System Frameworks #WWDC16

Developing CarPlay Systems, Part 2

Session 723

Tanya Kancheva CarPlay Engineering

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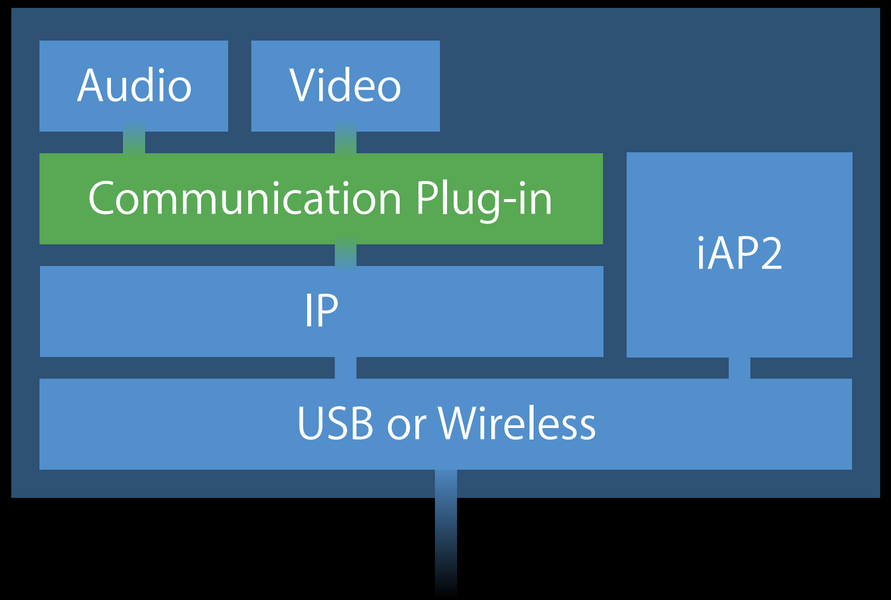
Resource Management

Application State Management

System Overview

System Overview



System Overview

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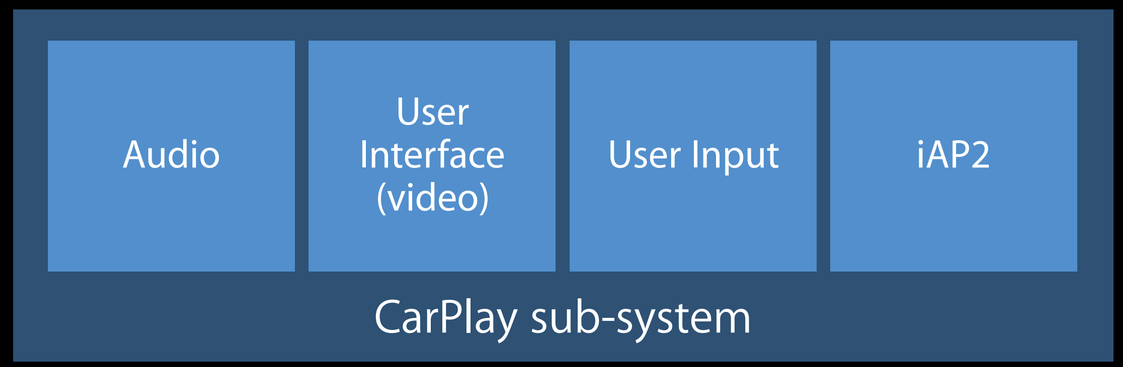

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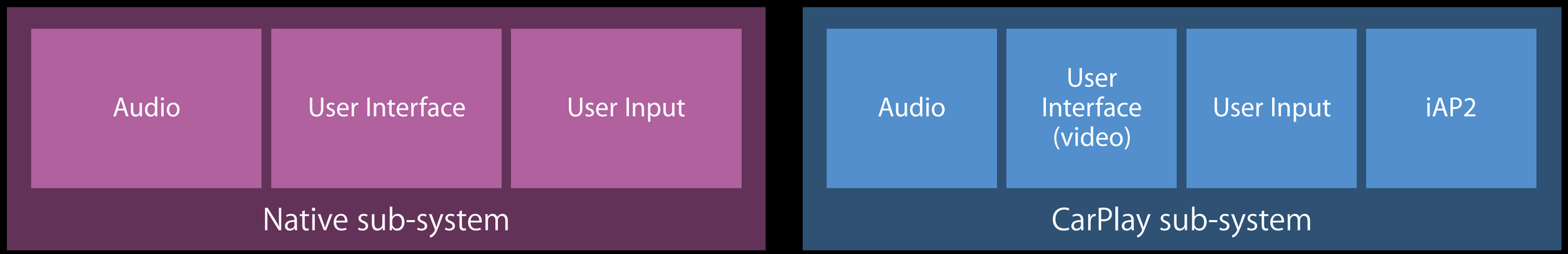

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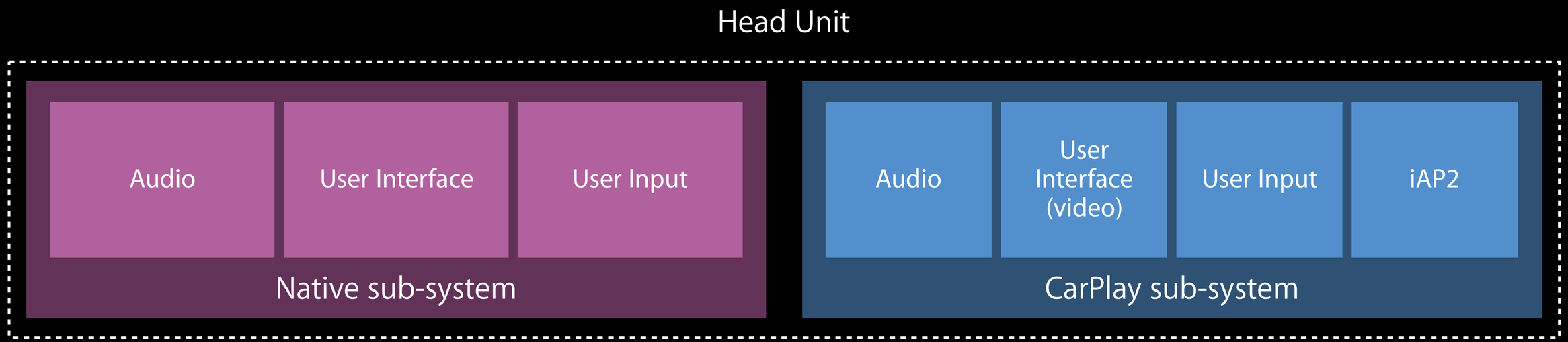

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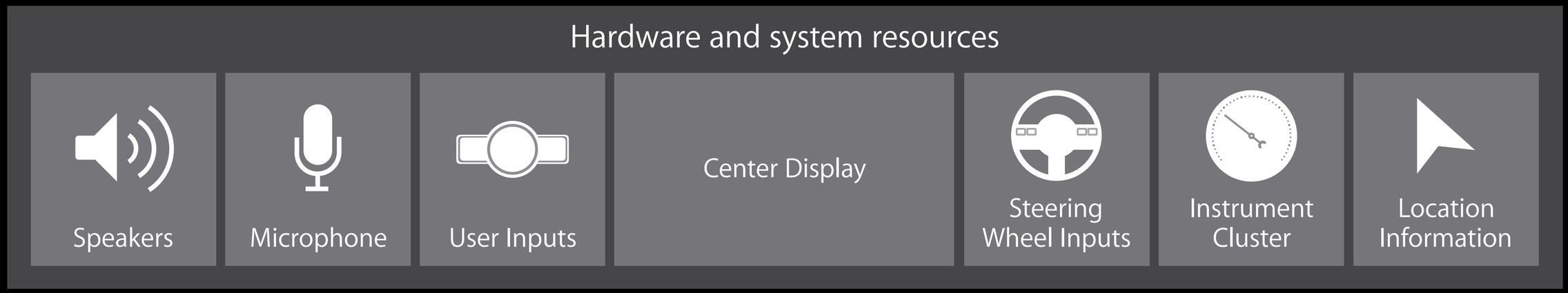

