#WWDC19

Building Apps with RealityKit

Ross Dexter, RealityKit Engineer
Courtland Idstrom, RealityKit Engineer

Expands on the intro session

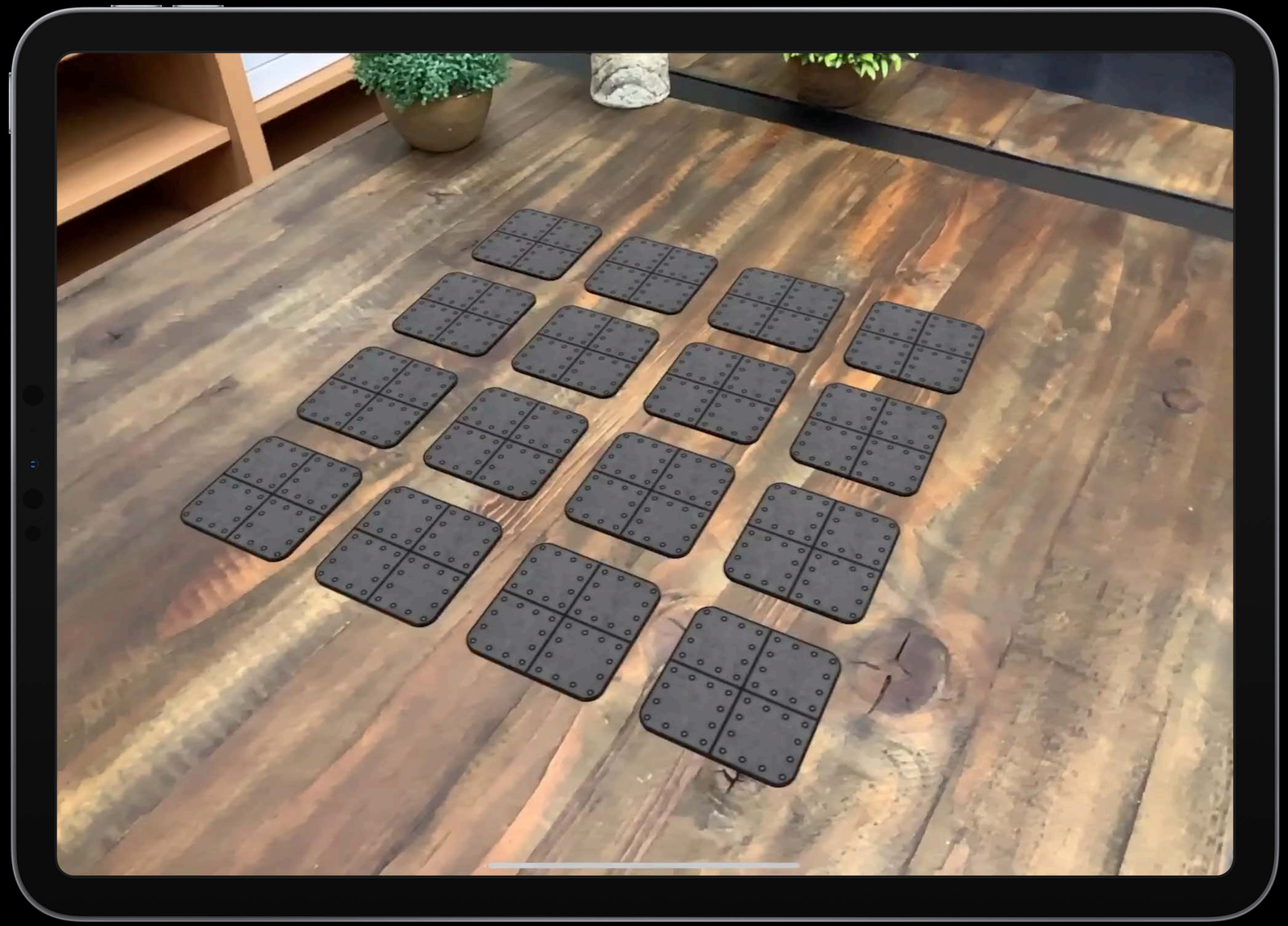
Applied usage of RealityKit

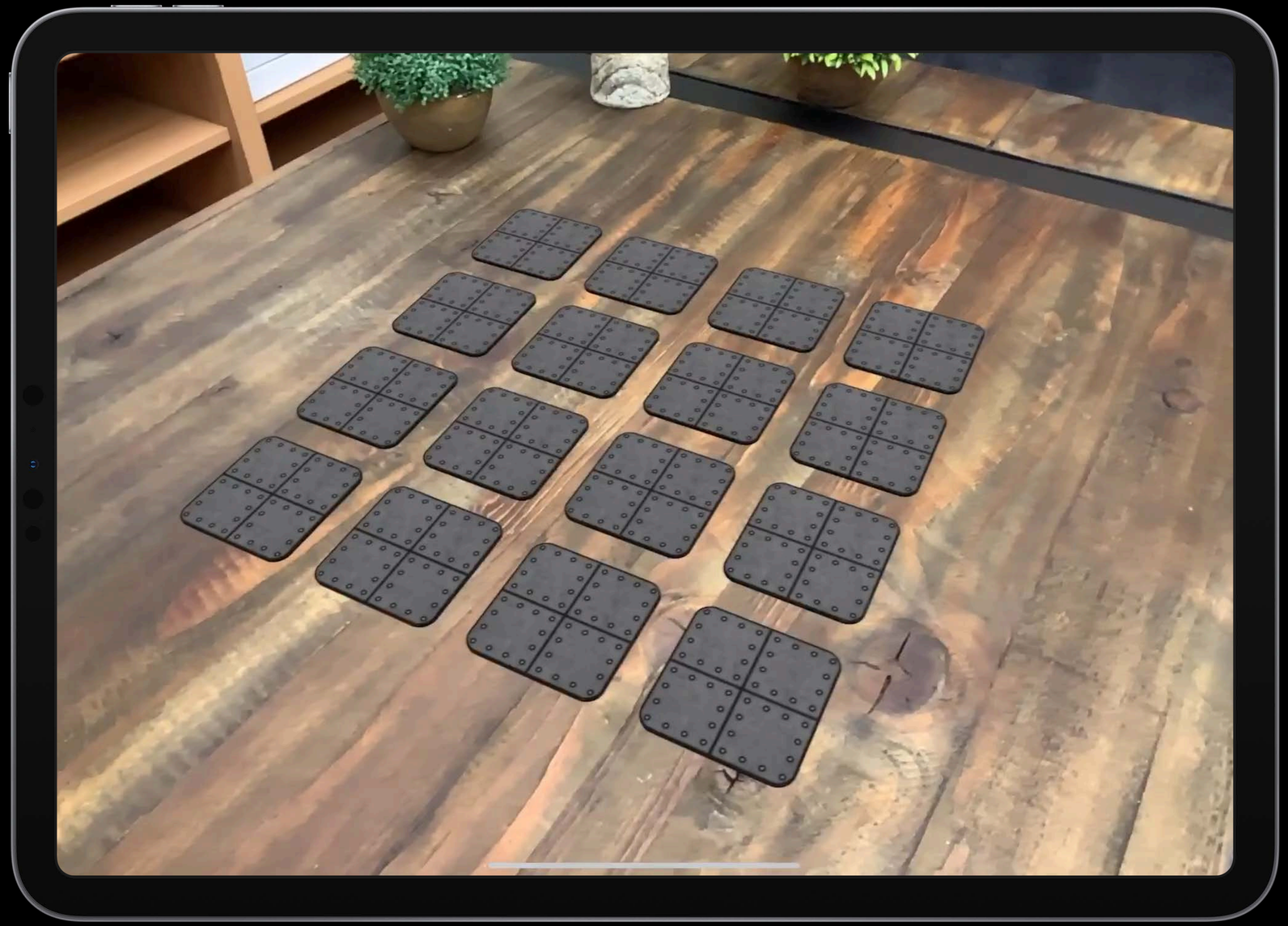
RealityKit Recap

AR First

Realistic rendering and simulation

Designed for Swift





Building Memory Cards

Building Memory Cards

Prototype

Building Memory Cards

Prototype

Adding polish

Building Memory Cards

Prototype

Adding polish

Tracking game state

Building Memory Cards

Prototype

Adding polish

Tracking game state

Multiplayer

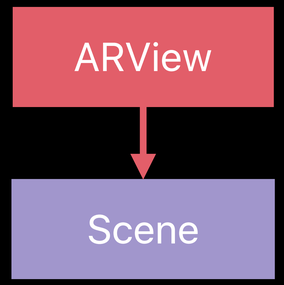
Prototype

RealityKit Elements

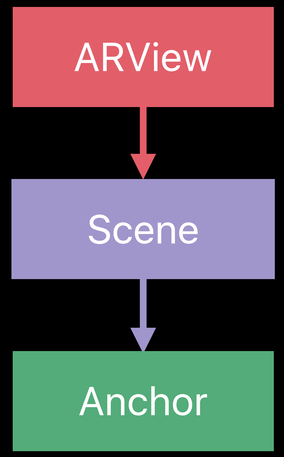
RealityKit Elements

ARView

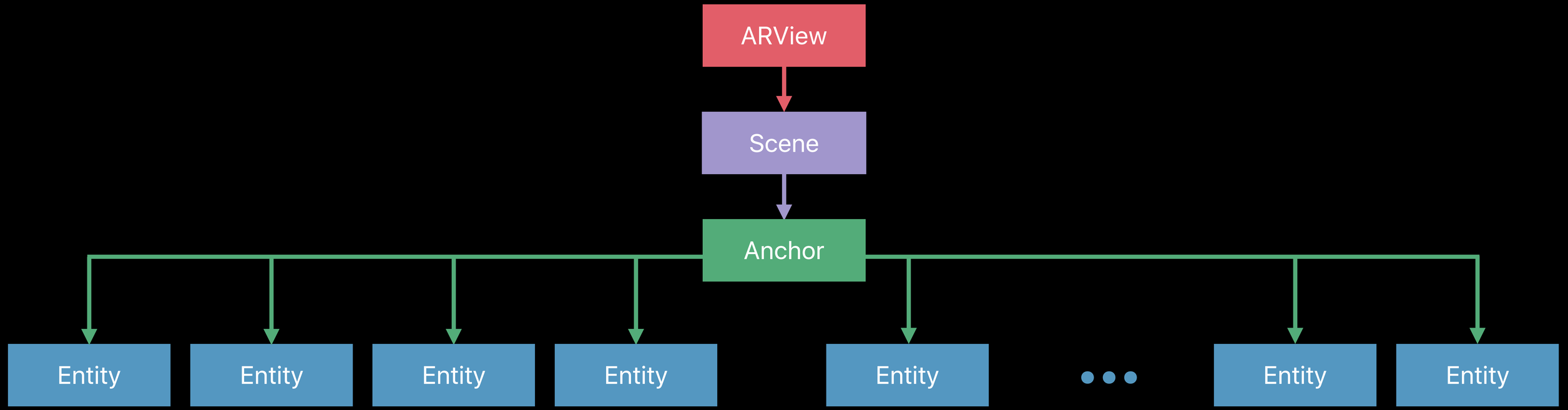
RealityKit Elements



RealityKit Elements



RealityKit Elements



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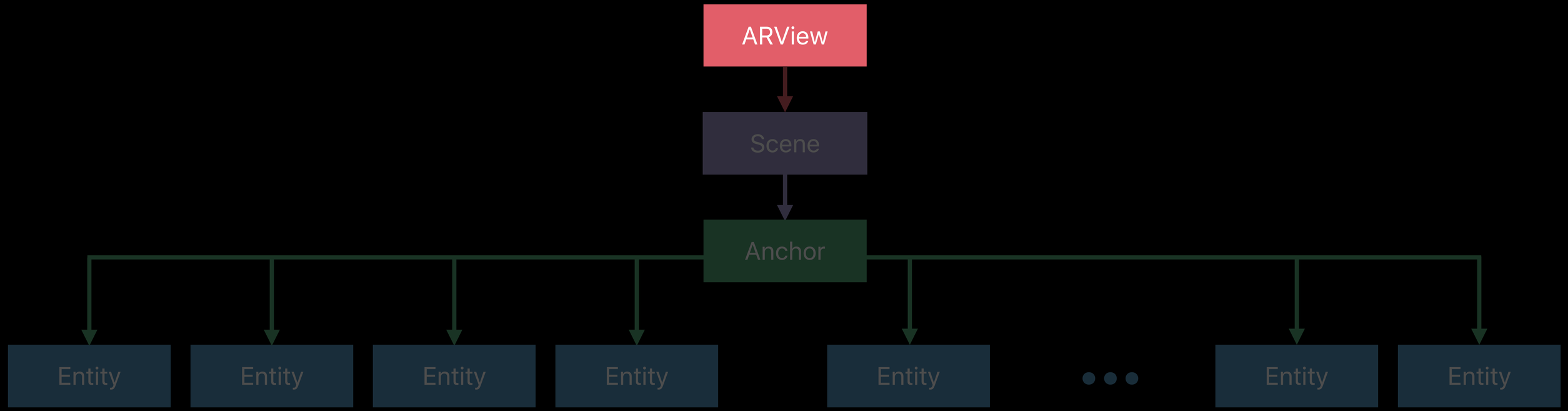

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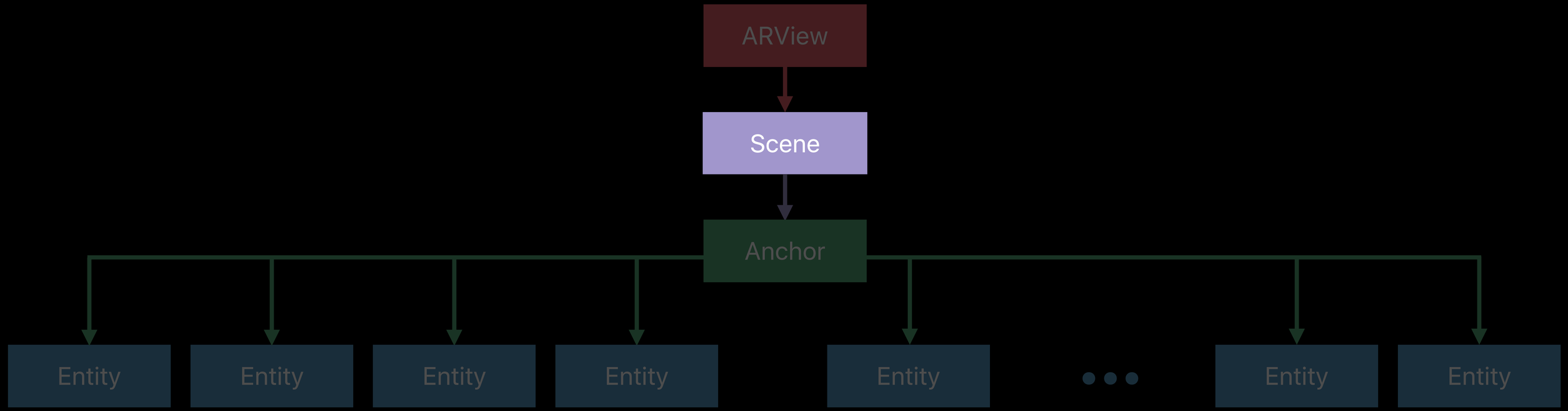
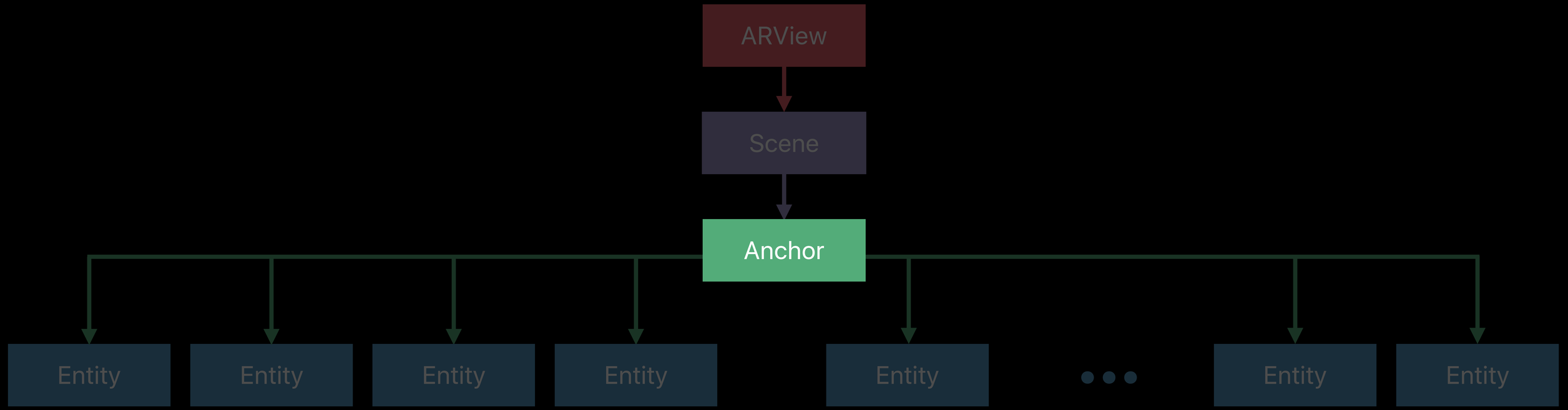
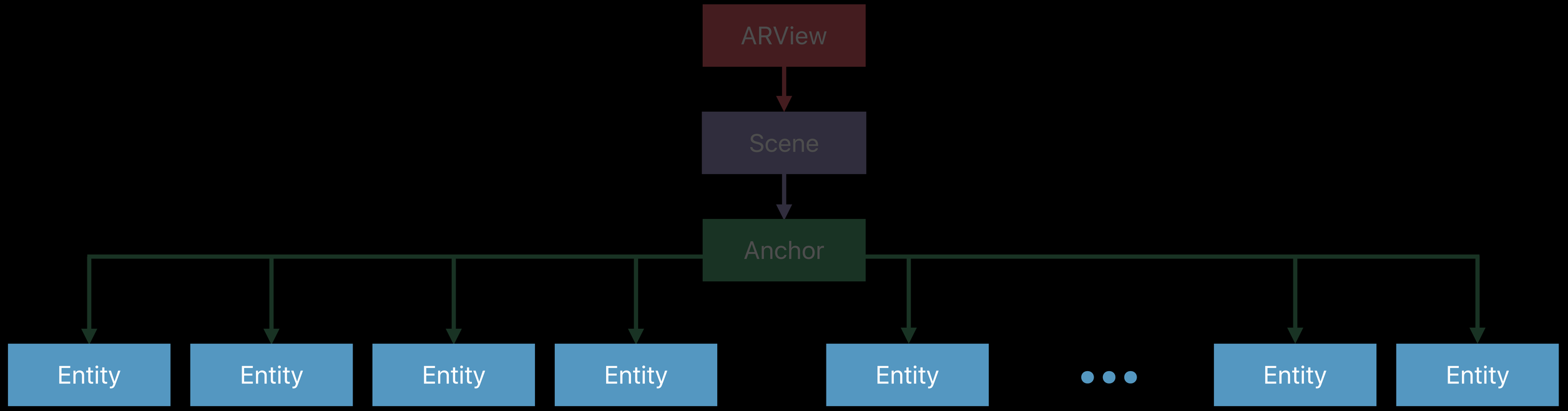


