

# Developing CarPlay Systems, Part 1

Session 722

Emily Schubert Engineering Manager, Car Experience

# 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

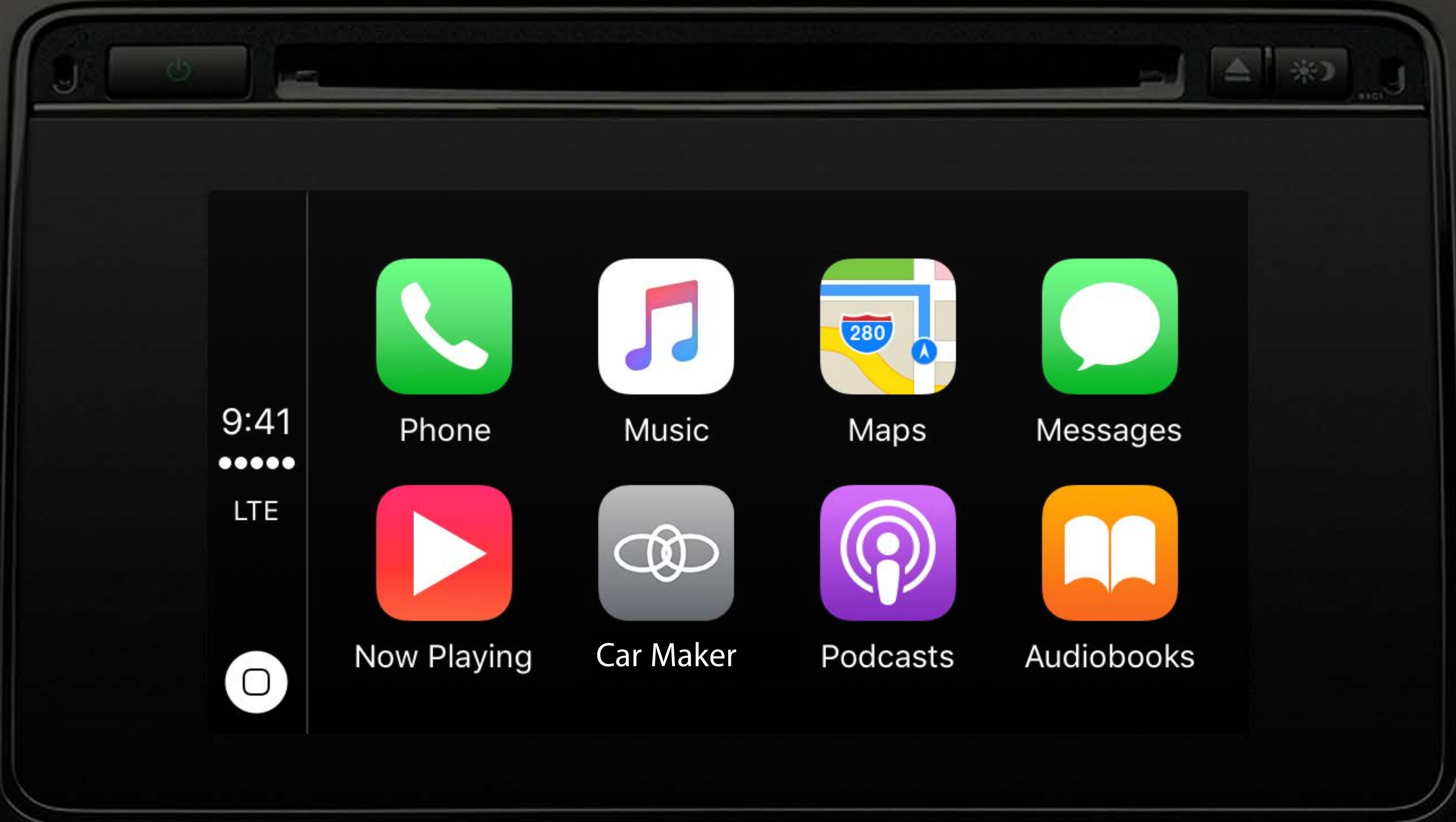
How CarPlay Works

Key Vehicle Requirements

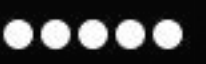
Design Guidelines

Supported Apps





9:41



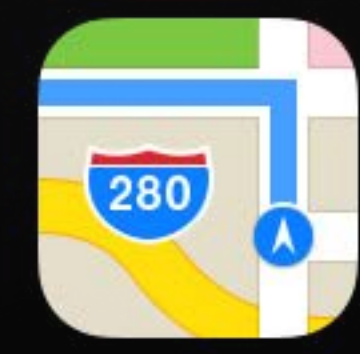
LTE



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

# iPhone



# Car

# iPhone



# Car

# iPhone



Communication  
Protocols



# Car

# iPhone



Communication  
Protocols



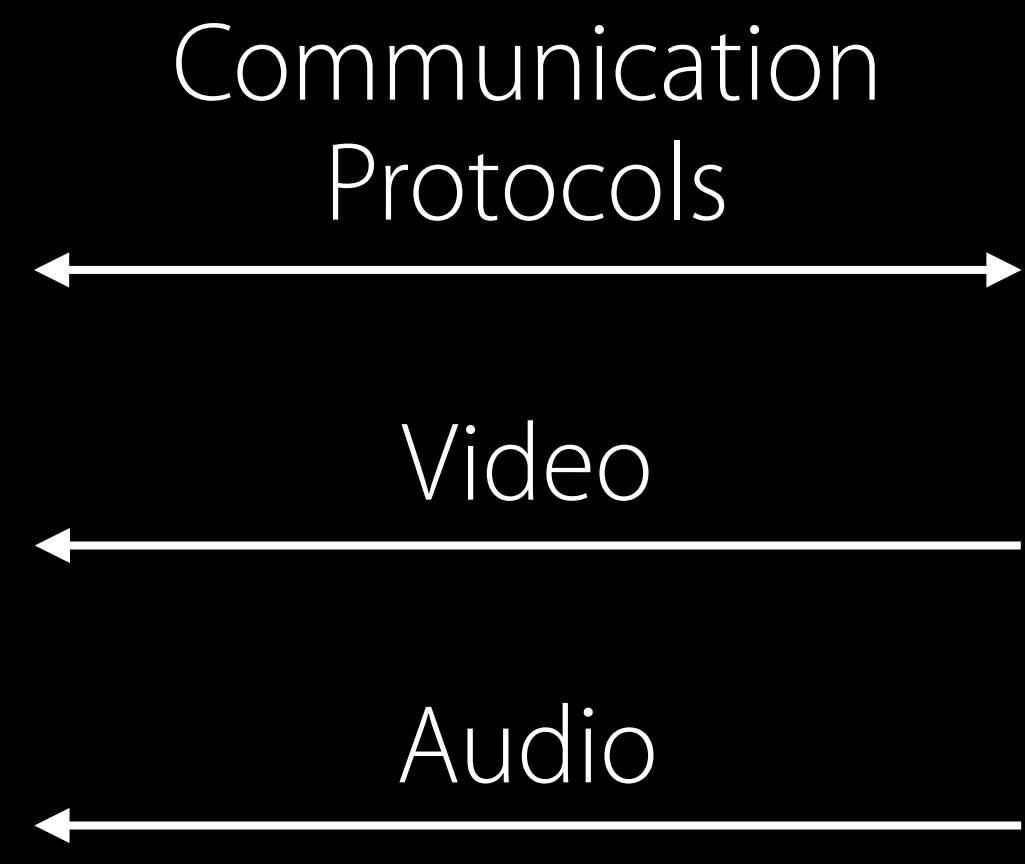
Video





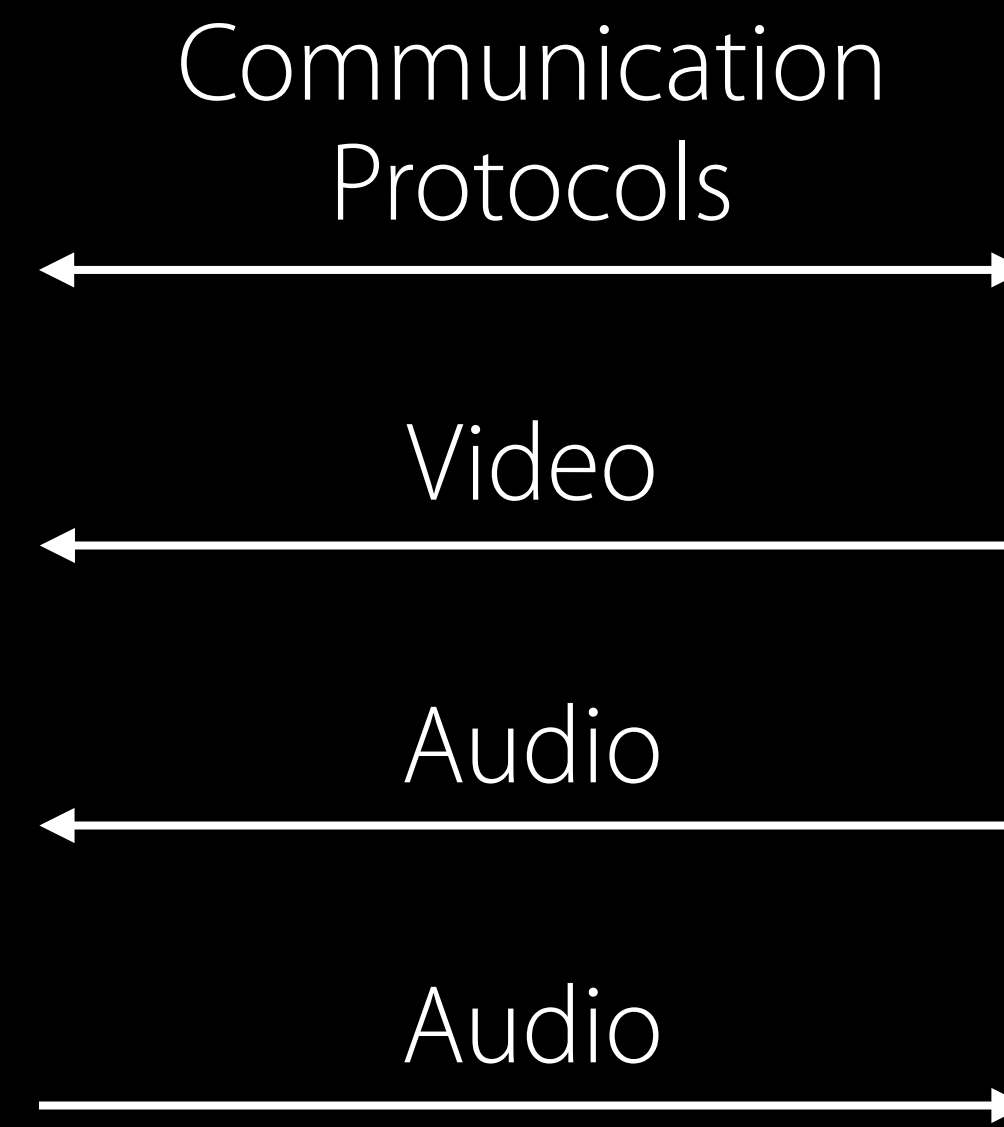
# Car

# iPhone



# Car

# iPhone



# Car

# iPhone



# Car

# iPhone



Communication  
Protocols



Video



Audio



Audio



Car

iPhone



# Car

# iPhone



Communication  
Protocols



Video



Audio



Audio