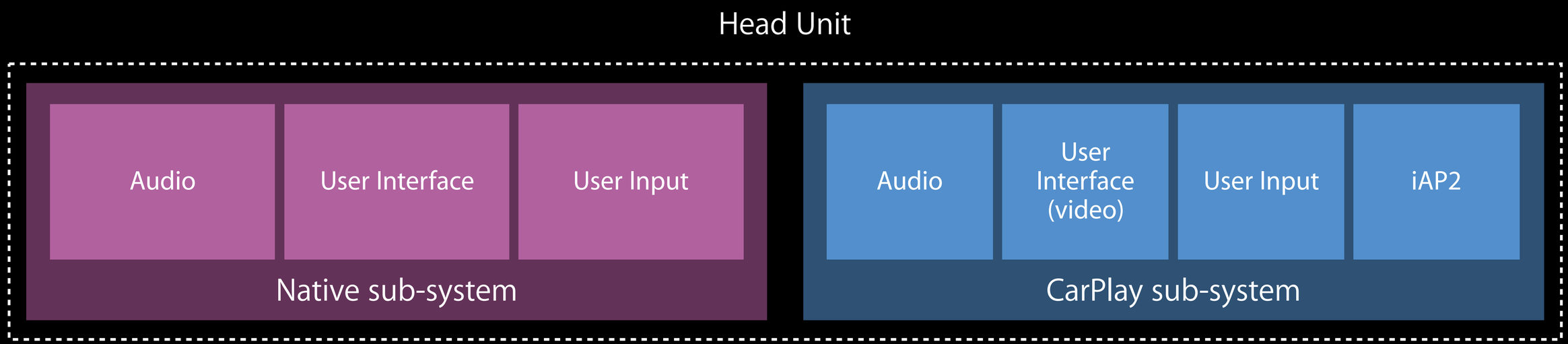

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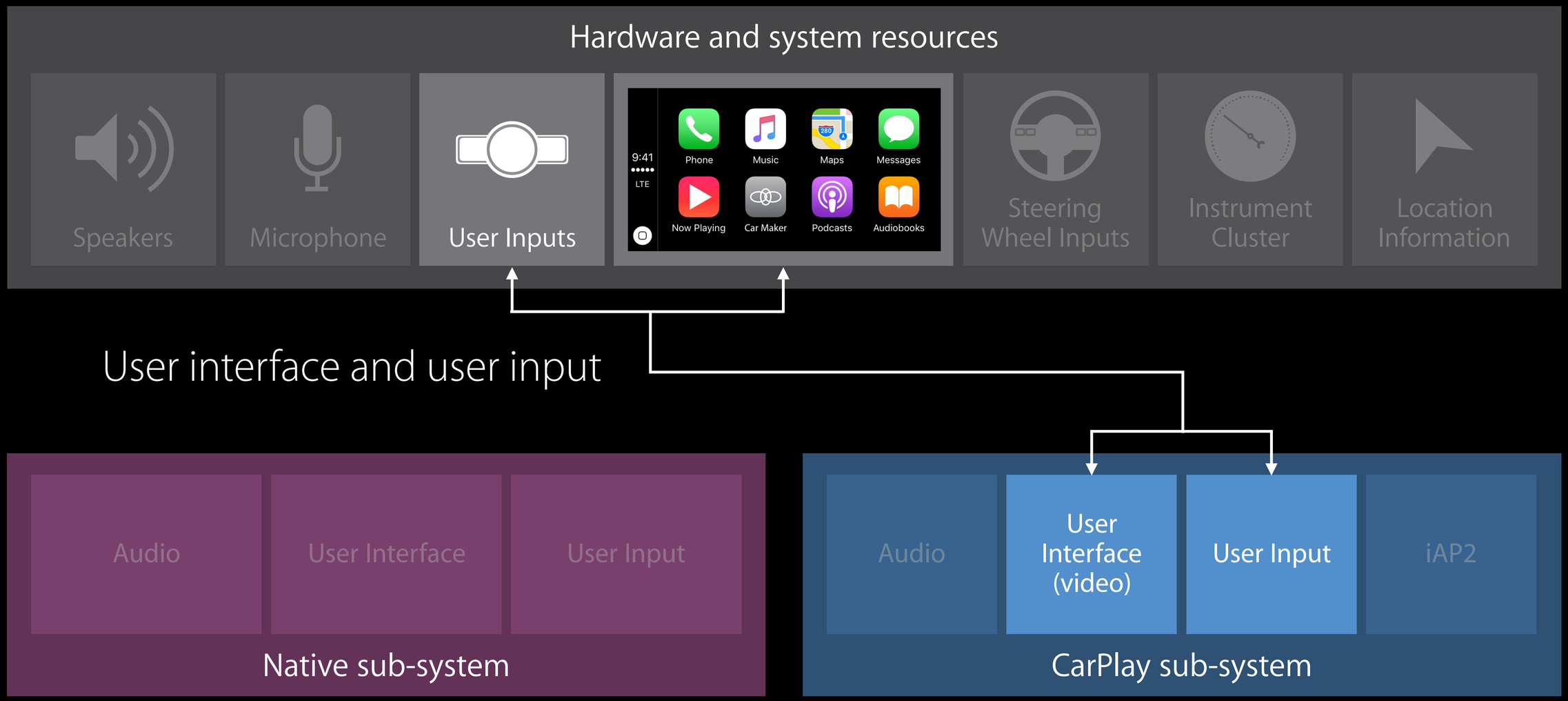
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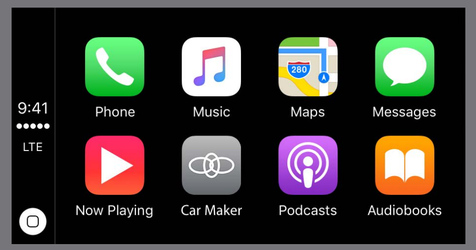

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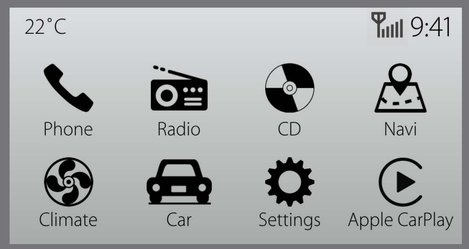

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User interface and user input

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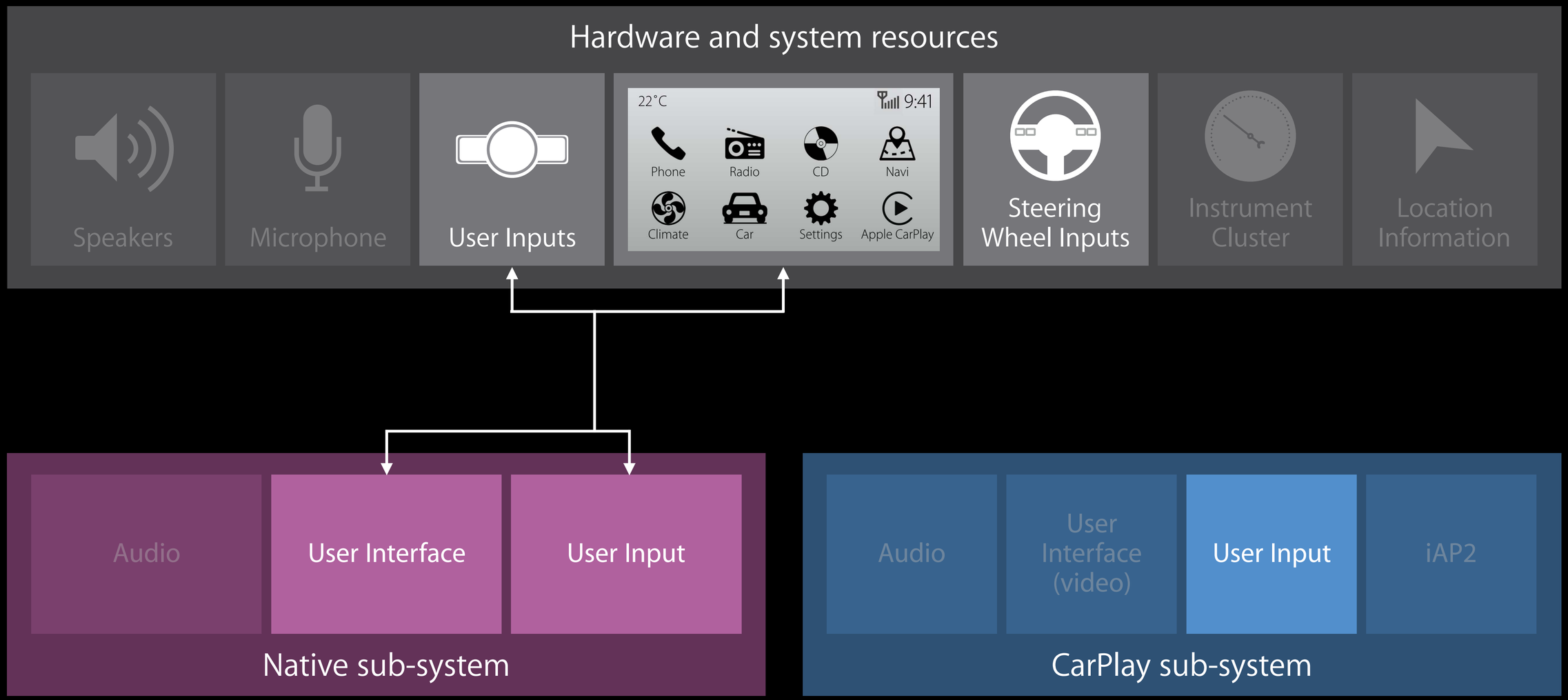
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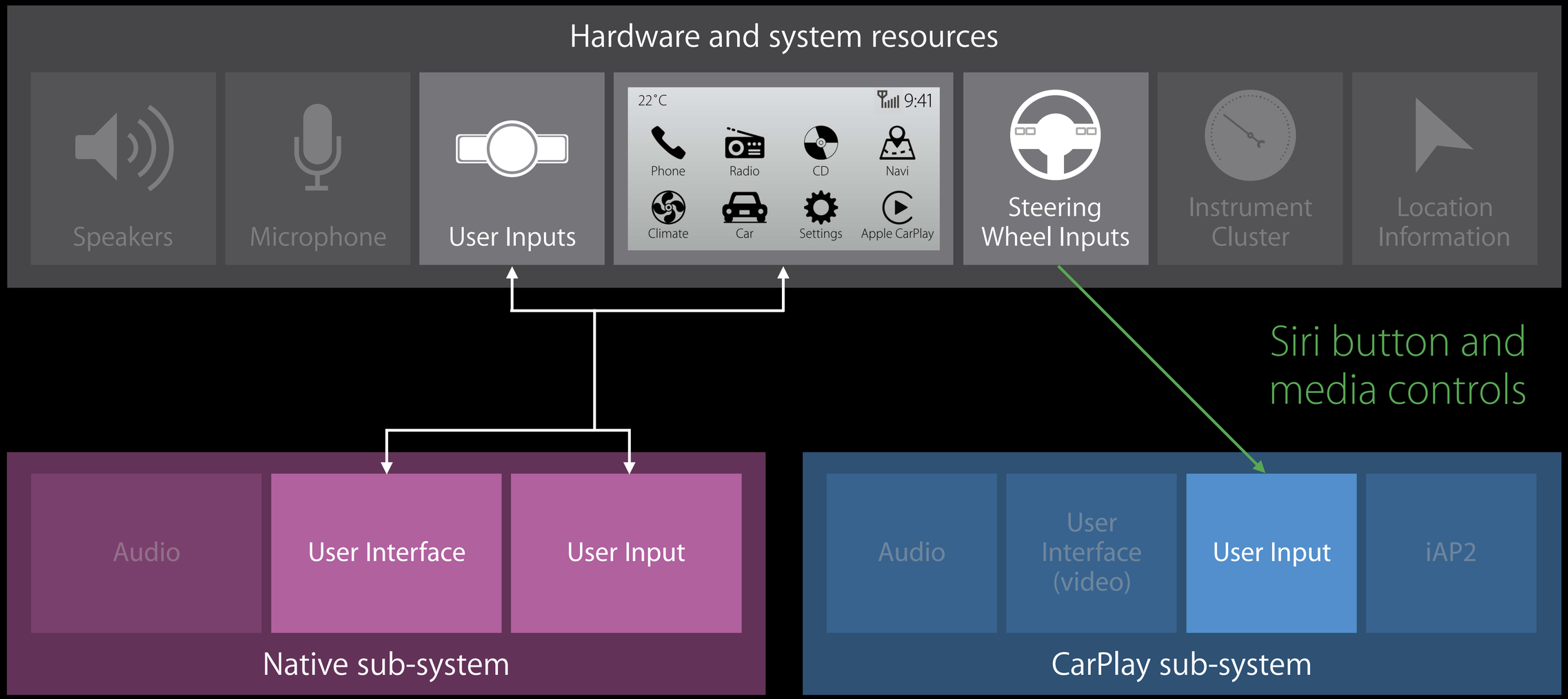
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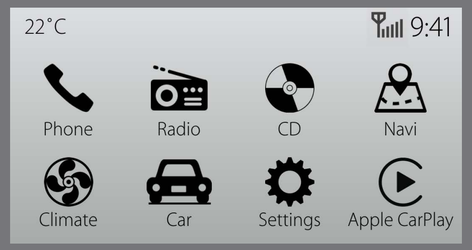