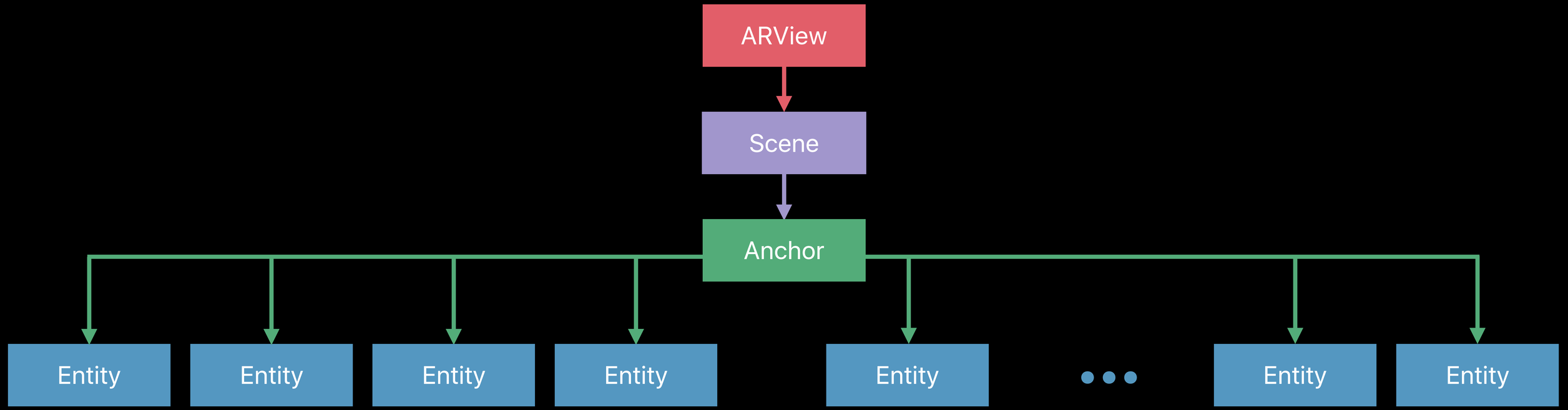
RealityKit Elements



RealityKit Elements

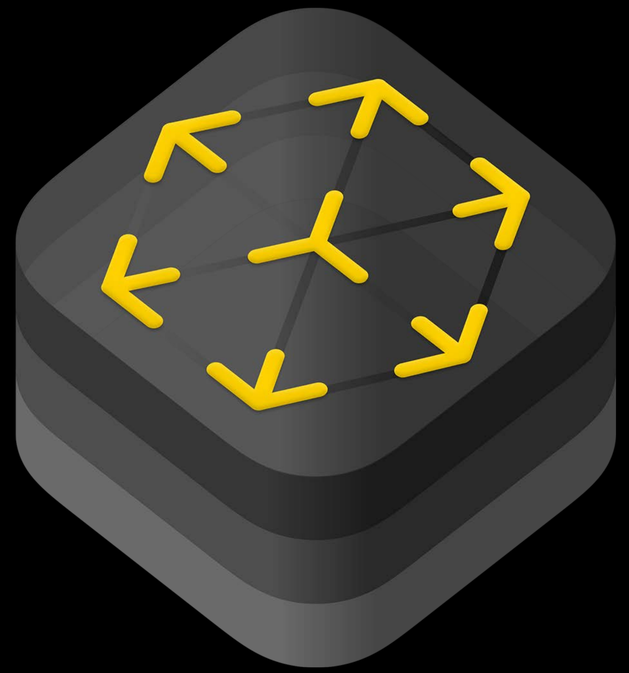


RealityKit Elements



Anchoring

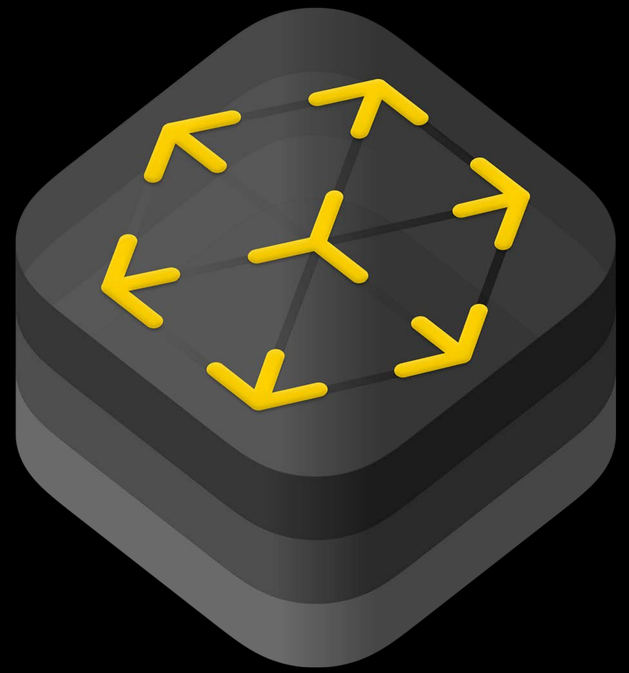
Integrated with ARKit



Anchoring

Integrated with ARKit

Create AnchorEntity

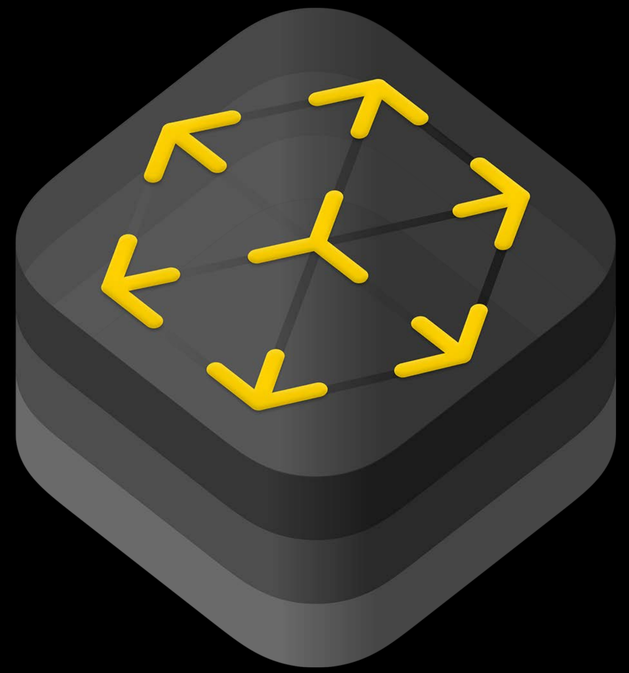


Anchoring

Integrated with ARKit

Create AnchorEntity

Declare anchoring type



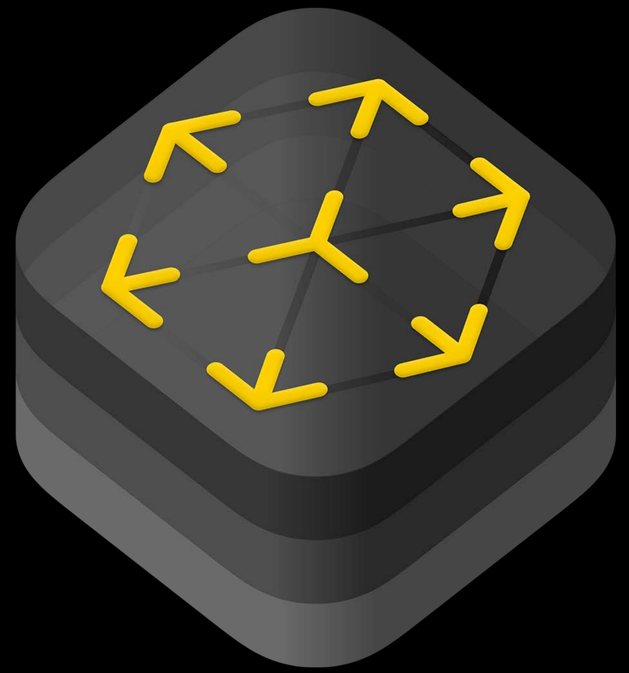
Anchoring

Integrated with ARKit

Create AnchorEntity

Declare anchoring type

Add to Scene



Anchoring

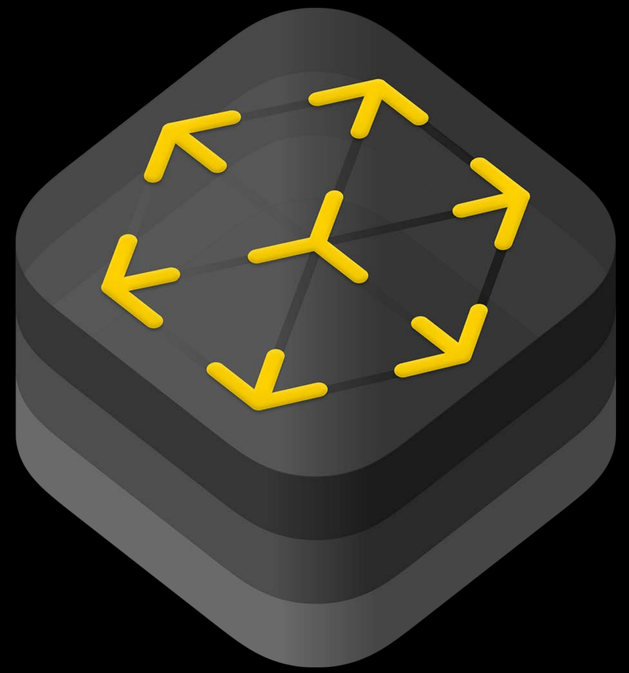
Integrated with ARKit

Create AnchorEntity

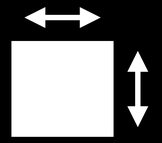
Declare anchoring type

Add to Scene

Automatically tracks target



Anchoring Types



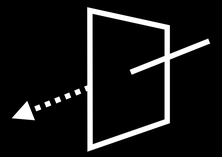
Plane

Face

Camera

Image

Body



ARRaycastResult

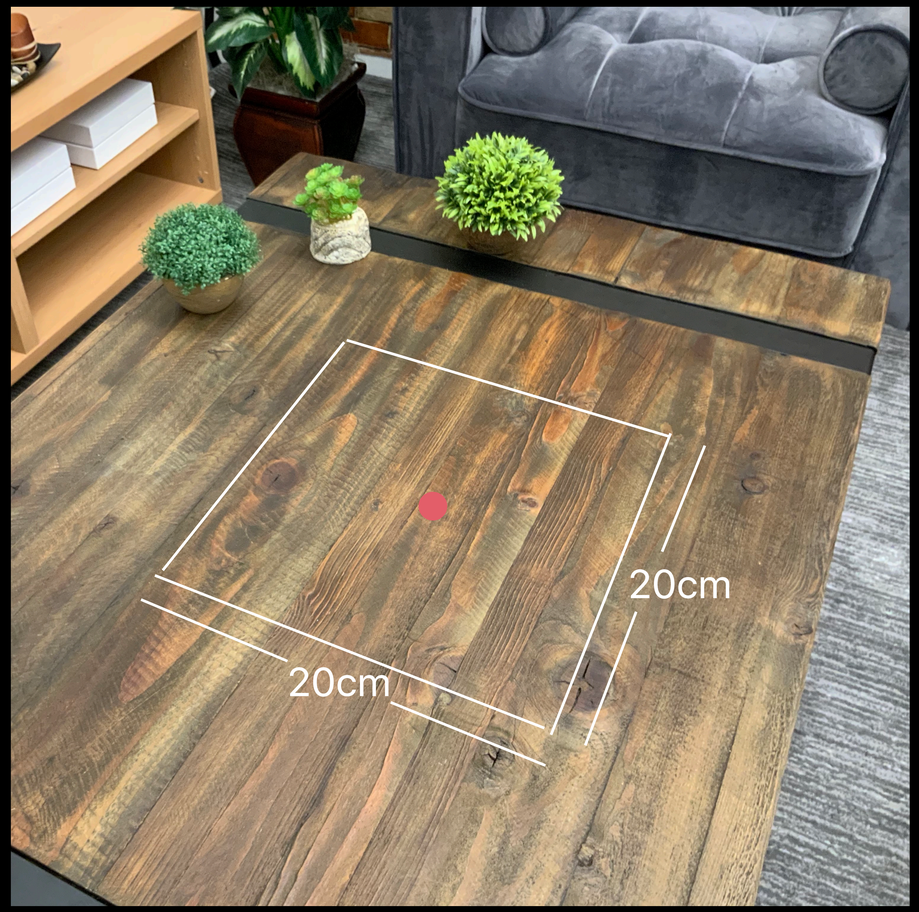
Object

World

ARAnchor

Anchoring

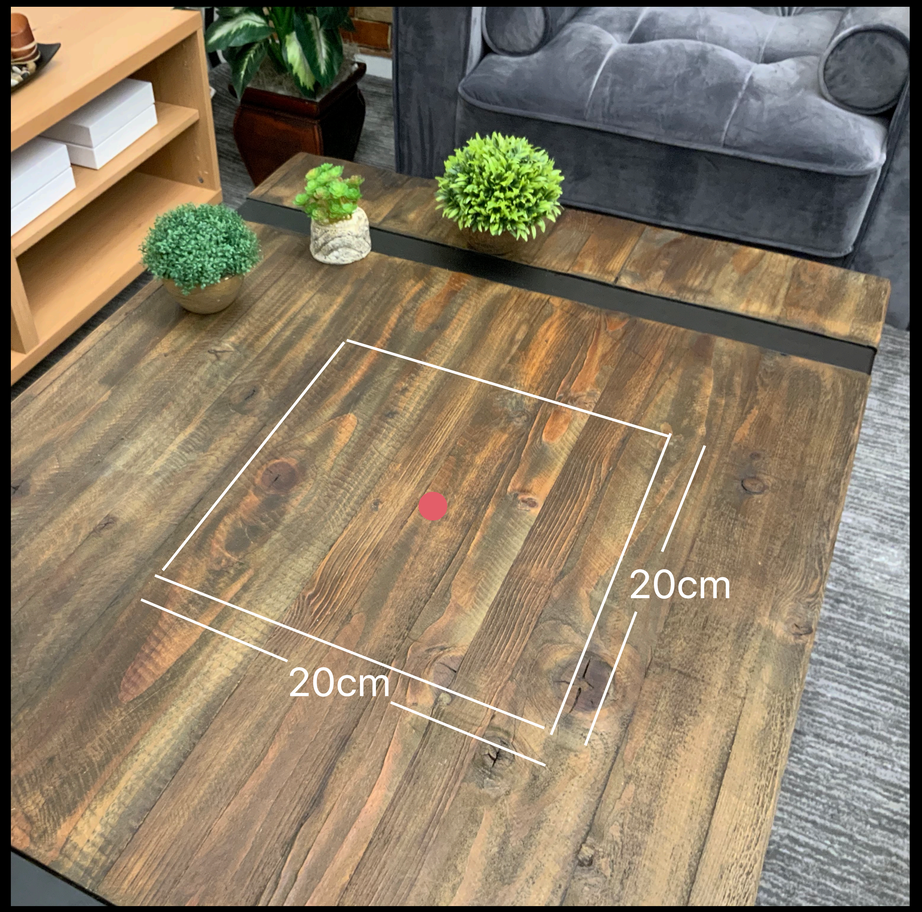
Single anchor for Memory Cards



Anchoring

Single anchor for Memory Cards

Horizontal surface, 20 cm²

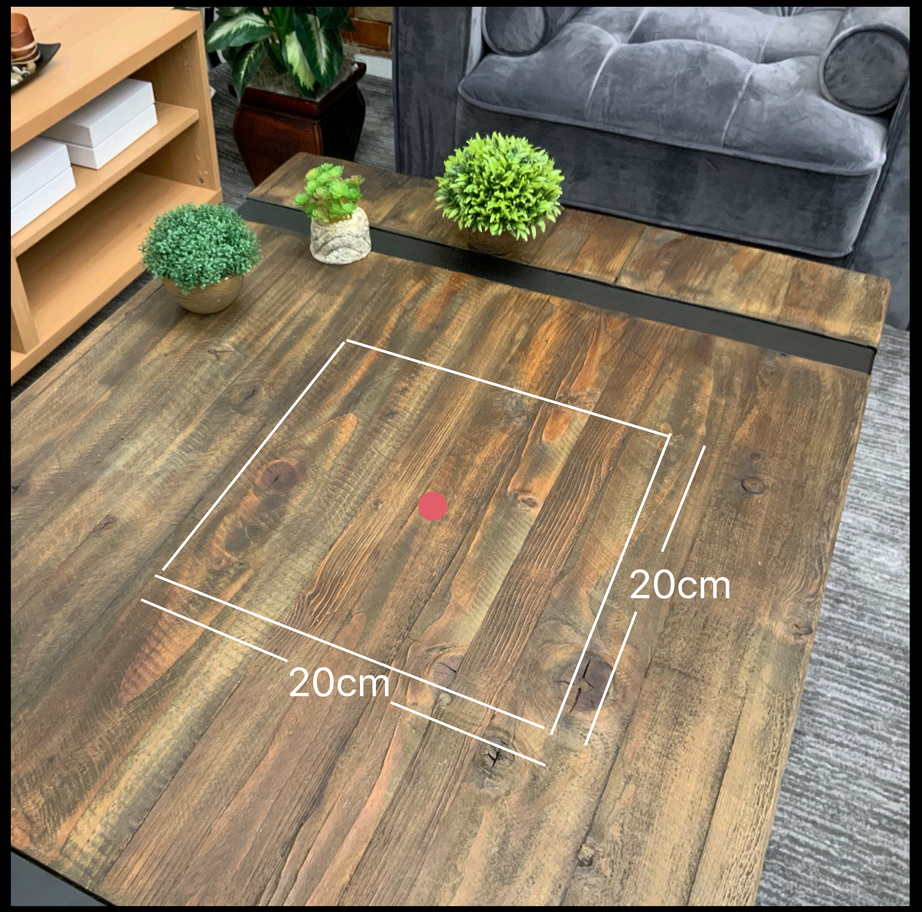


Anchoring

Single anchor for Memory Cards

Horizontal surface, 20 cm²

Places center of game board in the world



```
// Memory Cards Prototype

import UIKit
import RealityKit

class ViewController: UIViewController {
    @IBOutlet var arView: ARView!

    override func viewDidLoad() {
        super.viewDidLoad()




    }
}
```

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import UIKit
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class ViewController: UIViewController {
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// Memory Cards Prototype

import UIKit
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class ViewController: UIViewController {
    @IBOutlet var arView: ARView!

    override func viewDidLoad() {
        super.viewDidLoad()