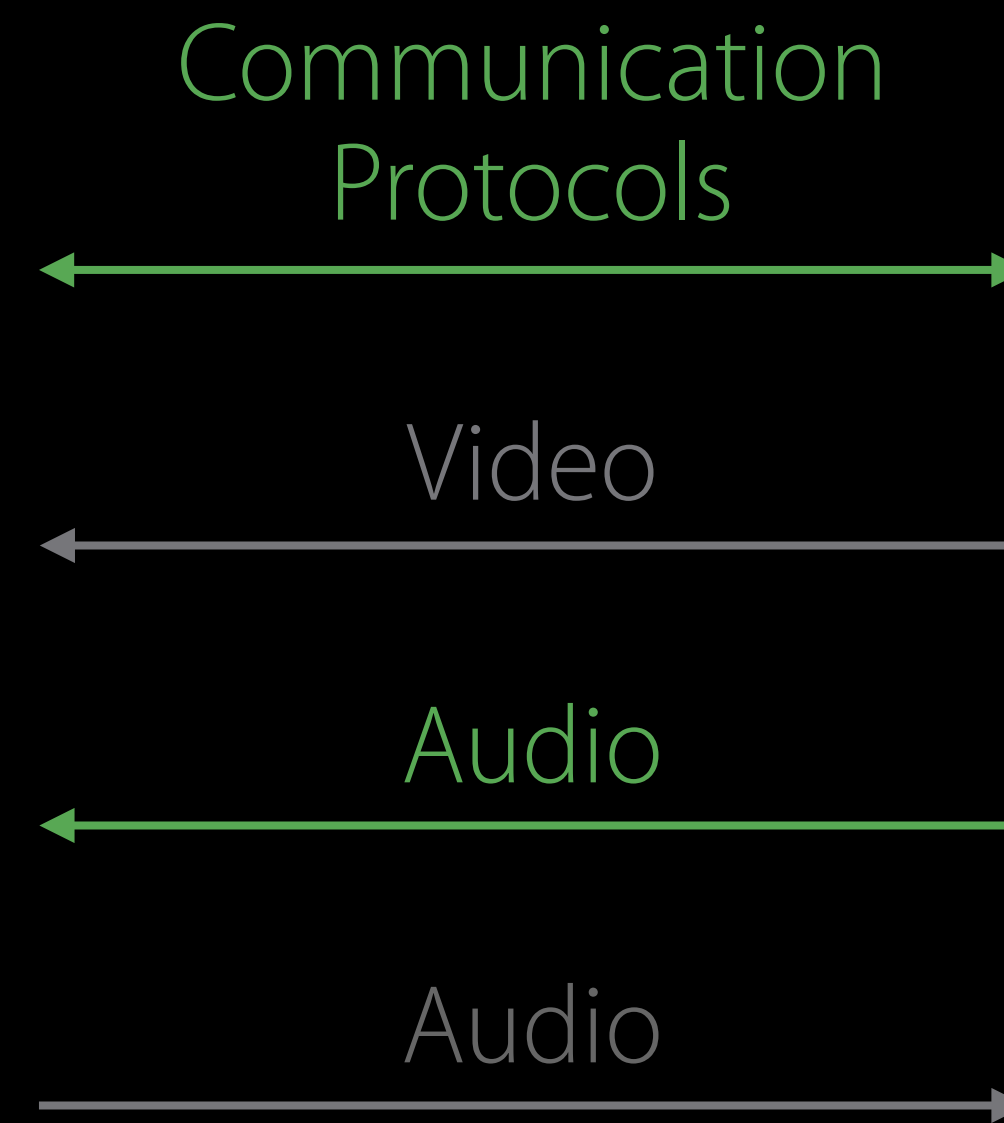
# Car

# iPhone



# Car

# iPhone





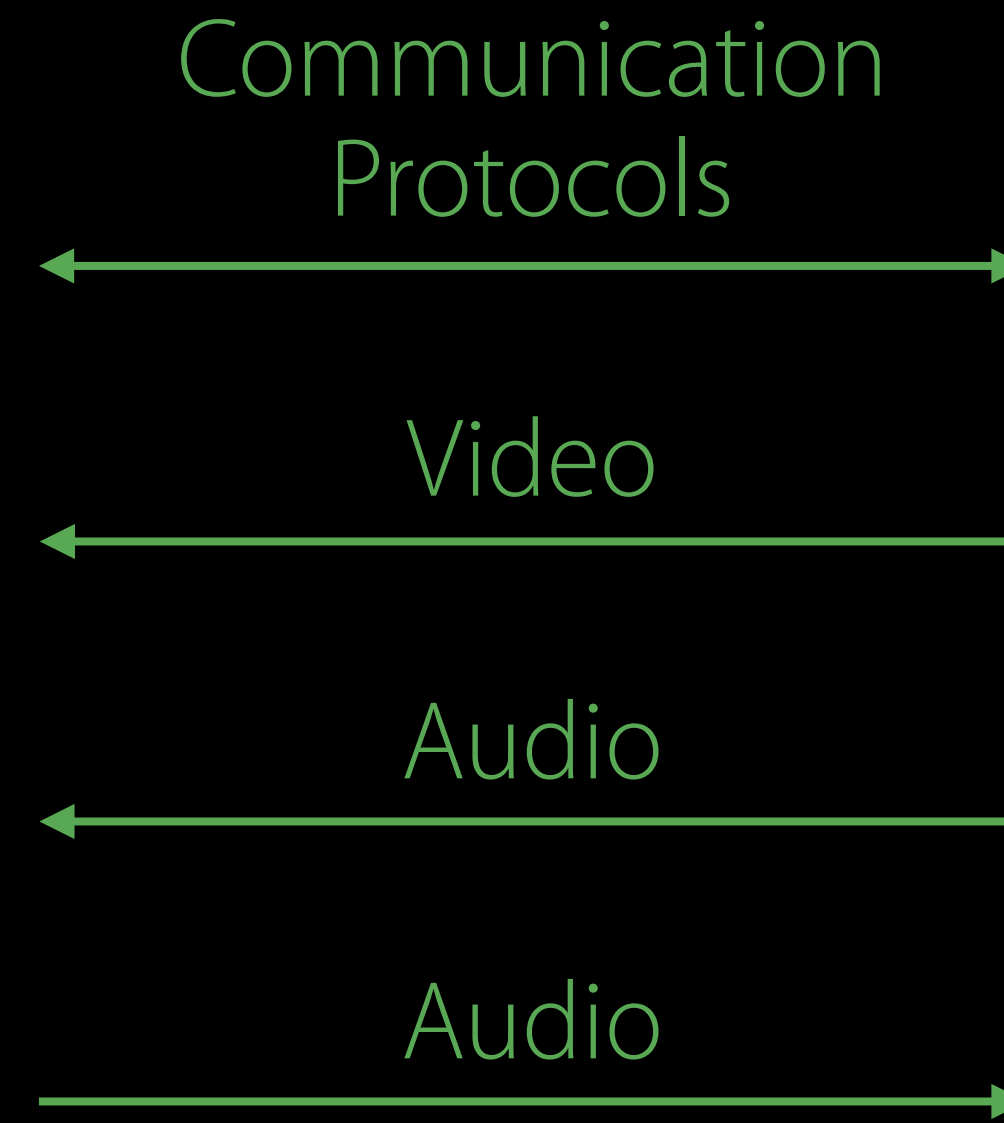
Car

iPhone



# Car

# iPhone



# Car

# iPhone



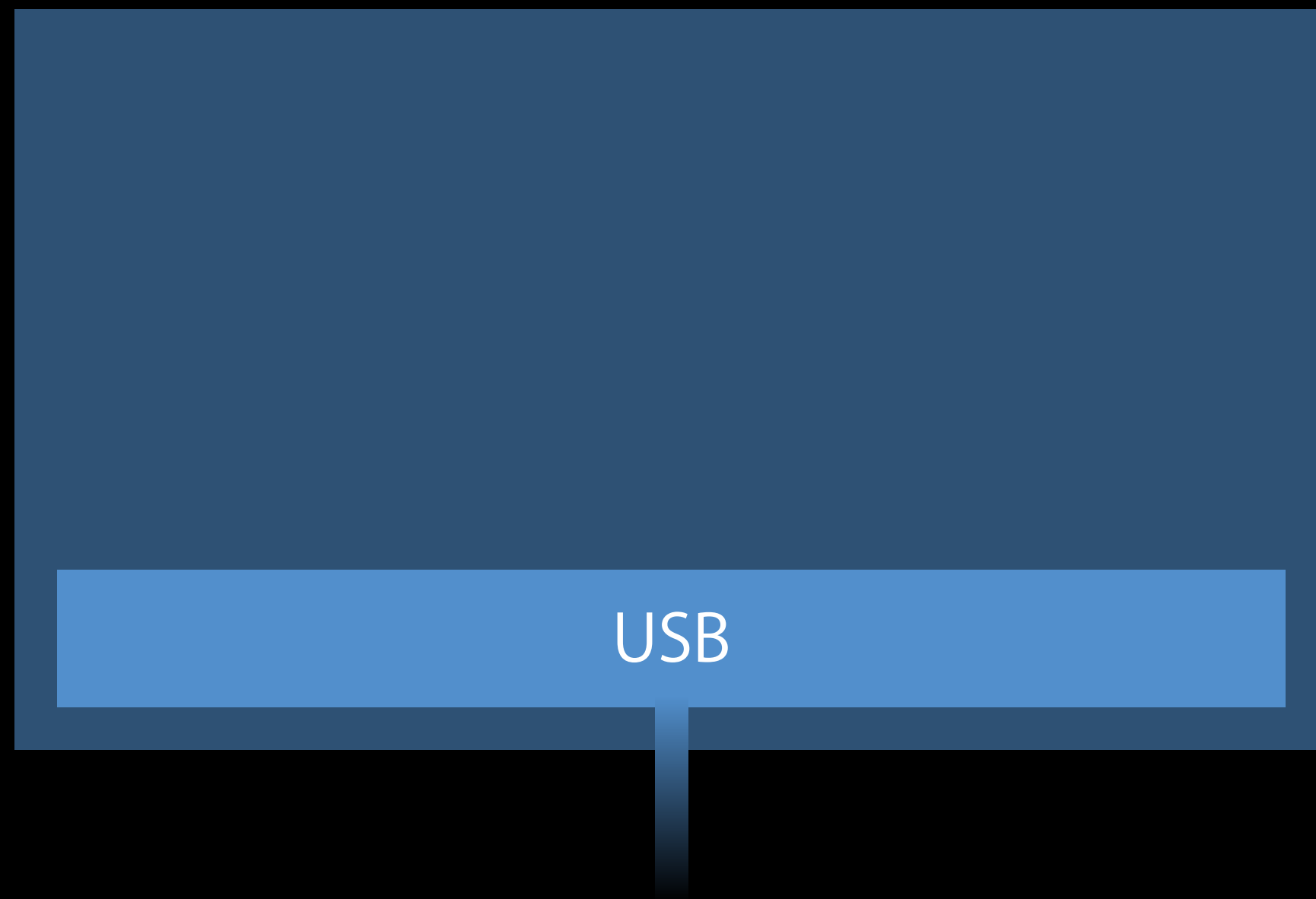
Car

iPhone



Car

iPhone

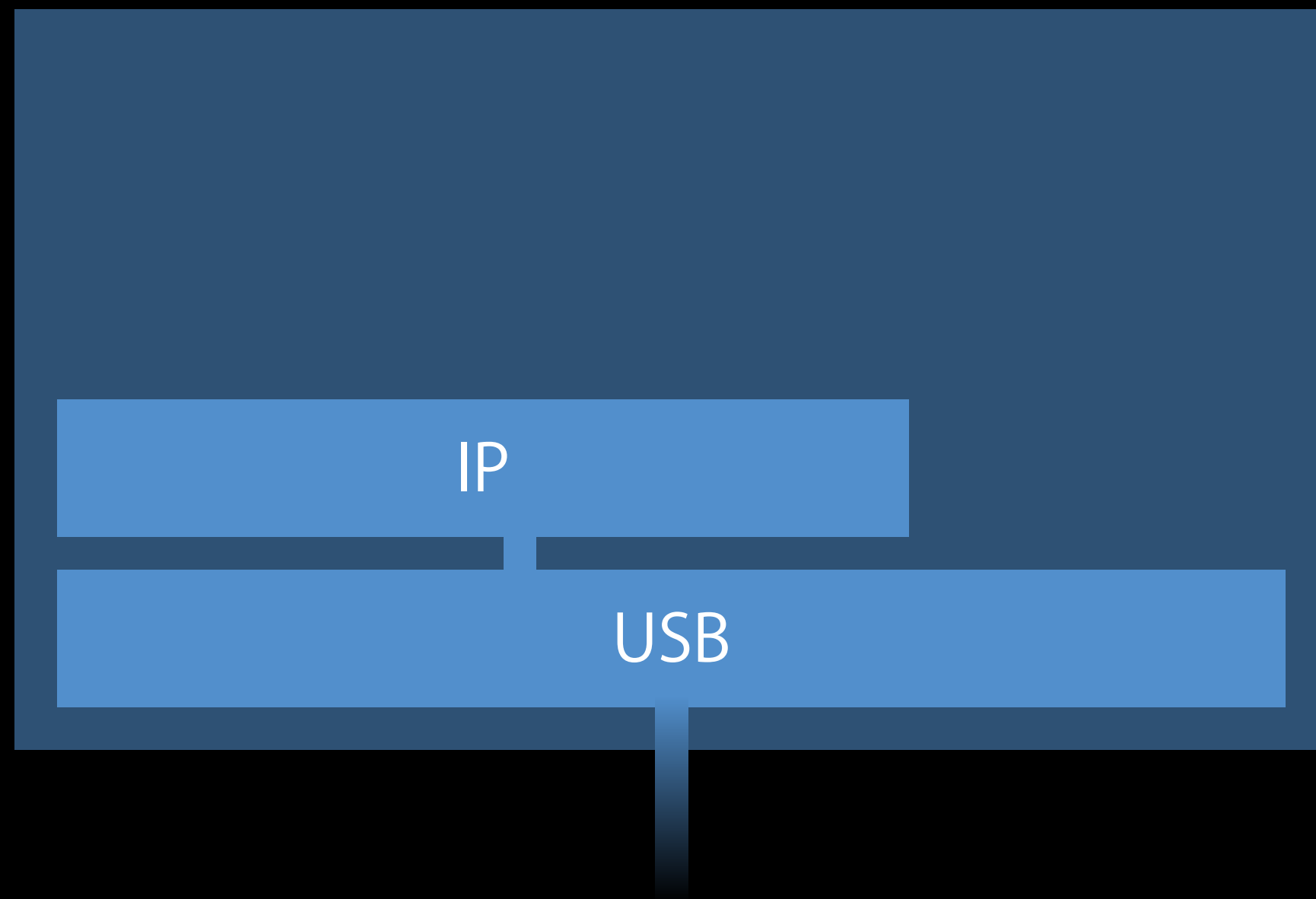


Wired Connection to iPhone



# Car

# iPhone

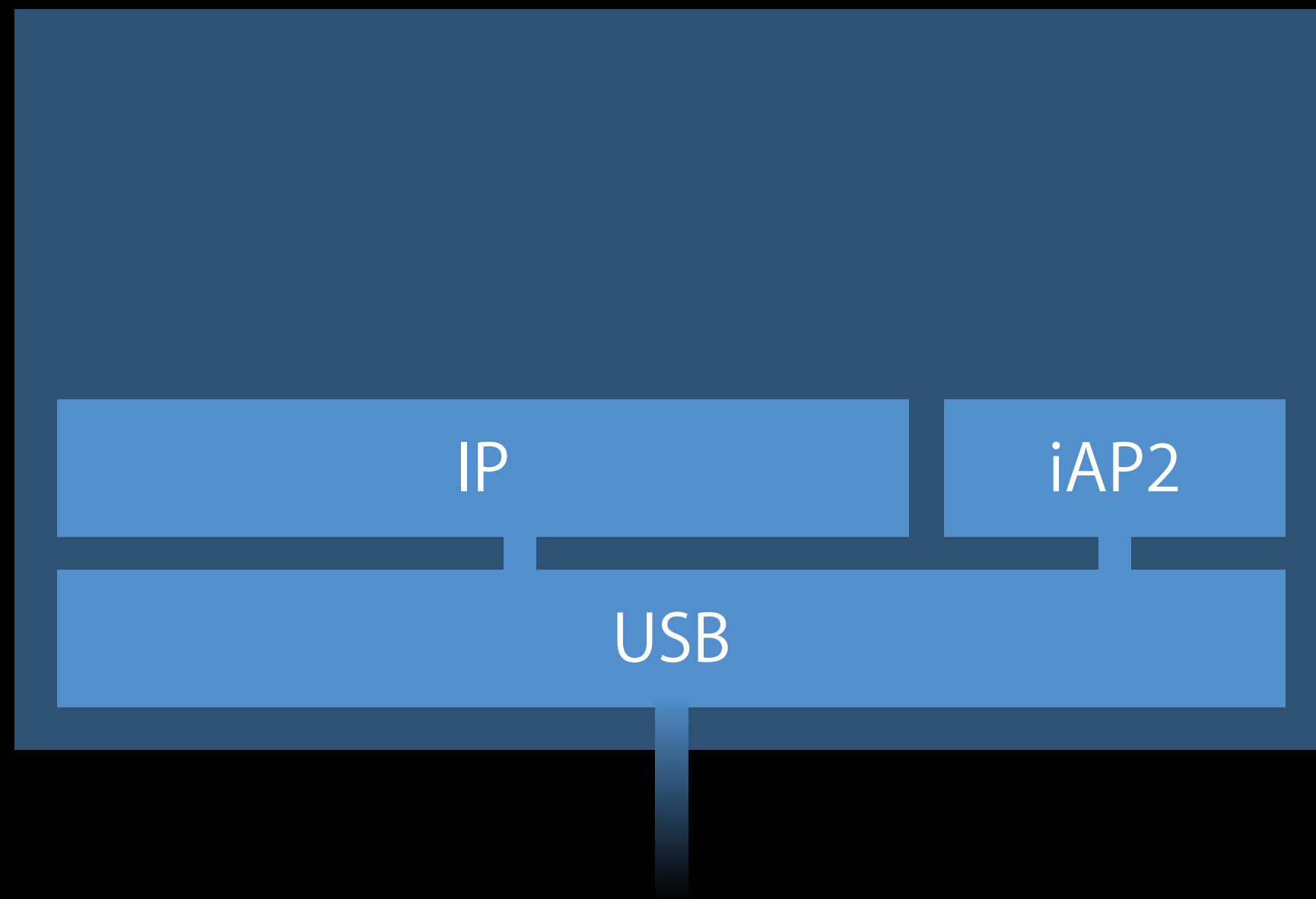


Wired Connection to iPhone



# Car

# iPhone

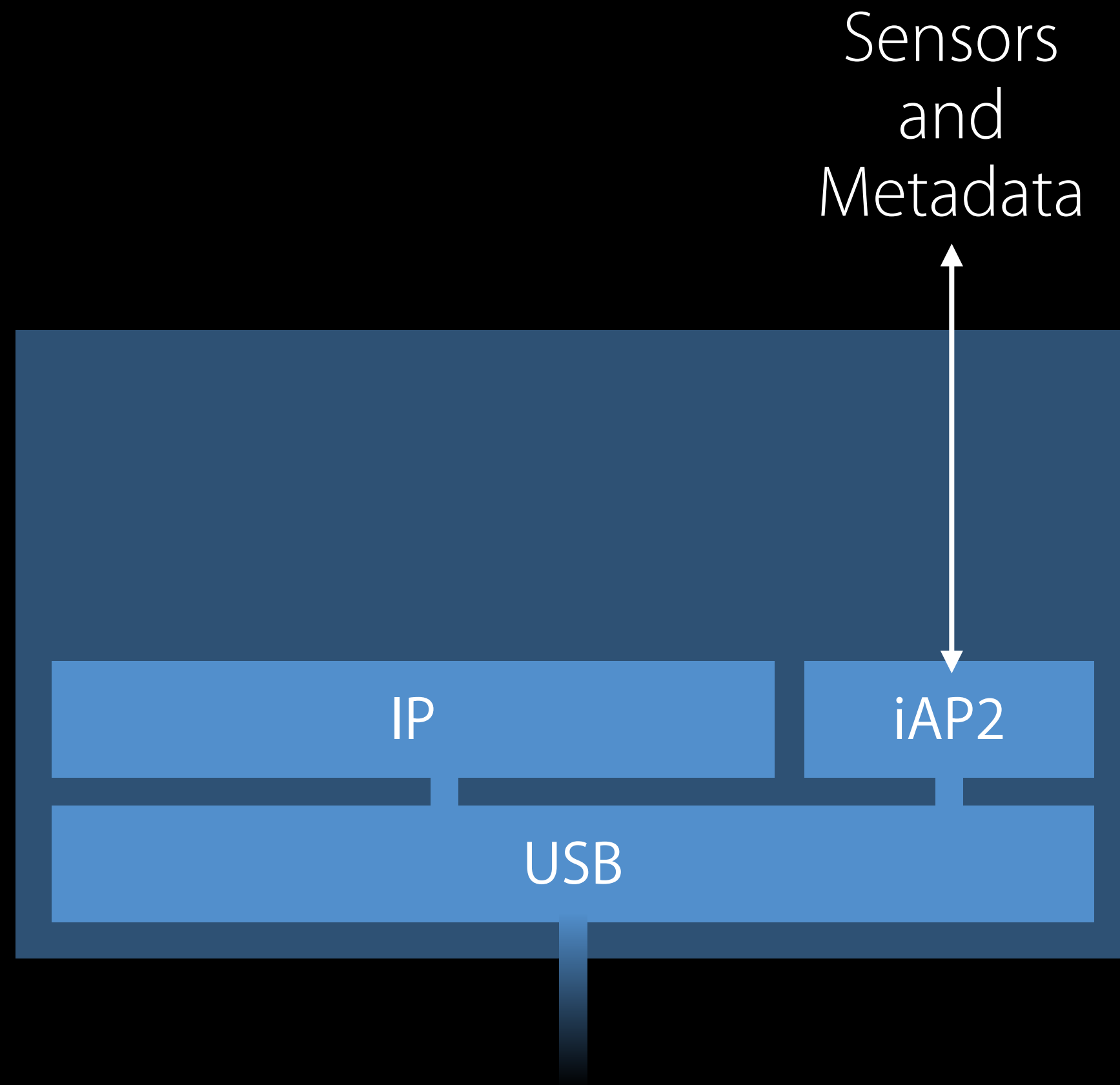


Wired Connection to iPhone



# Car

# iPhone



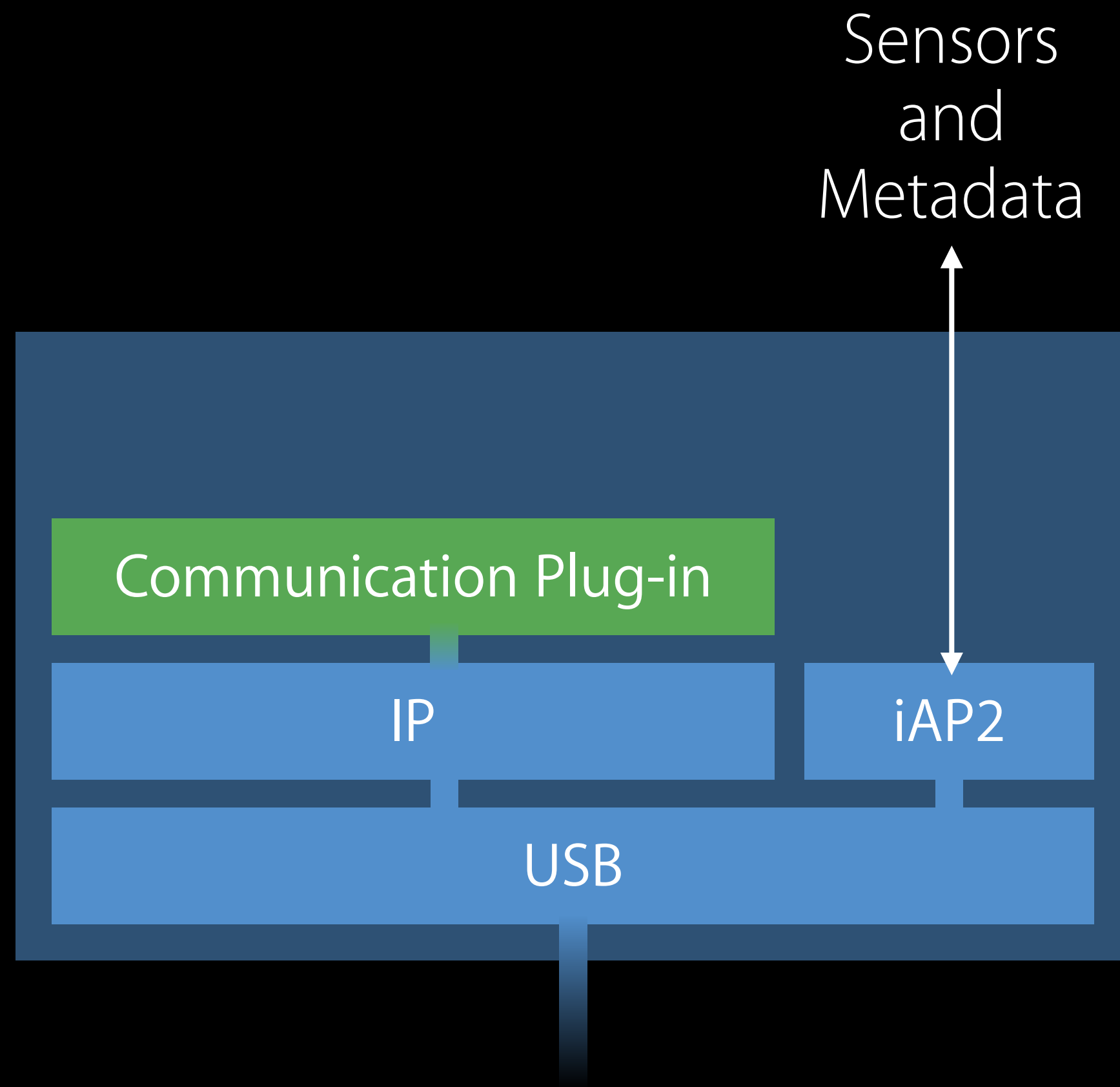
Wired Connection to iPhone





# Car

# iPhone

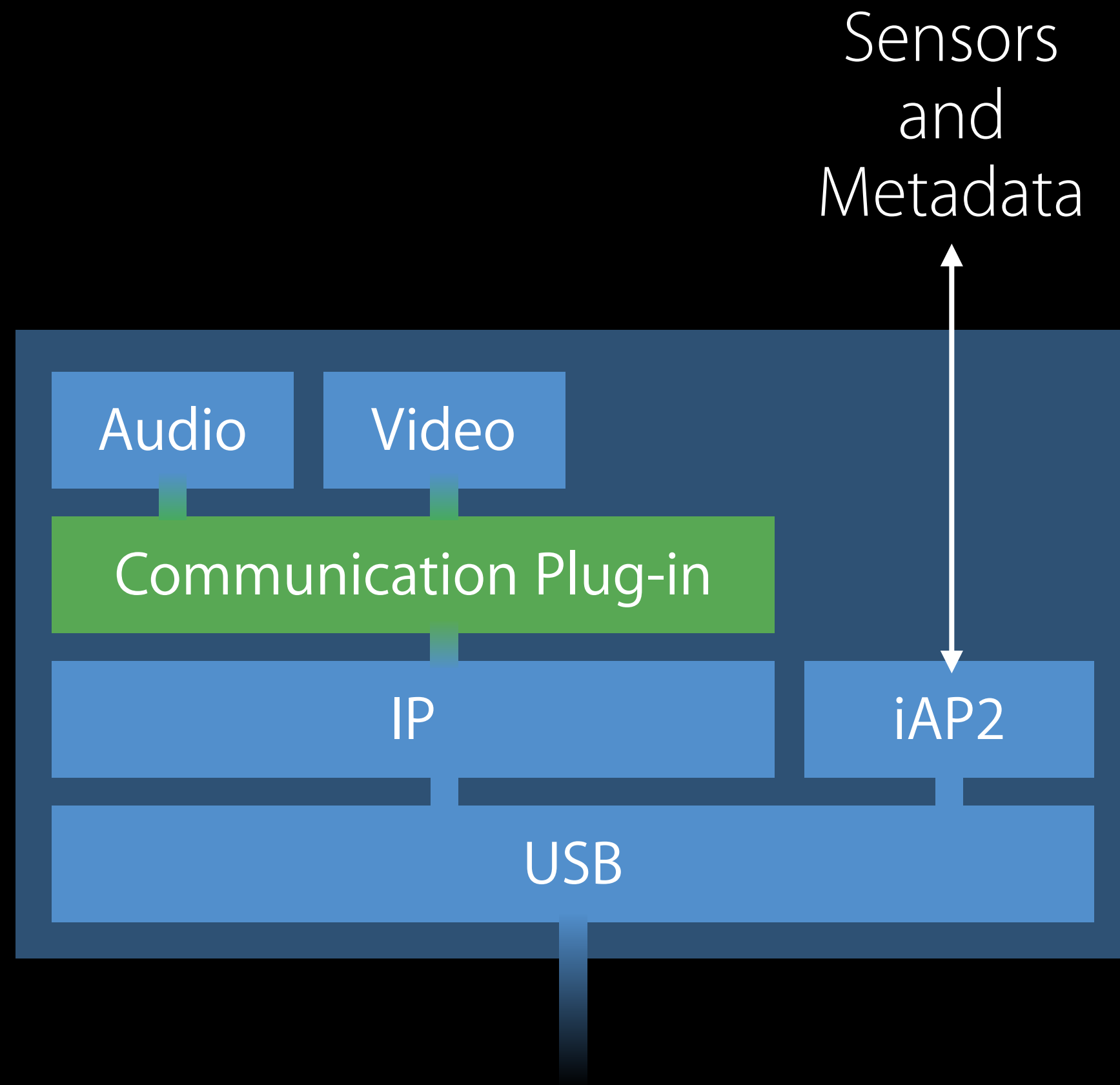


Wired Connection to iPhone



# Car

# iPhone

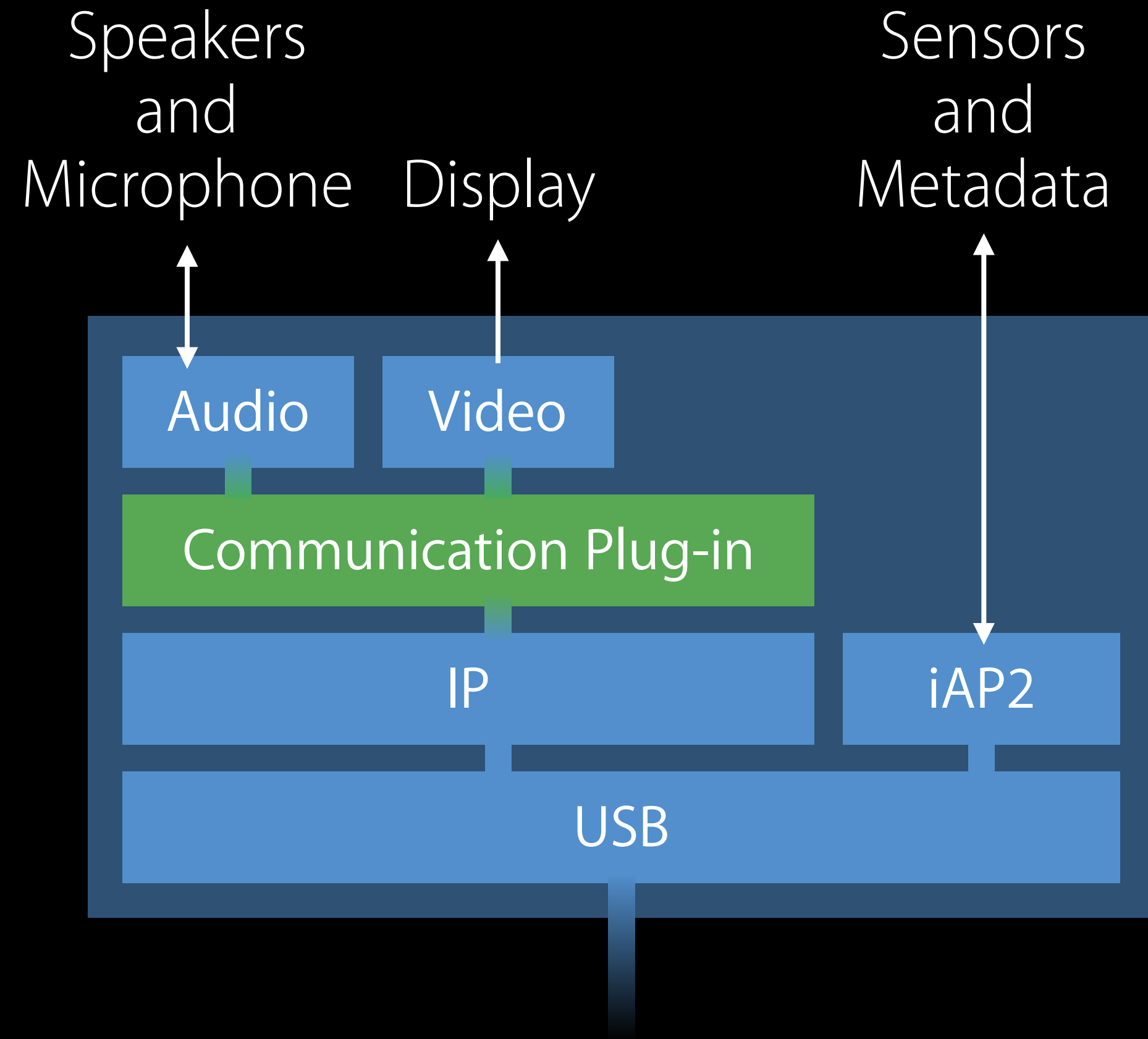


Wired Connection to iPhone



# Car

# iPhone

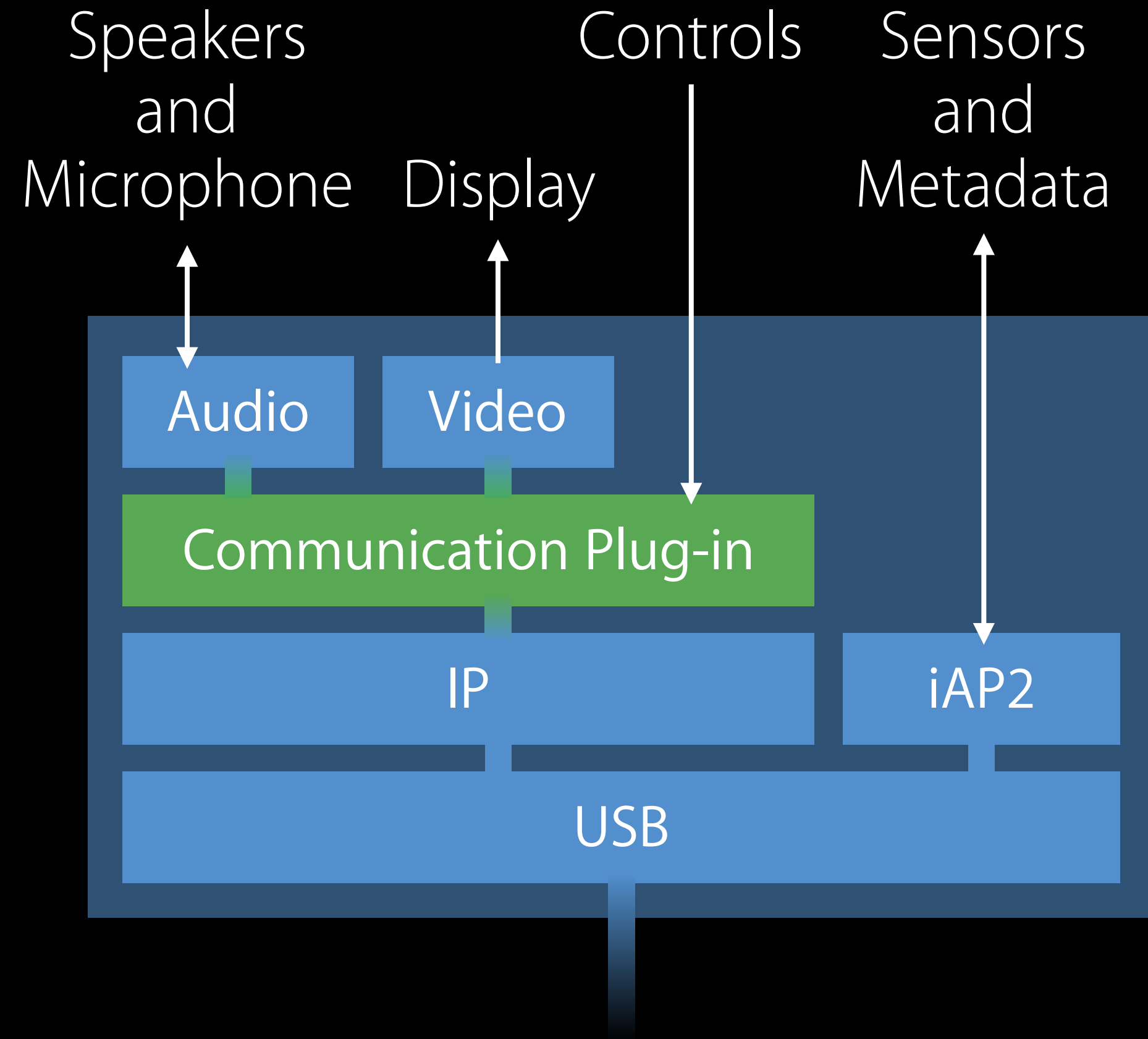


Wired Connection to iPhone



# Car

# iPhone

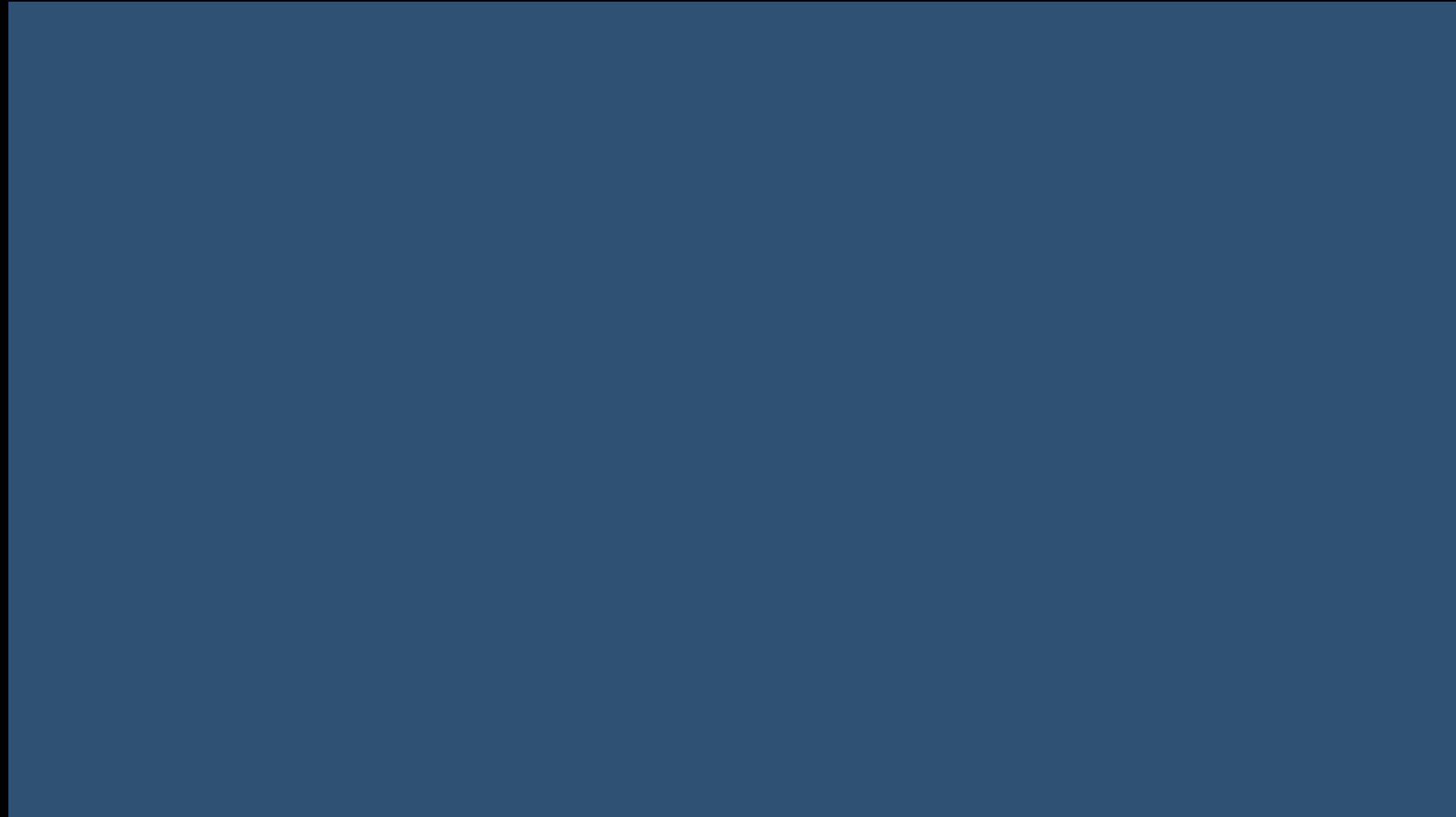


