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
How CarPlay Works
Car iPhone

Communication Protocols

Video

Audio

Audio
Car iPhone

Audio

Video

Communication Protocols

Audio

Audio
Car iPhone

Audio

Video

Communication Protocols

Audio

CarPlay
Car iPhone

Audio

Video

Communication Protocols

Audio

Audio
Car

Wired Connection to iPhone

iPhone

CarPlay
Wired Connection to iPhone
Wired Connection to iPhone
Car

Sensors and Metadata

Wired Connection to iPhone

iPhone

CarPlay
Car

Communication Plug-in

Sensors and Metadata

IP

iAP2

USB

Wired Connection to iPhone

iPhone

CarPlay
Car

- Audio
- Video
- Communication Plug-in
- IP
- iAP2
- USB

Sensors and Metadata

Wired Connection to iPhone

iPhone

CarPlay
Car

- Speakers and Microphone
- Display
- Communication Plug-in
- USB

Wired Connection to iPhone

iPhone

- Sensors and Metadata
- Audio
- Video
- CarPlay

iAP2
Car

- Speakers and Microphone
- Display
- Controls
- Sensors and Metadata

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<th>Video</th>
<th>Communication Plug-in</th>
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IP

iAP2

USB

Wired Connection to iPhone

iPhone

CarPlay
Wi-Fi and Bluetooth

Wireless Connection to iPhone
Wireless Connection to iPhone
Car

- Speakers and Microphone
- Display
- Controls
- Sensors and Metadata

Audio
Video
iAP2

Communication Plug-in
IP
Wi-Fi and Bluetooth

Wireless Connection to iPhone

iPhone

CarPlay

iPhone Car

iPhone

Wi-Fi and Bluetooth
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

800 x 480
Standard Display Resolutions

800 x 480

960 x 540
Standard Display Resolutions

- 800 x 480
- 960 x 540
- 1280 x 720
Standard Display Resolutions

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
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

- High Resolution Display
- Speakers and Microphone
- User Input
- Sensors
- Connection to iPhone
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

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
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
Low-Fidelity Touch

CarPlay user interface optimized for single touch interactions
Recommended for resistive touch screens
Favorites

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<tr>
<td>Katie Abeles</td>
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<td>Erin Steed</td>
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9:41
LTE
Touch

Knobs and Controls

Voice
Touch  Knobs and Controls  Voice
Knobs and Controls

Rotating knob
Knobs and Controls
Rotating knob

Rotate
Knobs and Controls

Rotating knob

Rotate

Select
Knobs and Controls

Rotating knob

Rotate

Back

Select
Knobs and Controls
Multi-axis rotating knob

Tilt
Knobs and Controls

Multi-axis rotating knob

Tilt
Knobs and Controls
Multi-axis rotating knob
Knobs and Controls
Multi-axis rotating knob

Tilt
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
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
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Connection to iPhone
Key Vehicle Requirements

- High Resolution Display
- Speakers and Microphone
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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
CarPlay Over Wireless

Two-stage process

Bluetooth

Wi-Fi
CarPlay Over Wireless

Two-stage process

Bluetooth connected
CarPlay Over Wireless

Two-stage process

Bluetooth

Bluetooth connected

↓

Car sends Wi-Fi credentials to iPhone
CarPlay Over Wireless

Two-stage process

Bluetooth

Bluetooth connected

Car sends Wi-Fi credentials to iPhone

Wi-Fi

Wi-Fi connected
CarPlay Over Wireless

Two-stage process

- 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 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
CarPlay is Designed to Use the Entire Display
Car Maker
Not recommended
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
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
Media Sources
Media Sources
Media Sources

🎵 iPhone Audio Playing

CarPlay
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

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
Psycho - 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
Psycho — Muse — Drones
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Make You Better
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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

- 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 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

<p>| Developing CarPlay Systems, Part 2               | Video Only |</p>
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