        // Create an anchor for a horizontal plane with a minimum area of 20 cm²
        let anchor = AnchorEntity(plane: .horizontal, minimumBounds: [0.2, 0.2])
        arView.scene.addAnchor(anchor)

        // Attach content to anchor here
    }
}
```

```
// Memory Cards Prototype

import UIKit
import RealityKit

class ViewController: UIViewController {
    @IBOutlet var arView: ARView!

    override func viewDidLoad() {
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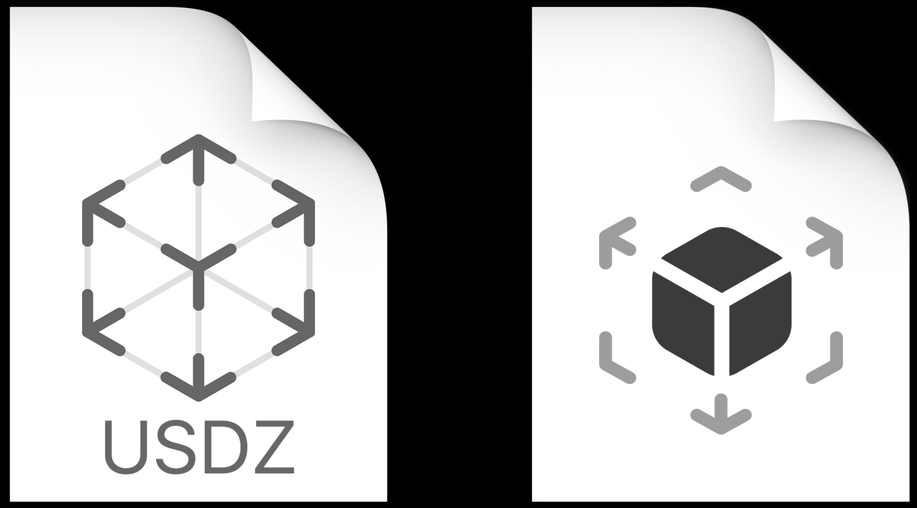
```

Load Model Assets

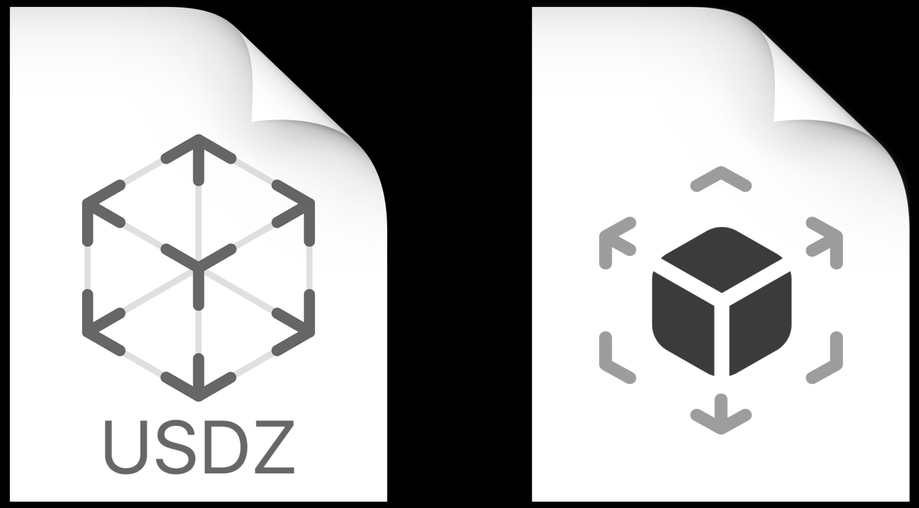
Supports usdz and Reality File



Load Model Assets

Supports usdz and Reality File

Synchronous and asynchronous loading

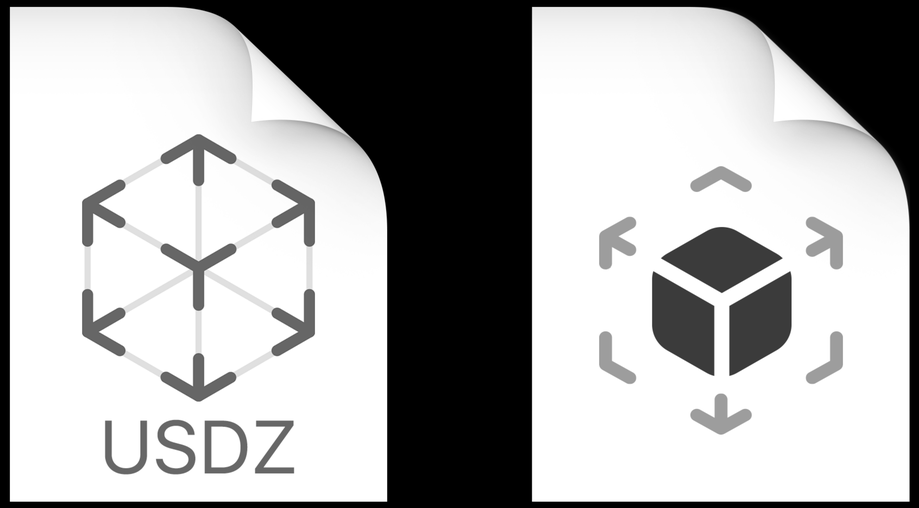


Load Model Assets

Supports usdz and Reality File

Synchronous and asynchronous loading

Automatically imports



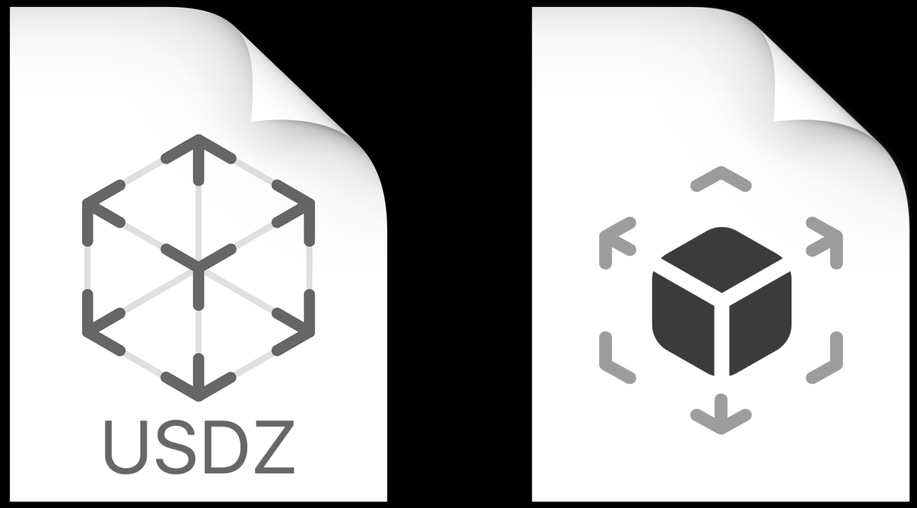
Load Model Assets

Supports usdz and Reality File

Synchronous and asynchronous loading

Automatically imports

- Entity hierarchy



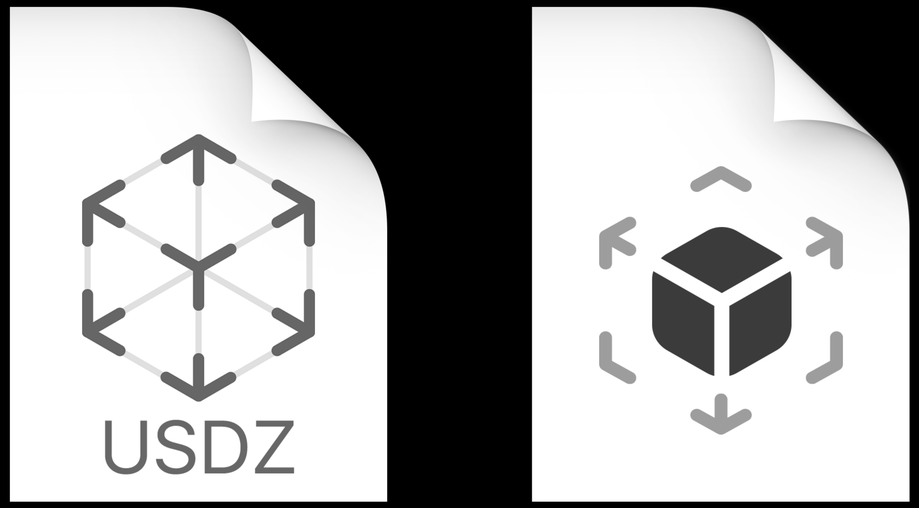
Load Model Assets

Supports usdz and Reality File

Synchronous and asynchronous loading

Automatically imports

- Entity hierarchy
- Meshes



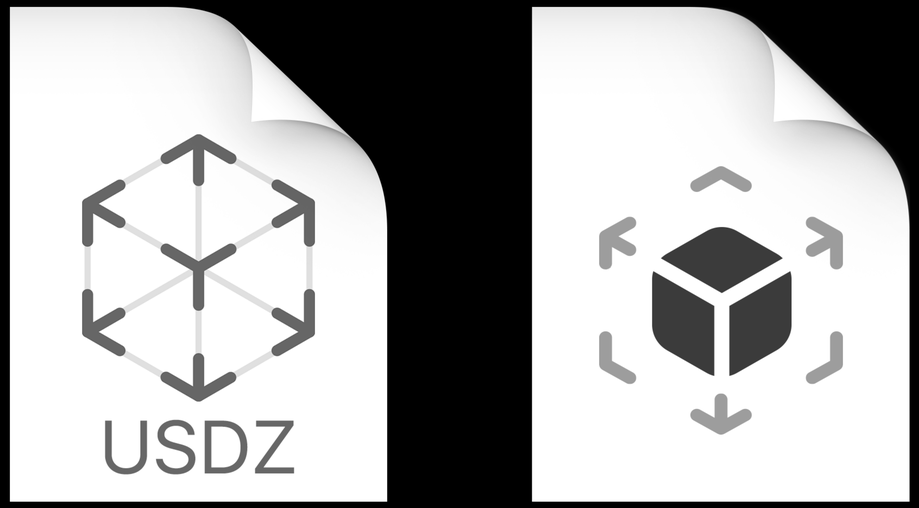
Load Model Assets

Supports usdz and Reality File

Synchronous and asynchronous loading

Automatically imports

- Entity hierarchy
- Meshes
- Materials



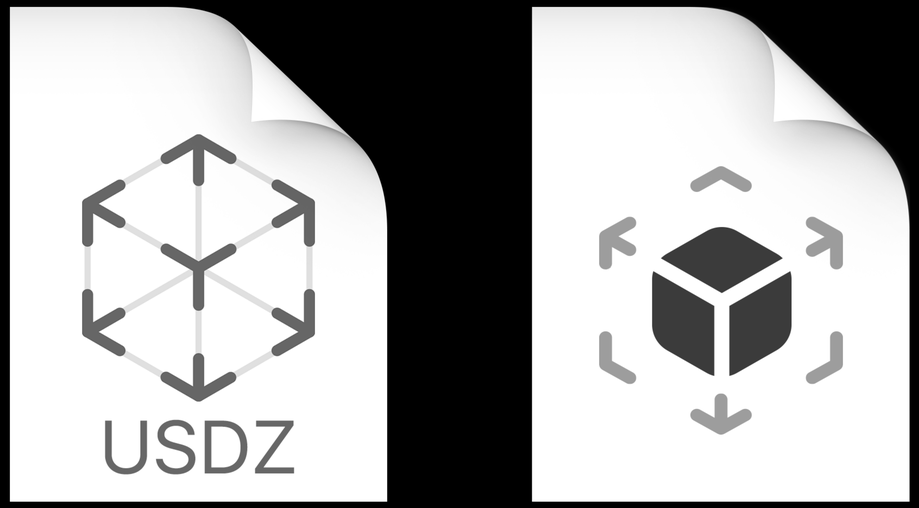
Load Model Assets

Supports usdz and Reality File

Synchronous and asynchronous loading

Automatically imports

- Entity hierarchy
- Meshes
- Materials
- Animations



```swift
// Load Model Assets

var cardTemplates: [Entity] = []

// Load the model asset for each card
for index in 1...8 {
    let assetName = "memory_card_\(index)"
    let cardTemplate = try! Entity.loadModel(named: assetName)
    cardTemplates.append(cardTemplate)
}
```

```
// Load Model Assets

var cardTemplates: [Entity] = []