Wired Connection to iPhone



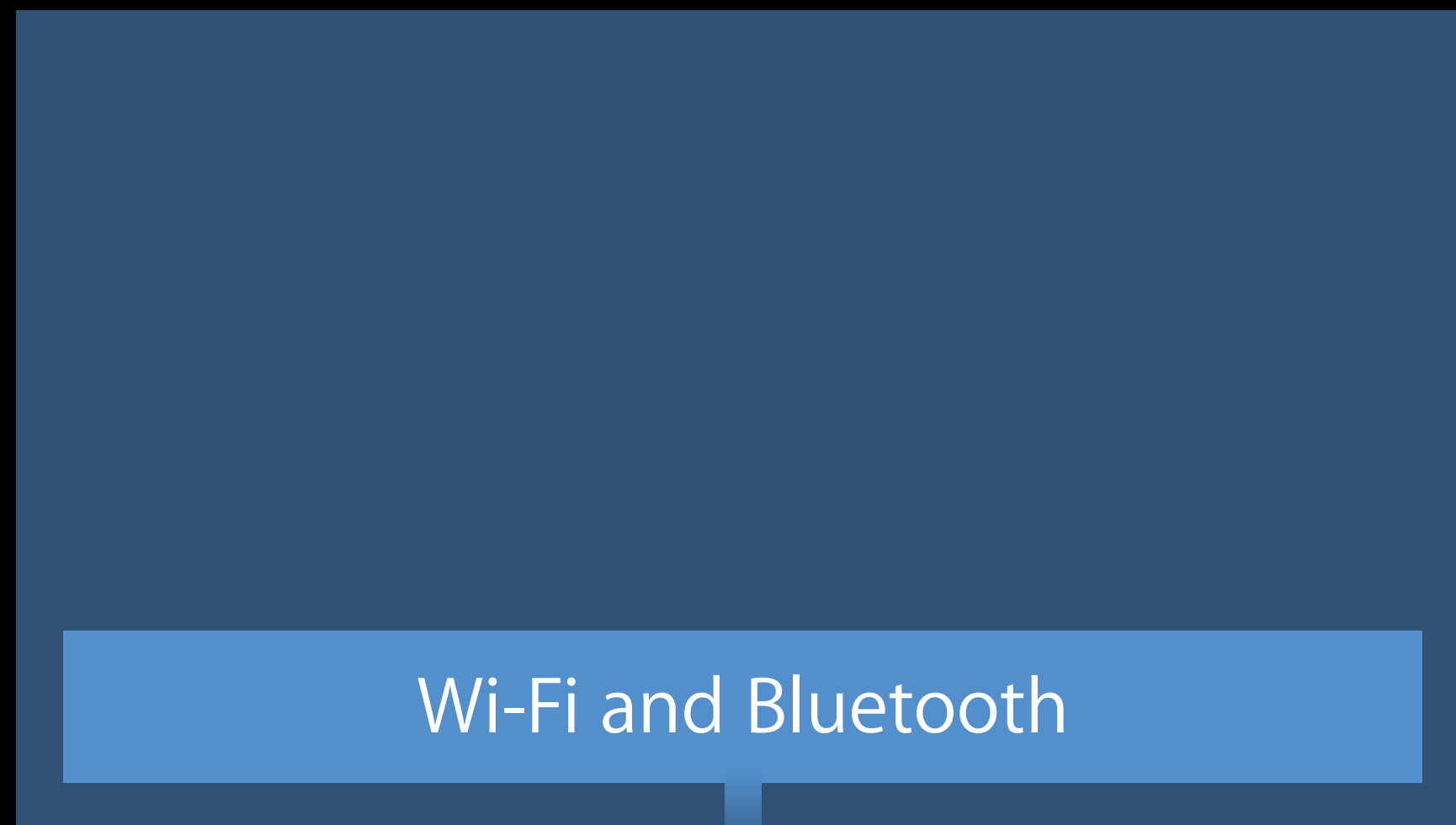
Car

iPhone



Car

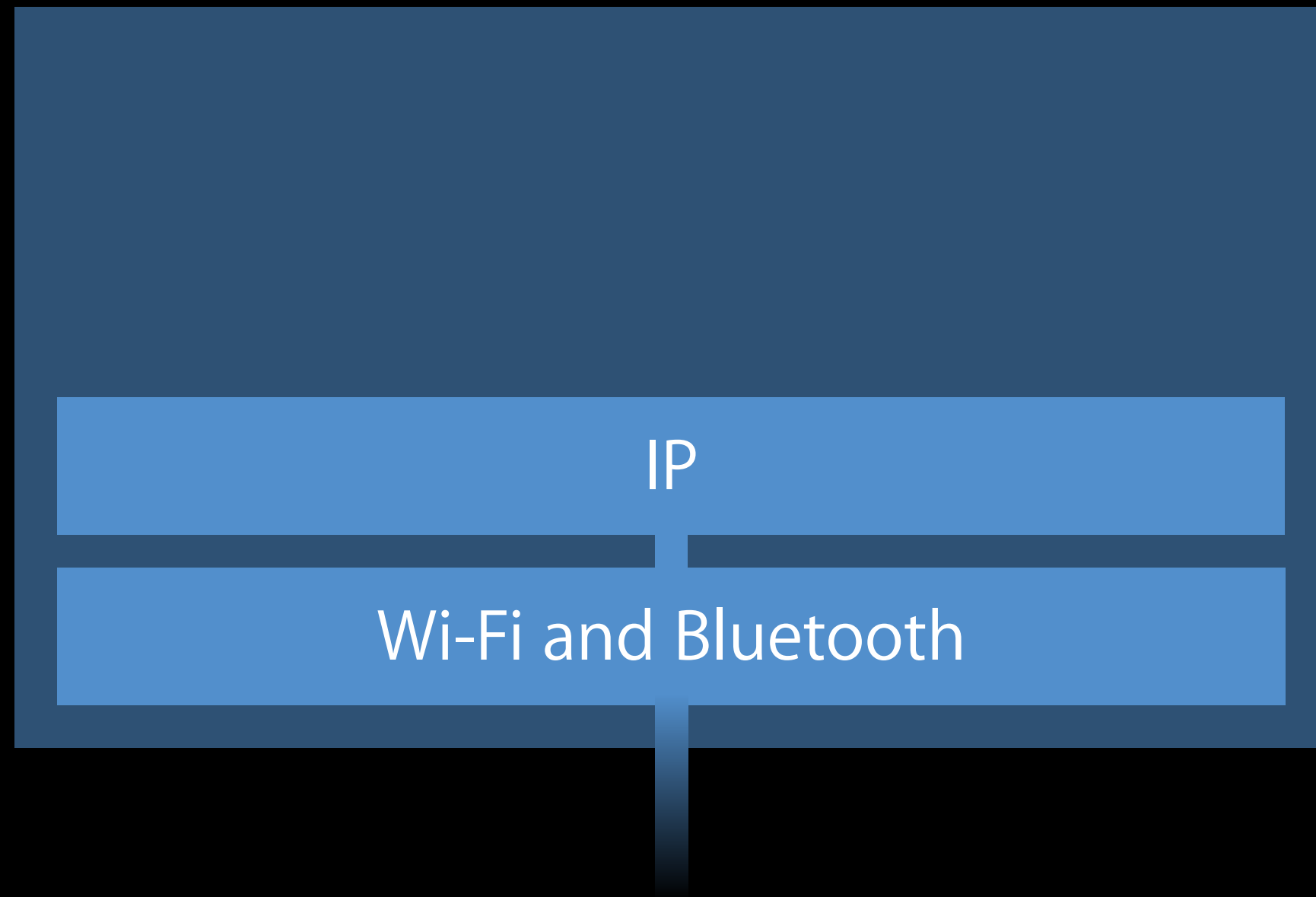
iPhone



Wireless Connection to iPhone

Car

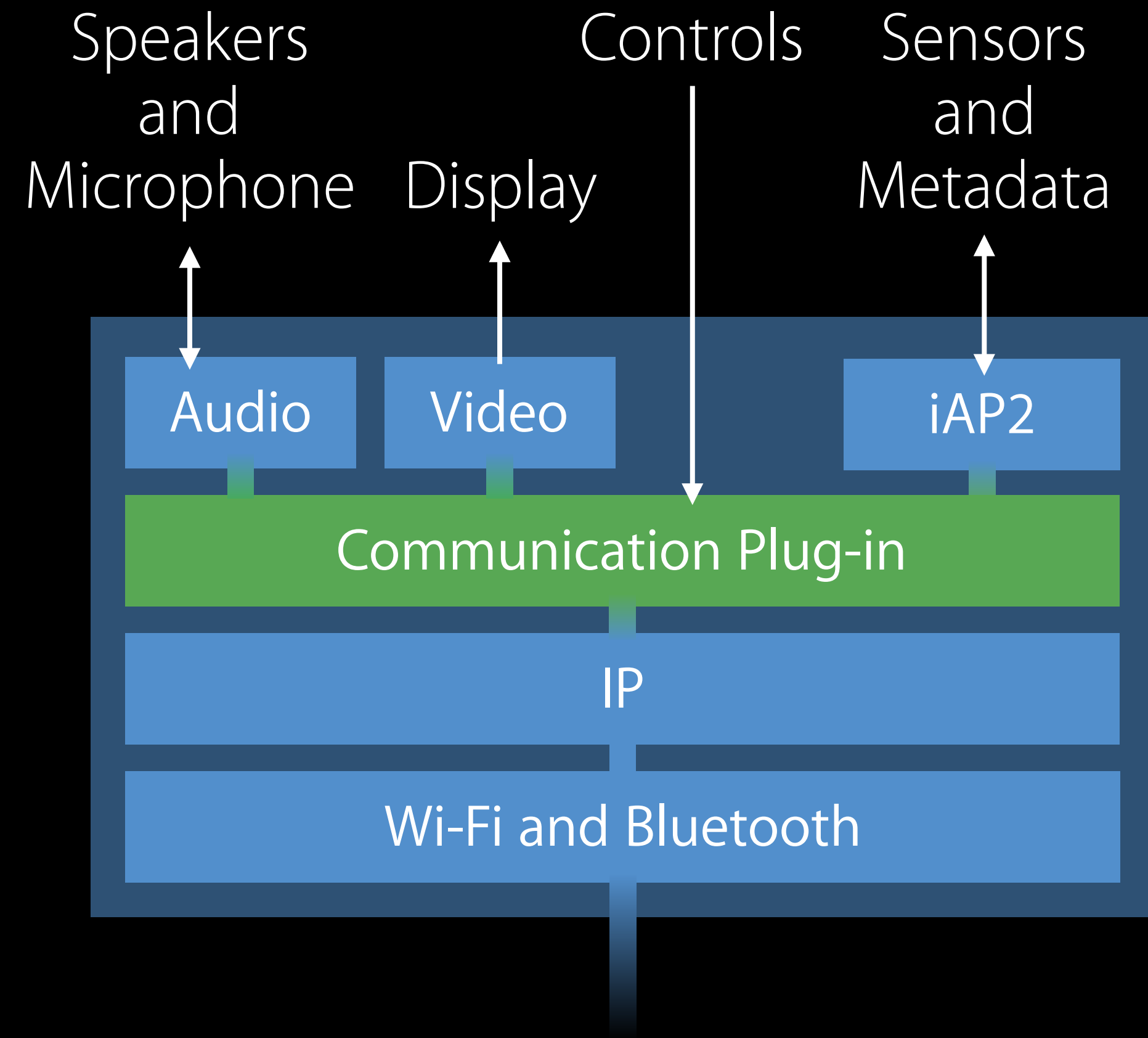
iPhone



Wireless Connection to iPhone

# Car

# iPhone



Wireless Connection to 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

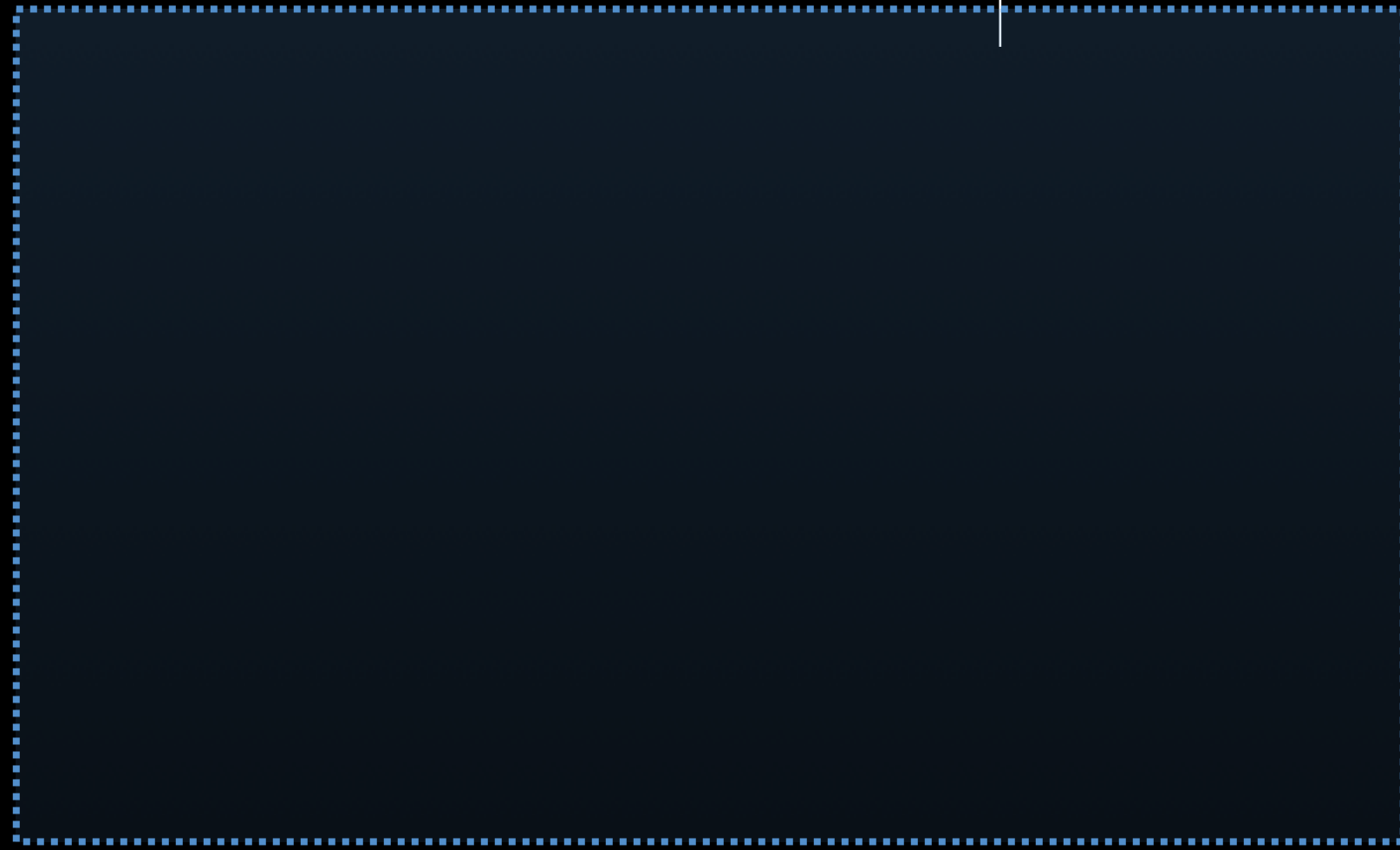
Sensors

Connection to iPhone

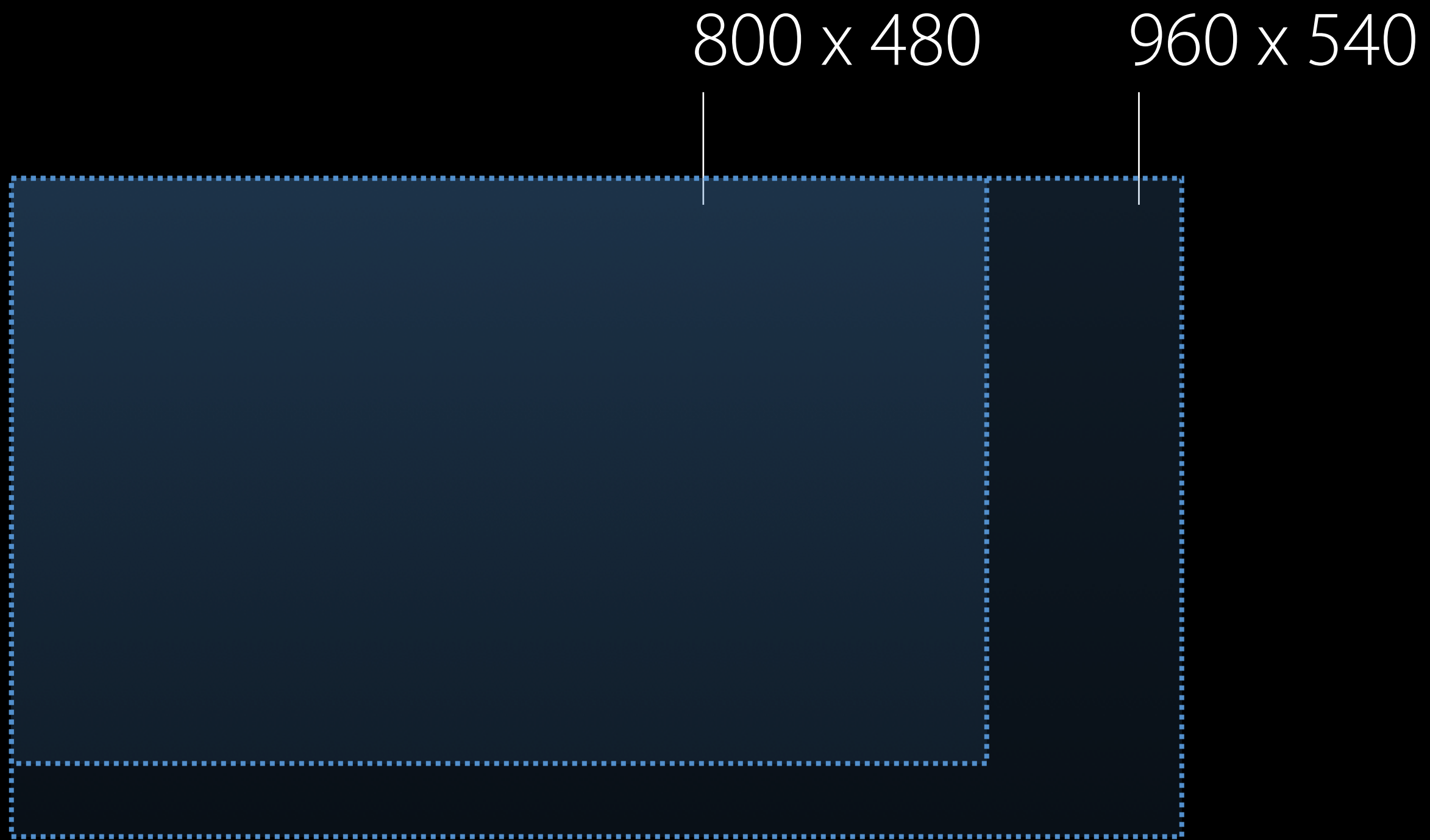
# Standard Display Resolutions

# Standard Display Resolutions

800 x 480



# Standard Display Resolutions

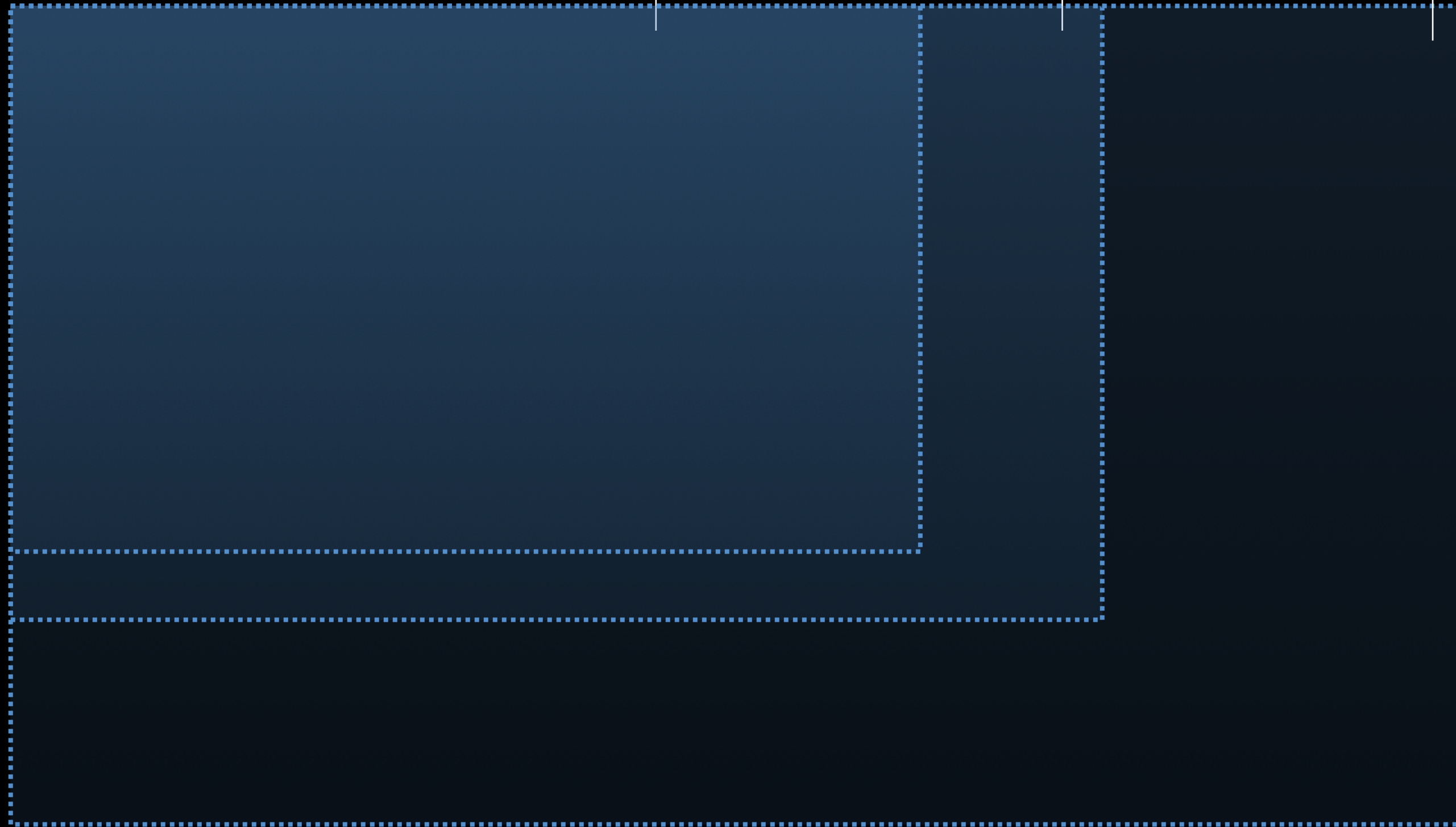


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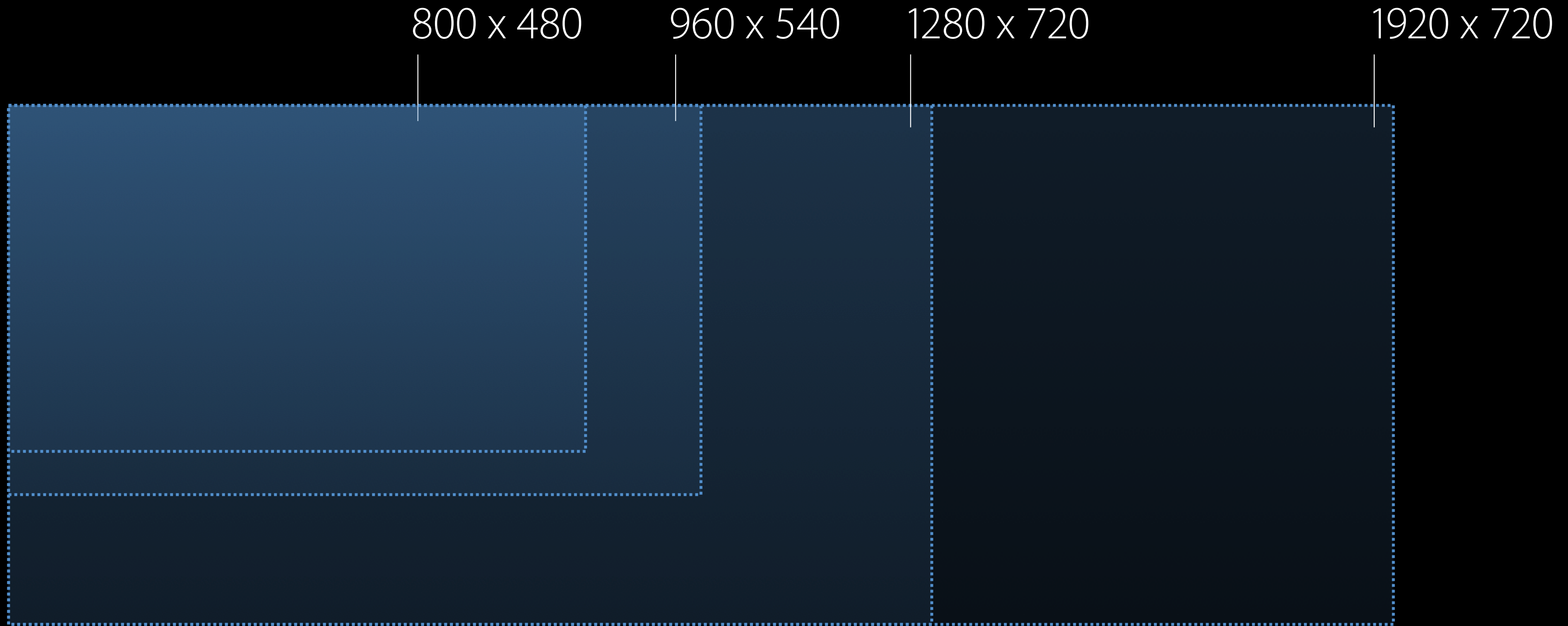
800 x 480

960 x 540

1280 x 720



# Standard Display Resolutions





# Pixel Density

800 x 480

960 x 540

1280 x 720

1920 x 720