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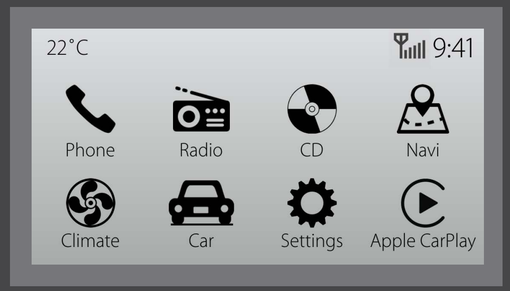

User Input

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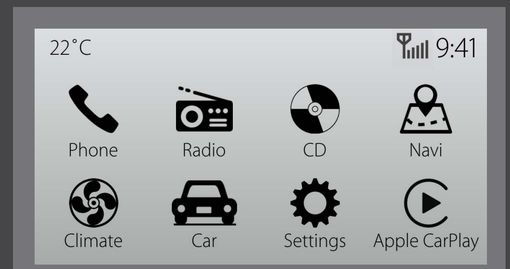

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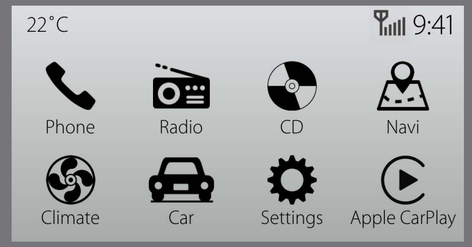

Instrument Cluster

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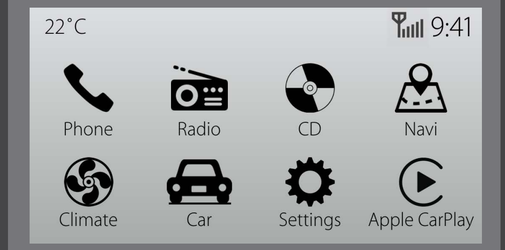

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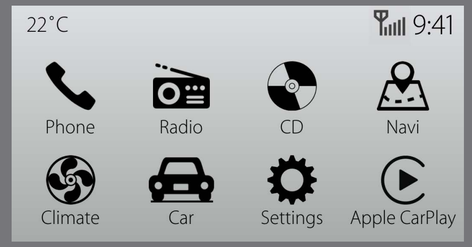

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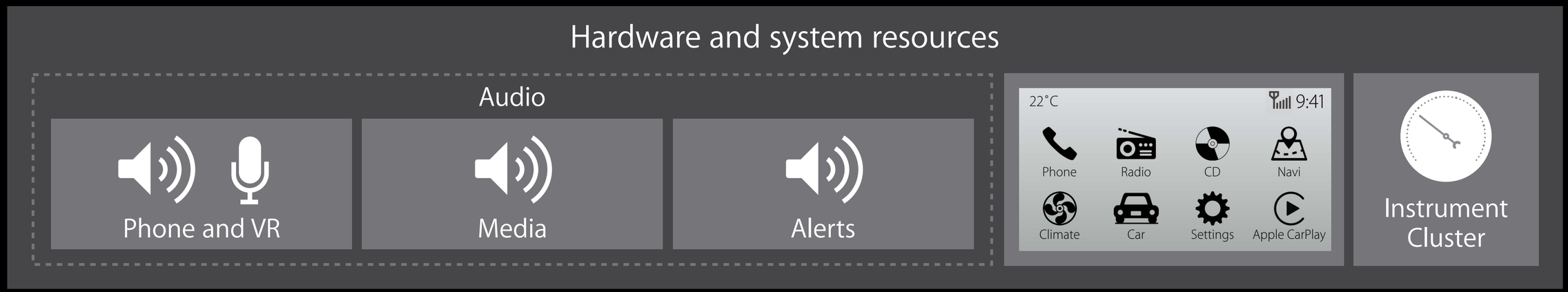
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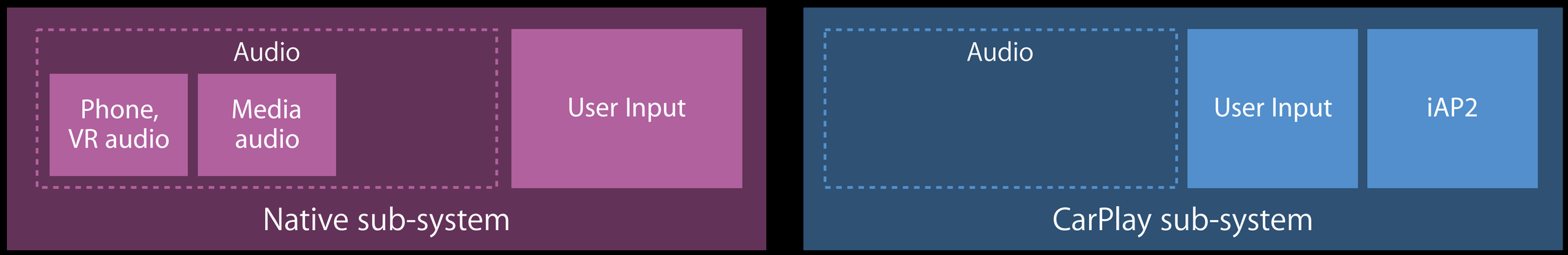
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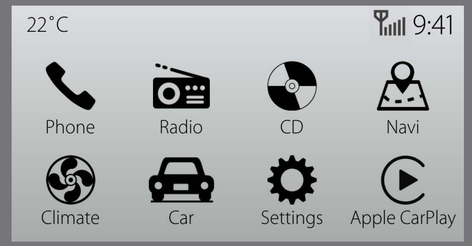

