio
CD
Navi
Climate
Car
Settings
Apple CarPlay

22°C
9:41
Phone
Radio
CD
Navi
Climate
Car
Settings
Apple CarPlay

22°C
9:41
Phone
Radio
CD
Navi
Climate
Car
Settings
Apple CarPlay

22°C
9:41
Phone
Radio
CD
Navi
Climate
Car
Settings
Apple CarPlay

22°C

9:41

Phone

Radio

CD

Navi

Climate

Car

Settings

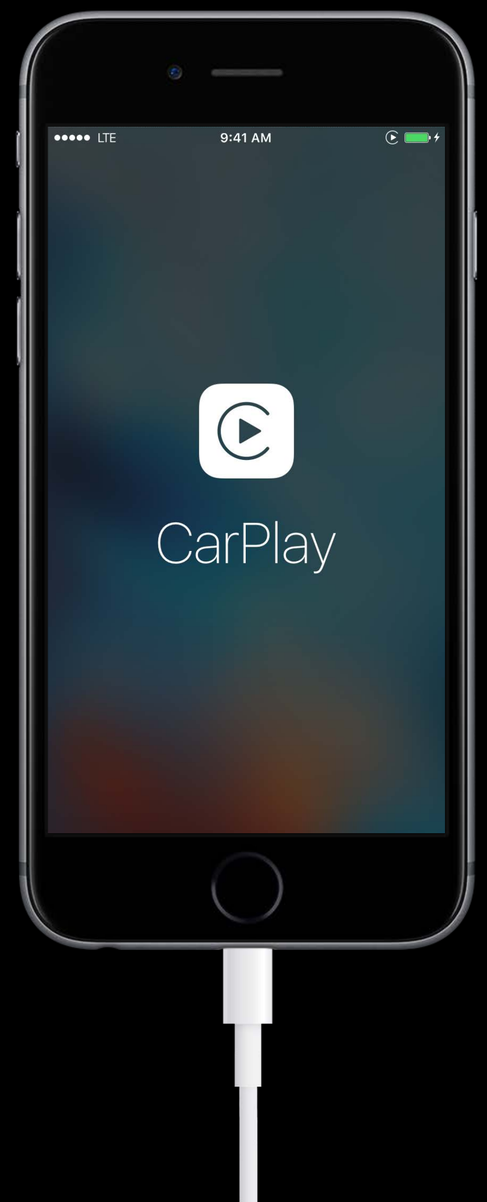
Apple CarPlay

Media Sources

Media Sources

Media Sources

iPhone Audio Playing



Media Sources

Silence

Media Sources

If iPhone is disconnected while iPhone audio is playing

User hears silence

Don’t switch to alternative media sources without explicit user action

Support for Buttons

Siri Button

Should be on the car's steering wheel

Must work at any time, even if CarPlay is not visible on the car's display

Must work the same way as the home button on iPhone

If your native system does not have voice recognition, Siri is also launched with a short press

If your native system has voice recognition, Siri is launched with a long press

- Long press must be 600 ms or less

Media Buttons

Media buttons should control CarPlay media

- Play, Pause
- Next track, previous track
- Fast forward, rewind

Direct Shortcut Buttons

Shortcut buttons should launch the appropriate CarPlay screen, if present

- Phone
- Media
- Navigation

Supported Apps

Emily Schubert Engineering Manager, Car Experience

Supported Apps

Appear on the CarPlay home screen

Limited to specific categories

- Audio apps
- Automaker apps
- Messaging apps

Audio Apps

Appear in any car that supports CarPlay

Fixed user interface, similar to the built-in Music app

- Provide a hierarchical list to navigate and select audio content
- Provide media metadata for the Now Playing screen
- Handle remote control events