// Load the model asset for each card
for index in 1...8 {
    let assetName = "memory_card_\(index)"
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}
```

Create Cards

Game has sixteen cards

Create Cards

Game has sixteen cards

- Eight card types

Create Cards

Game has sixteen cards

- Eight card types
- Two instances of each type

Create Cards

Game has sixteen cards

- Eight card types
- Two instances of each type

Could call Entity.loadModel() again

Create Cards

Game has sixteen cards

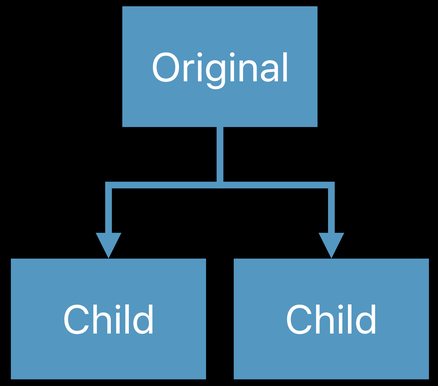
- Eight card types
- Two instances of each type

Could call Entity.loadModel() again

Cloning makes things easier

Cloning Entities

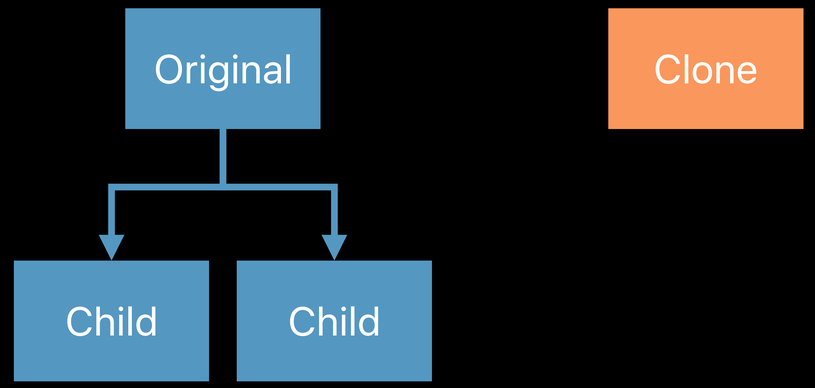
Entity.clone()



Cloning Entities

Entity.clone()

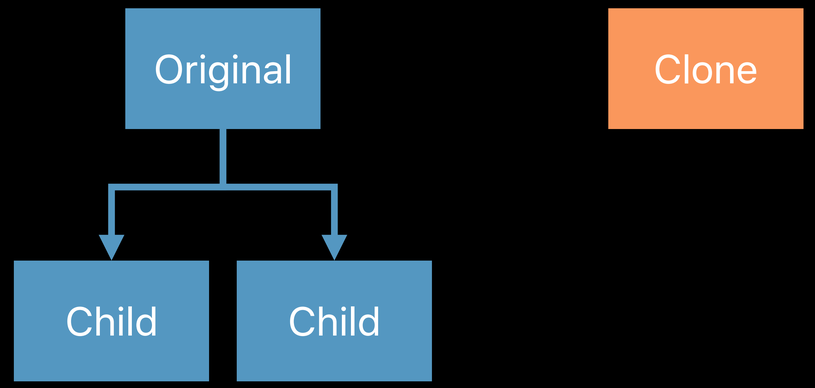
- Creates identical copy



Cloning Entities

Entity.clone()

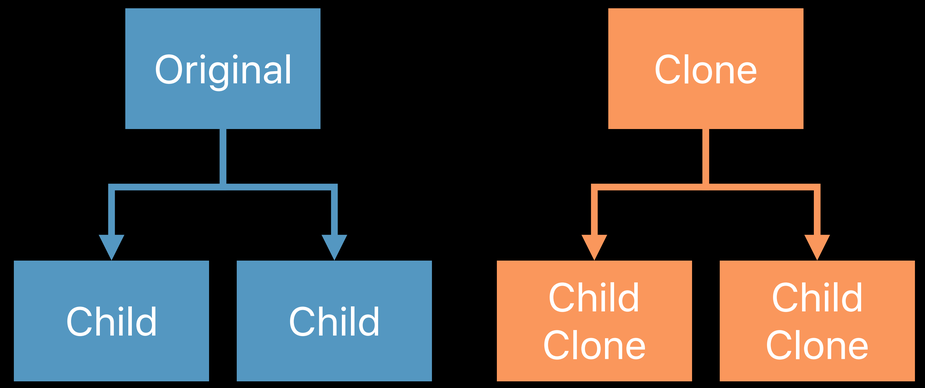
- Creates identical copy
- References same assets



Cloning Entities

Entity.clone()

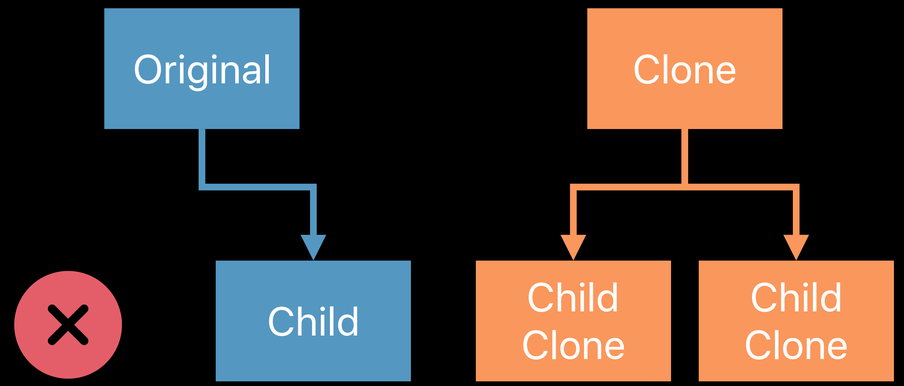
- Creates identical copy
- References same assets
- Can clone recursively



Cloning Entities

Entity.clone()

- Creates identical copy
- References same assets
- Can clone recursively
- Clone is a copy, not an instance



```
// Create Cards

var cards: [Entity] = []

for cardTemplate in cardTemplates {
    // Clone each card template twice
    for _ in 1...2 {
        cards.append(cardTemplate.clone(recursive: true))
    }
}
```

```
// Create Cards

var cards: [Entity] = []

for cardTemplate in cardTemplates {
    // Clone each card template twice
    for _ in 1...2 {
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```
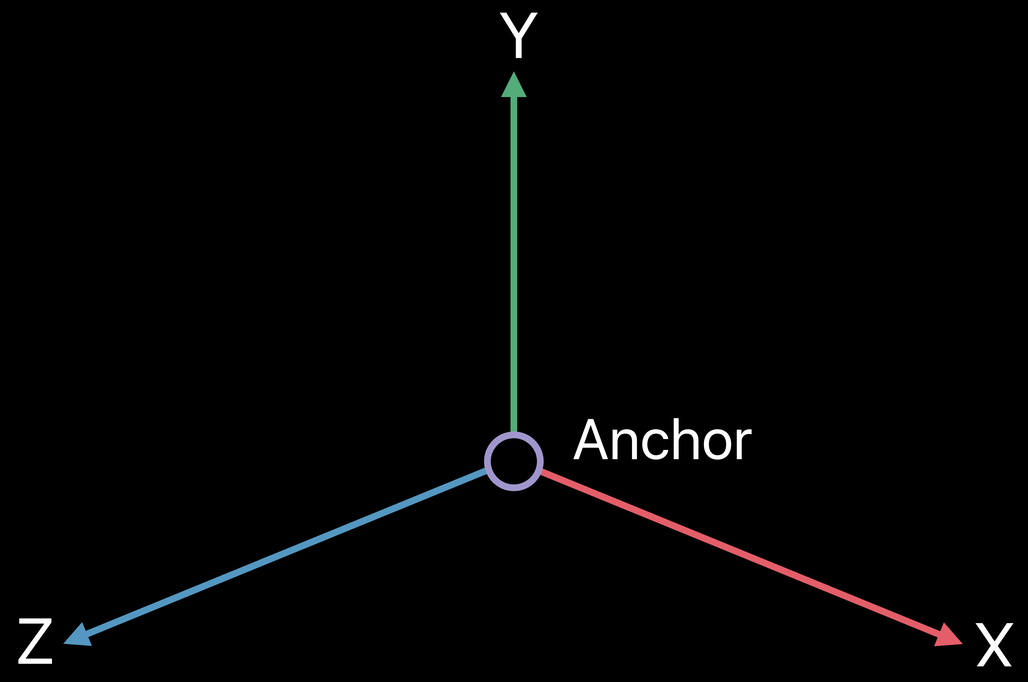

Build the Board

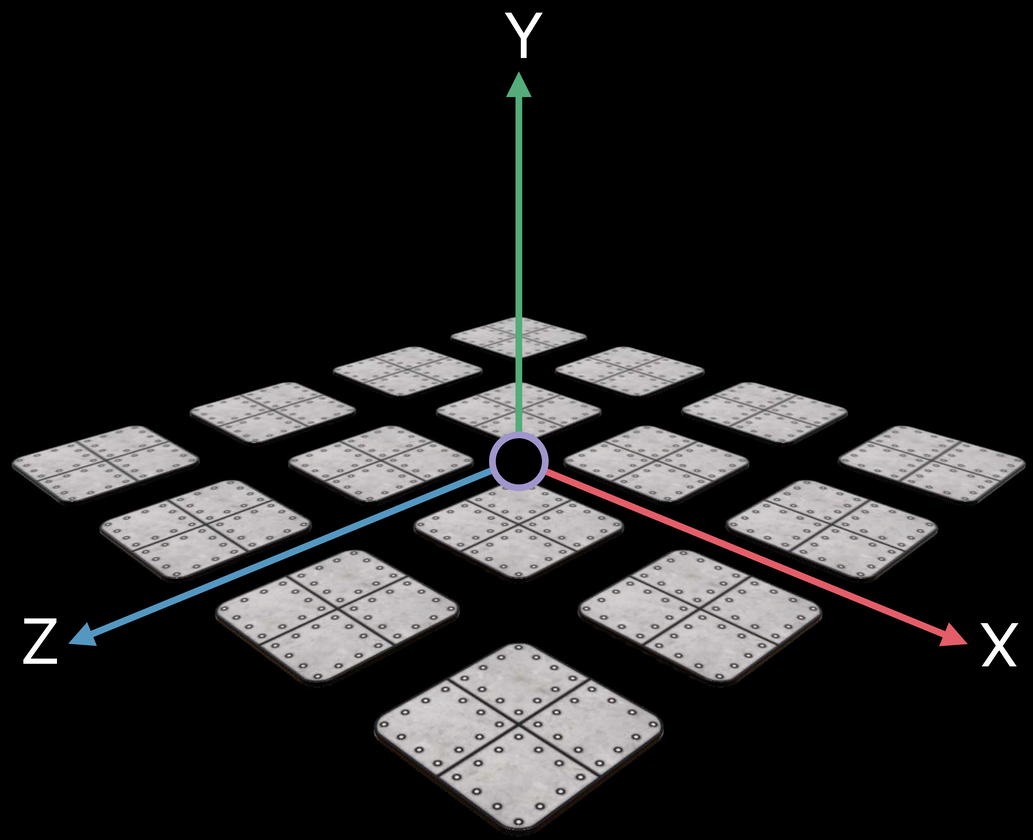
Anchor is the center of play area



Build the Board

Anchor is the center of play area

Cards arranged in 4-by-4 grid

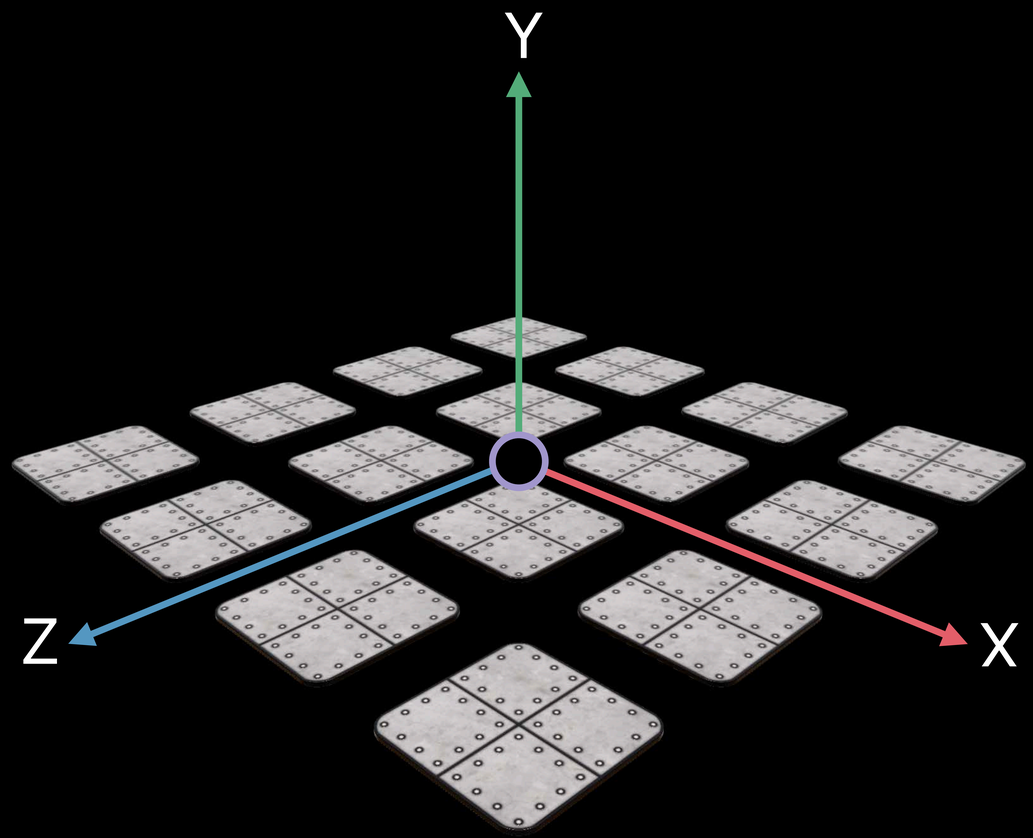


Build the Board

Anchor is the center of play area

Cards arranged in 4-by-4 grid

Add cards to anchor to display in AR



```
// Build the Board

// Shuffle the cards so they are randomly ordered
cards.shuffle()

// Position the shuffled cards in a 4-by-4 grid
for (index, card) in cards.enumerated() {
    let x = Float(index % 4) - 1.5
    let z = Float(index / 4) - 1.5

    // Set the position of the card
    card.position = [x * 0.1, 0, z * 0.1]

    // Add the card to the anchor
    anchor.addChild(card)
}
```

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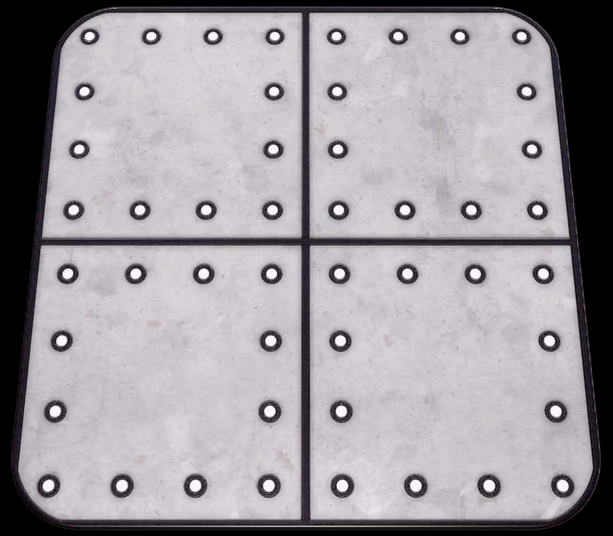
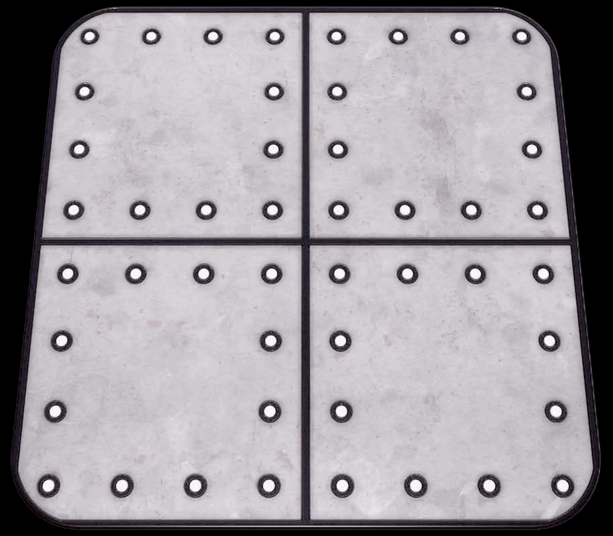
Adding Interaction