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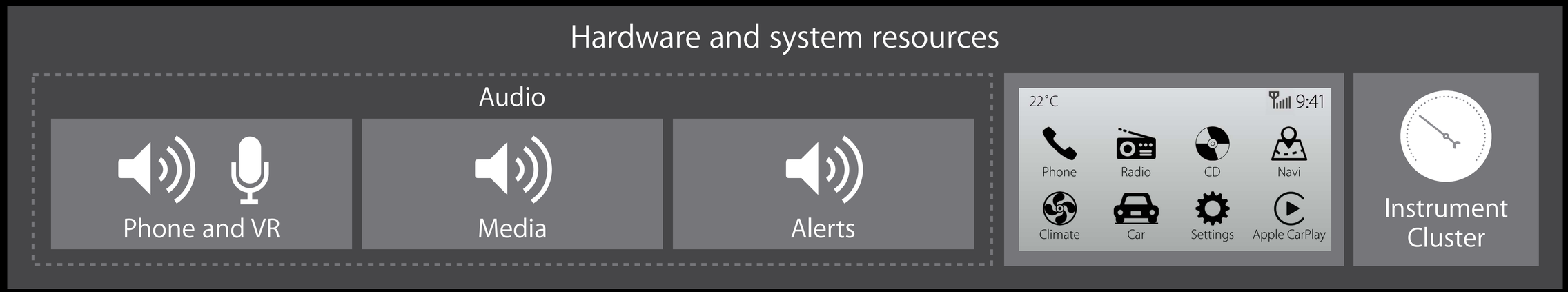
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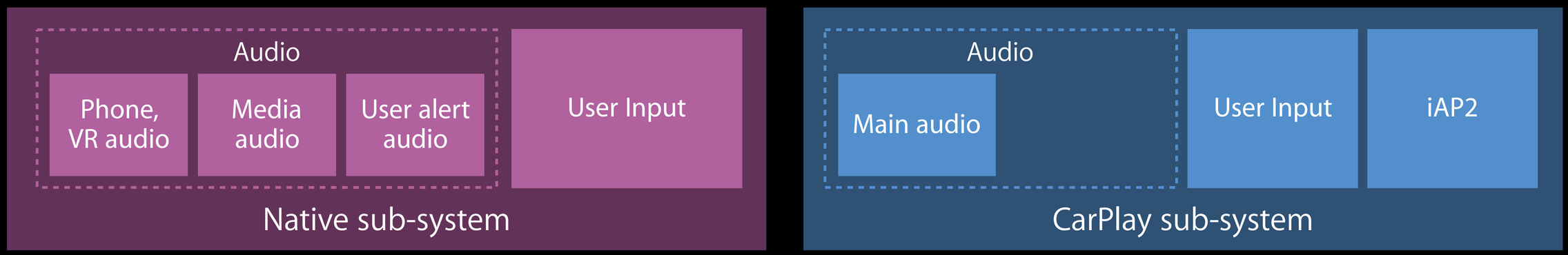
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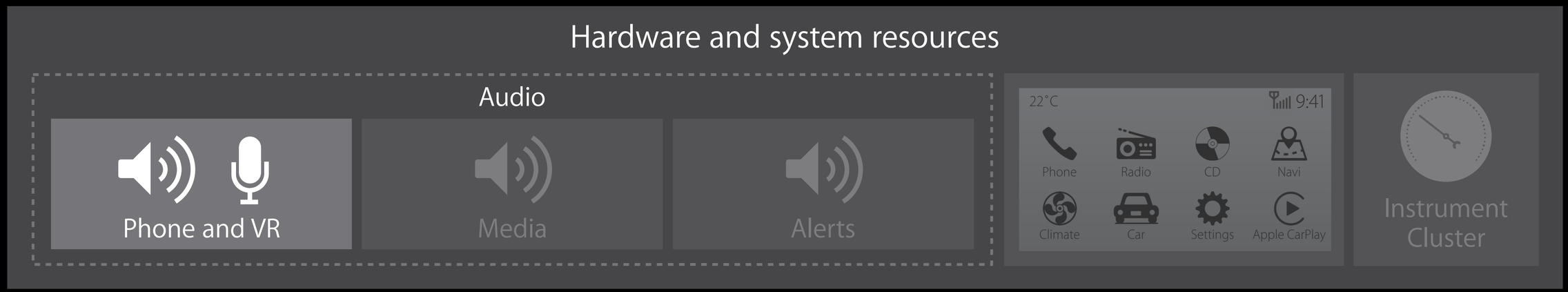
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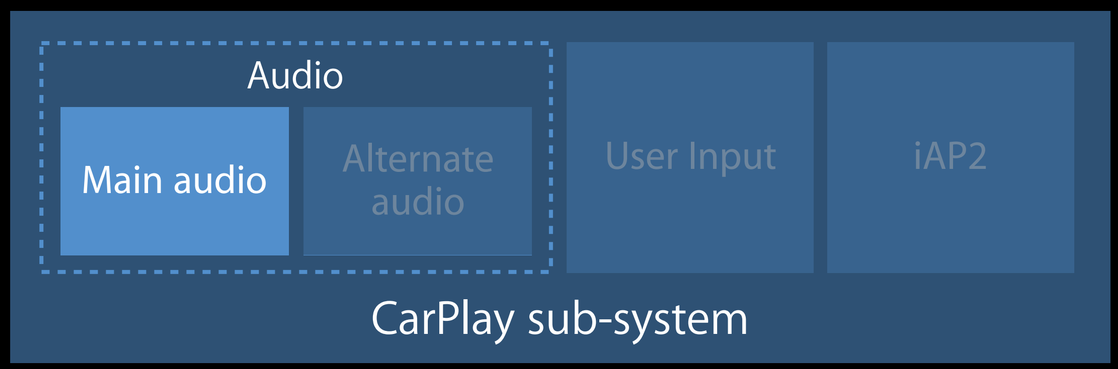
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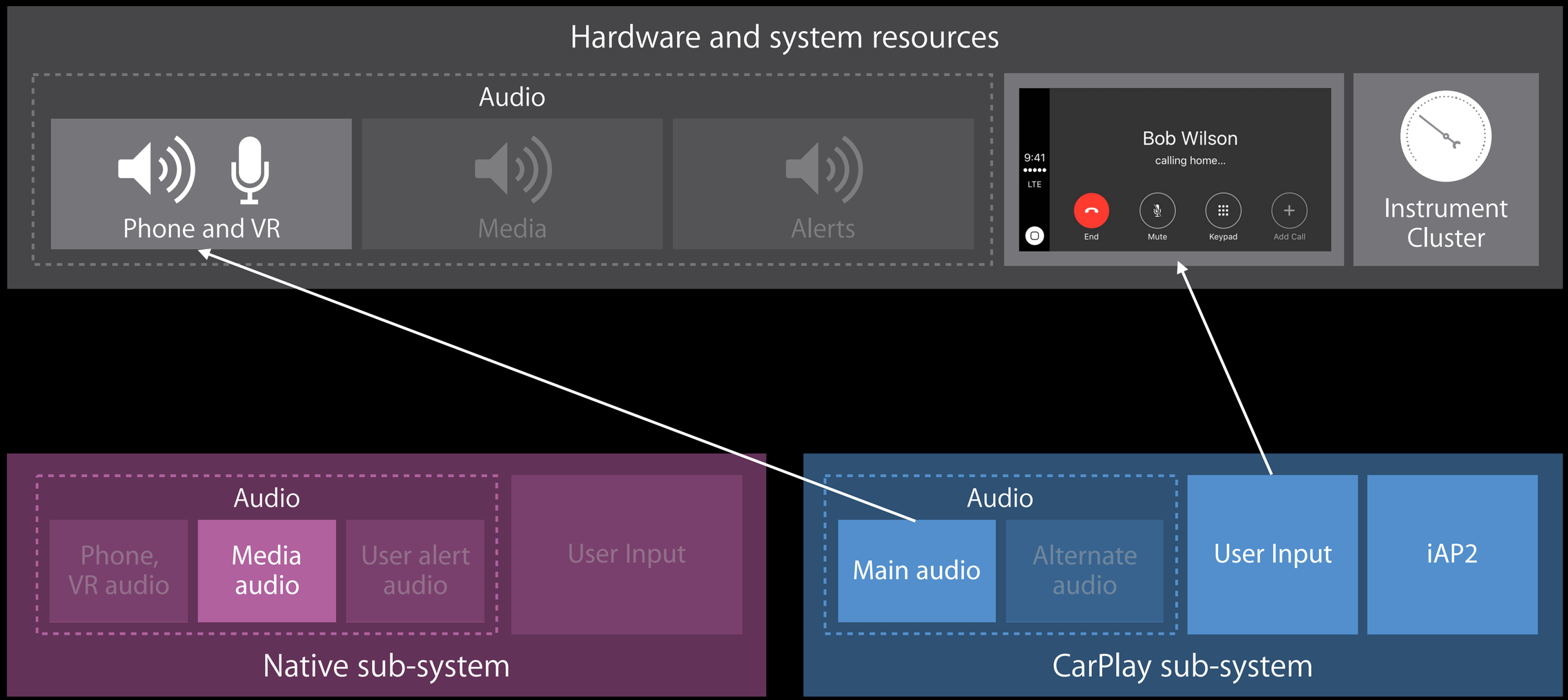