# Pixel Density

Adjusted to similar physical display sizes

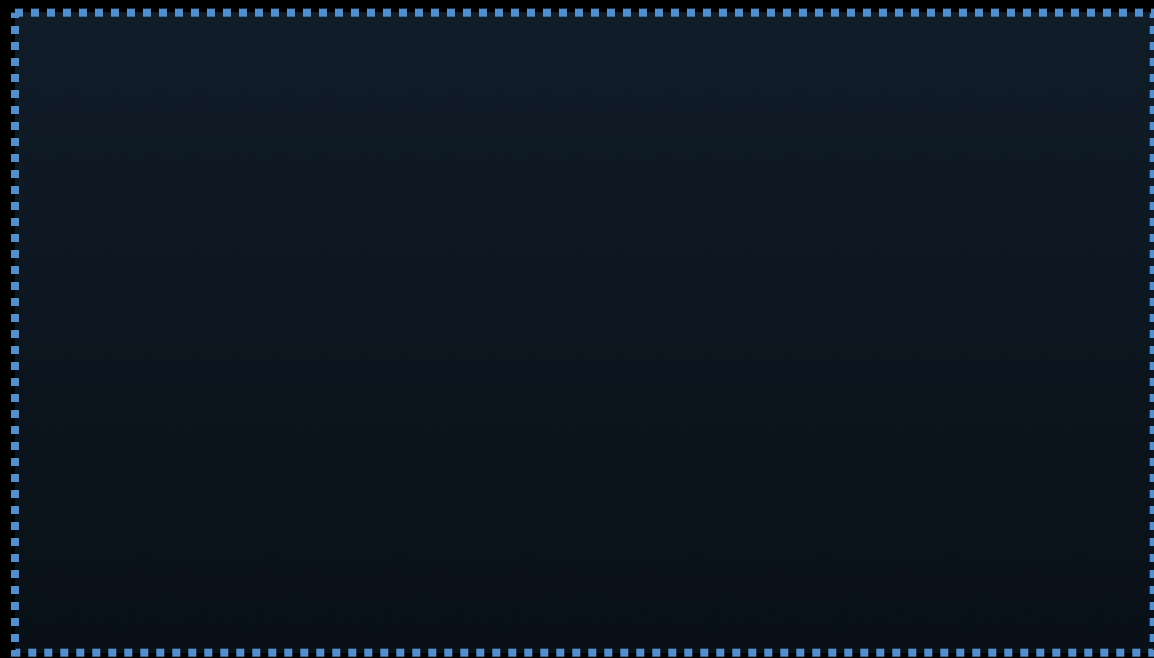
800 x 480



1280 x 720



960 x 540



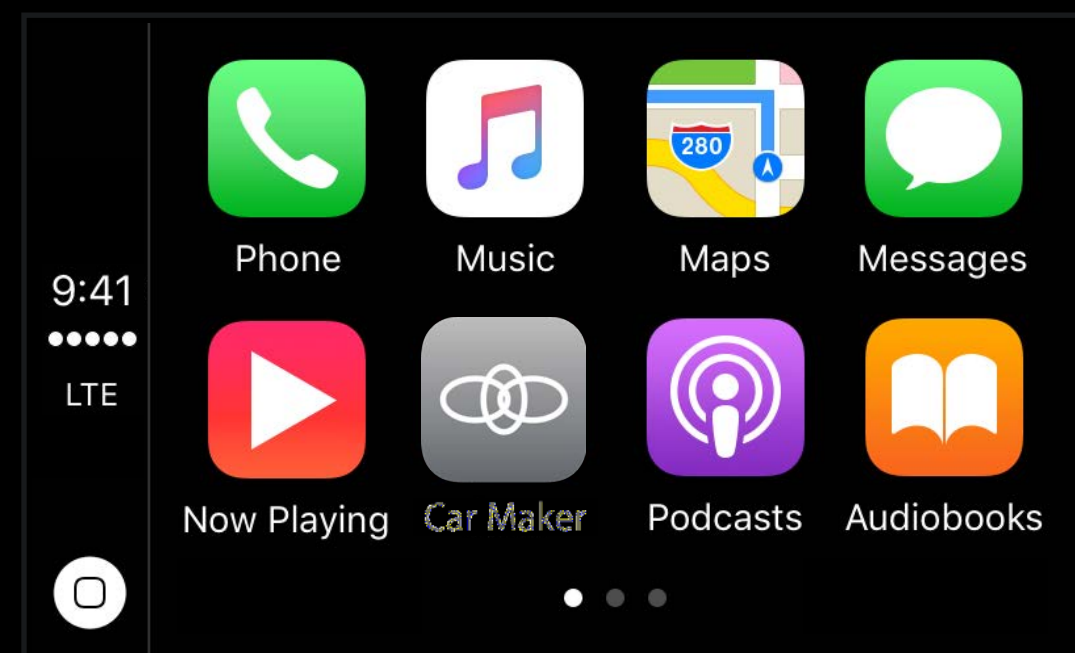
1920 x 720



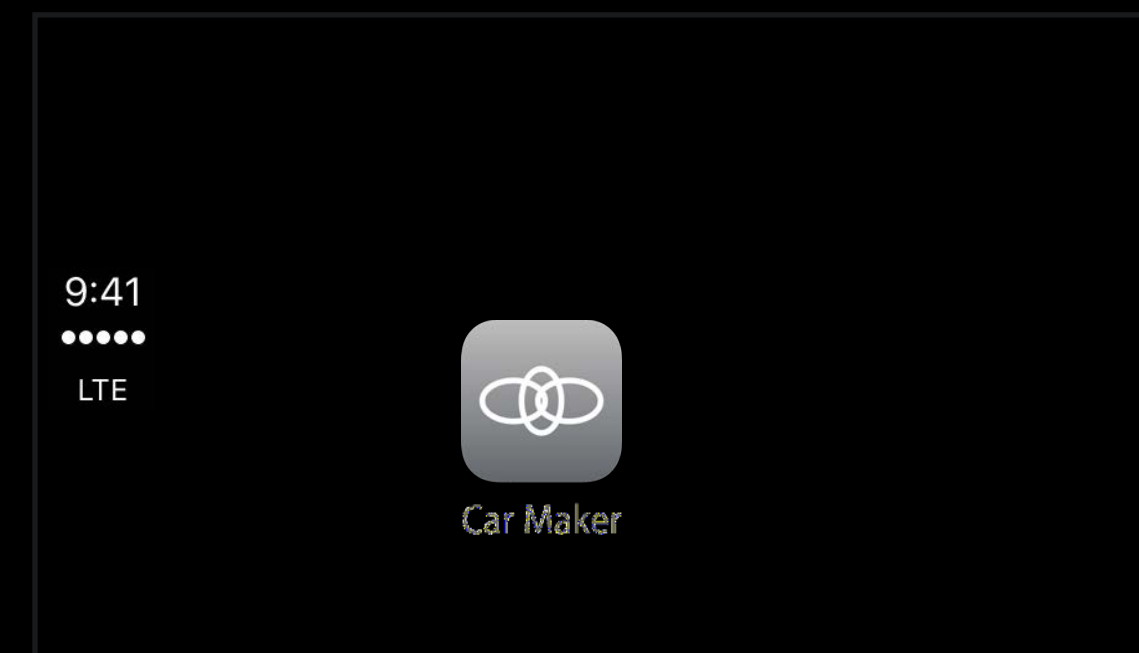
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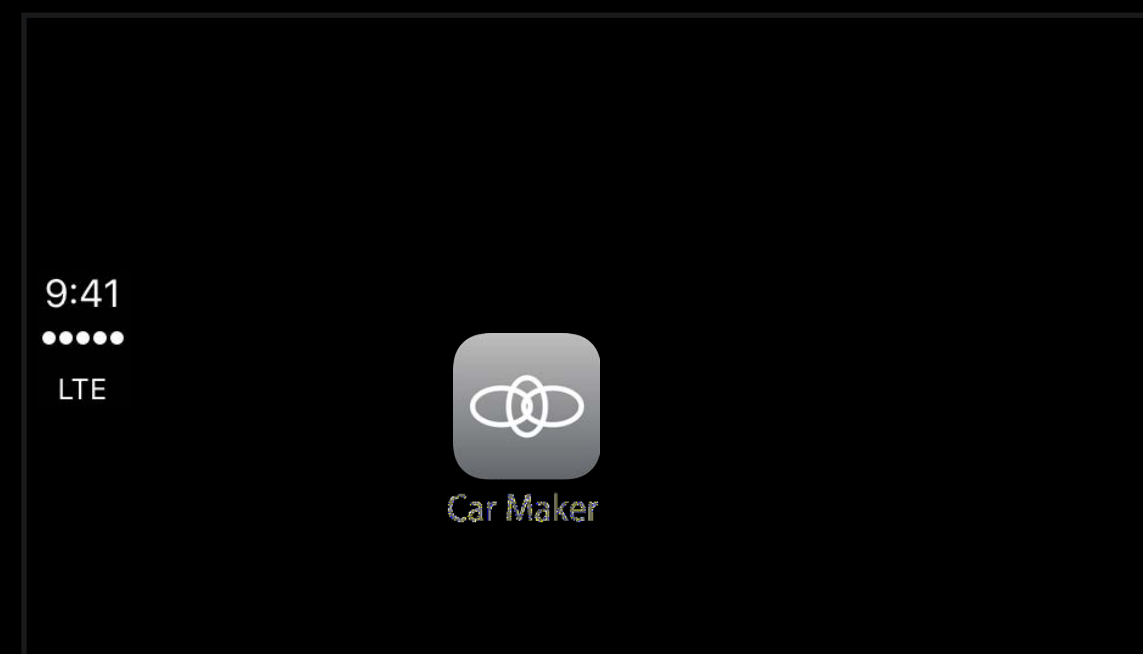
800 x 480



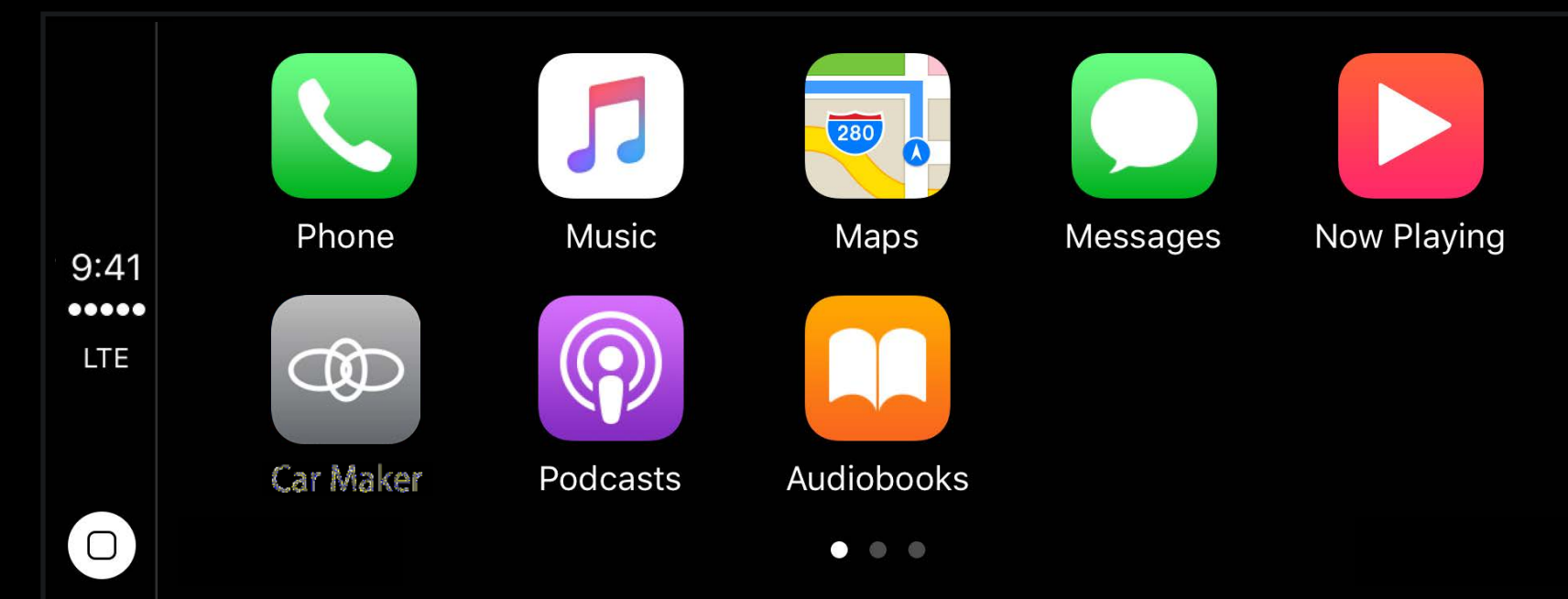
1280 x 720



960 x 540



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

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Touch



Knobs and Controls



Voice



Touch



Knobs and Controls



Voice

# Touchscreen

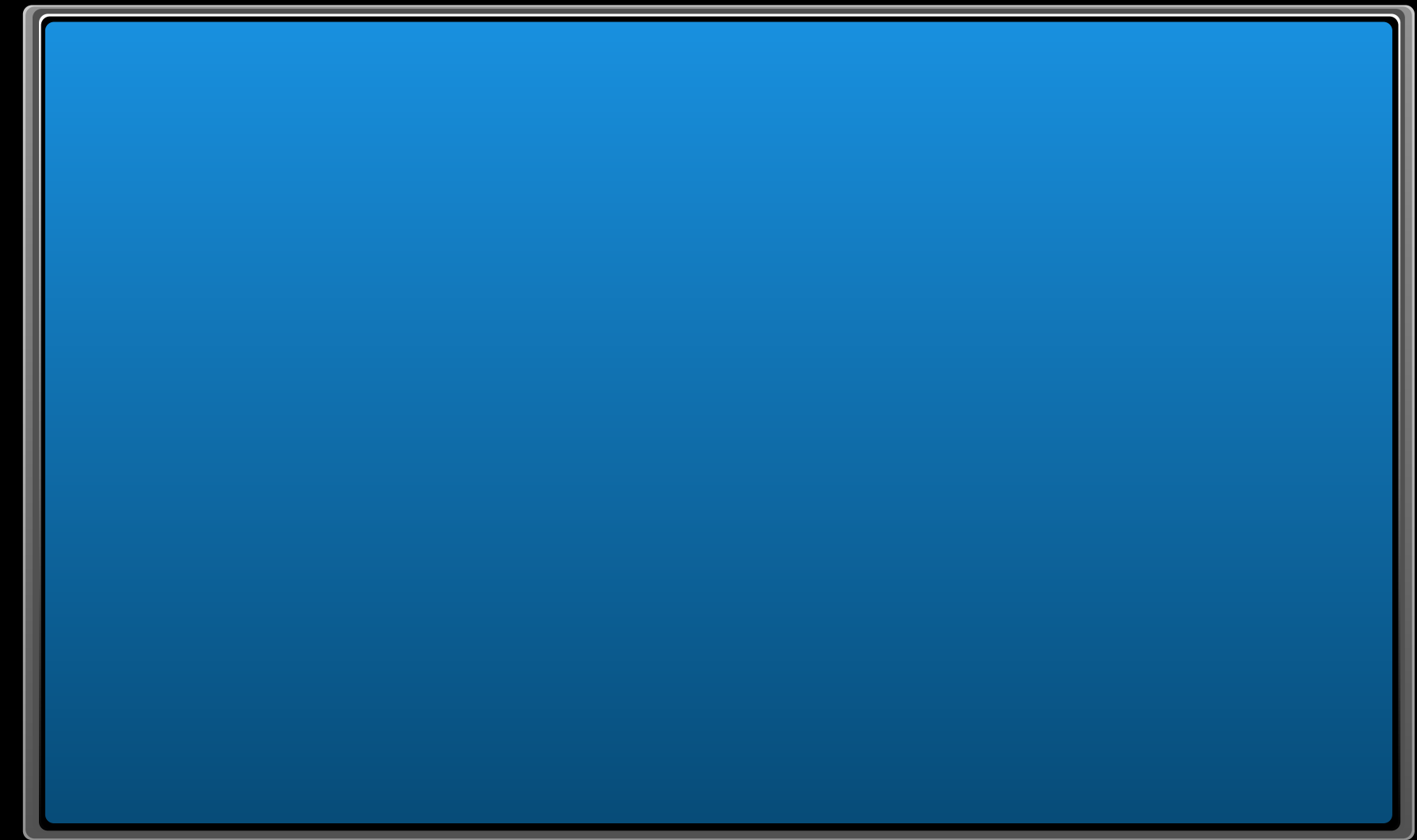
Direct interaction with user interface

Car sends x and y coordinates

Single touch

60 Hz refresh rate

High-fidelity or low-fidelity touch



# Touchscreen

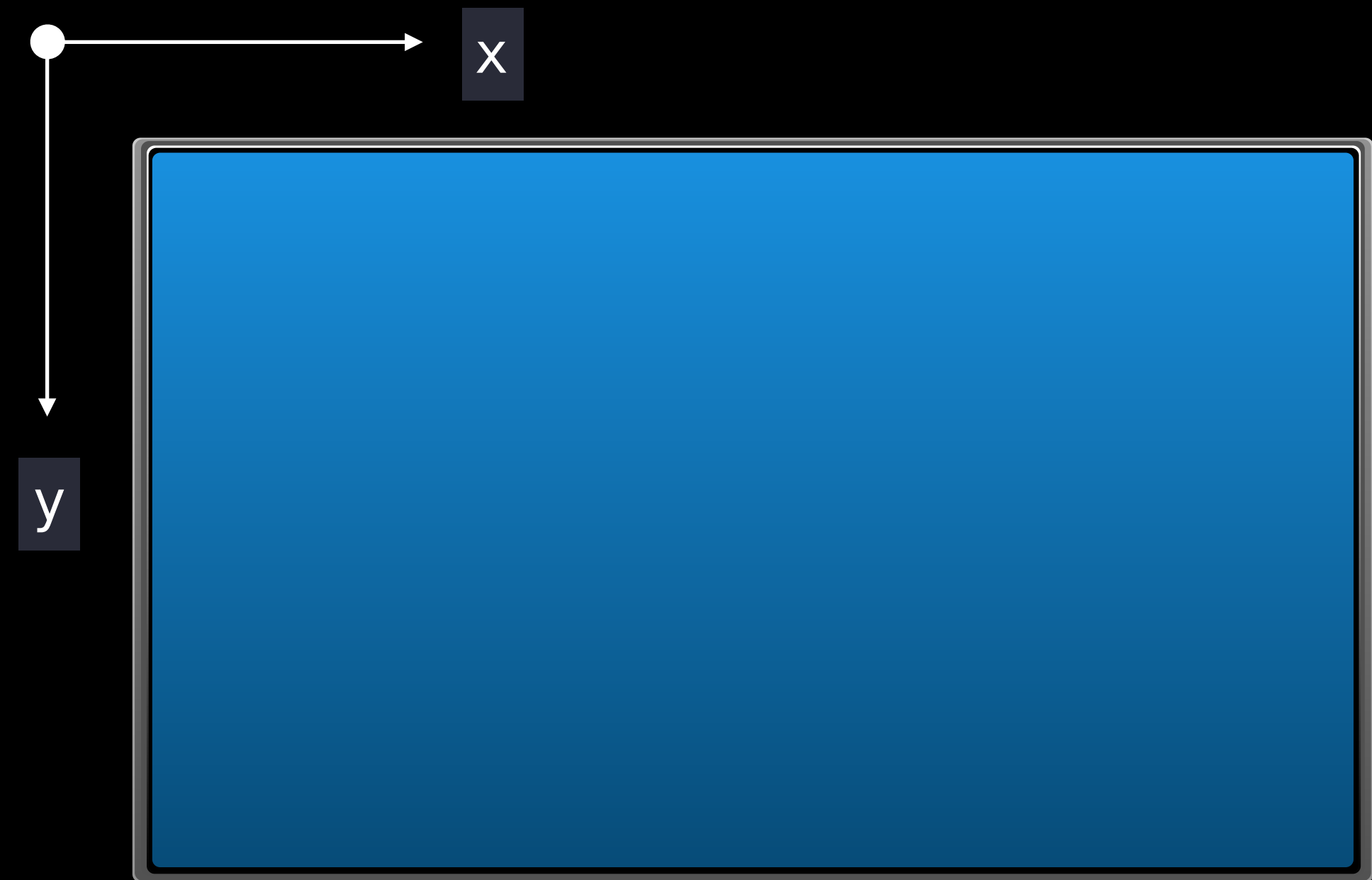
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Single touch