Flip cards when we tap on them



Adding Interaction

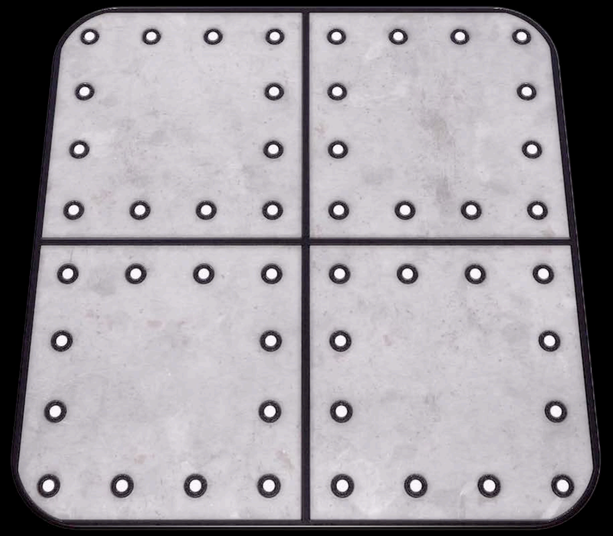
Flip cards when we tap on them



Adding Interaction

Flip cards when we tap on them

Need to know what we’re tapping on

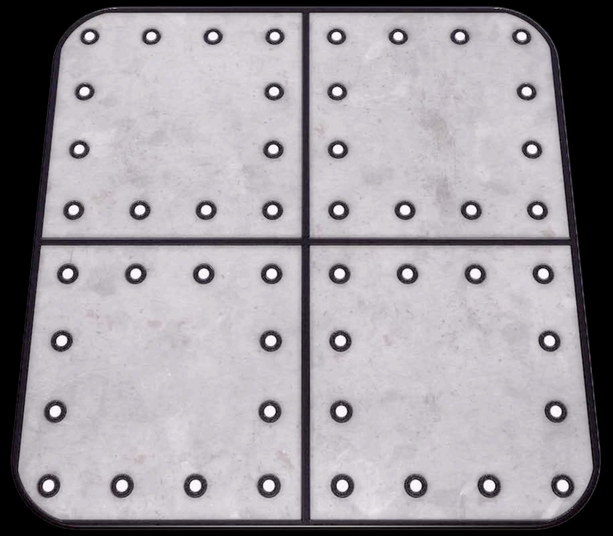


Adding Interaction

Flip cards when we tap on them

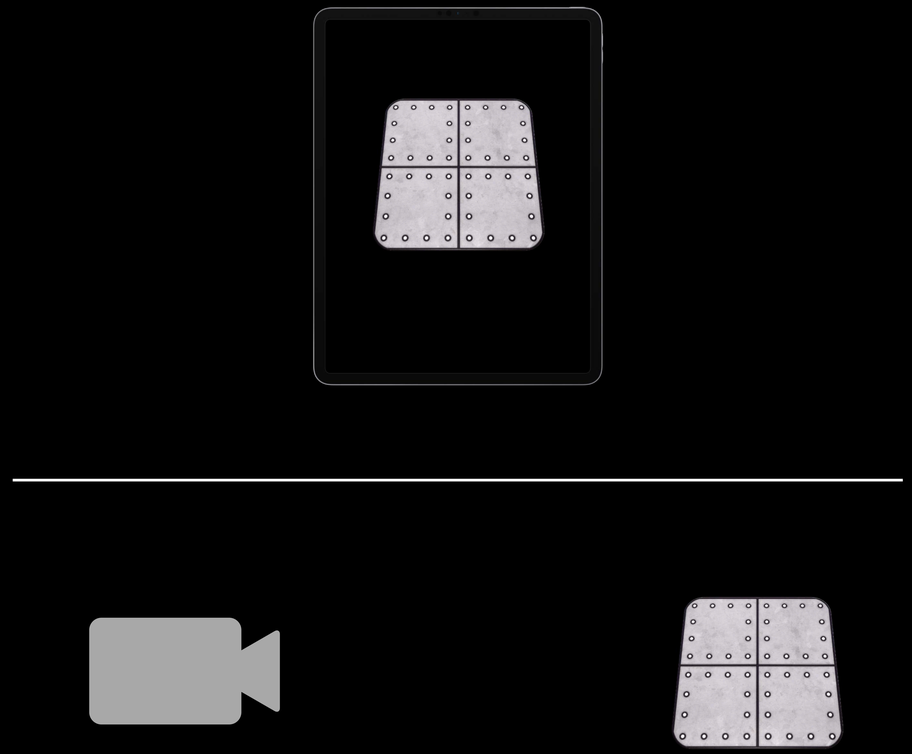
Need to know what we’re tapping on

RealityKit’s solution — hit testing



Hit Testing

Hit testing turns screen point into ray



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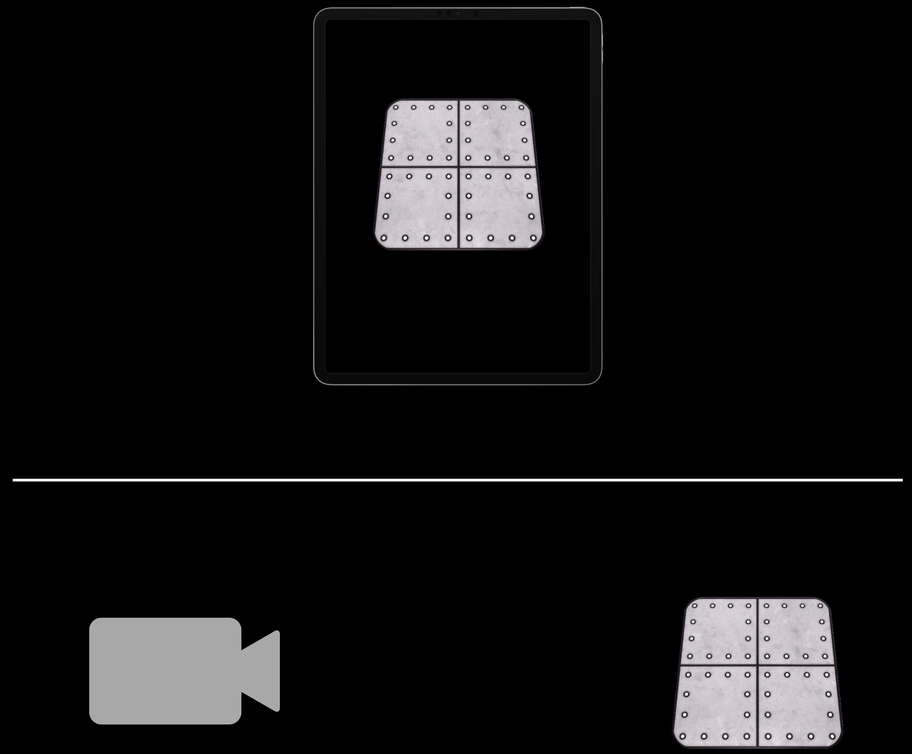
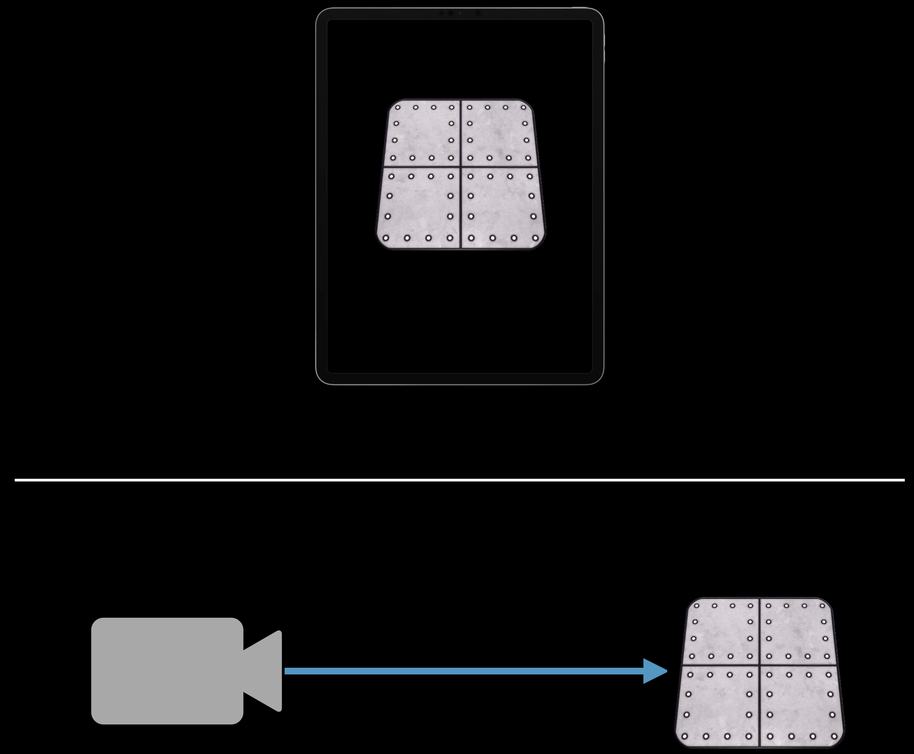


Hit Testing

Hit testing turns screen point into ray

Ray is cast into scene

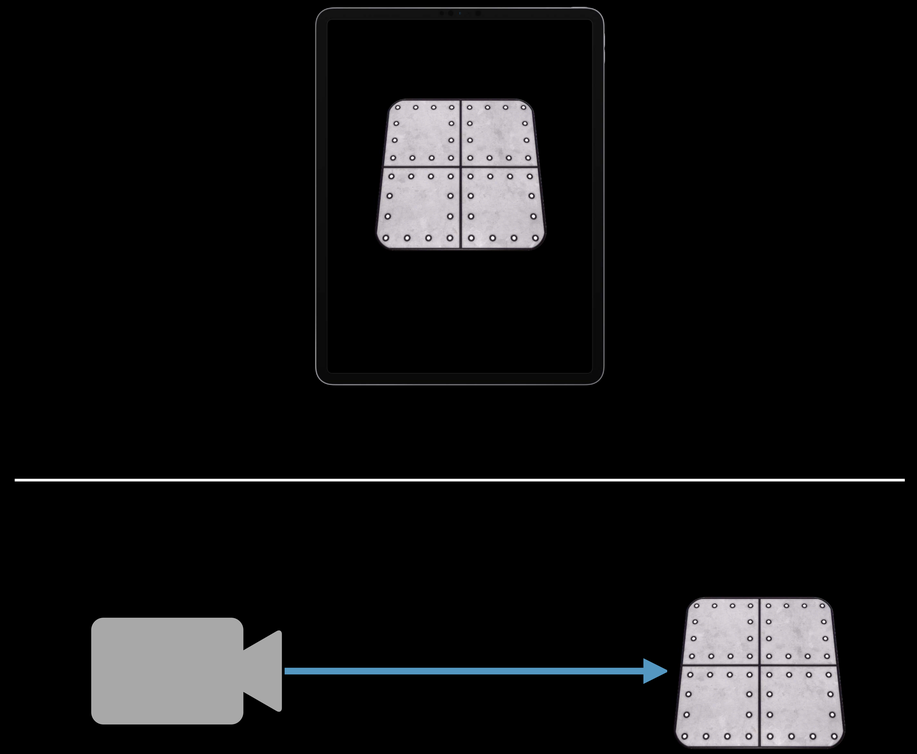


Hit Testing

Hit testing turns screen point into ray

Ray is cast into scene

Returns intersected entities



Hit Testing

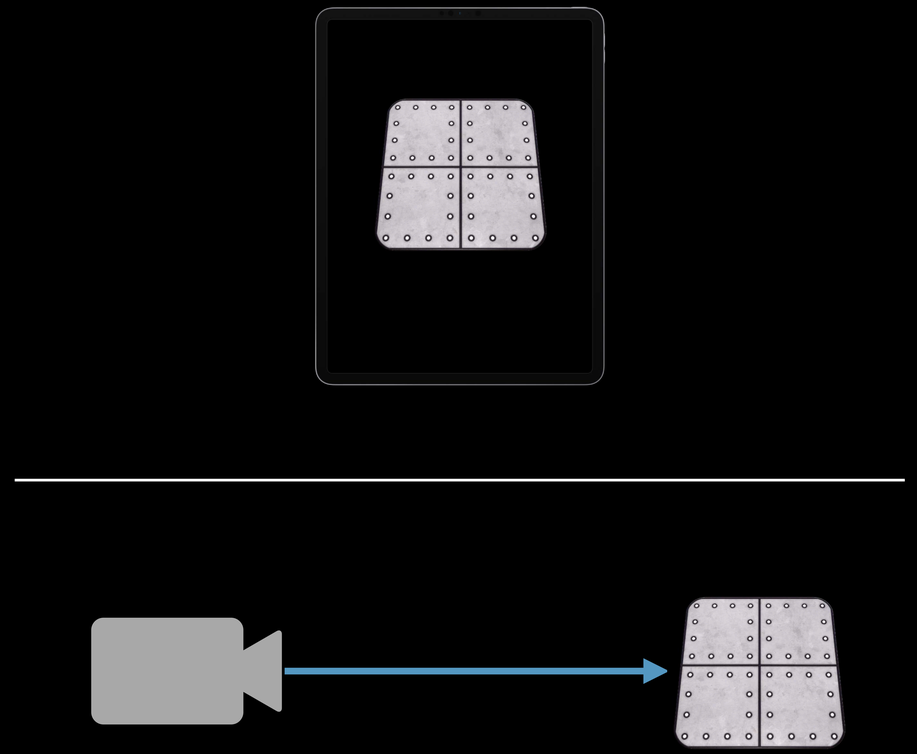
Hit testing turns screen point into ray

Ray is cast into scene

Returns intersected entities

ARView provides hit testing methods

- entity(at point:)
- entities(at point:)



```
// Hit Testing

@IBAction func onTap(_ sender: UITapGestureRecognizer) {
    let tapLocation = sender.location(in: arView)

    // Get the entity at the location we've tapped, if one exists
    if let card = arView.entity(at: tapLocation) {
        // For testing purposes, print the name of the tapped entity
        print(card.name)

        // Add interaction code here
    }
}
```

```swift
// Hit Testing

@IBAction func onTap(_ sender: UITapGestureRecognizer) {
    let tapLocation = sender.location(in: arView)

    // Get the entity at the location we've tapped, if one exists
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        // Add interaction code here
    }
}
```
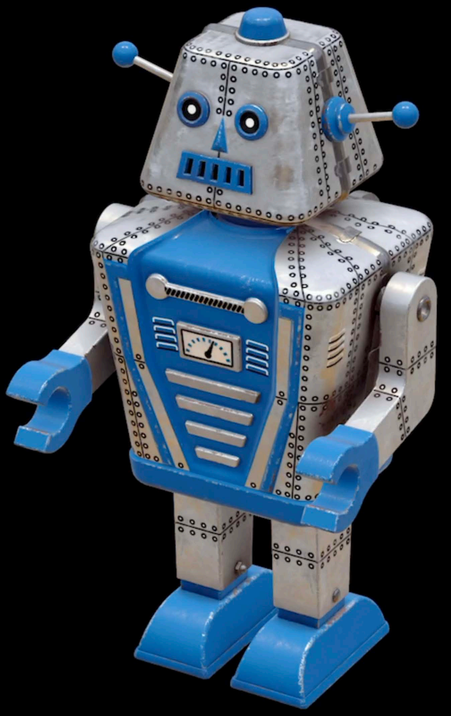

Collision Shapes

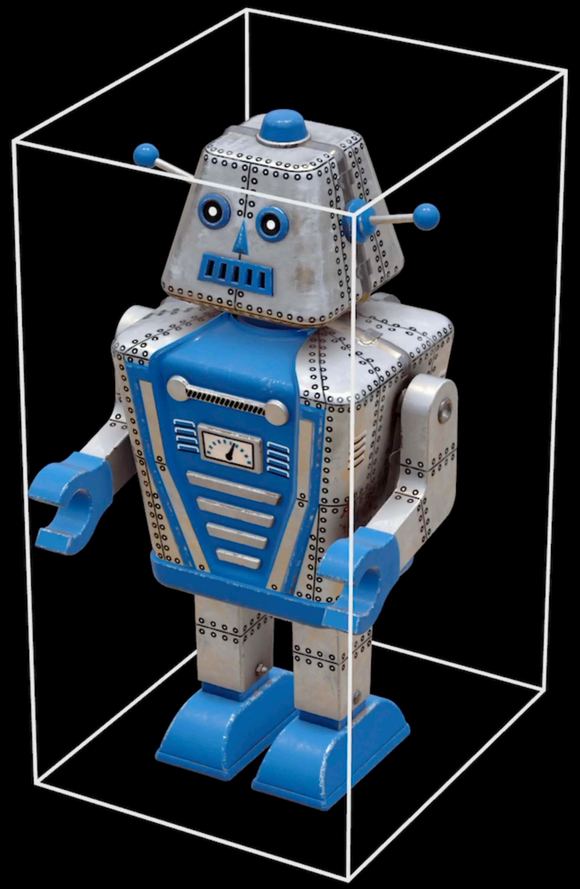
To be hit-testable, entities need collision