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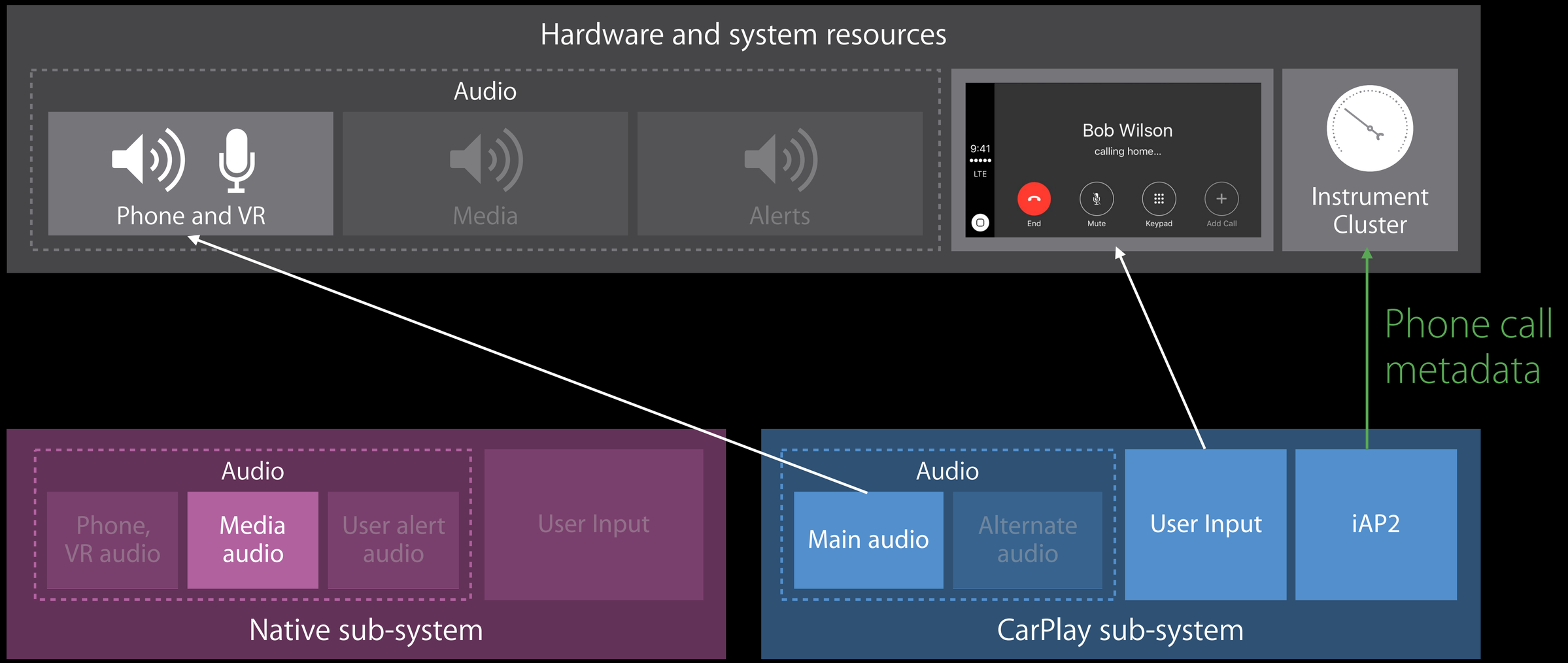
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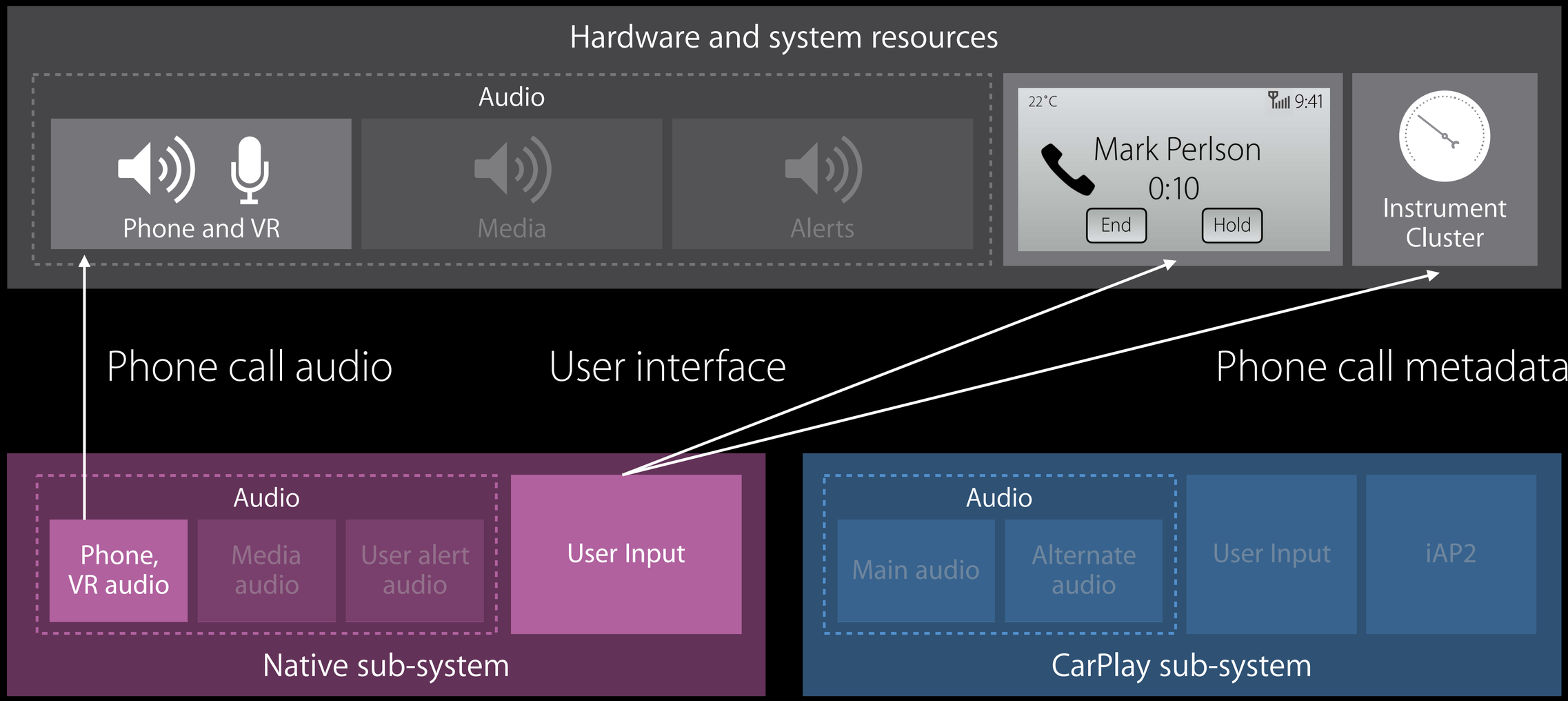
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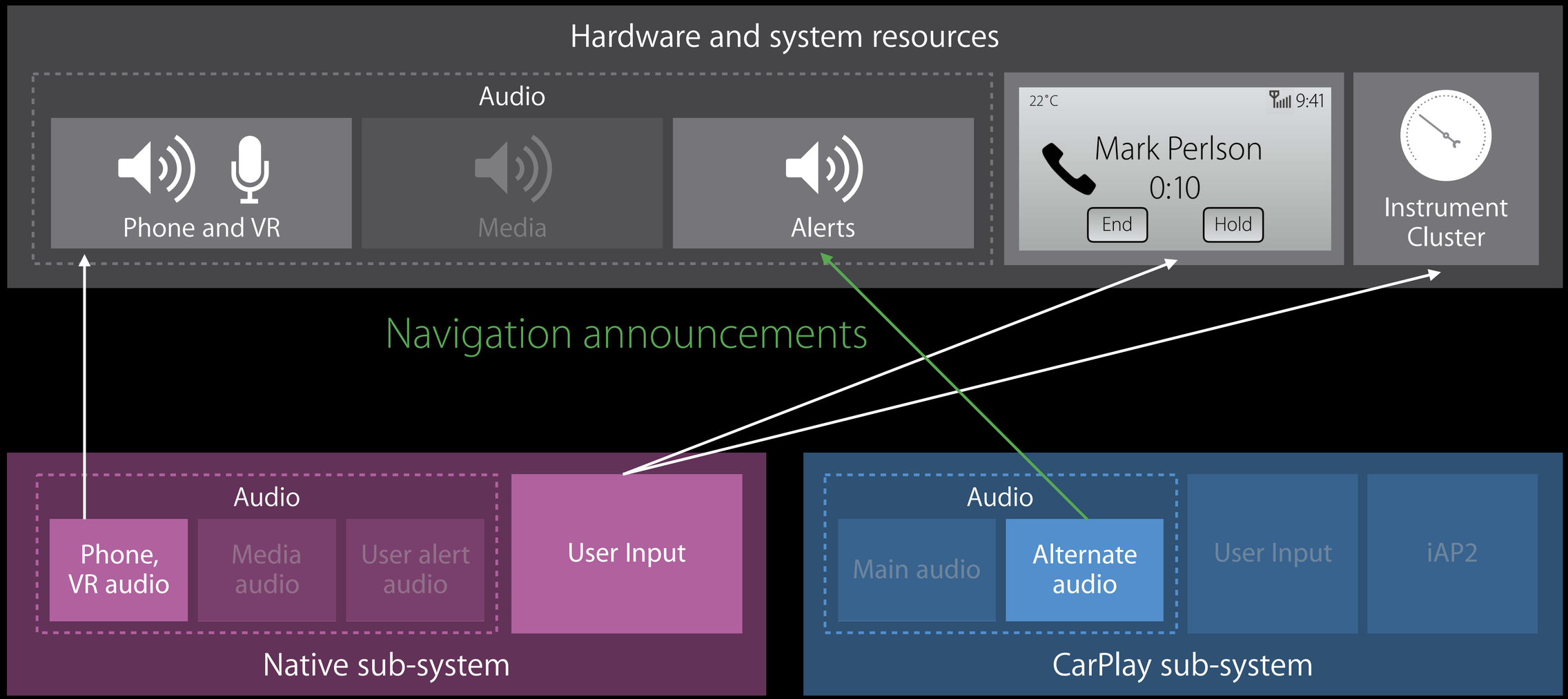
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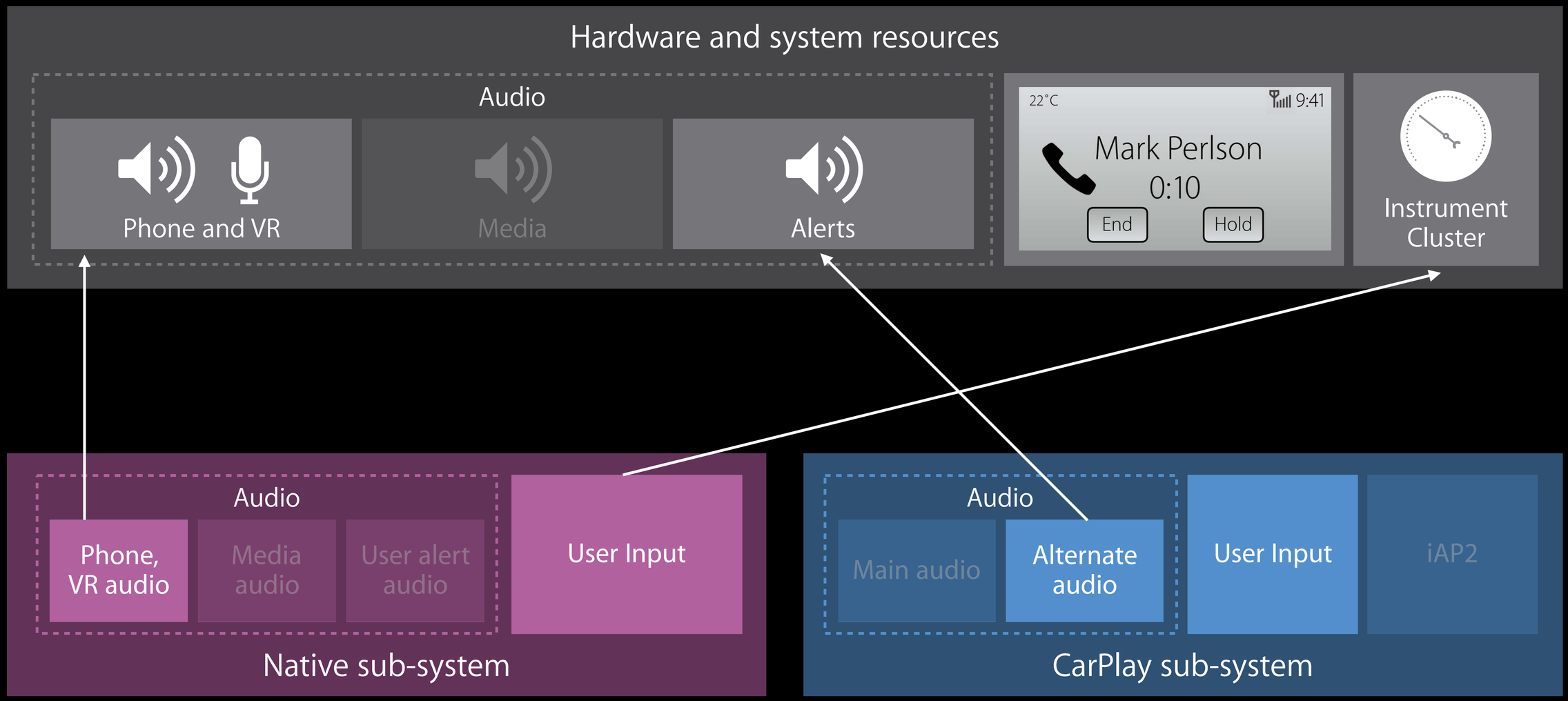
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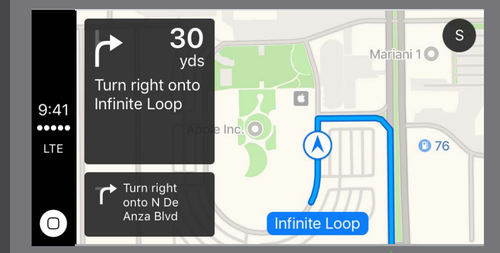