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



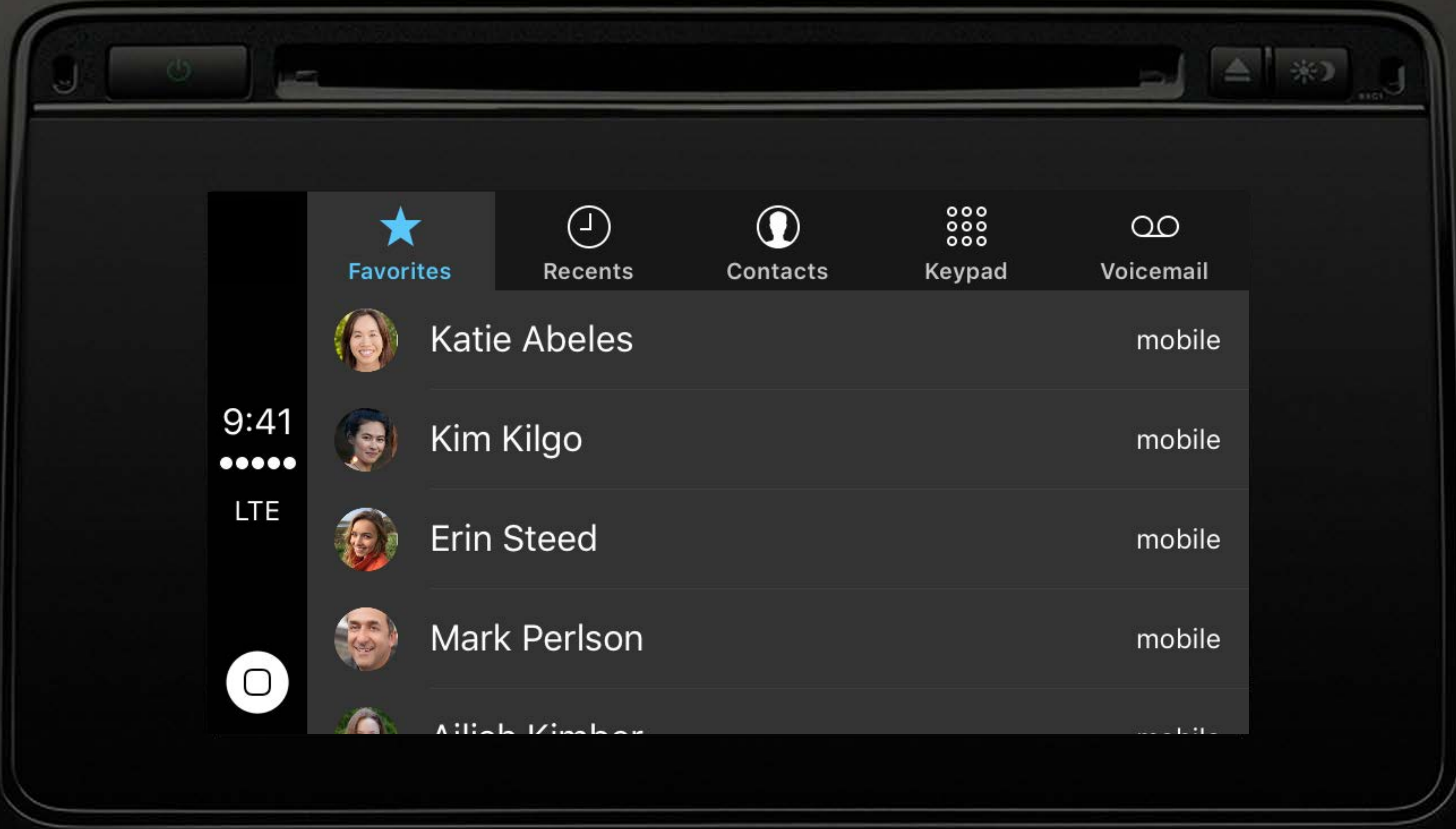
# High-Fidelity Touch

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

9:41



LTE



Katie Abeles

mobile



Kim Kilgo

mobile



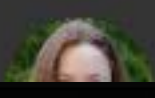
Erin Steed

mobile



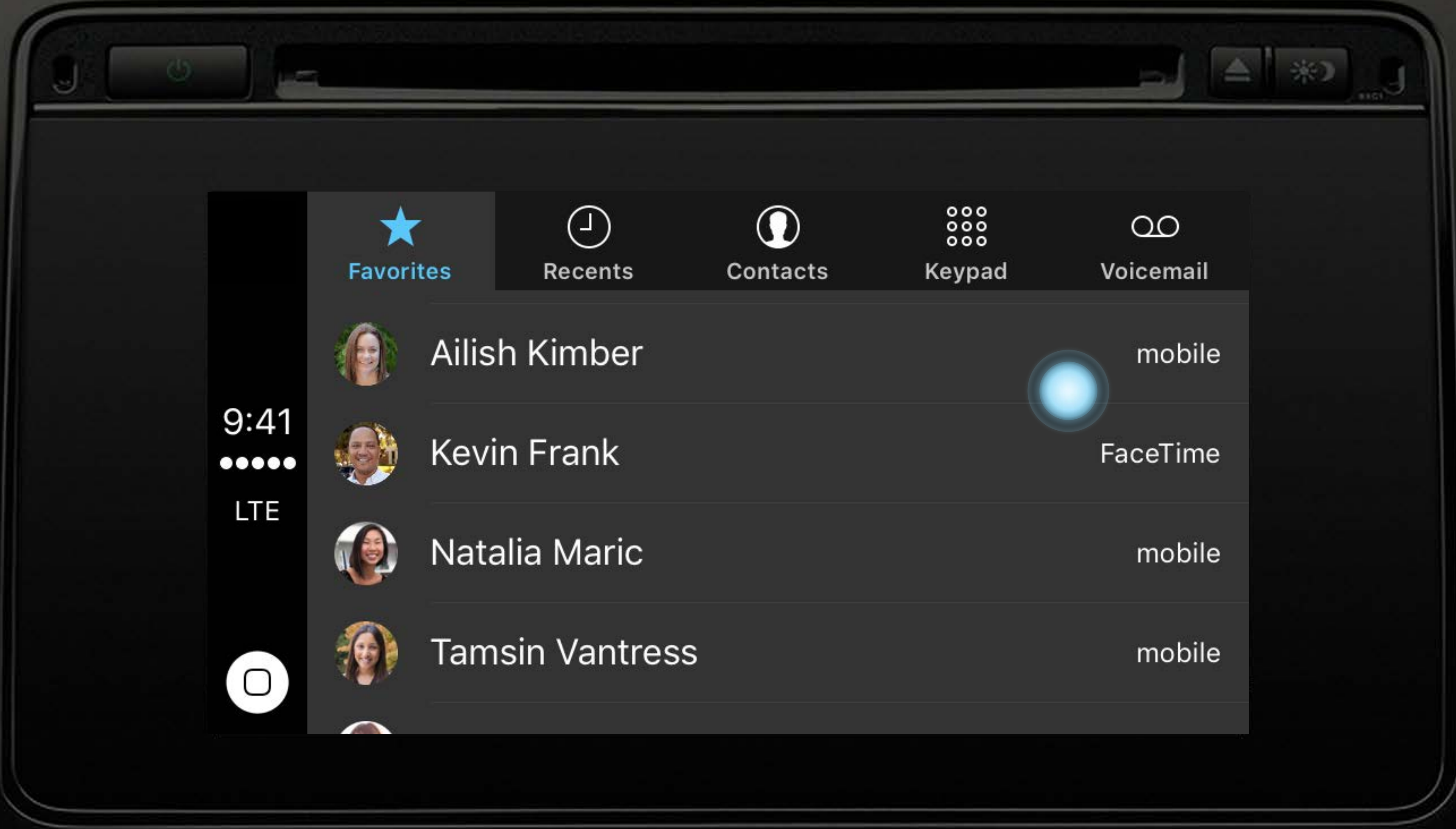
Mark Perlson

mobile



Allison Kimber

mobile



  
Favorites

  
Recents

  
Contacts

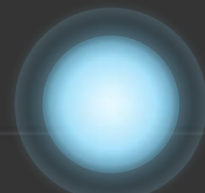
  
Keypad

  
Voicemail

9:41  
●●●●●  
LTE



Ailish Kimber



mobile



Kevin Frank

FaceTime



Natalia Maric

mobile



Tamsin Vantress

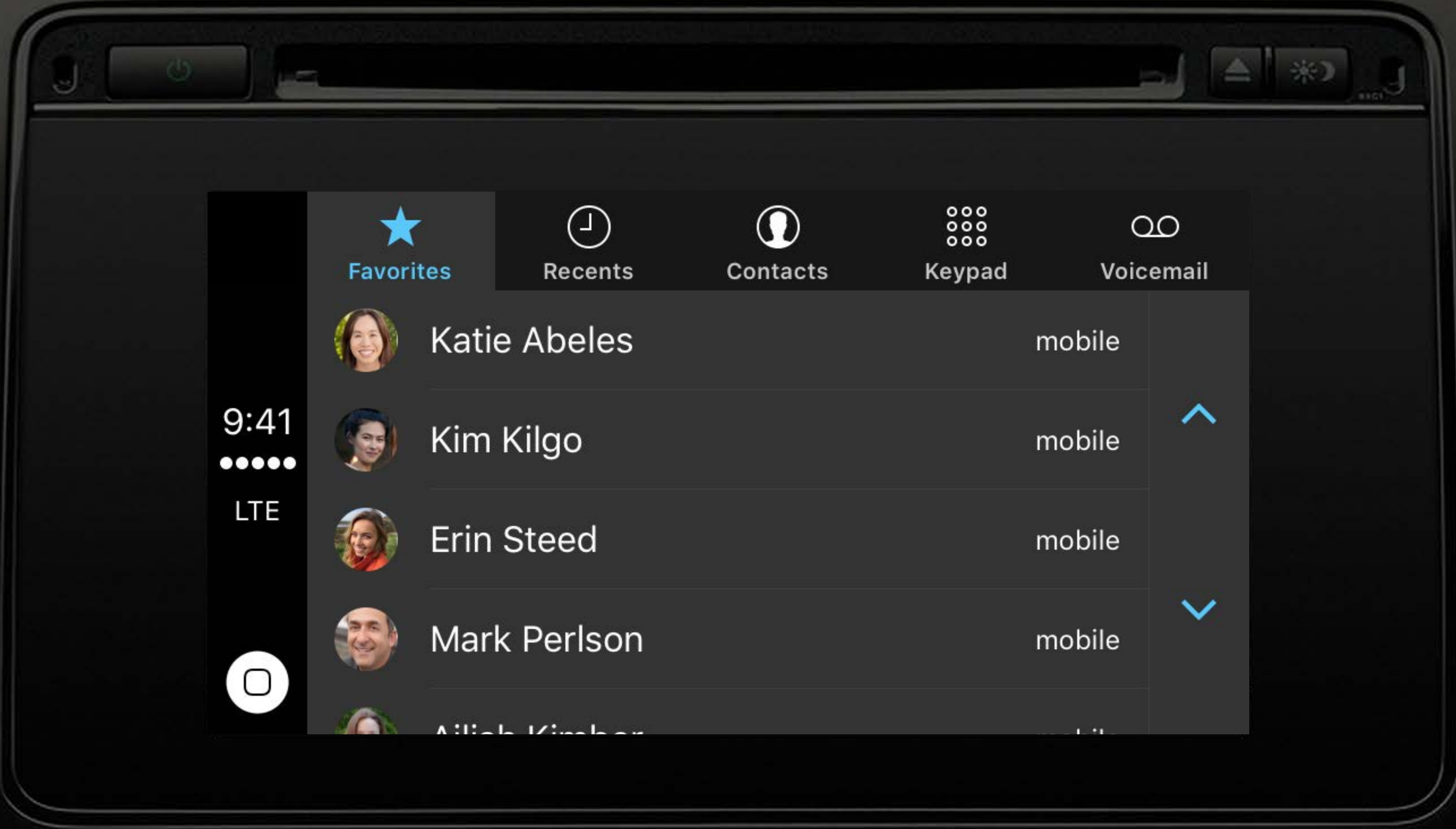
mobile



# Low-Fidelity Touch

CarPlay user interface optimized for single touch interactions

Recommended for resistive touch screens



Favorites



Recents



Contacts



Keypad



Voicemail



Katie Abeles

mobile

9:41



LTE



Kim Kilgo

mobile



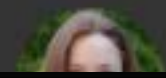
Erin Steed

mobile



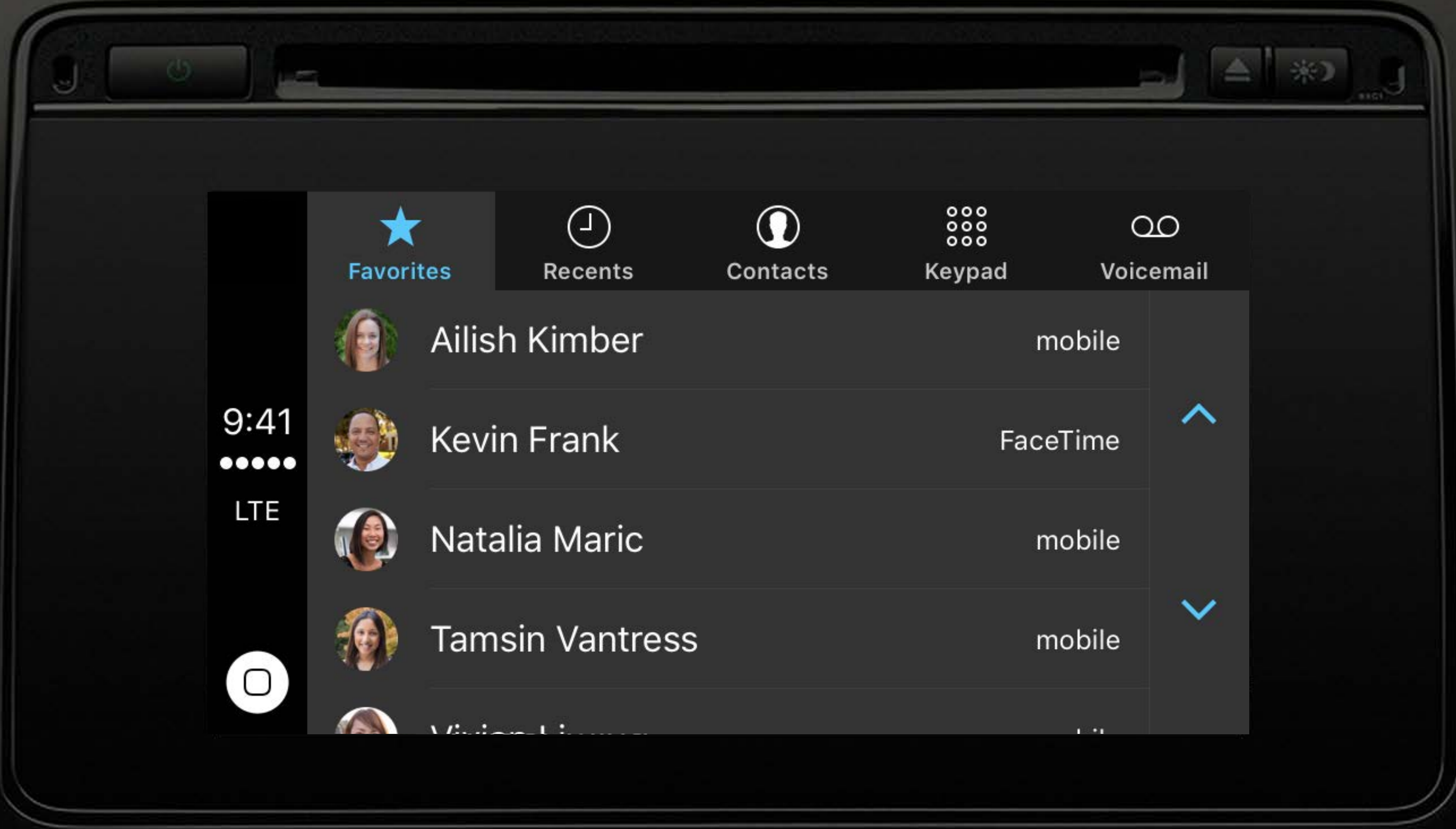
Mark Perlson

mobile



Alisha Kinsler

mobile



Favorites



Recents



Contacts



Keypad



Voicemail

9:41



LTE



Ailish Kimber

mobile



Kevin Frank

FaceTime



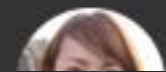
Natalia Maric

mobile



Tamsin Vantress

mobile



Visitor...