Collision Shapes

To be hit-testable, entities need collision

Collision shapes are simple geometry

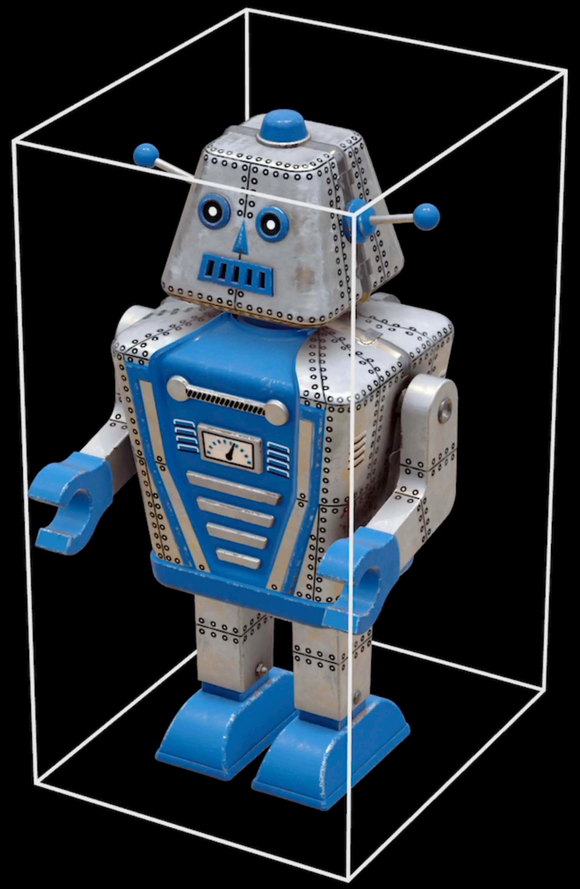


Collision Shapes

To be hit-testable, entities need collision

Collision shapes are simple geometry

- Easy to define

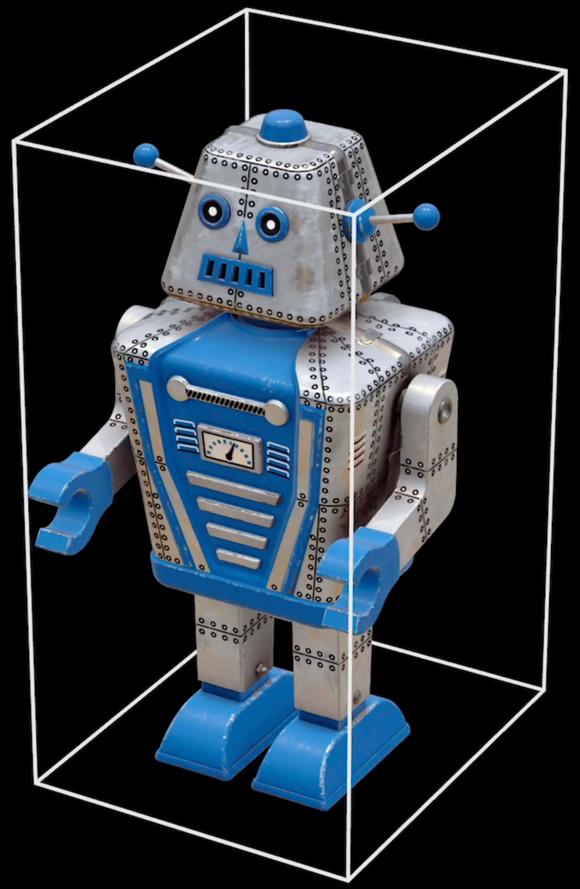


Collision Shapes

To be hit-testable, entities need collision

Collision shapes are simple geometry

- Easy to define
- Efficient for intersection and collision

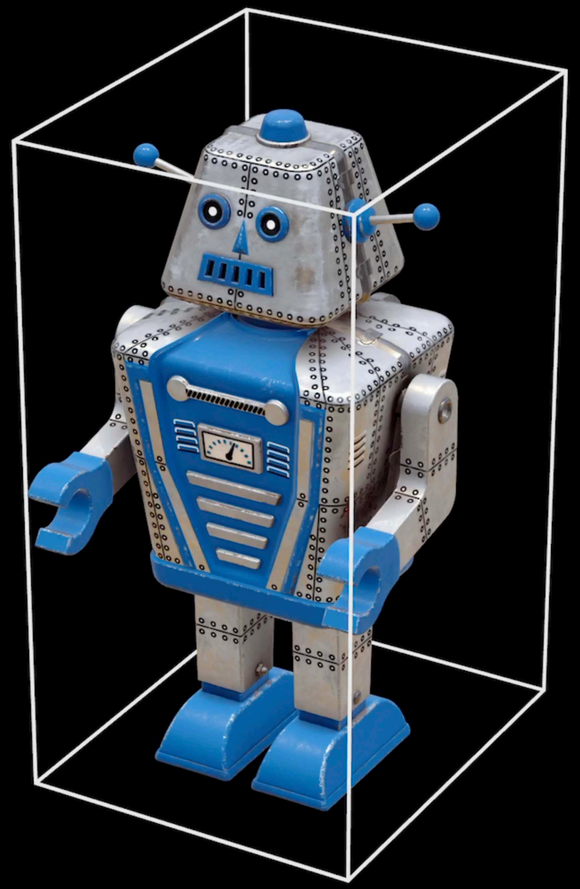


Collision Shapes

To be hit-testable, entities need collision

Collision shapes are simple geometry

- Easy to define
- Efficient for intersection and collision
- Required for hit testing



```
// Adding Collision Shapes

var cardTemplates: [ModelEntity] = []

// Load the model asset for each card
for index in 1...8 {
    let assetName = "memory_card_\(index)"
    let cardTemplate = try! Entity.loadModel(named: assetName)
    cardTemplates.append(cardTemplate)









}
```

```
// Adding Collision Shapes

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// Load the model asset for each card
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    let assetName = "memory_card_\(index)"
    let cardTemplate = try! Entity.loadModel(named: assetName)

    // Generate collision shapes for the card so we can interact with it
    cardTemplate.generateCollisionShapes(recursive: true)

    // Give the card a name so we'll know what we're interacting with
    cardTemplate.name = assetName

    cardTemplates.append(cardTemplate)
}
```

```
// Adding Collision Shapes

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Animation

Built-in animation support

Animation

Built-in animation support

Transform animation

Animation

Built-in animation support

Transform animation

- Position

Animation

Built-in animation support

Transform animation

- Position
- Rotation

Animation

Built-in animation support

Transform animation

- Position
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- Scale

Animation

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Asset animation

Animation

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Asset animation

Animation

Built-in animation support

Transform animation

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Asset animation

Completion handler

Transform Animation

Timing functions

Transform Animation

Timing functions

- Linear

Transform Animation

Timing functions

- Linear
- Ease in

Transform Animation

Timing functions

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Transform Animation

Timing functions

- Linear
- Ease in
- Ease out

Transform Animation

Timing functions

- Linear
- Ease in
- Ease out

Transform Animation

Timing functions

- Linear
- Ease in
- Ease out
- Ease in and out

Transform Animation

Timing functions

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Transform Animation

Timing functions

- Linear
- Ease in
- Ease out
- Ease in and out
- Cubic bezier for more customization

```
// Adding Transform Animation, Flip Face-Up

// Copy card's current transform
var flipUpTransform = card.transform

// Set the card to rotate to π radians (180 degrees)
flipUpTransform.rotation = simd_quatf(angle: .pi, axis: [1, 0, 0])

// Move the card to the new transform over 0.25 seconds
let flipUpController = card.move(to: flipUpTransform,
                                 relativeTo: card.parent,
                                 duration: 0.25,
                                 timingFunction: .easeInOut)

flipUpController.completionHandler {
    // Card is done flipping face-up
}
```

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                                 duration: 0.25,
                                 timingFunction: .easeInOut)

flipUpController.completionHandler {
    // Card is done flipping face-up
}
```

```
// Adding Transform Animation, Flip Face-Down

// Copy card's current transform
var flipDownTransform = card.transform

// Set the card to rotate back to 0 degrees
flipDownTransform.rotation = simd_quatf(angle: 0, axis: [1, 0, 0])

// Move the card to the new transform over 0.25 seconds
let flipDownController = card.move(to: flipDownTransform,
                                   relativeTo: card.parent,
                                   duration: 0.25,
                                   timingFunction: .easeInOut)

flipDownController.completionHandler {
    // Card is done flipping back to face-down
}
```

Adding Polish

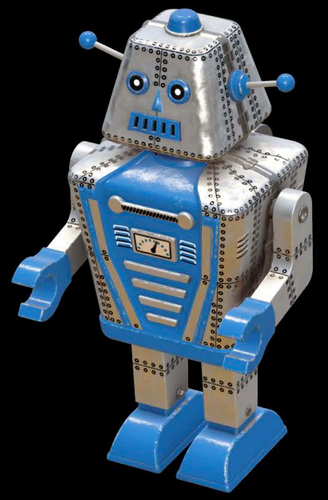
Advanced Assets

Advanced Assets










Advanced Assets

Can still use Entity.loadModel()

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Larger assets take longer to load

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App will be blocked during loading

Advanced Assets

Can still use Entity.loadModel()

Larger assets take longer to load

App will be blocked during loading

With lots of assets, load times add up

Asynchronous Loading

Use Entity.loadModelAsync() to unblock app

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Assets loaded in background

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Allows app to continue uninterrupted

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Assets loaded in background

Allows app to continue uninterrupted

Receive callback when loading is finished

Asynchronous Loading

Use Entity.loadModelAsync() to unblock app

Assets loaded in background

Allows app to continue uninterrupted

Receive callback when loading is finished

Combine load requests and wait for all

```
// Asynchronous Loading

// Load a model asynchronously
_ = Entity.loadModelAsync(named: "vintage_car_green")
    .sink { model in
    // Model has been loaded
}
```

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    // Model has been loaded
}
```

```
// Asynchronous Loading

// Load two models asynchronously
_ = Entity.loadModelAsync(named: "vintage_car_green")
    .append(Entity.loadModelAsync(named: "vintage_car_yellow"))
    .collect()
    .sink { models in
        // Both models have been loaded
}
```

```
// Asynchronous Loading

// Load two models asynchronously
_ = Entity.loadModelAsync(named: "vintage_car_green")
    .append(Entity.loadModelAsync(named: "vintage_car_yellow"))
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    .sink { models in
        // Both models have been loaded
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    .sink { models in
        // Both models have been loaded
}
```

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// Asynchronous Loading

// Load two models asynchronously
_ = Entity.loadModelAsync(named: "vintage_car_green")
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    .collect()
    .sink { models in
        // Both models have been loaded
}
```

```
// Asynchronous Loading

// Load all eight models asynchronously
_ = Entity.loadModelAsync(named: "vintage_car_green")
    .append(Entity.loadModelAsync(named: "vintage_car_yellow"))
    .append(Entity.loadModelAsync(named: "vintage_robot_blue"))
    .append(Entity.loadModelAsync(named: "vintage_robot_red"))
    .append(Entity.loadModelAsync(named: "vintage_drummer_red"))
    .append(Entity.loadModelAsync(named: "vintage_drummer_green"))
    .append(Entity.loadModelAsync(named: "vintage_plane_green"))
    .append(Entity.loadModelAsync(named: "vintage_plane_yellow"))
    .collect()
    .sink { models in
        // All models have been loaded
}
```

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    .append(Entity.loadModelAsync(named: "vintage_plane_yellow"))
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        // All models have been loaded
}
```

```
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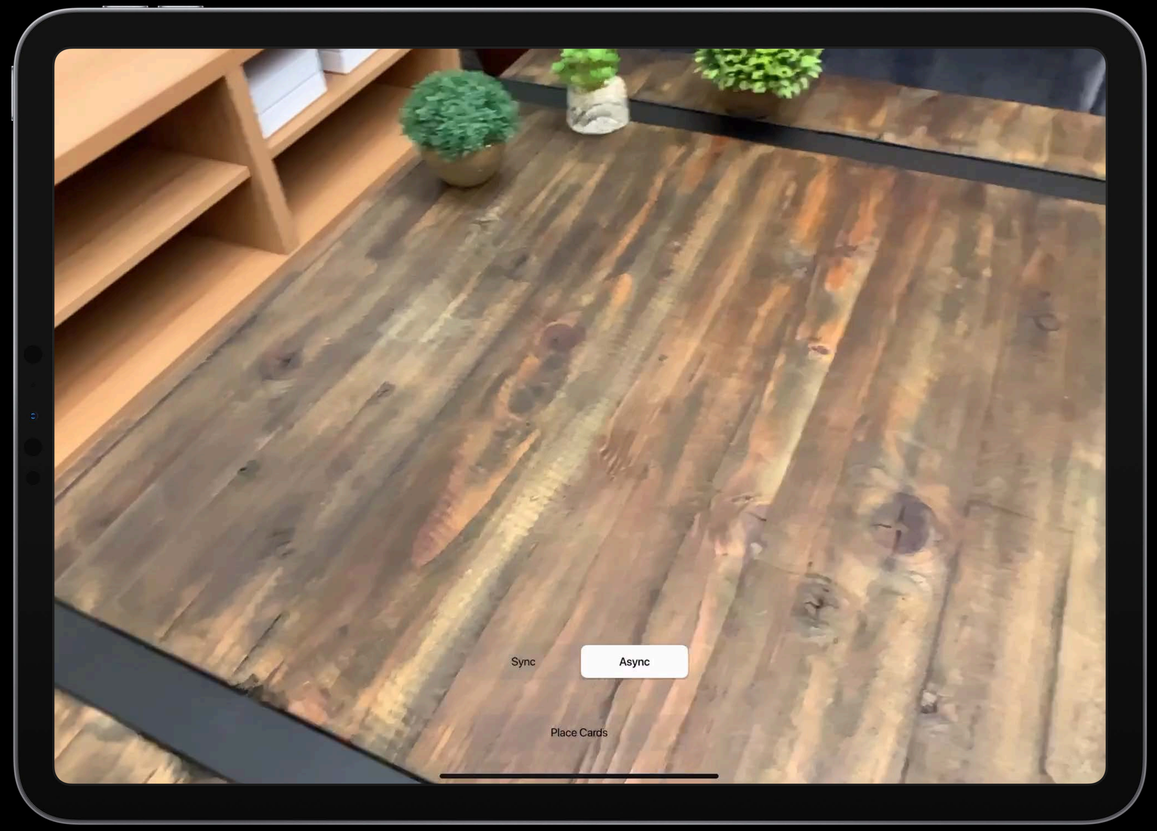
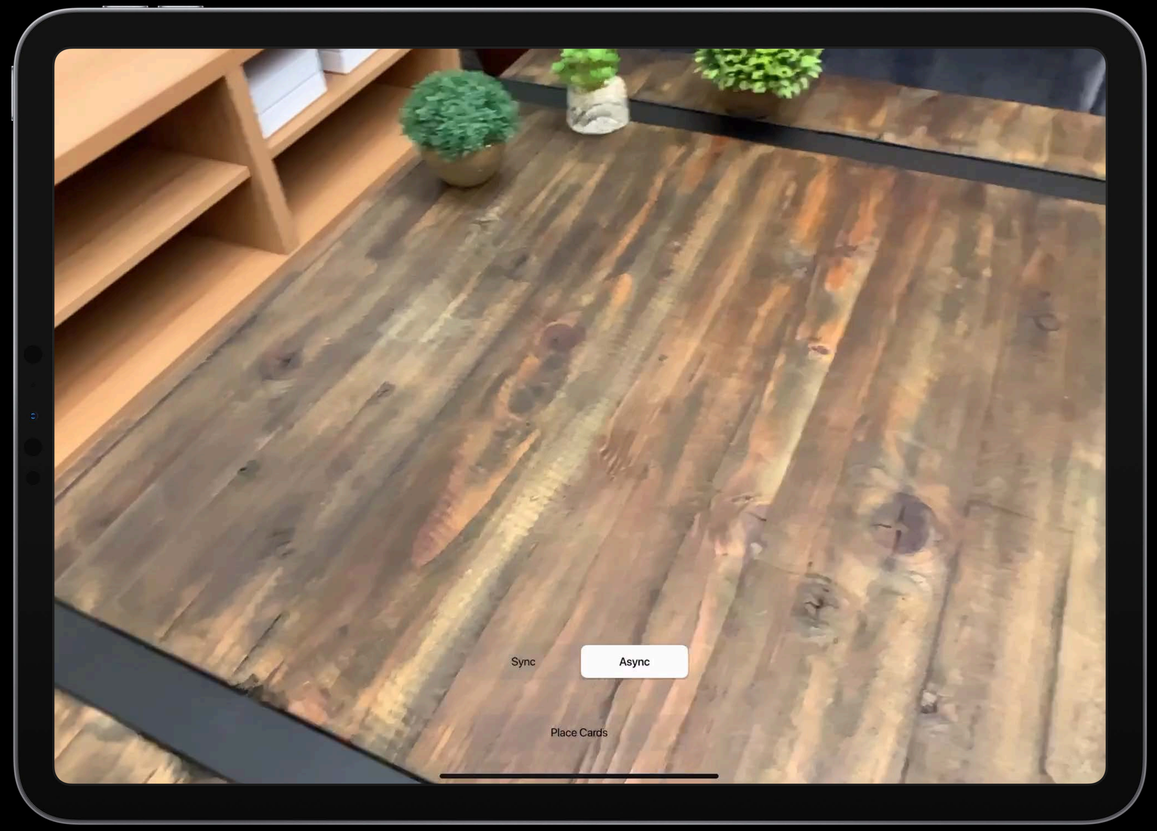