Instrument Cluster

Maps user interface

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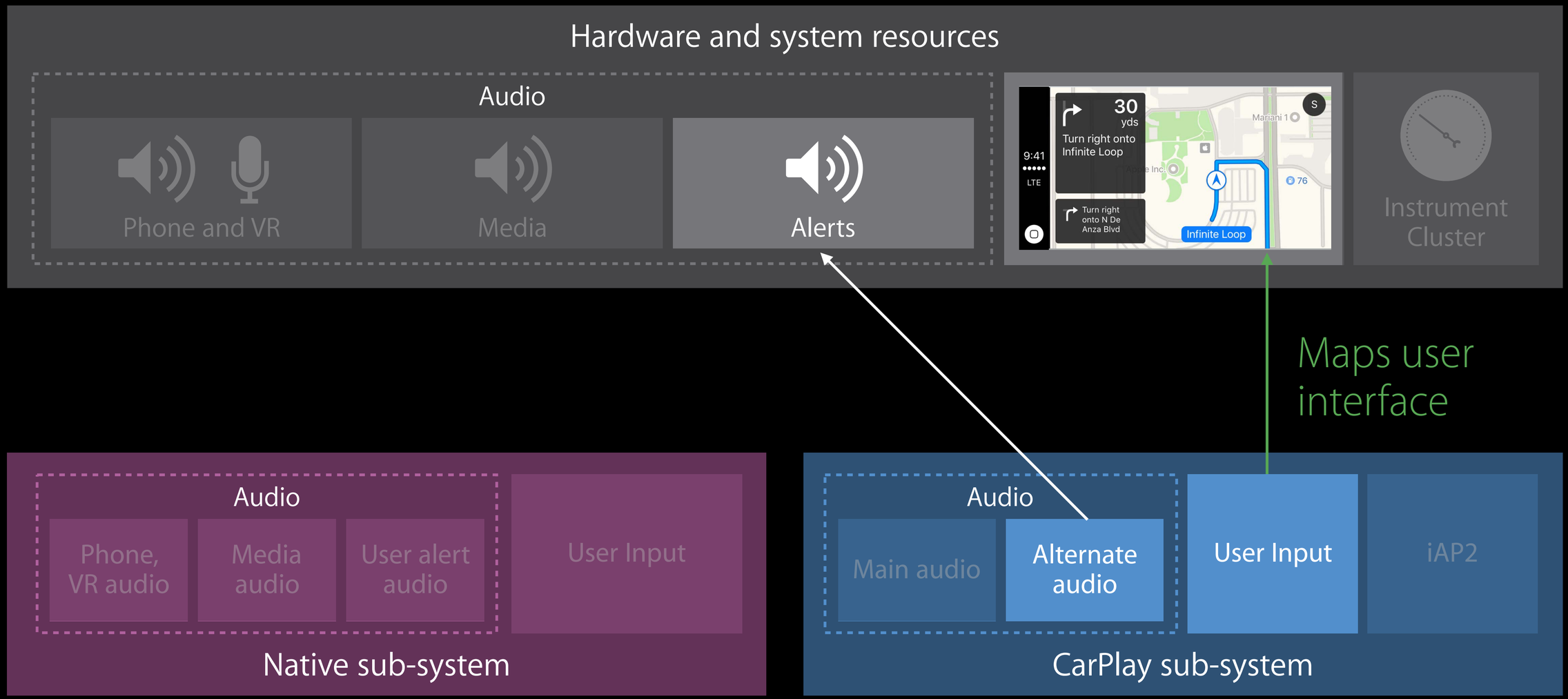
User Input

iAP2


Hardware and system resources
Audio
Phone and VR
Media
Alerts
9:41
LTE
30
yds
Turn right onto Infinite Loop
Turn right onto N De Anza Blvd
Infinite Loop
Mariani 1
S
76
Instrument Cluster
Maps user interface
Audio
Phone, VR audio
Media audio
User alert audio
User Input
Native sub-system
Audio
Main audio
Alternate audio
User Input
iAP2
CarPlay sub-system

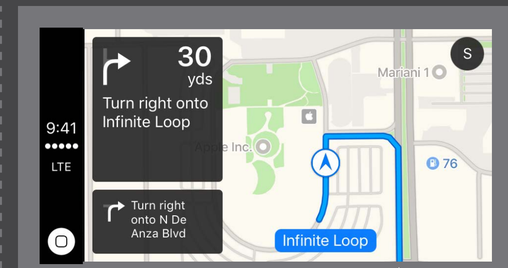
Hardware and system resources

Audio

Phone and VR

Media

Alerts



Instrument Cluster

Native sub-system

Audio

Phone, VR audio

Media audio

User alert audio

User Input

CarPlay sub-system

Audio

Main audio

Alternate audio

User Input

iAP2

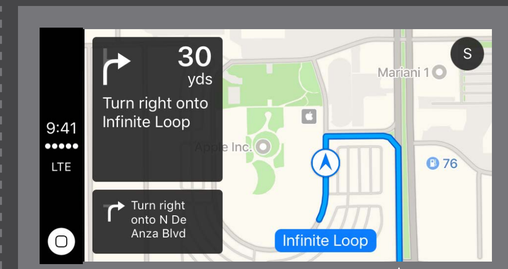
Hardware and system resources

Audio

Phone and VR

Media

Alerts



Instrument Cluster

Media playback

Audio

Phone, VR audio

Media audio

User alert audio

User Input

Native sub-system

Audio

Main audio

Alternate audio

User Input

iAP2

CarPlay sub-system

Volume Management

22°C
9:41
Phone
Radio
CD
Navi
Climate
4
Apple CarPlay
Volume

22°C
9:41
Phone
Radio
CD
Navi
Climate
7
Apple CarPlay
Volume

9:41
LTE
What can I help you with?
Voice
3
Volume

9:41

LTE

Bob Wilson

home

Decline

Message

Accept

Ringtone 9

Volume

9:41
LTE
Bob Wilson
00:04
End
Mute
Keypad
Add Call
Phone
6
Volume

250 feet
Turn right onto Infinite Loop
Phone
Music
Maps
Messages
280
9:41
LTE
Nav
9
Volume