Touch



Knobs and Controls



Voice



Touch



Knobs and Controls

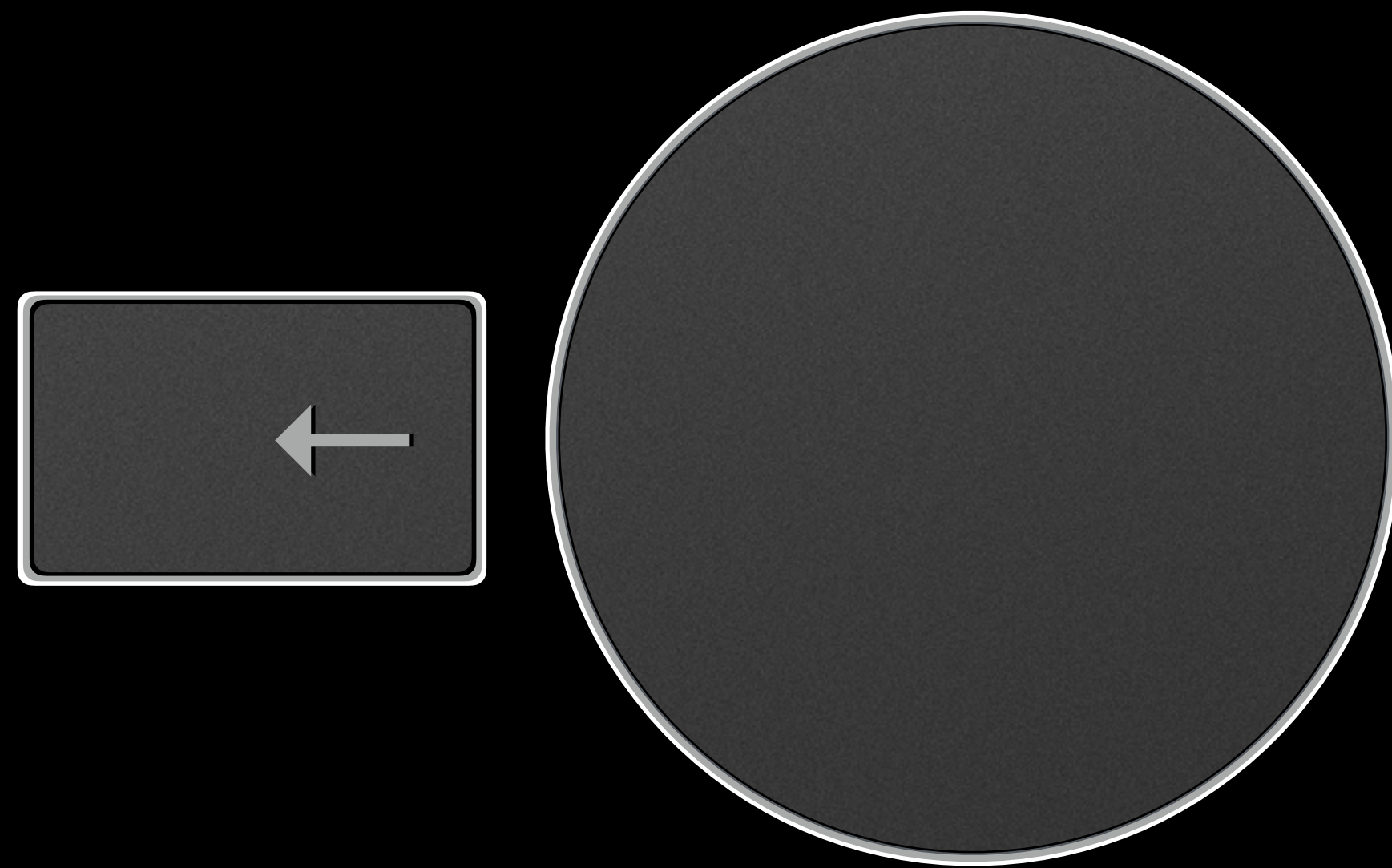


Voice



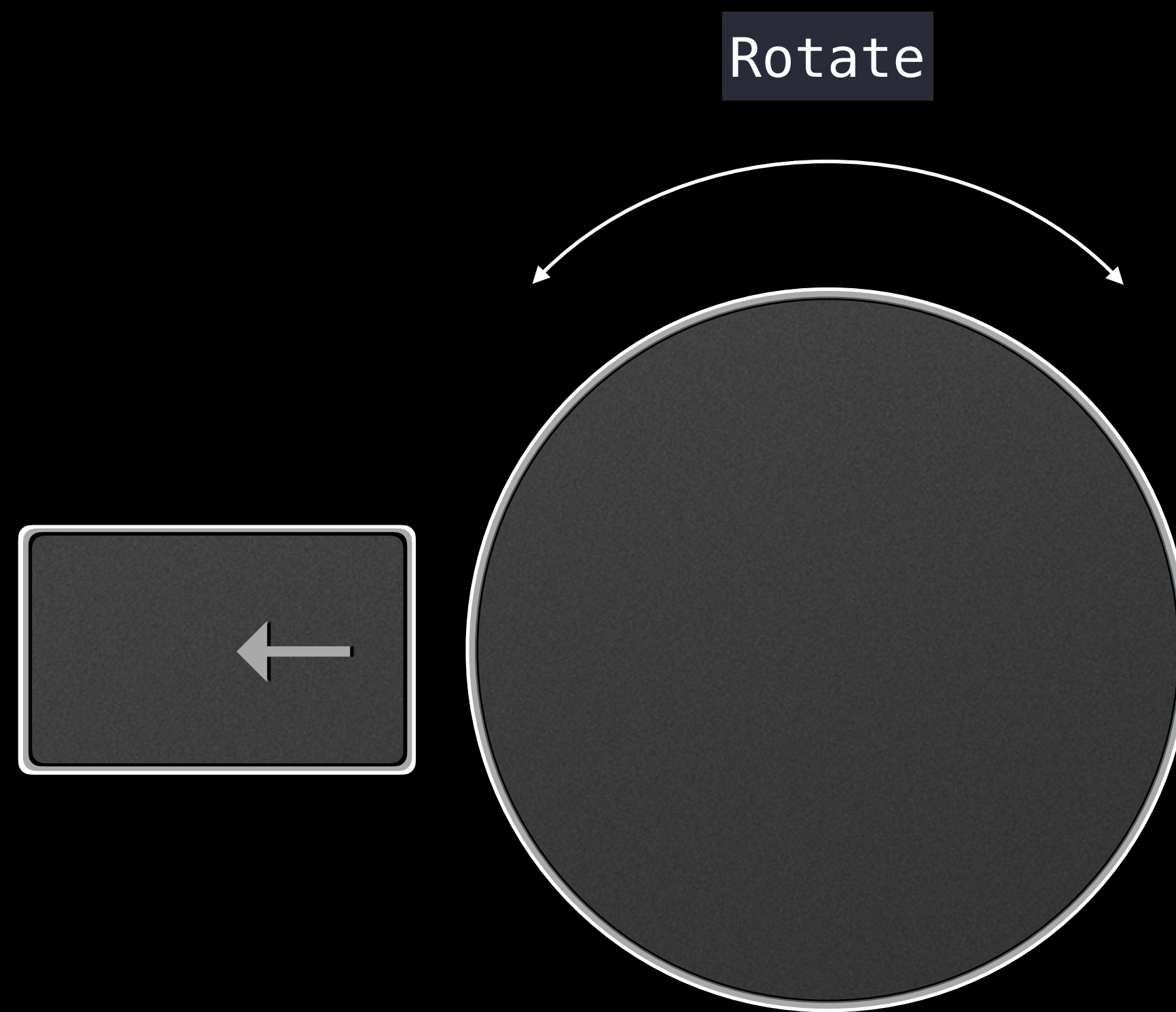
# Knobs and Controls

Rotating knob



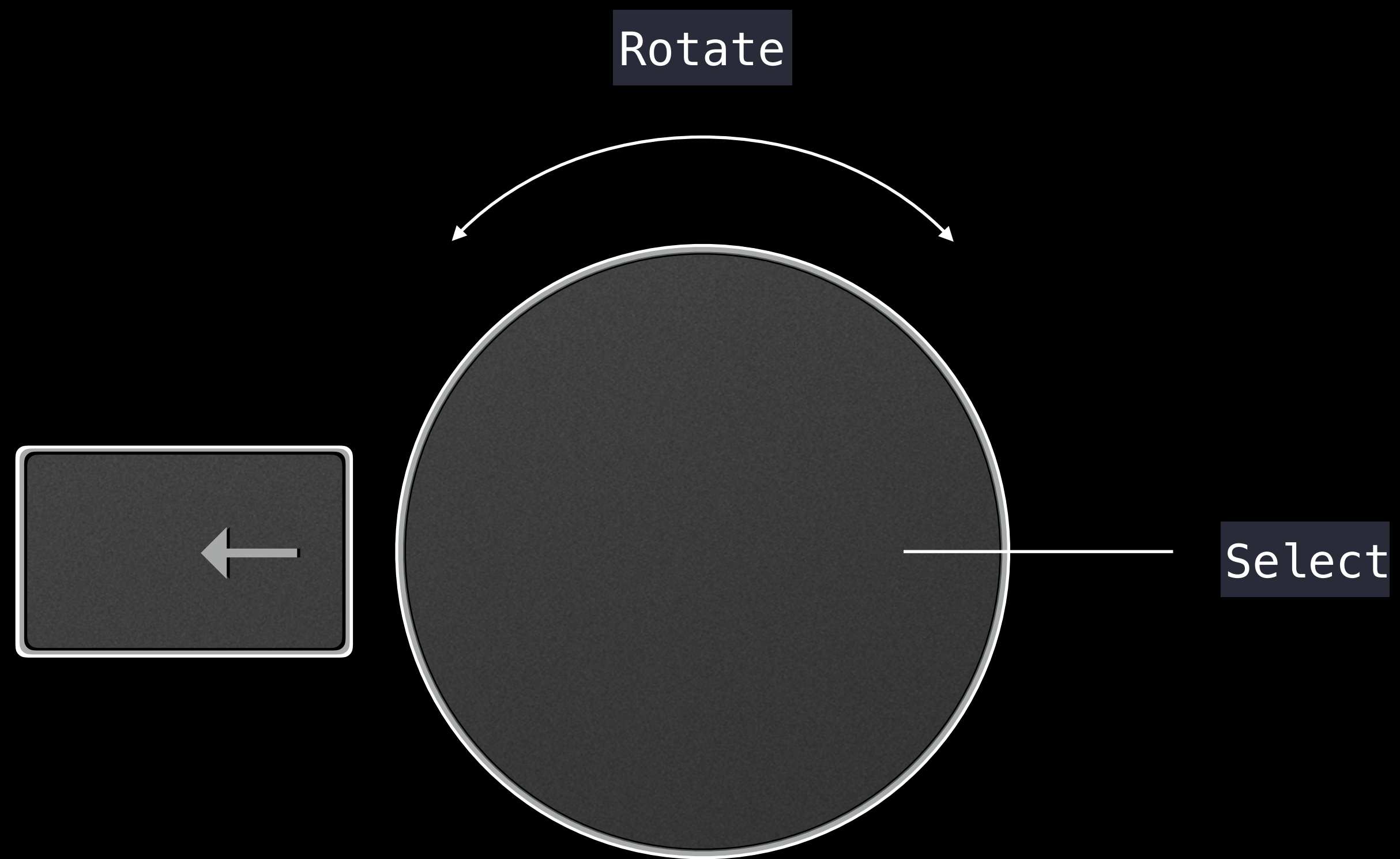
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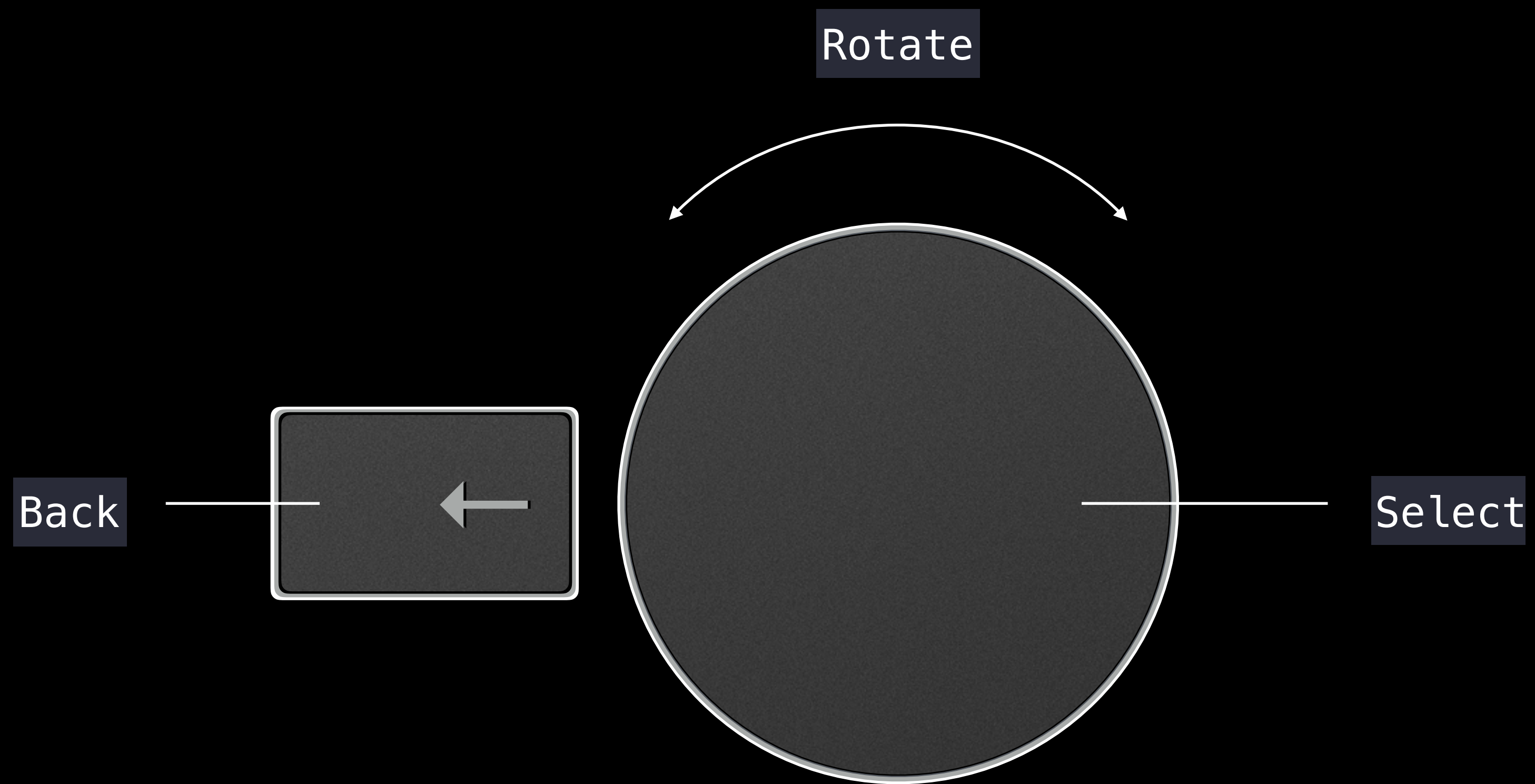
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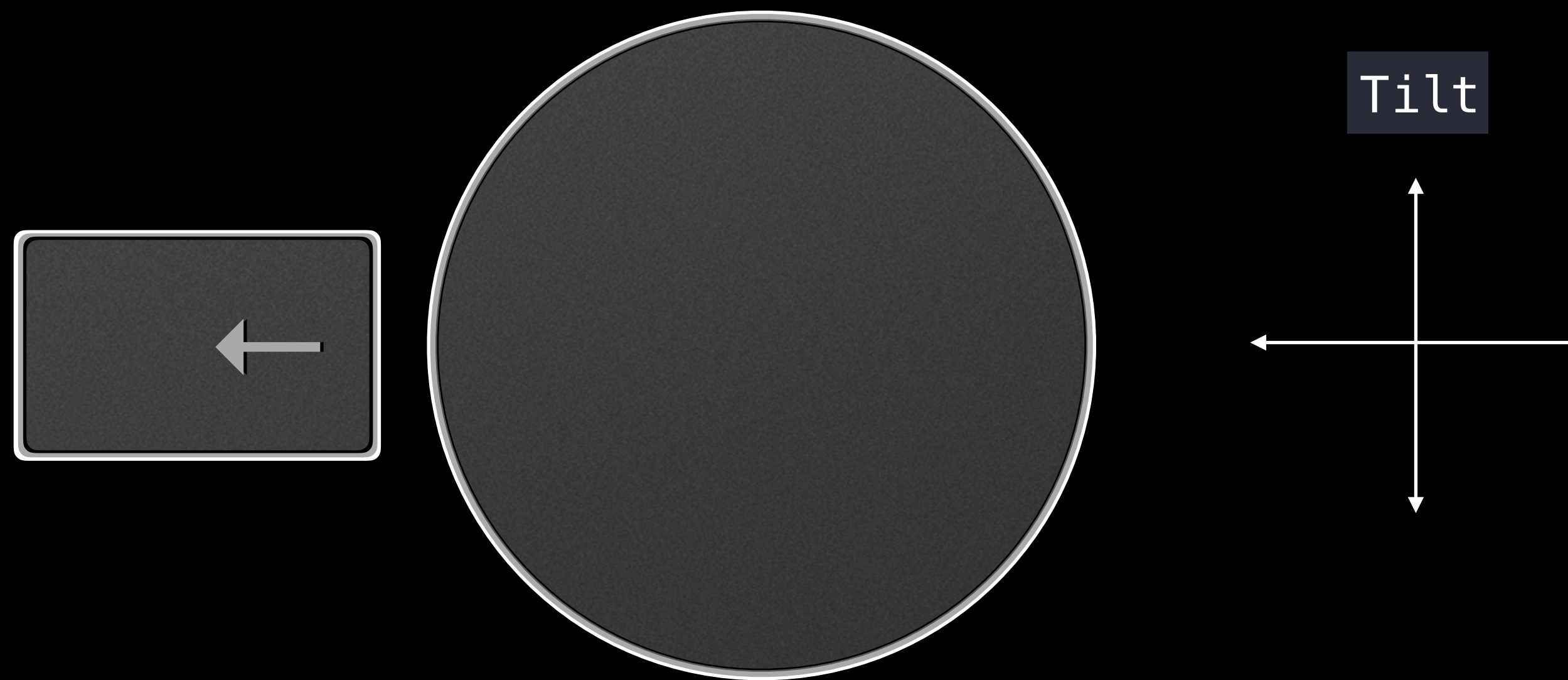
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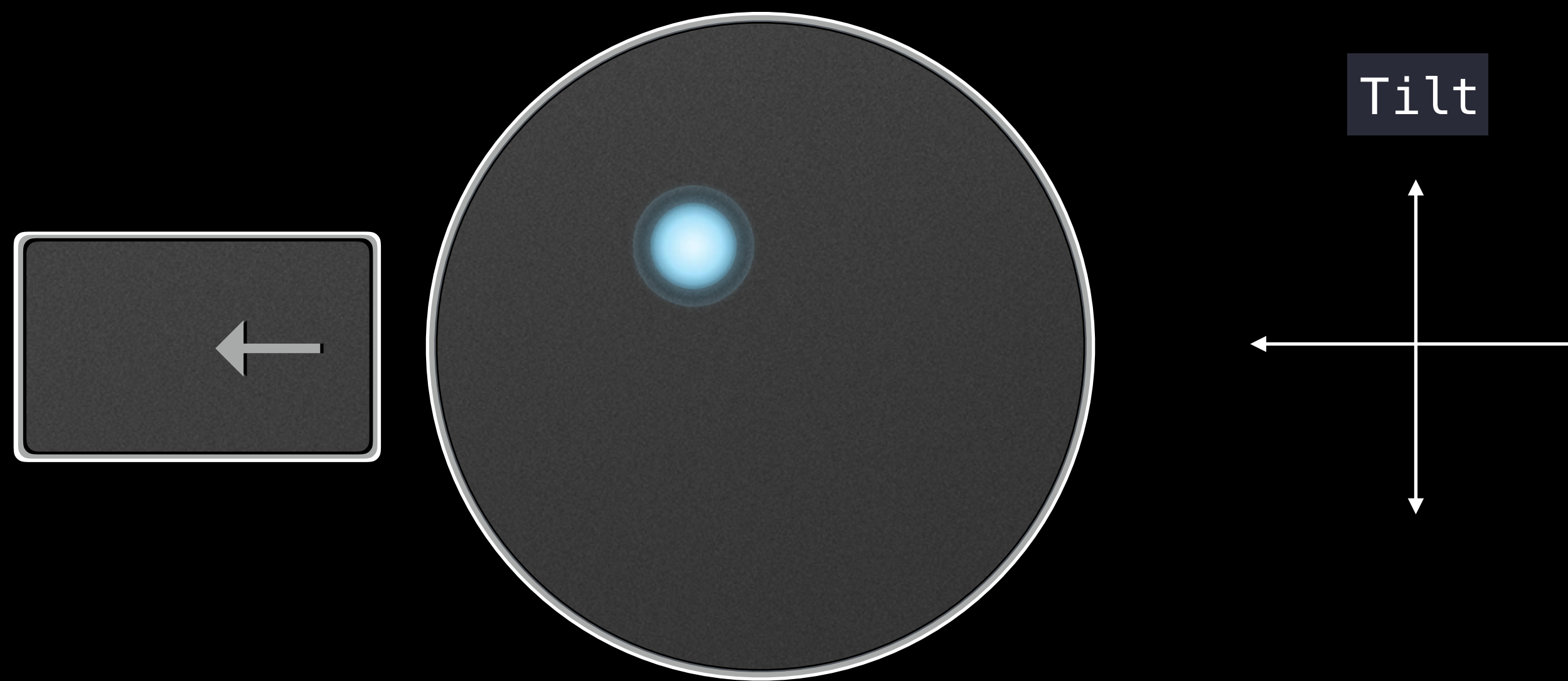
# Knobs and Controls