Synchronous **vs.** Asynchronous



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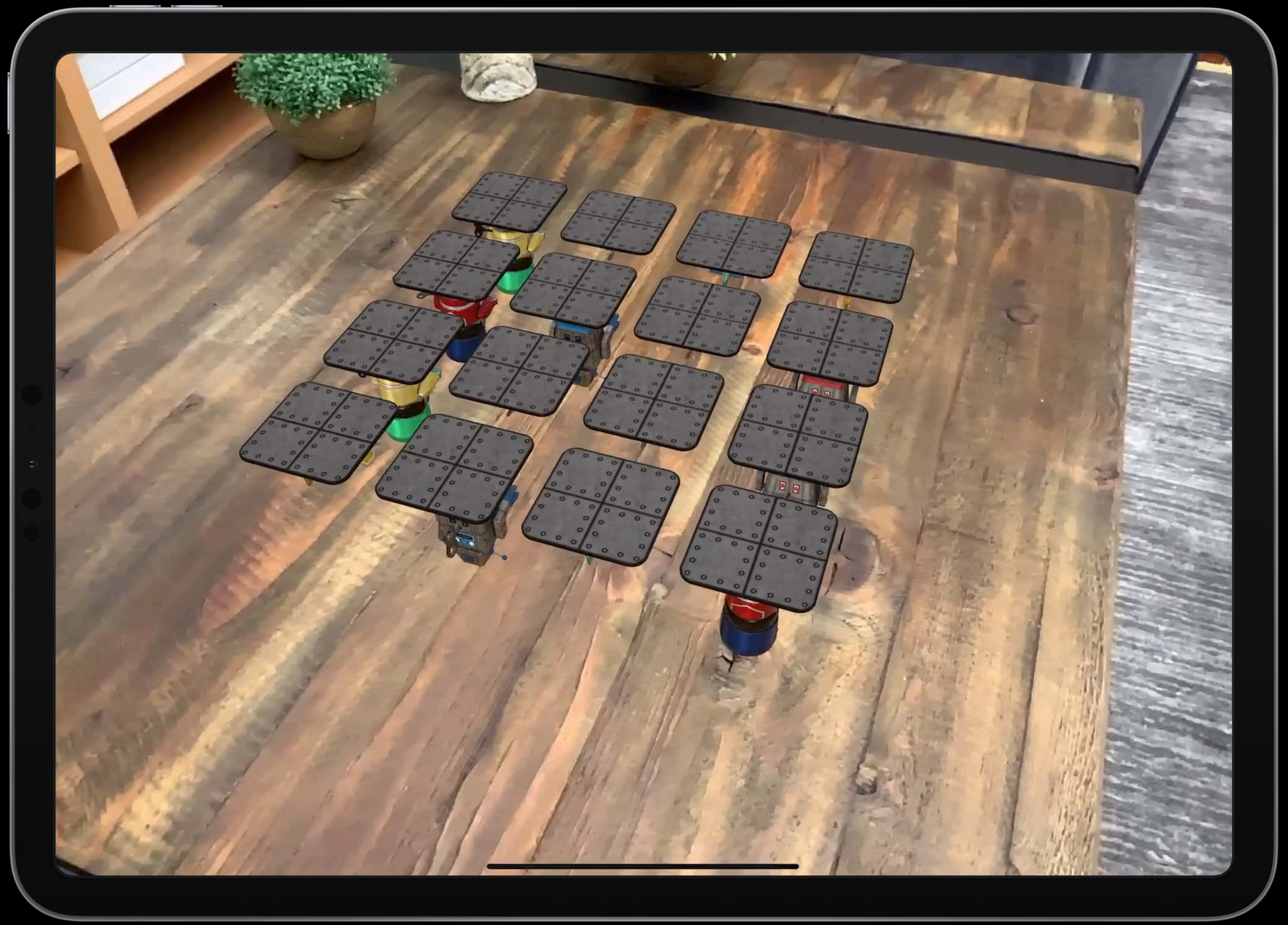

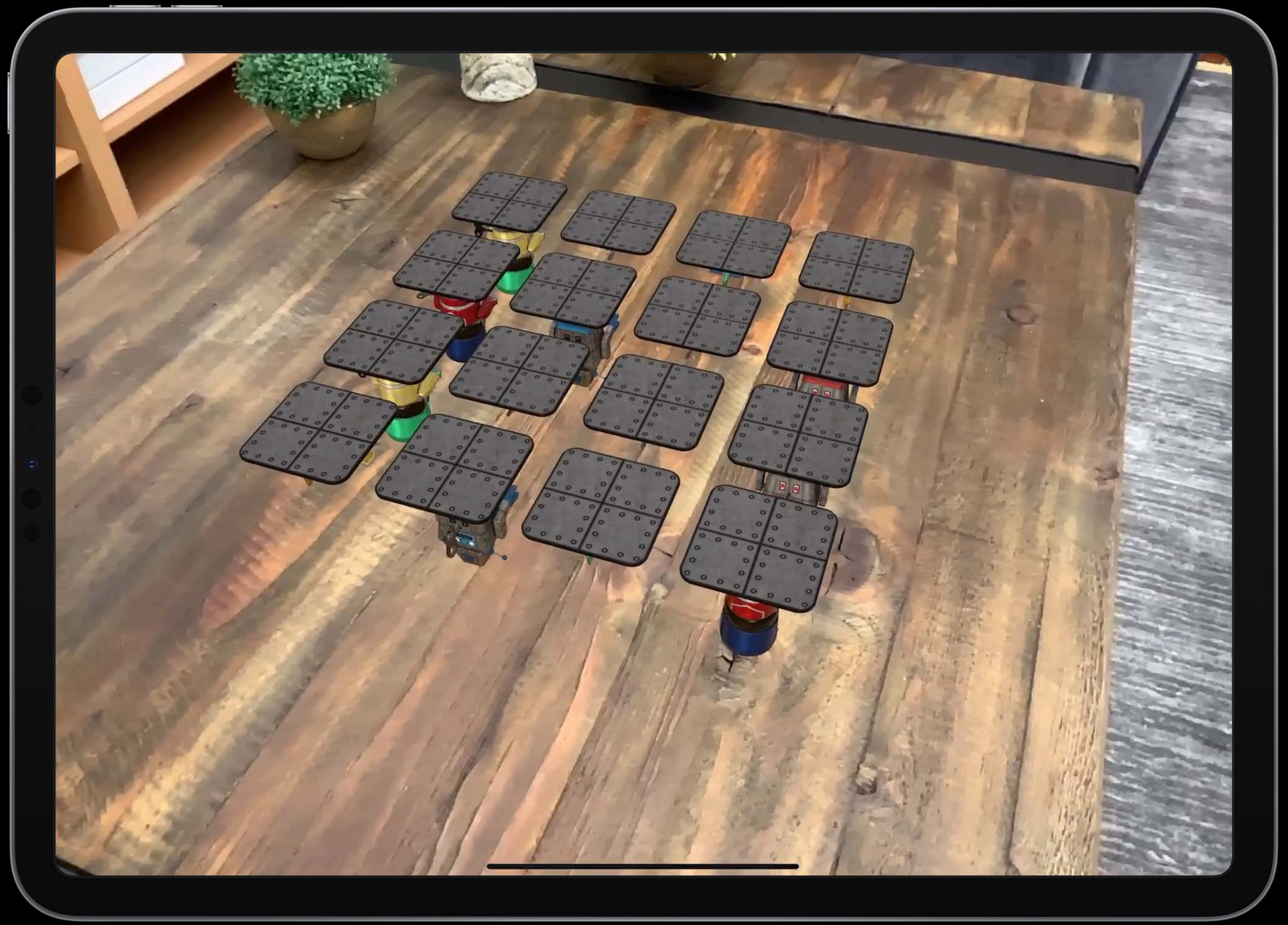

Occlusion

Reveals video passthrough

Simulates real world objects

Occlusion

Reveals video passthrough

Simulates real world objects

```
// Adding Occlusion Plane

// Create plane mesh, 0.5 meters wide & 0.5 meters deep
let planeMesh = MeshResource.generatePlane(width: 0.5, depth: 0.5)

// Create occlusion material
let material = OcclusionMaterial()

// Create ModelEntity using mesh and materials
let occlusionPlane = ModelEntity(mesh: planeMesh, materials: [material])

// Position plane below game board
occlusionPlane.position.y = -0.001

// Add to anchor
anchor.addChild(occlusionPlane)
```

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occlusionPlane.position.y = -0.001

// Add to anchor
anchor.addChild(occlusionPlane)
```

```
// Adding Occlusion Box

// Create box mesh, 0.5 meters on all sides
let boxSize: Float = 0.5
let boxMesh = MeshResource.generateBox(size: boxSize)

// Create Occlusion Material
let material = OcclusionMaterial()

// Create ModelEntity using mesh and materials
let occlusionBox = ModelEntity(mesh: boxMesh, materials: [material])

// Position box with top slightly below game board
occlusionBox.position.y = -boxSize / 2 - 0.001

// Add to anchor
anchor.addChild(occlusionBox)
```

```
// Adding Occlusion Box

// Create box mesh, 0.5 meters on all sides
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```swift
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Tracking Game State

Courtland Idstrom, RealityKit Engineer

Entity and Component

Composition over inheritance

Promotes reuse

Flexible and scalable

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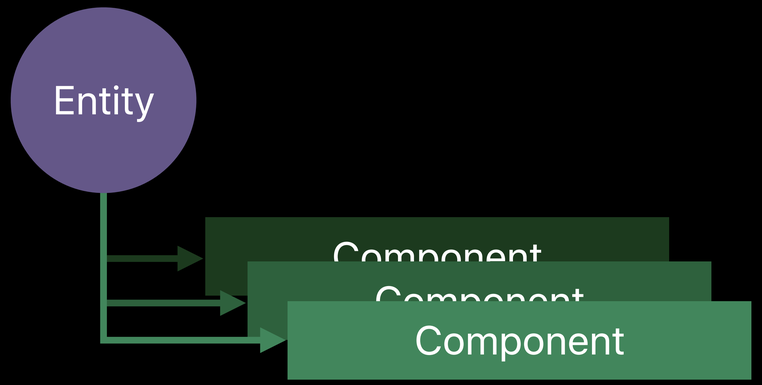
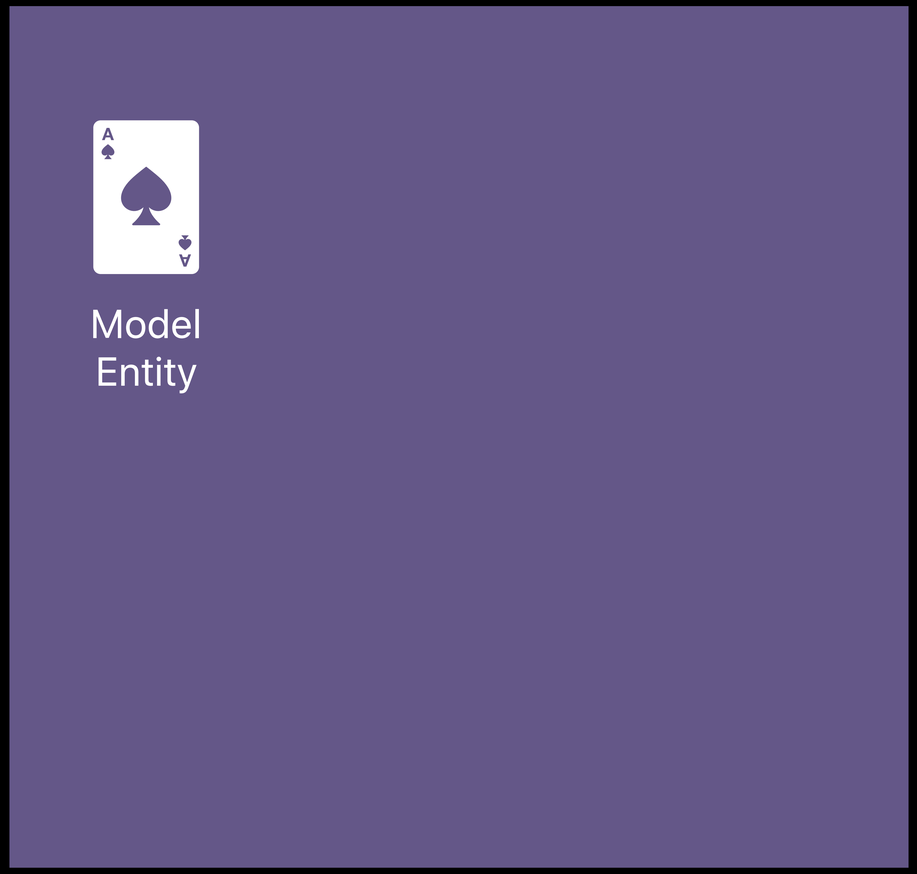
Composition over inheritance