Require a CarPlay entitlement

http://developer.apple.com/carplay

Audio Apps

What's new in iOS 10

NEW

Tabs support

App name in Now Playing screen

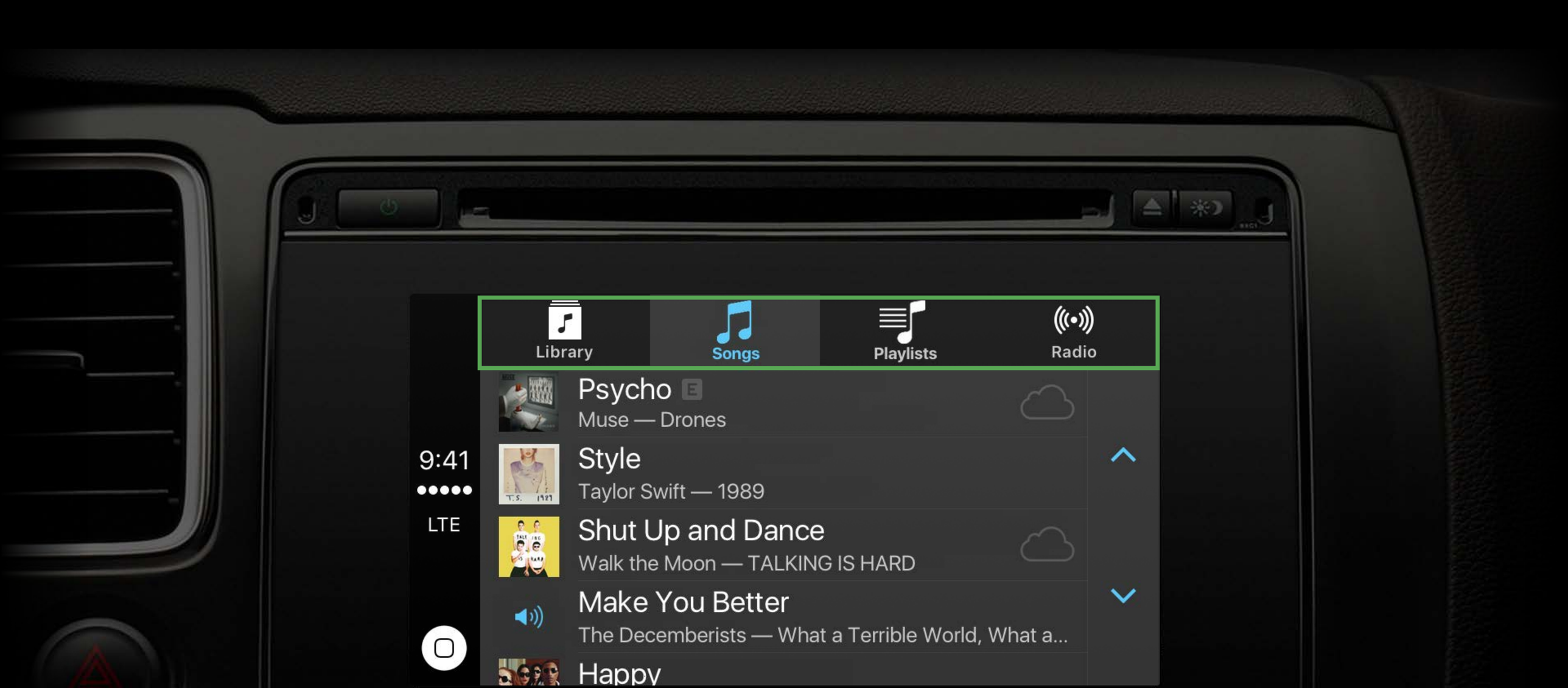
Shuffle and Repeat playback options

Additional information in list and Now Playing screens

- Mark media as currently playing, streaming, explicit, or a live stream

Support for apps with no list screen

Library
Songs
Playlists
Radio
9:41
LTE
Psycho E
Muse — Drones
Style
Taylor Swift — 1989
Shut Up and Dance
Walk the Moon — TALKING IS HARD
Make You Better
The Decemberists — What a Terrible World, What a...
Happy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Happy

9:41
LTE
Back
YourAudioApp — 4 of 7
Make You Better
The Decemberists — What a Terrible World, What a Beautiful World
0:04
-5:03

Back
YourAudioApp — 4 of 7
Make You Better
The Decemberists — What a Terrible World, What a Beautiful World
9:41
LTE
0:04
-5:03

9:41
LTE
Back
YourAudioApp — 4 of 7
Make You Better
The Decemberists — What a Terrible World, What a Beautiful World
0:04
-5:03

Automaker Apps

Appear only in compatible cars

Published by the automaker

Require a CarPlay entitlement

Automakers should contact Apple for more details

Automaker Apps

What's new in iOS 10

NEW

Appear only in compatible cars

Published by the automaker

Require a CarPlay entitlement

Automakers should contact Apple for more details

Support for Siri

Declare Compatibility

Choose appropriate protocol names

External Accessory protocol names determine which apps appear in which cars

Cars may declare multiple protocol names for different use cases

Include a protocol name to match all cars

- `com.brand`

Include protocol names to match cars with specific features

- `com.brand.feature`

Include protocol names to match specific car models

- `com.brand.model`

Declare Compatible Vehicles

In the car

Implement the following in iAP2 IdentificationInformation

- Declare at least one `SupportedExternalAccessoryProtocol`
- Declare support for `StartExternalProtocolSession` and `StopExternalProtocolSession`
- Set `ExternalAccessoryProtocolCarPlay` to true
- Implement on all supported transports (USB, Bluetooth and CarPlay)

If your automaker app communicates with the car to perform tasks

- Implement a communication protocol using External Accessory protocol

Declare Compatible Vehicles

In the app's Entitlements.plist

Match all cars

```
<key>com.apple.developer.carplay-protocols</key>
<array>
<string>com.brand</string>
</array>
```

Match only a specific feature

```
<key>com.apple.developer.carplay-protocols</key>
<array>
<string>com.brand.feature</string>
</array>
```

Messaging Apps

NEW

New in iOS 10

CarPlay enabled messaging apps appear on the CarPlay home screen

Interaction is driven by Siri

Require a CarPlay entitlement

Summary

CarPlay is a smarter, safer way to use your iPhone in the Car

Be future-ready

Follow the design guidelines for the best experience

Detailed specifications available through the MFi Program

http://developer.apple.com/mfi

More Information

https://developer.apple.com/wwdc16/722

Related Sessions

Developing CarPlay Systems, Part 2	Video Only

Labs

CarPlay Lab	Frameworks Lab B	Wednesday 3:30PM
Accessories Lab	Frameworks Lab C	Wednesday 1:00PM
Accessories Lab	Frameworks Lab C	Friday 9:00AM

WWDC16