Multi-axis rotating knob



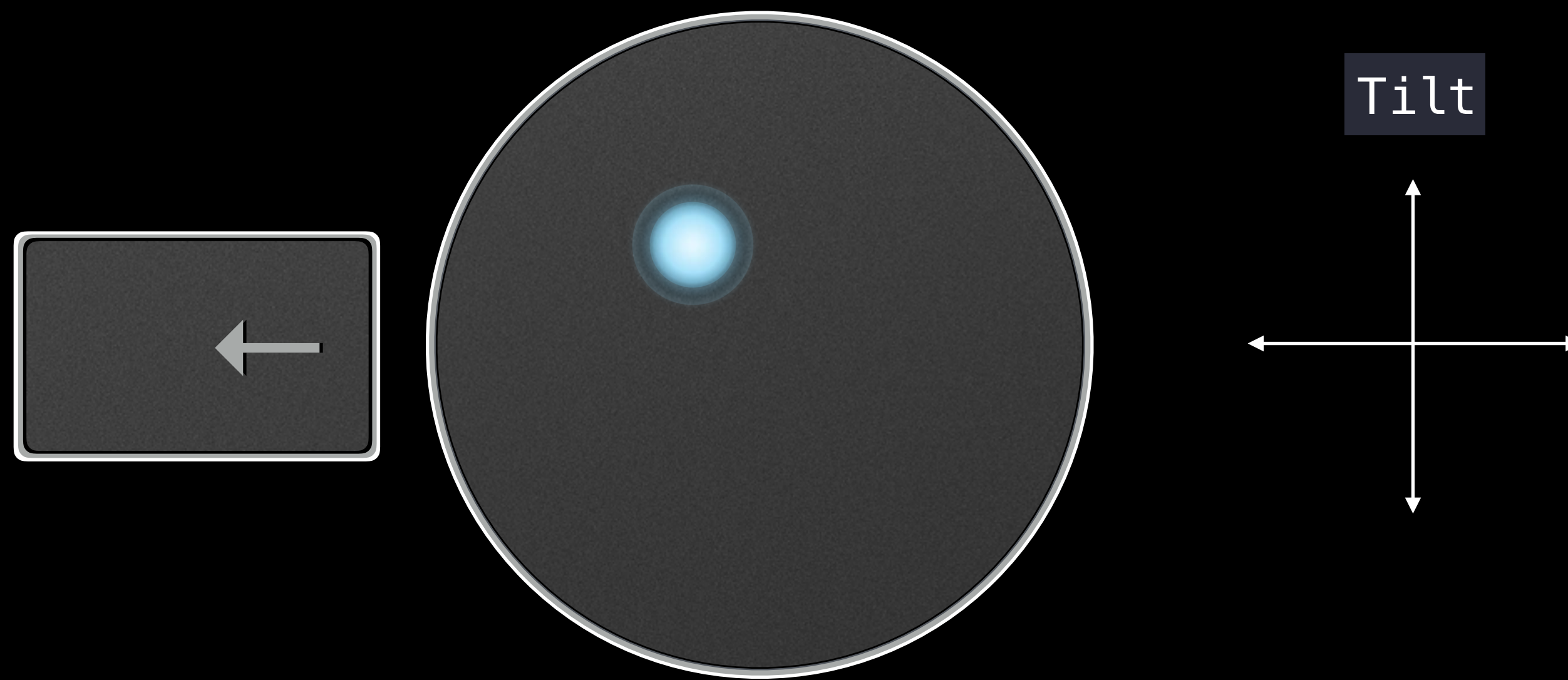
# Knobs and Controls

Multi-axis rotating knob



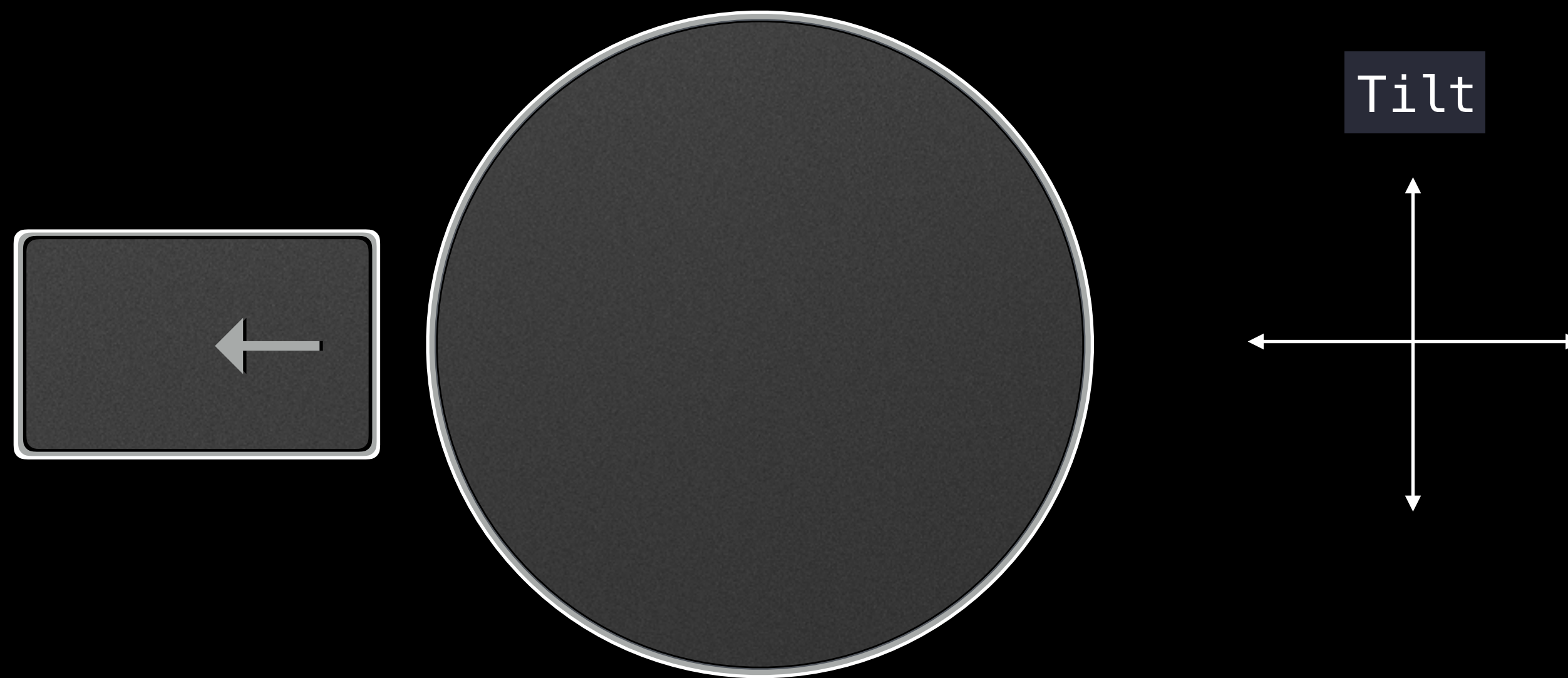
# Knobs and Controls

Multi-axis rotating knob



# Knobs and Controls

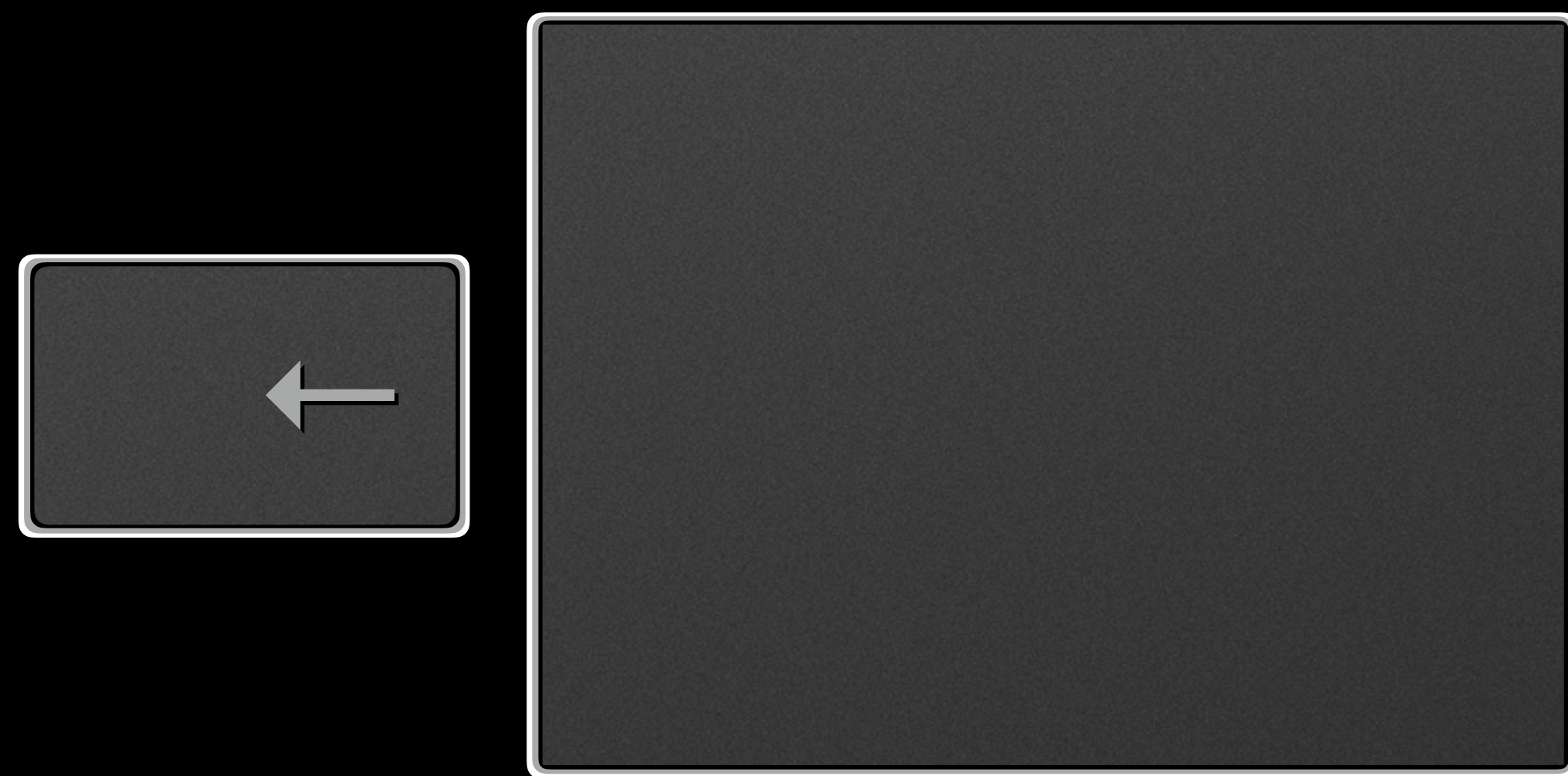
Multi-axis rotating knob





# Knobs and Controls

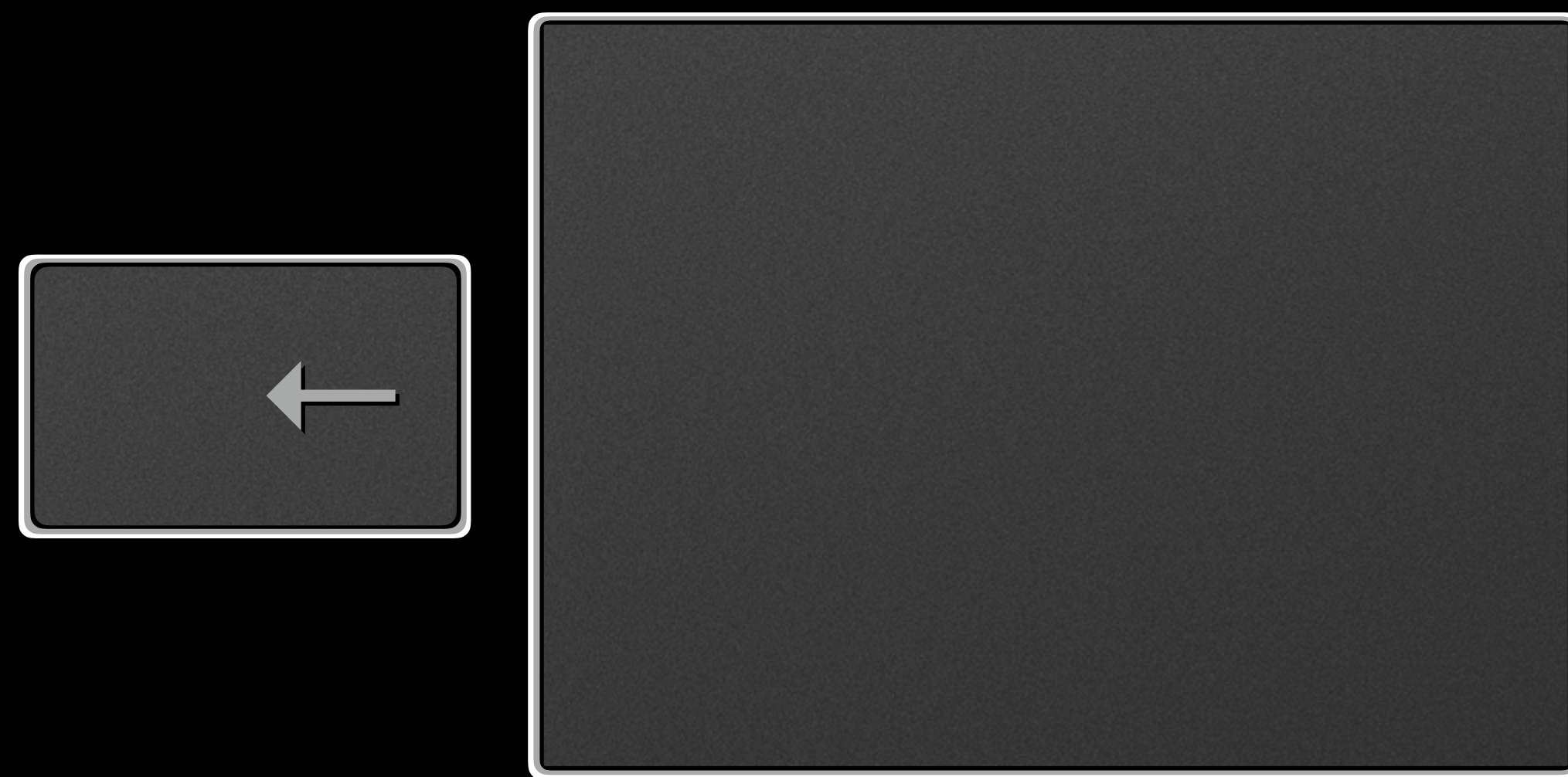
Touchpad



# Knobs and Controls

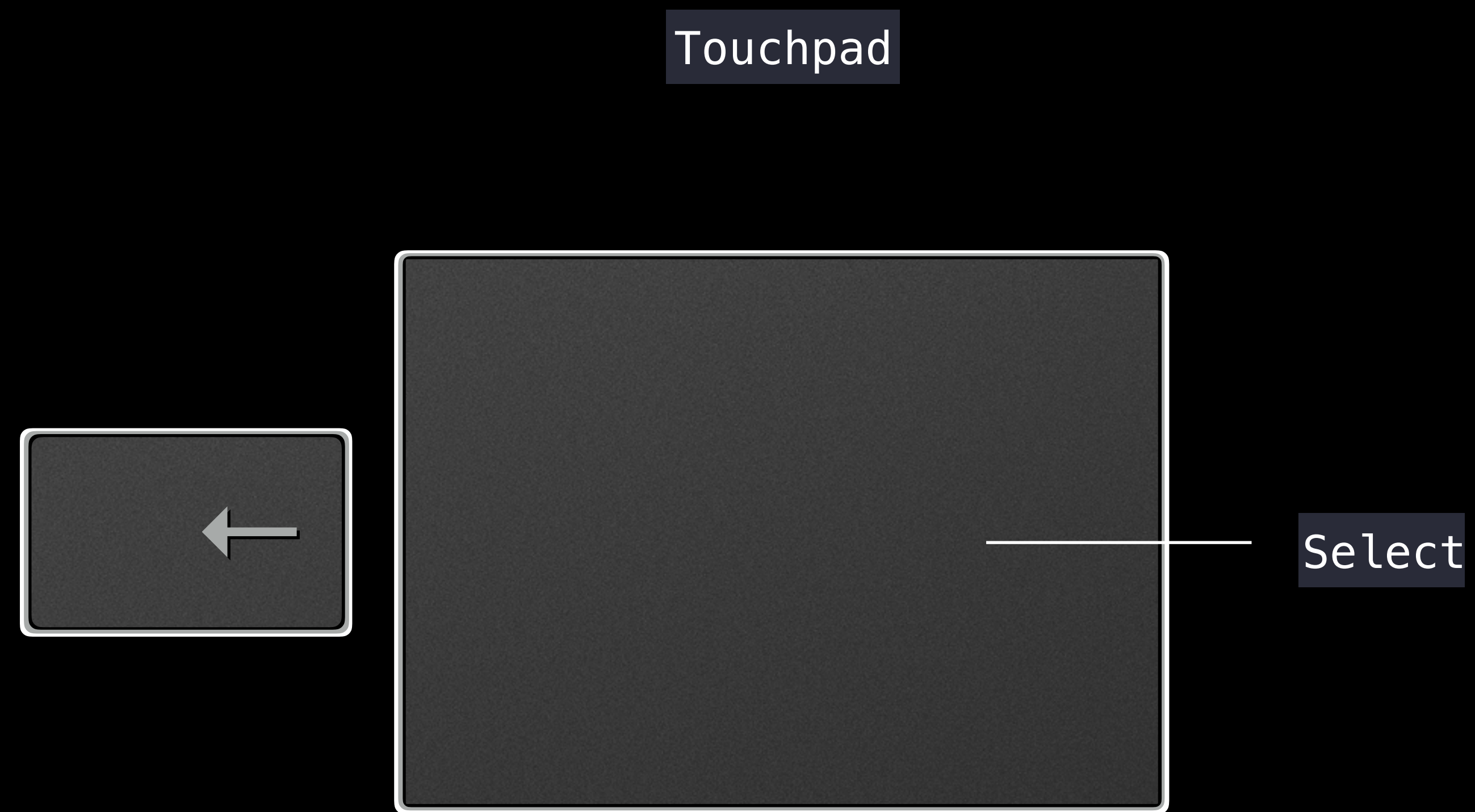
Touchpad

Touchpad



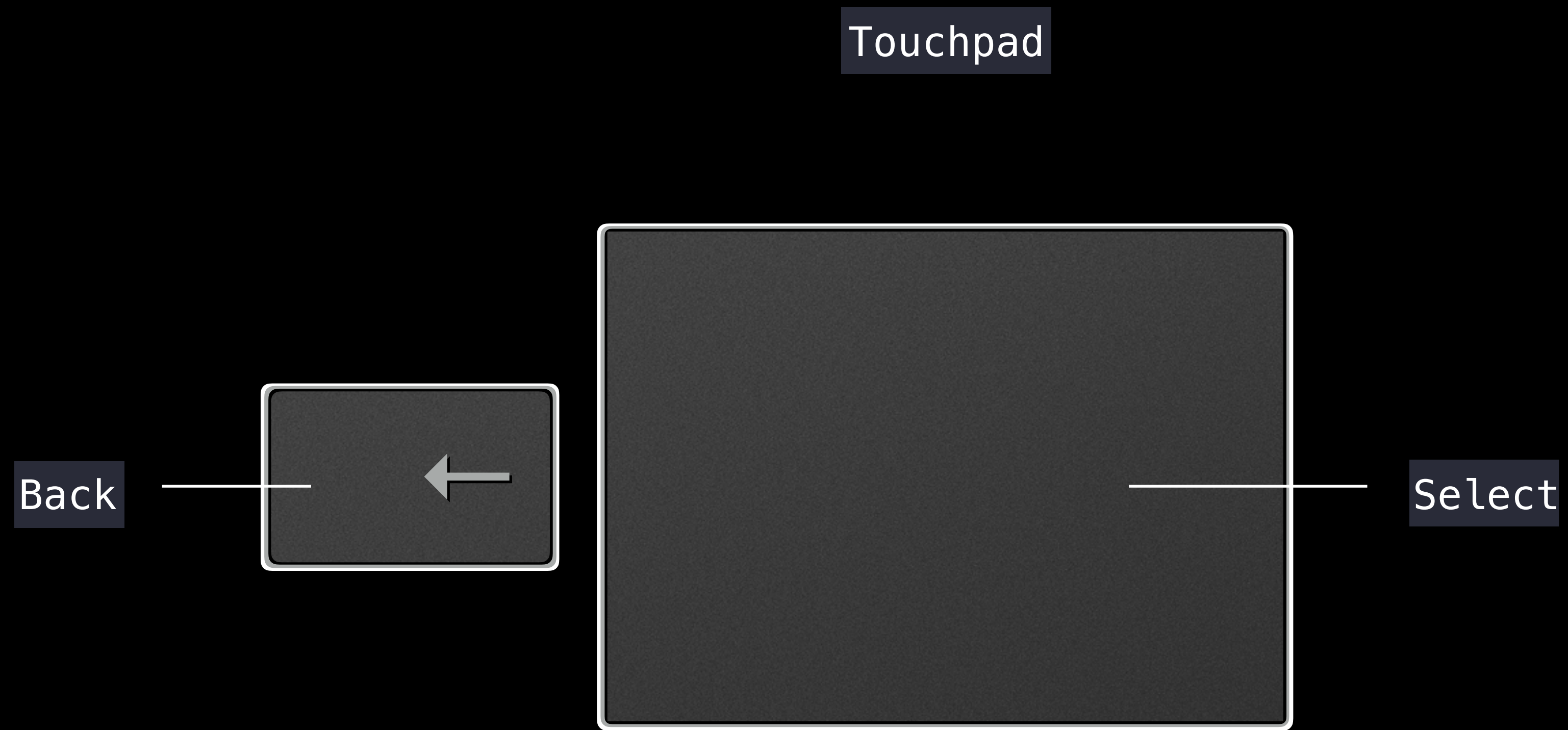
# Knobs and Controls

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

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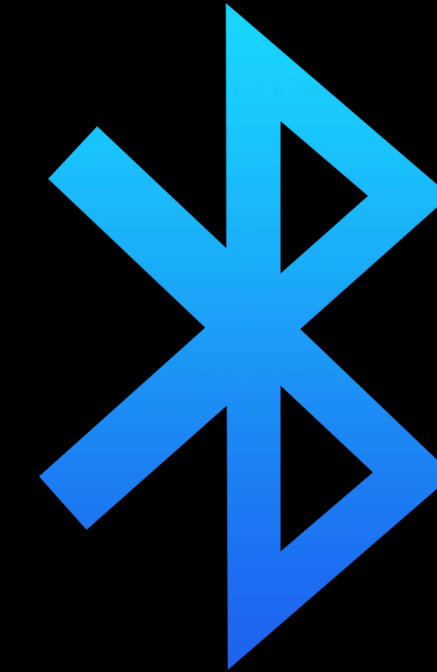
Connection to iPhone



Wired



+

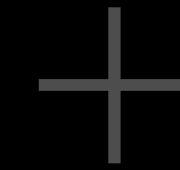


Wireless





Wired



Wireless

# Wired Connection

## USB

Requires support for USB role swap

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

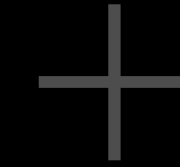
High throughput required

Port labeling

- Contact Apple for use of CarPlay icon



Wired



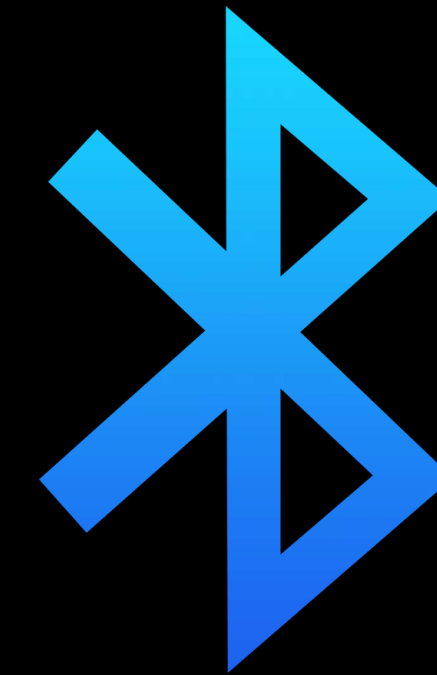
Wireless



Wired



+



Wireless

# CarPlay Over Wireless

Two-stage process



Bluetooth



Wi-Fi

# CarPlay Over Wireless

Two-stage process



Bluetooth

Bluetooth connected



Wi-Fi

# 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

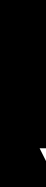
Bluetooth connected



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



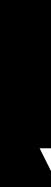
Car sends Wi-Fi credentials to iPhone



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

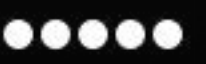
# Design Guidelines

Donald Pitschel Human Interface

CarPlay is Designed to Use the Entire Display



9:41



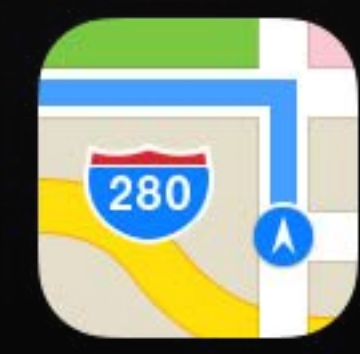
LTE



Phone



Music



Maps



Messages



Now Playing



Car Maker



Podcasts



Audiobooks

22°C

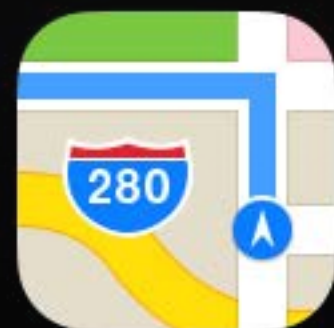
9:42



Phone



Music



Maps



Messages

9:41



LTE



Now Playing



Car Maker



Podcasts



Audiobooks

22°C

9:42



Phone



Music



Maps



Messages

9:41



LTE



Now Playing



Car Maker



Podcasts



Audiobooks





22°C

9:42

9:41



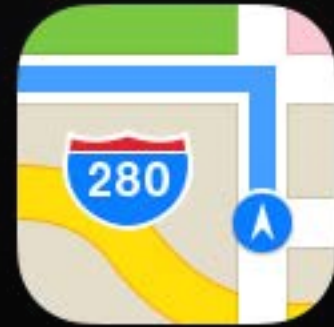
LTE



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Podcasts



Audiobooks

22°C

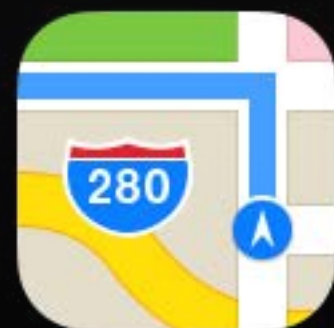
9:42



Phone



Music



Maps



Messages

9:41



LTE



Now Playing



Car Maker



Podcasts



Audiobooks

22°C

9:42

9:41



LTE



Phone



Music



Maps



Messages



Now Playing



Car Maker



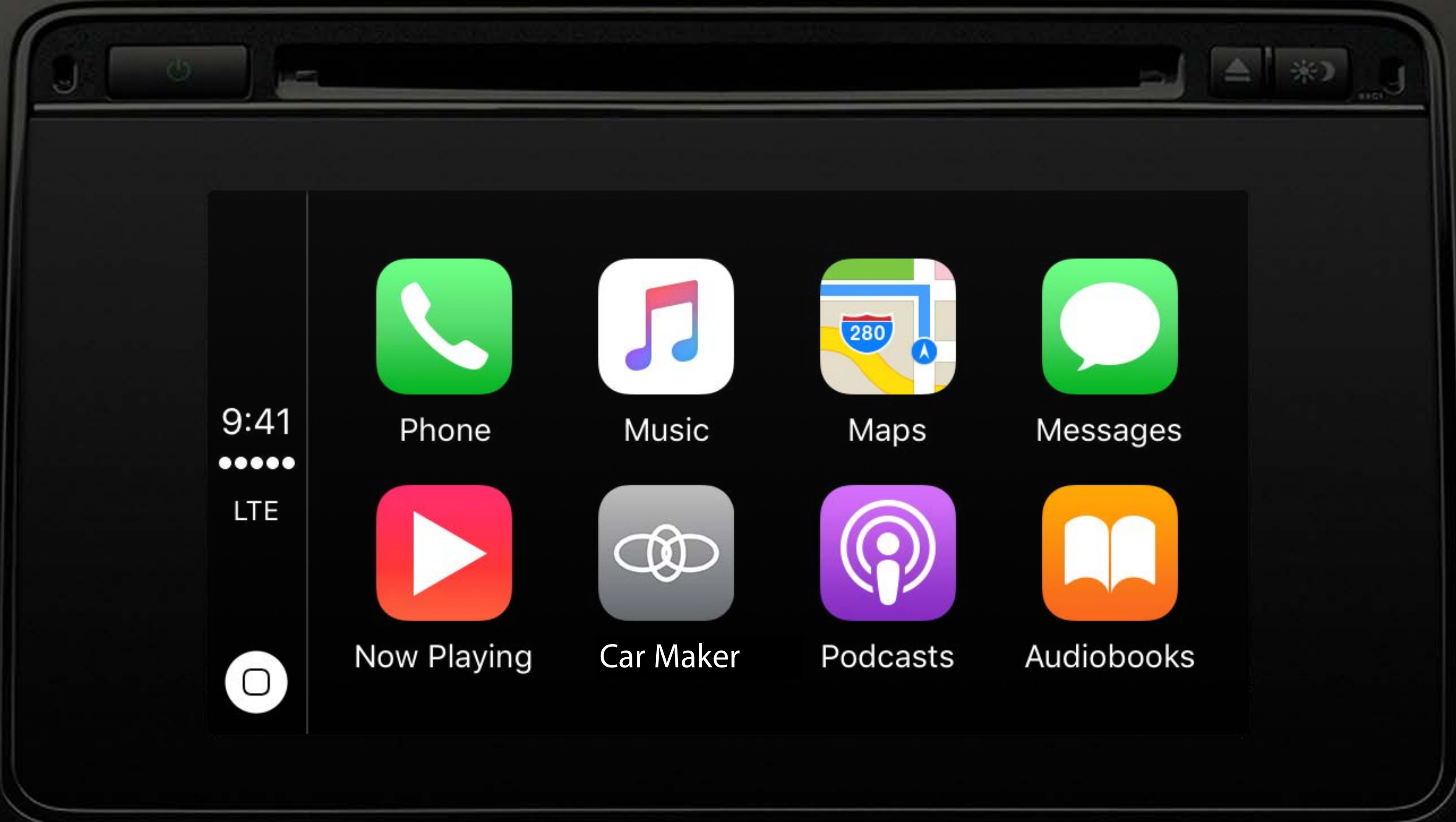
Podcasts



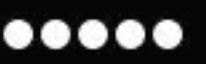
Audiobooks



Not  
recommended



9:41



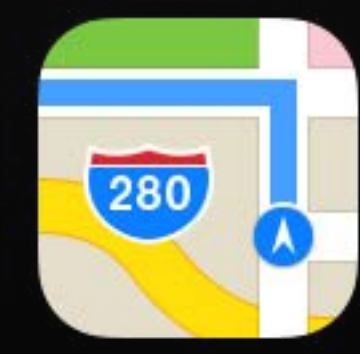
LTE



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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