Back
3 of 13
Jackie and Wilson
Hozier - Hozier
9:41
LTE
0:12
-3:31
Media
11
Volume

Resource Management

Resource Management

Managed Resources

Resource Manager

Resource Management Commands

Examples

Managed Resources

Managed Resources

Two resources are coordinated

`mainScreen`	Access to center display in car
`mainAudio`	Access to speakers and microphone in car

Managed Resources

Use for limited or undetermined periods of time

`take`	Use for undetermined period of time Resource owner changes permanently
`borrow`	Use for limited period of time Resource owner transferred temporarily until action completes When action completes, resource returns to previous owner

Main Screen

Native user interface takes the display

Main Screen

Native user interface takes the display

Native UI takes the display when the user

- Presses a hard key linked to the native UI
- Presses the OEM icon in CarPlay
- Activates a feature using the native voice recognizer

Main Screen

Native user interface takes the display

Main Screen

Native user interface takes the display

Main Screen

CarPlay takes the display

Main Screen

CarPlay takes the display

CarPlay takes the display when the user

- Presses a hard key linked to CarPlay
- Selects the CarPlay button in the native UI
- Uses Siri to launch an application
  - For example “Open Maps”

Main Screen

Borrowing the display

Borrow the display for applications with limited duration

Main Screen

Borrowing the display

Borrow the display for applications with limited duration

- Phone calls
- Siri or native voice recognition
- Notifications
- Alerts

Main Screen

Native user interface owns the display

Main Screen

Native user interface owns the display

Main Screen

Native user interface owns the display

Main Screen

Display is returned to the native user interface

Main Audio

Distributes hardware resources based on audio type

Main Audio

Distributes hardware resources based on audio type

Audio type	Hardware resource	Application

Main Audio

Distributes hardware resources based on audio type

Audio type	Hardware resource	Application
`media`	Speakers	Media playback

Main Audio

Distributes hardware resources based on audio type

Audio type	Hardware resource	Application
`media`	Speakers	Media playback
`alert`	Speakers	Ringtones and alerts

Main Audio

Distributes hardware resources based on audio type

Audio type	Hardware resource	Application
`media`	Speakers	Media playback
`alert`	Speakers	Ringtones and alerts
`speechRecognition`	Speakers and microphone	Siri

Main Audio

Distributes hardware resources based on audio type

Audio type	Hardware resource	Application
`media`	Speakers	Media playback
`alert`	Speakers	Ringtones and alerts
`speechRecognition`	Speakers and microphone	Siri
`telephony`	Speakers and microphone	Phone calls

Main Audio

Distributes hardware resources based on audio type

Audio type	Hardware resource	Application
`media`	Speakers	Media playback
`alert`	Speakers	Ringtones and alerts
`speechRecognition`	Speakers and microphone	Siri
`telephony`	Speakers and microphone	Phone calls
`default`	Speakers and microphone	Undefined

Alternate Audio

Not a managed resource

Audio played over `alternateAudio`

- Maps turn-by-turn announcements
- New message alerts

Always mixed with content playing through the in-car speakers over `mainAudio`

Resource Manager

Tom Powell CarPlay Engineering

Resource Manager

Two systems need to manage access to screen and audio

Resource Manager

Arbitrates the access to the resources

Resource Manager

Resource Manager

Responsibilities

Holds current state

Follows strict set of rules

Assigns resources

Resource Manager

Handling requests for resources

Resource Manager

Resource Manager

Handling requests for resources

Request screen

Resource Manager

Request screen

Resource Manager

Handling requests for resources

Resource Manager

Check state

Assign resource

Set new state

Resource Manager

Handling requests for resources

Resource Manager

Resource Manager

Handling requests for resources

State changes should only be triggered by the resource manager

Resource Manager

Notify new screen owner

Resource Manager

Implement in native or CarPlay sub-system?

Resource Manager

Resource Manager

Implement in native or CarPlay sub-system?

Resource Manager

iPhone is referred to as the “controller”

Head unit is referred to as the “accessory”

Same rules apply to both native and CarPlay applications

Resource Management Commands

Commands for Managing Resources

`changeModes`	Request or release resources
`modesChanged`	Notification that state changed

Request or Release Resources

Sent from head unit to controller

Request or Release Resources

Sent from head unit to controller

```
changeModes
```

Request or Release Resources

changeModes

States what the accessory intends to do with the resources

Declares why the head unit needs the resources

If the resource is transferred, it defines who can get access to it from the new owner

Notification that Resource Owner Changed

Sent from controller to head unit

Notification that Resource Owner Changed

Sent from controller to head unit

`modesChanged`

Notification that Resource Owner Changed

modesChanged

States the current owner of the managed resources

Sent when there is a state change

Examples

Examples

Play FM radio

Use native voice recognition

Show backup camera

Ask Siri to play music

Examples

Play FM radio

Use native voice recognition

Show backup camera

Ask Siri to play music

Play FM Radio

Play FM Radio

iPhone audio playing

Play FM Radio

iPhone audio playing

Play FM Radio

iPhone audio playing

Play FM Radio

Request to take the audio resource indefinitely

iPhone audio playing

Play FM Radio

Request to take the audio resource indefinitely

iPhone audio playing

`changeModes`

```
{ resource: mainAudio,
  transferType: take }
```

Play FM Radio

Request to take the audio resource indefinitely

iPhone audio playing

```
changeModes
```

```
{ resource: mainAudio,
  transferType: take }
```

Play FM Radio

Audio resource is assigned to the head unit

iPhone audio playing

Play FM Radio

Audio resource is assigned to the head unit

iPhone audio playing

`modesChanged`

```
{ resource: mainAudio,
  owner: accessory }
```

Play FM Radio

Audio resource is assigned to the head unit

iPhone audio playing

`modesChanged`

```
{ resource: mainAudio,
  owner: accessory }
```

Play FM Radio

Play FM Radio

FM radio playing

Take Resources

Take resources for actions that last an undetermined period of time

Resource owner changes permanently

Don’t use resources when not the owner

Examples

Play FM radio

Use native voice recognition

Show backup camera

Ask Siri to play music

Examples

Play FM radio

Use native voice recognition

Show backup camera

Ask Siri to play music

Use Native Voice Recognition

Use Native Voice Recognition

FM radio playing

Use Native Voice Recognition

FM radio playing

Use Native Voice Recognition

FM radio playing

Use Native Voice Recognition

Borrow audio and screen for duration of voice dialog

FM radio playing

Use Native Voice Recognition

Borrow audio and screen for duration of voice dialog

FM radio playing

`changeModes`

```
{ resource: mainAudio,
  transferType: borrow }
{ resource: mainScreen,
  transferType: borrow }
```

Use Native Voice Recognition

Borrow audio and screen for duration of voice dialog

FM radio playing

`changeModes`

```
{ resource: mainAudio,
  transferType: borrow }
{ resource: mainScreen,
  transferType: borrow }
```

Use Native Voice Recognition

Audio and screen are assigned to head unit

FM radio playing

Use Native Voice Recognition

Audio and screen are assigned to head unit

FM radio playing

```
modesChanged
```

```
{ resource: mainAudio,
  owner: accessory }
{ resource: mainScreen,
  owner: accessory }
```

Use Native Voice Recognition

Audio and screen are assigned to head unit

FM radio playing

`modesChanged`

```
{ resource: mainAudio,
  owner: accessory }
{ resource: mainScreen,
  owner: accessory }
```

Use Native Voice Recognition

Use Native Voice Recognition

Native voice recognition

Use Native Voice Recognition

Return resources when finished

Native voice recognition

Use Native Voice Recognition

Return resources when finished

Native voice recognition

```
changeModes
```

```
{ resource: mainAudio,
  transferType: unborrow }
{ resource: mainScreen,
  transferType: unborrow }
```

Use Native Voice Recognition

Return resources when finished

Native voice recognition

```
changeModes
```

```
{ resource: mainAudio,
  transferType: unborrow }
{ resource: mainScreen,
  transferType: unborrow }
```

Use Native Voice Recognition

Resources are returned to the head unit

Native voice recognition

Use Native Voice Recognition

Resources are returned to the head unit

Native voice recognition

```
modesChanged
```

```
{ resource: mainAudio,
  owner: accessory }
{ resource: mainScreen,
  owner: accessory }
```

Use Native Voice Recognition

Resources are returned to the head unit

Native voice recognition

```
modesChanged
```

```
{ resource: mainAudio,
  owner: accessory }
{ resource: mainScreen,
  owner: accessory }
```

Use Native Voice Recognition

Use Native Voice Recognition

FM radio playing

Borrow Resources

Borrow resources for temporary actions

When action completes, resource returns to previous owner

Always borrow resources even if you are already the owner, since priorities may have changed

Examples

Play FM radio

Use native voice recognition

Show backup camera

Ask Siri to play music

Examples

Play FM radio

Use native voice recognition

Show backup camera

Ask Siri to play music

Show Backup Camera

Show Backup Camera

iPhone audio playing

Show Backup Camera

State that the screen can never be assigned to anyone else

iPhone audio playing

Show Backup Camera

State that the screen can never be assigned to anyone else

iPhone audio playing

`changeModes`

```
{ resource: mainScreen,
  transferType: borrow,
  borrowConstraint: never }
```

Show Backup Camera

State that the screen can never be assigned to anyone else

iPhone audio playing

```
changeModes
```

```
{ resource: mainScreen,
  transferType: borrow,
  borrowConstraint: never }
```