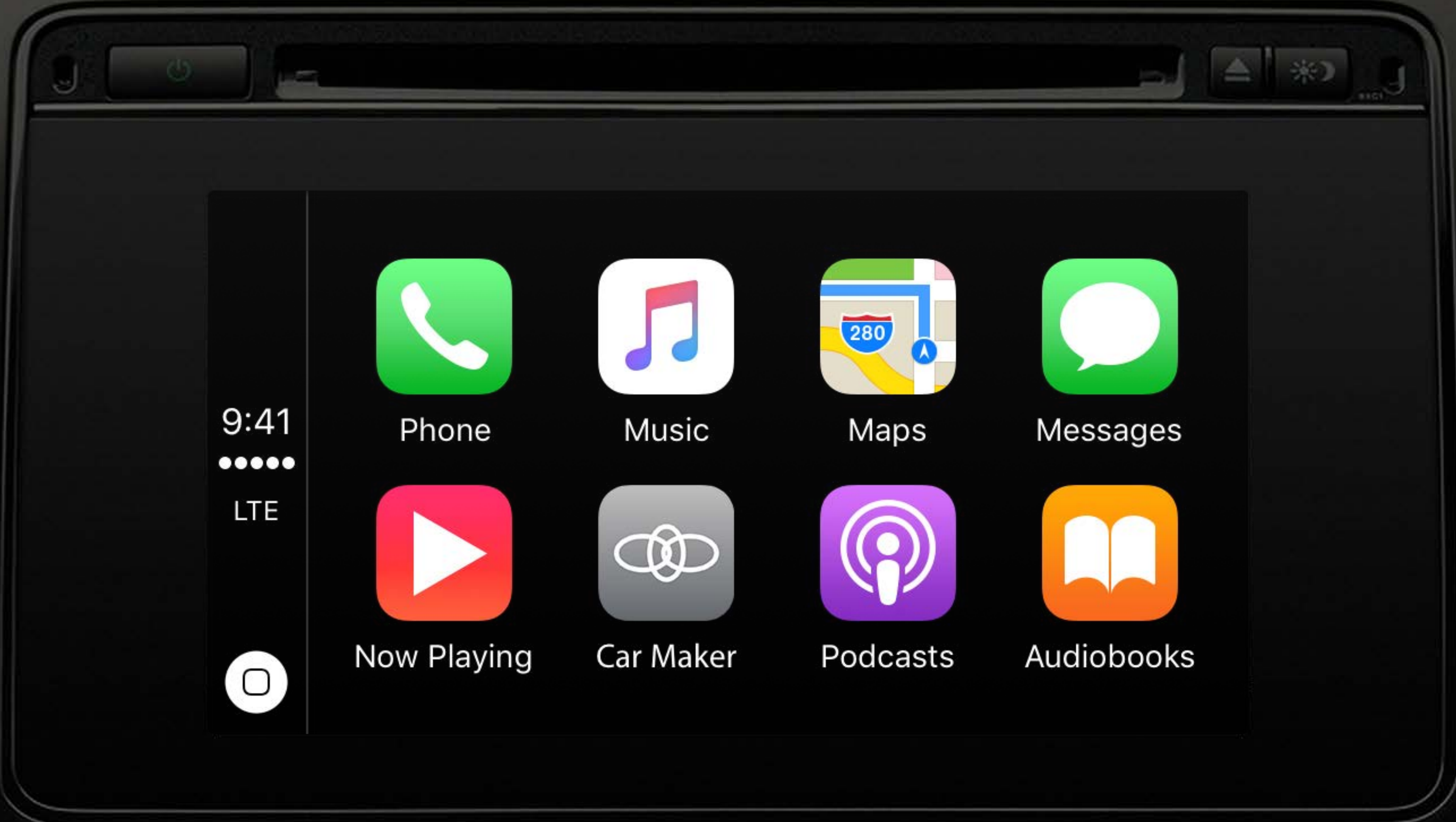


If CarPlay was not last shown, remain in the car's user interface



If iPhone audio was playing, iPhone audio should play again

Switching to and from the CarPlay Display



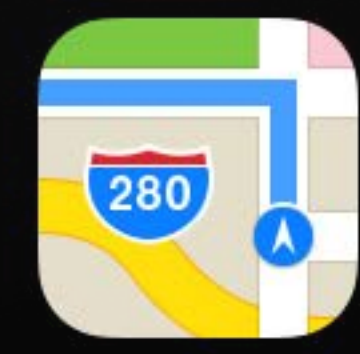
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22°C

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Radio



CD



Navi



Climate



Car

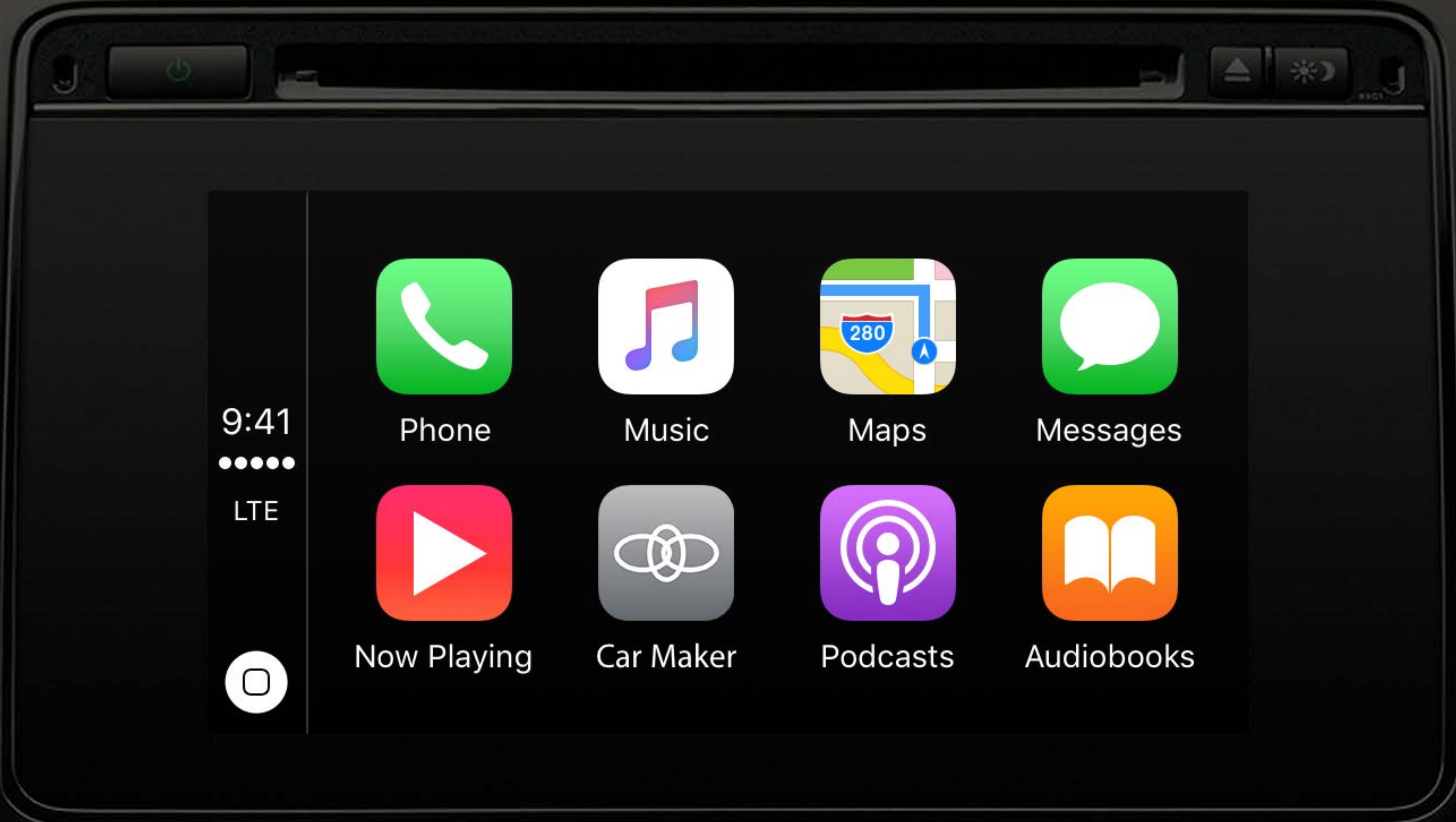


Settings



Apple CarPlay





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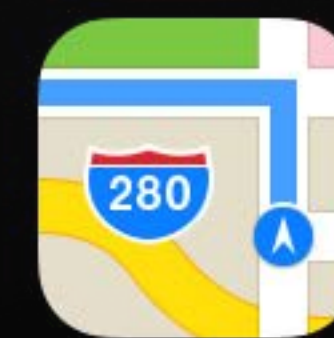
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22°C

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CD



Navi



Climate



Car



Settings



Apple CarPlay

22°C

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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

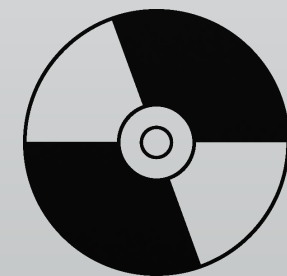
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Phone



Radio



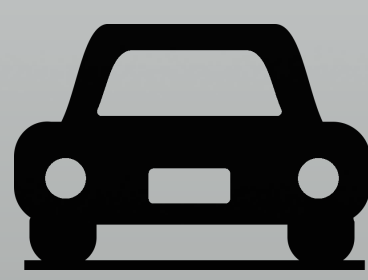
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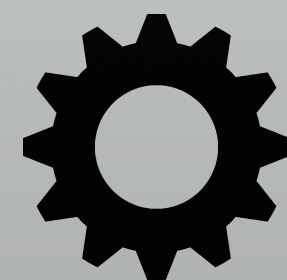
Navi



Climate



Car



Settings



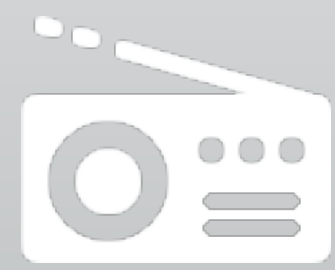
Apple CarPlay

22°C

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Phone



Radio



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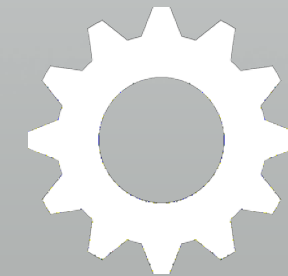
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Apple CarPlay



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Settings



Apple CarPlay

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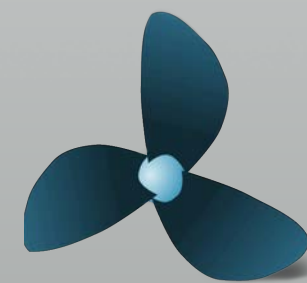
Radio



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

NEW

## What's new in iOS 10

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

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Psycho E  
Muse — Drones



Style  
Taylor Swift — 1989



Shut Up and Dance  
Walk the Moon — TALKING IS HARD



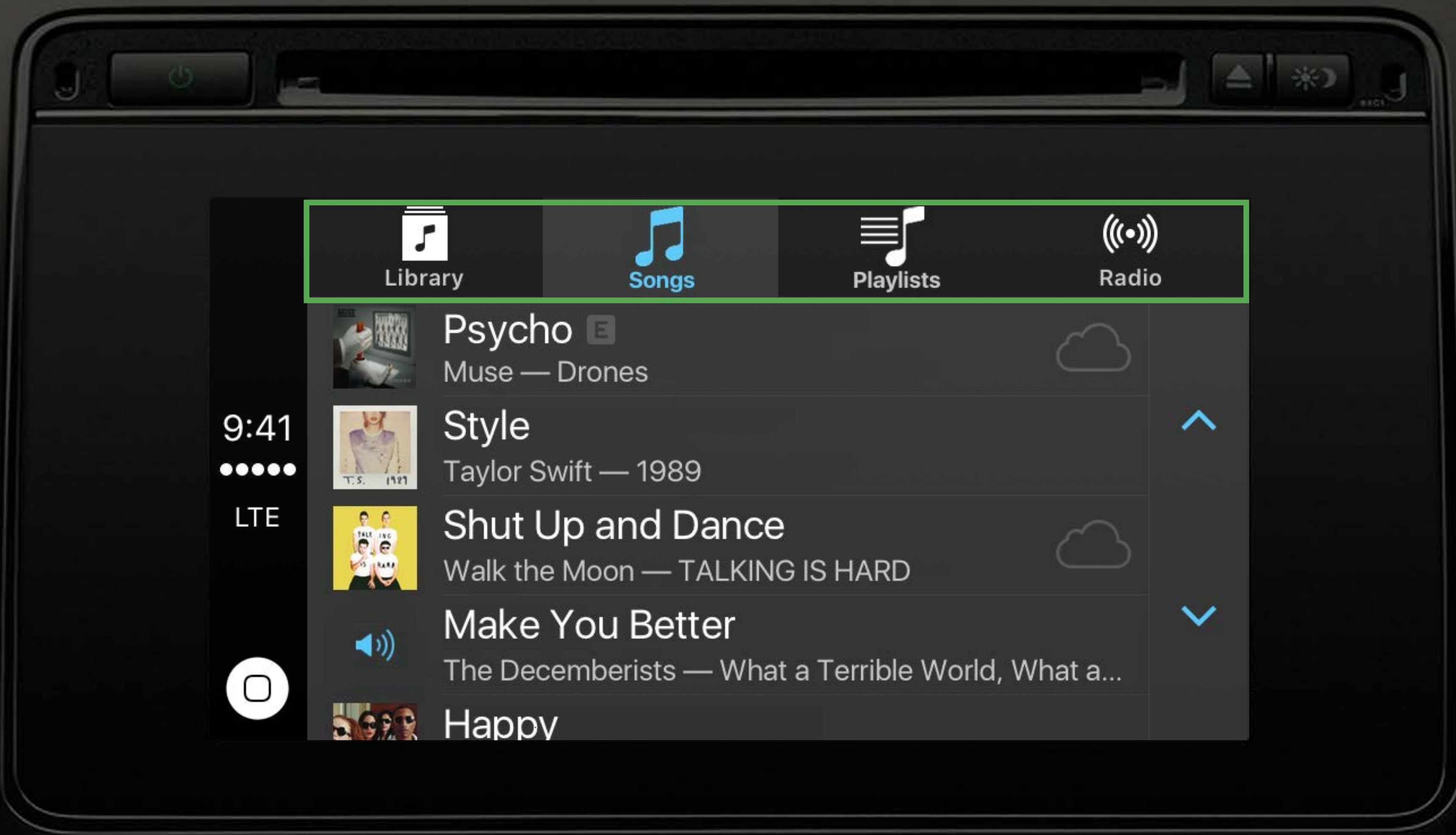
Make You Better  
The Decemberists — What a Terrible World, What a...



Happy








- Library
- Songs**
- Playlists
- Radio

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- 
**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**





Library

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Playlists

Radio



Psycho E  
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Make You Better  
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Happy

9:41  
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Library

Songs

Playlists

Radio

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Psycho E  
Muse — Drones



Style  
Taylor Swift — 1989



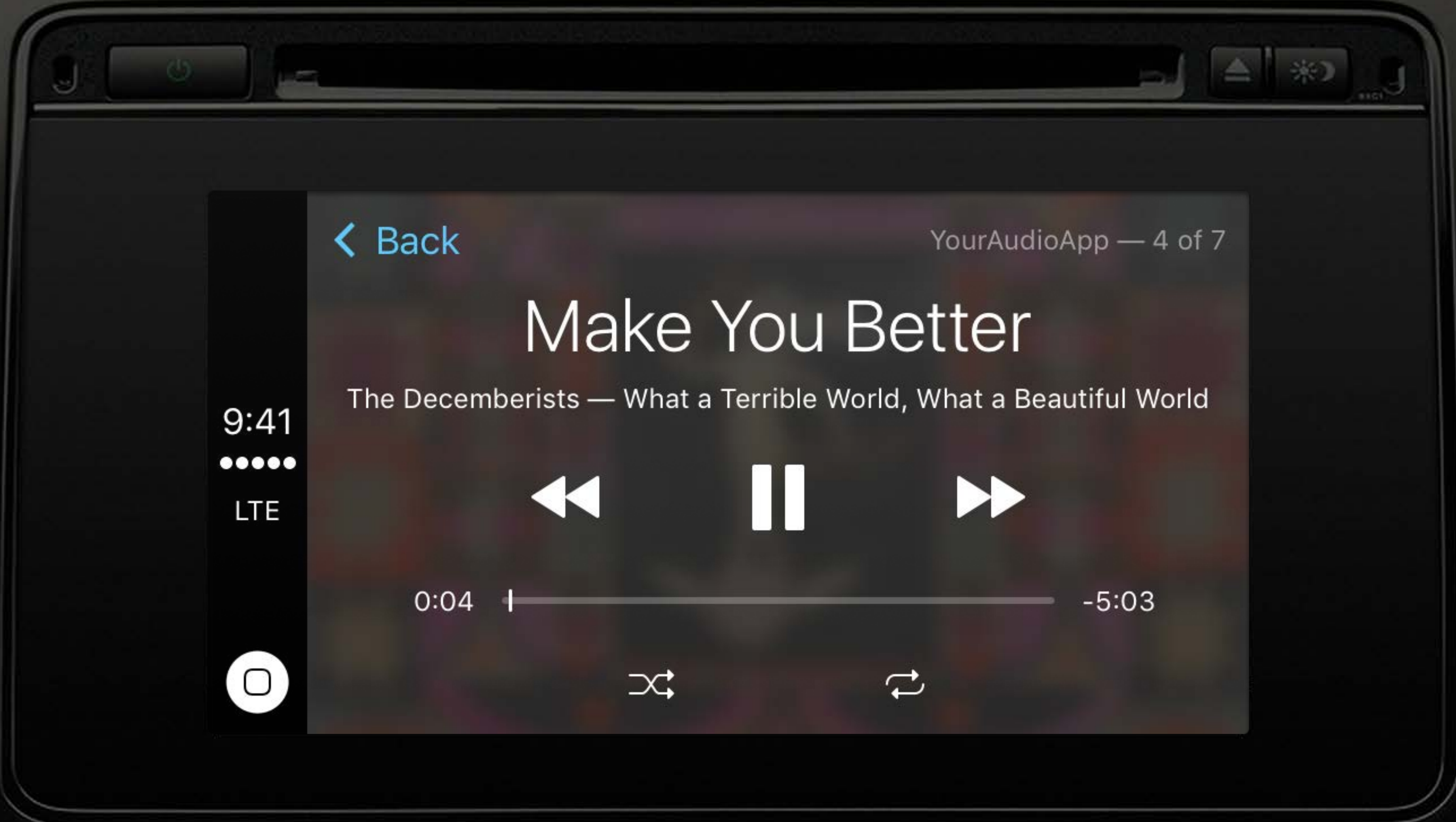
Shut Up and Dance  
Walk the Moon — TALKING IS HARD



Make You Better  
The Decemberists — What a Terrible World, What a...



Happy



< Back

YourAudioApp — 4 of 7

# Make You Better

The Decemberists — What a Terrible World, What a Beautiful World

9:41



LTE

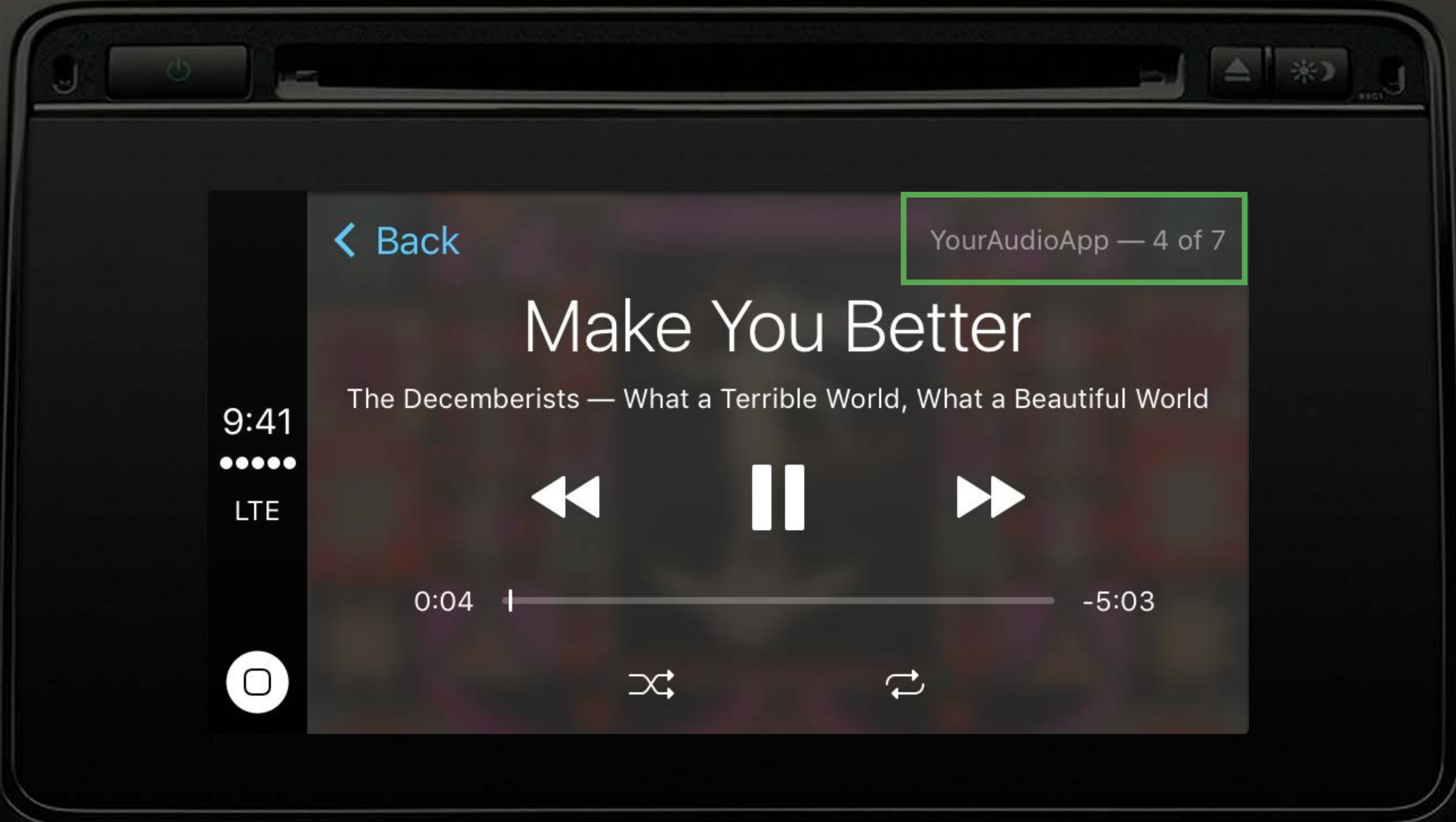


0:04



-5:03





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YourAudioApp — 4 of 7

# Make You Better

The Decemberists — What a Terrible World, What a Beautiful World

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YourAudioApp — 4 of 7

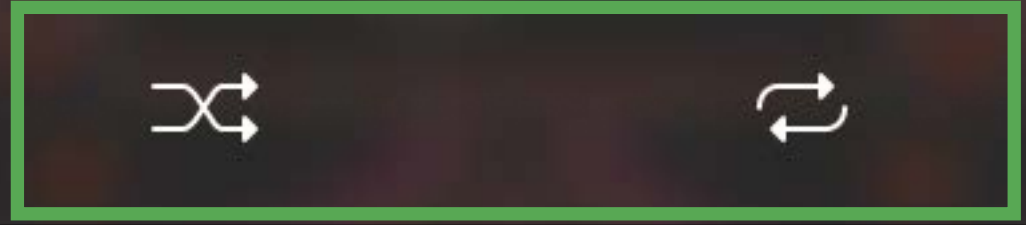
# Make You Better

The Decemberists — What a Terrible World, What a Beautiful World

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LTE



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

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Developing CarPlay Systems, Part 2

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Video Only

# Labs

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

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WWDC 16 