Show Backup Camera

iPhone audio playing

Show Backup Camera

iPhone audio playing

```
modesChanged
```

```
{ resource: mainScreen,
  owner: accessory }
```

Show Backup Camera

iPhone audio playing

`modesChanged`

`{ resource: mainScreen, owner: accessory }`

Show Backup Camera

iPhone audio playing

Show Backup Camera

CarPlay does not appear if head unit constrains access

Show Backup Camera

CarPlay does not appear if head unit constrains access

Ringtone playing

Defining the Constraints

Define the rules while you are the owner

`anytime`	Allow any application to get access
`user-initiated`	Allow only user-initiated applications to get access
`never`	Do not let any application get access

Define the Constraints

Define the rules while you are the owner

When taking resources, make sure to define both take constraints and borrow constraints

When borrowing resources, only define borrow constraints

In most cases use `anytime`, unless the native user interface needs immediate attention

Examples

Play FM radio

Use native voice recognition

Show backup camera

Ask Siri to play music

Examples

Play FM radio

Use native voice recognition

Show backup camera

Ask Siri to play music

Ask Siri to Play Music

Ask Siri to Play Music

FM radio playing

Ask Siri to Play Music

FM radio playing

Ask Siri to Play Music

FM radio playing

Ask Siri to Play Music

Siri has been assigned resources and head unit is notified

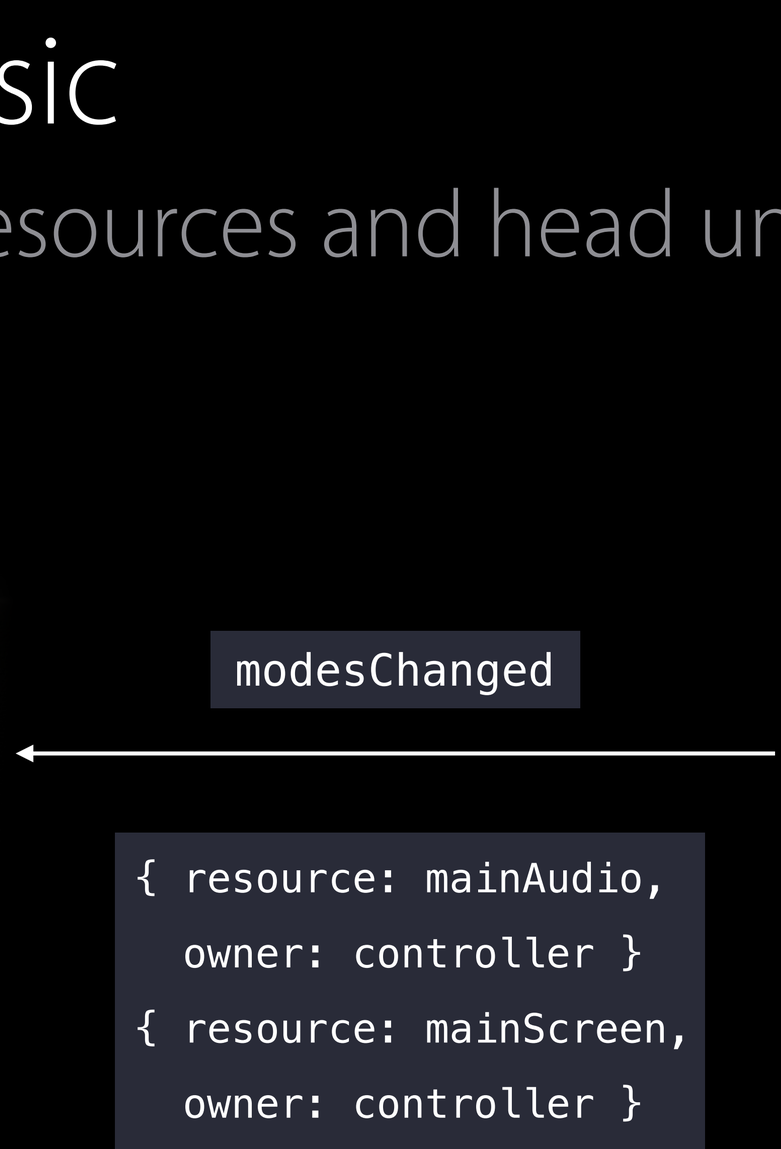
FM radio playing

Ask Siri to Play Music

Siri has been assigned resources and head unit is notified

FM radio playing

```
modesChanged
```



```
{ resource: mainAudio,
  owner: controller }
{ resource: mainScreen,
  owner: controller }
```

Ask Siri to Play Music

Siri has been assigned resources and head unit is notified

FM radio playing

```
modesChanged
```

```
{ resource: mainAudio,
  owner: controller }
{ resource: mainScreen,
  owner: controller }
```

Ask Siri to Play Music

Ask Siri to Play Music

Siri active

“Siri, play some music”

Ask Siri to Play Music

Siri ends, music playback starts and head unit is notified

Siri active

Ask Siri to Play Music

Siri ends, music playback starts and head unit is notified

Siri active

`modesChanged`

```
{ resource: mainAudio,
  owner: controller }
{ resource: mainScreen,
  owner: accessory }
```

Ask Siri to Play Music

Siri ends, music playback starts and head unit is notified

Siri active

`modesChanged`

```
{ resource: mainAudio,
  owner: controller }
{ resource: mainScreen,
  owner: accessory }
```

Ask Siri to Play Music

Ask Siri to Play Music

iPhone audio playing

Observe State Changes

State changes may occur at any time

- User actions
- Events on iPhone

After each state change, verify if the owner has changed and honor the new state

Application State Management

Application State Management

Manage applications which have similar features

Route guidance active

- Maps turn-by-turn versus native route guidance

Phone call in progress

- CarPlay phone call versus native phone call

Voice interaction in progress

- Siri versus native voice recognition

Application State Management

appState

`TurnByTurn`	Route guidance active
`PhoneCall`	Phone call in progress
`Speech`	Voice interaction in progress

Application State Management

Route guidance active

- Maps turn-by-turn versus native route guidance

Phone call in progress

- CarPlay phone call versus native phone call

Voice interaction in progress

- Siri versus native voice recognition

Route Guidance Active

Native navigation starts

Route Guidance Active

Native navigation starts

```
changeModes
```

```
{ appState: TurnByTurn
  state: true }
```

Route Guidance Active

Native navigation starts

```
changeModes
```

```
{ appState: TurnByTurn
  state: true }
```

Route Guidance Active

Turn-by-turn application state assigned to head unit

`modesChanged`

Route Guidance Active

Turn-by-turn application state assigned to head unit

`modesChanged`

```
{ appState: TurnByTurn,
  entity: Accessory }
```

Route Guidance Active

Turn-by-turn application state assigned to head unit

Native navigation announcements

```
modesChanged
```

```
{ appState: TurnByTurn,
  entity: Accessory }
```

Route Guidance Active

User sets destination with Apple Maps

Native navigation announcements

Route Guidance Active

User sets destination with Apple Maps

Native navigation announcements

“Siri, take me to the closest coffee shop”

Route Guidance Active

Turn-by-turn application state assigned to controller

`modesChanged`

Route Guidance Active

Turn-by-turn application state assigned to controller

`modesChanged`

`{ appState: TurnByTurn,`
`  entity: Controller }`

Route Guidance Active

Turn-by-turn application state assigned to controller

`modesChanged`

```
{ appState: TurnByTurn,
  entity: Controller }
```

Route Guidance Active

Native navigation route guidance ends

Route Guidance Active

Apple Maps route guidance starts

Apple Maps turn-by-turn spoken directions

Application State Management

Route guidance active

- Maps turn-by-turn versus native route guidance

Phone call in progress

- CarPlay phone call versus native phone call

Voice interaction in progress

- Siri versus native voice recognition

Application State Management

Route guidance active

- Maps turn-by-turn versus native route guidance

Phone call in progress

- CarPlay phone call versus native phone call

Voice interaction in progress

- Siri versus native voice recognition

Phone Call in Progress

If head unit supports second phone connected using BT

Phone Call in Progress

If head unit supports second phone connected using BT

Phone call active

Phone Call in Progress

If head unit supports second phone connected using BT

Phone call active

Phone Call in Progress

If head unit supports second phone connected using BT

Phone call active

Ringtone

Application State Management

Route guidance active

- Maps turn-by-turn versus native route guidance

Phone call in progress

- CarPlay phone call versus native phone call

Voice interaction in progress

- Siri versus native voice recognition

Application State Management

Route guidance active

- Maps turn-by-turn versus native route guidance

Phone call in progress

- CarPlay phone call versus native phone call

Voice interaction in progress

- Siri versus native voice recognition

Voice Recognition

If head unit supports native voice recognition

Voice Recognition

If head unit supports native voice recognition

Native voice recognition active

Voice Recognition

If head unit supports native voice recognition

Native voice recognition active

Voice Recognition

If head unit supports native voice recognition

Native voice recognition active

Voice Recognition

If head unit supports native voice recognition

Voice Recognition

If head unit supports native voice recognition

Siri active

Summary

CarPlay relies on the same resources as your native system and is designed to coexist with your native user interface

For a great CarPlay experience, consider resource handling for each use case and follow CarPlay design recommendations

CarPlay specifications available through the MFi Program

http://developer.apple.com/mfi

More Information

https://developer.apple.com/wwdc16/723

Related Sessions

Developing CarPlay Systems, Part 1	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

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