Promotes reuse

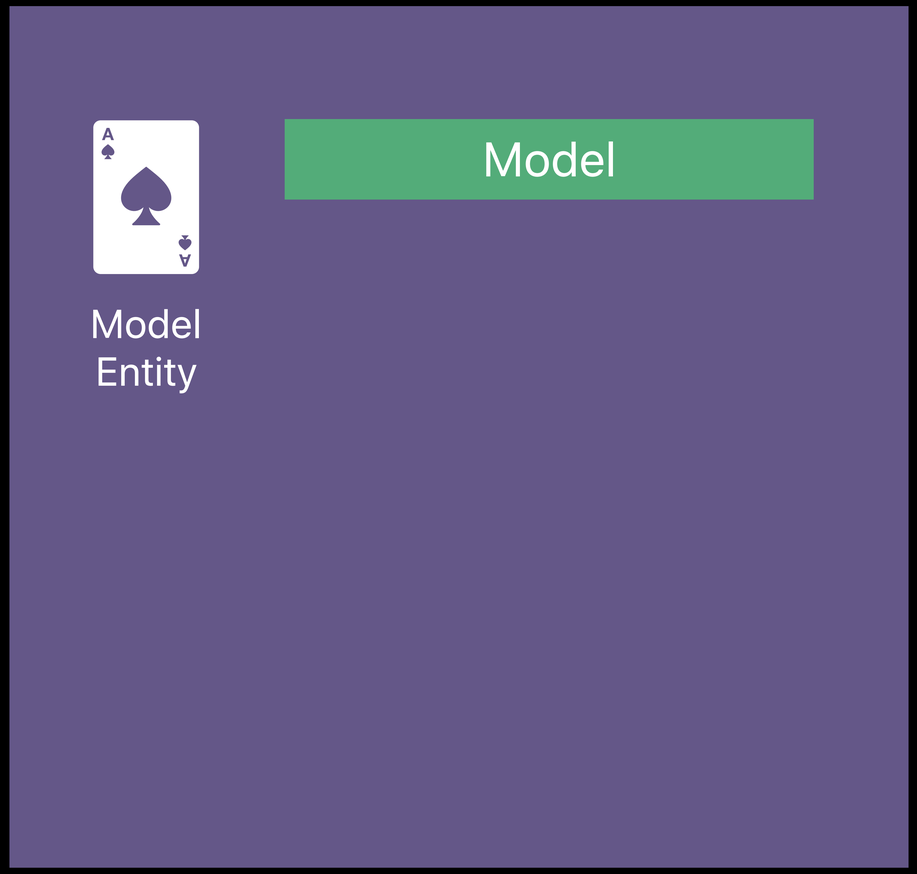
Flexible and scalable



Entity and Component



Entity and Component



Entity and Component

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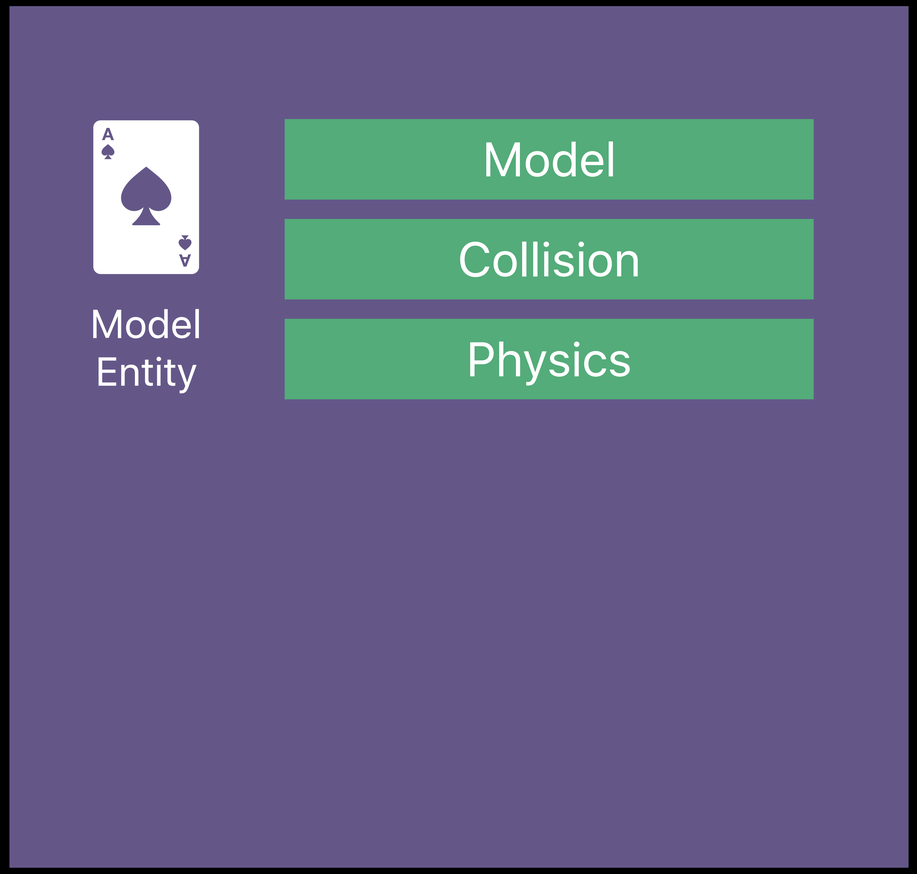
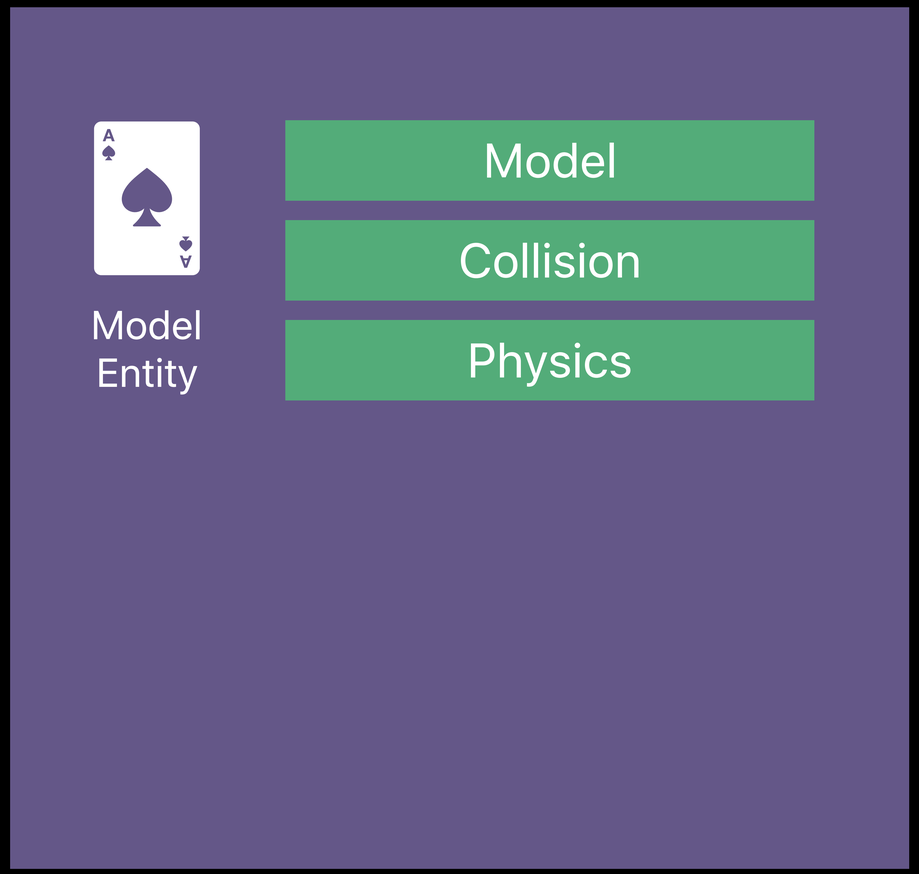
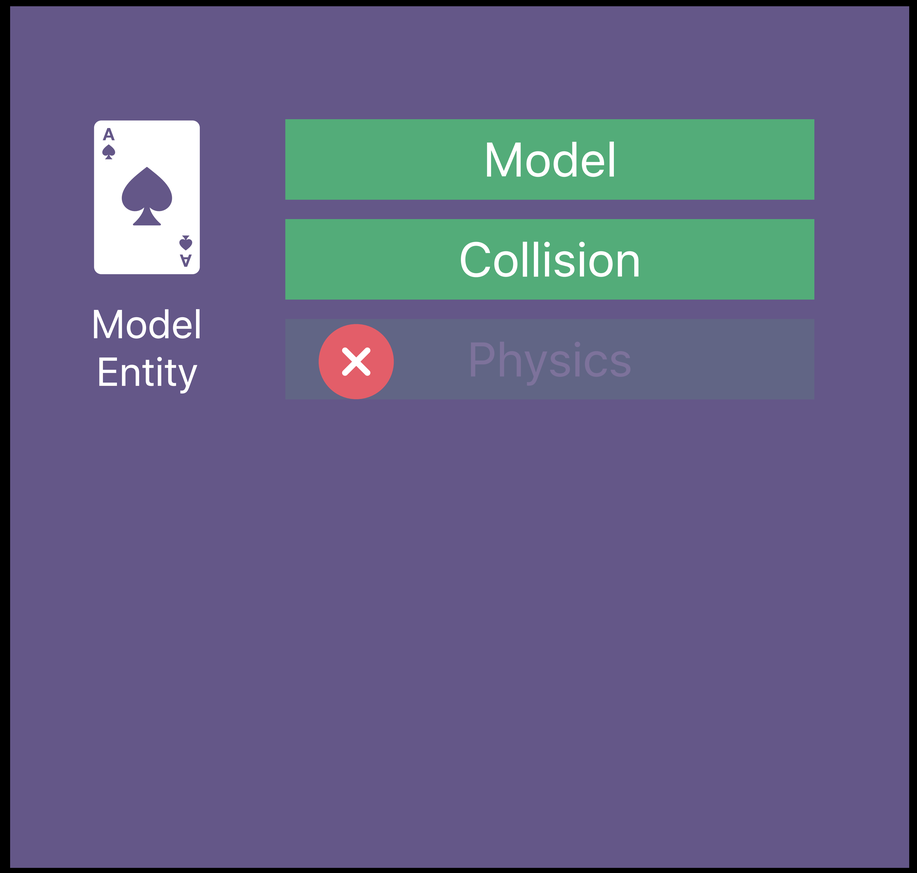


Entity and Component



Entity and Component

Remove Physics

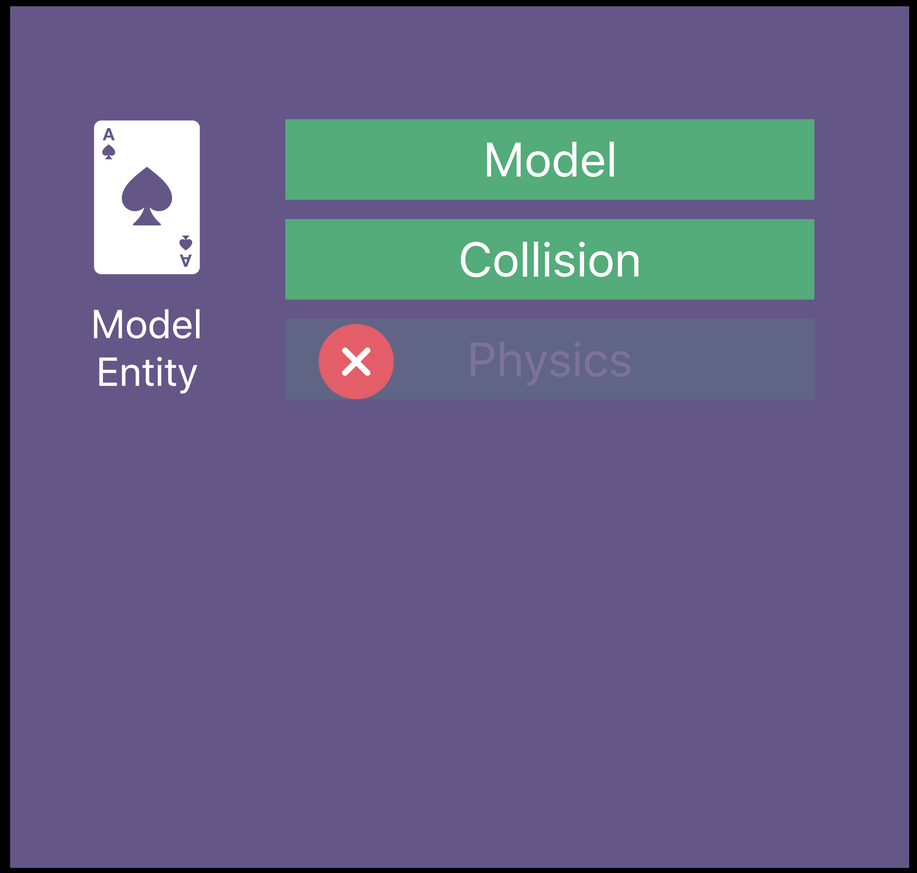


Entity and Component

Remove Physics

Card properties

- Hidden/Revealed

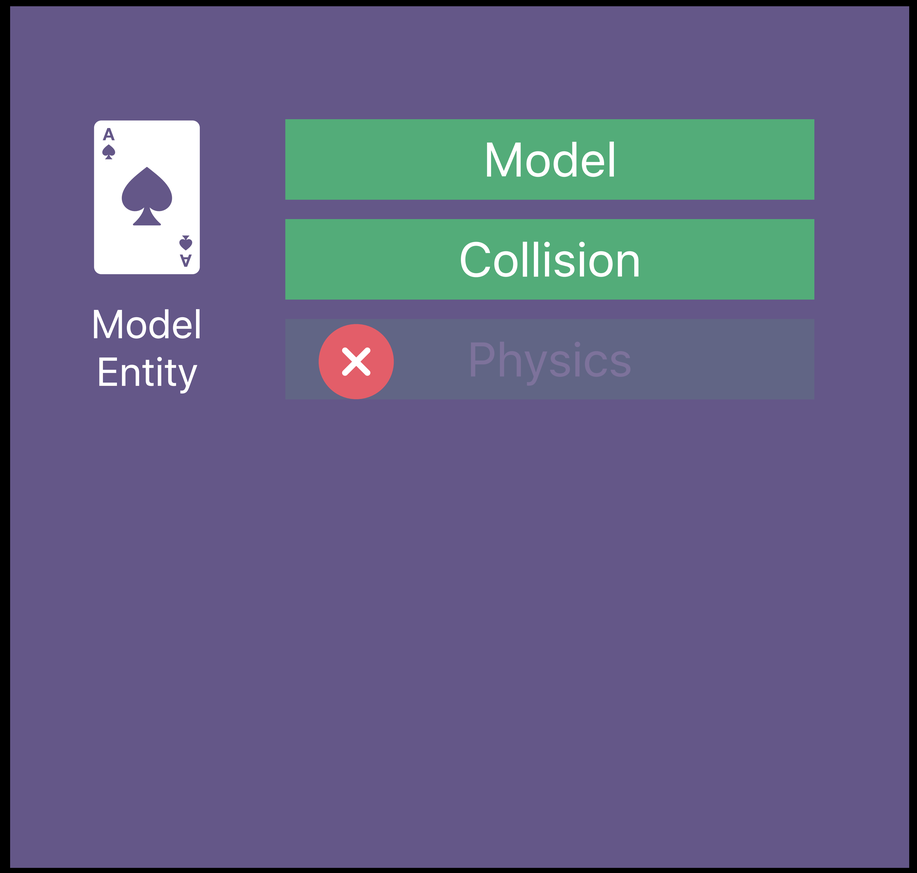


Entity and Component

Remove Physics

Card properties

- Hidden/Revealed
- Kind



Entity and Component

Remove Physics

Card properties

- Hidden/Revealed
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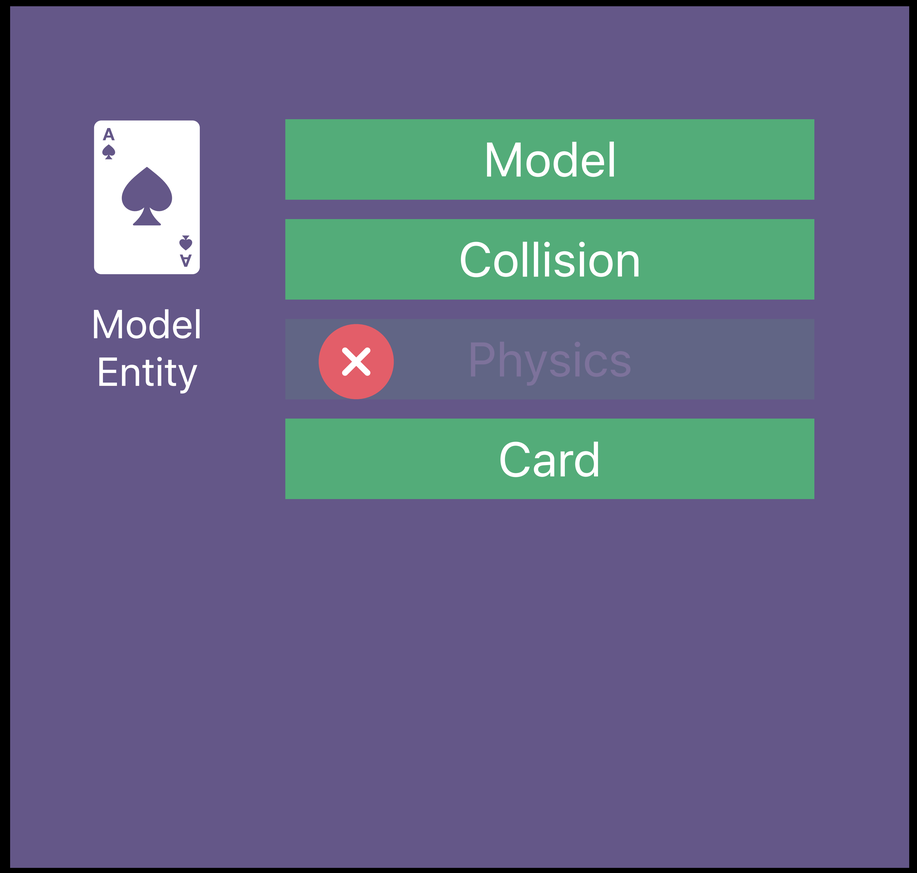

Custom Component

Struct containing your properties

Custom Component

Struct containing your properties

Conforms to Component protocol

Custom Component

Struct containing your properties

Conforms to Component protocol

Attach data to Entity

Custom Component

Struct containing your properties

Conforms to Component protocol

Attach data to Entity

Optionally conforms to Codable

```swift
// Declare Card Component
struct CardComponent: Component, Codable {
    var revealed = false
    var kind = ""
 }

// Load a model
let entity = try! Entity.loadModel(named: "memory_card_1")

// Remove Physics Body Component
entity.physicsBody = nil

// Add Card Component
entity.components[CardComponent.self] = CardComponent()

// Modify kind property
entity.components[CardComponent.self]?.kind = "memory_card_1"
```

```
// Declare Card Component
struct CardComponent: Component, Codable {
    var revealed = false
    var kind = ""
 }

// Load a model
let entity = try! Entity.loadModel(named: "memory_card_1")

// Remove Physics Body Component
entity.physicsBody = nil

// Add Card Component
entity.components[CardComponent.self] = CardComponent()

// Modify kind property
entity.components[CardComponent.self]?.kind = "memory_card_1"
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Custom Entity

Common configurations

Custom Entity

Common configurations

Compile-time type checking

Custom Entity

Common configurations

Compile-time type checking

Encapsulate functionality

Custom Entity

Common configurations

Compile-time type checking

Encapsulate functionality

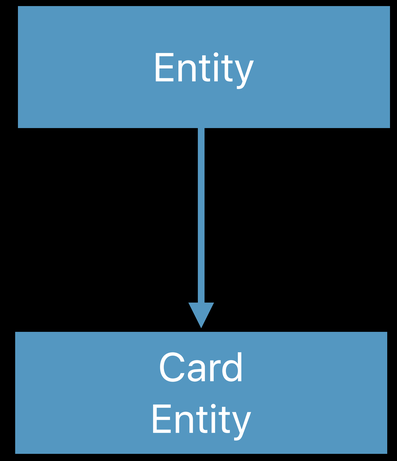
Updates to multiple components

Creating a Custom Entity

Create class derived from Entity

Creating a Custom Entity

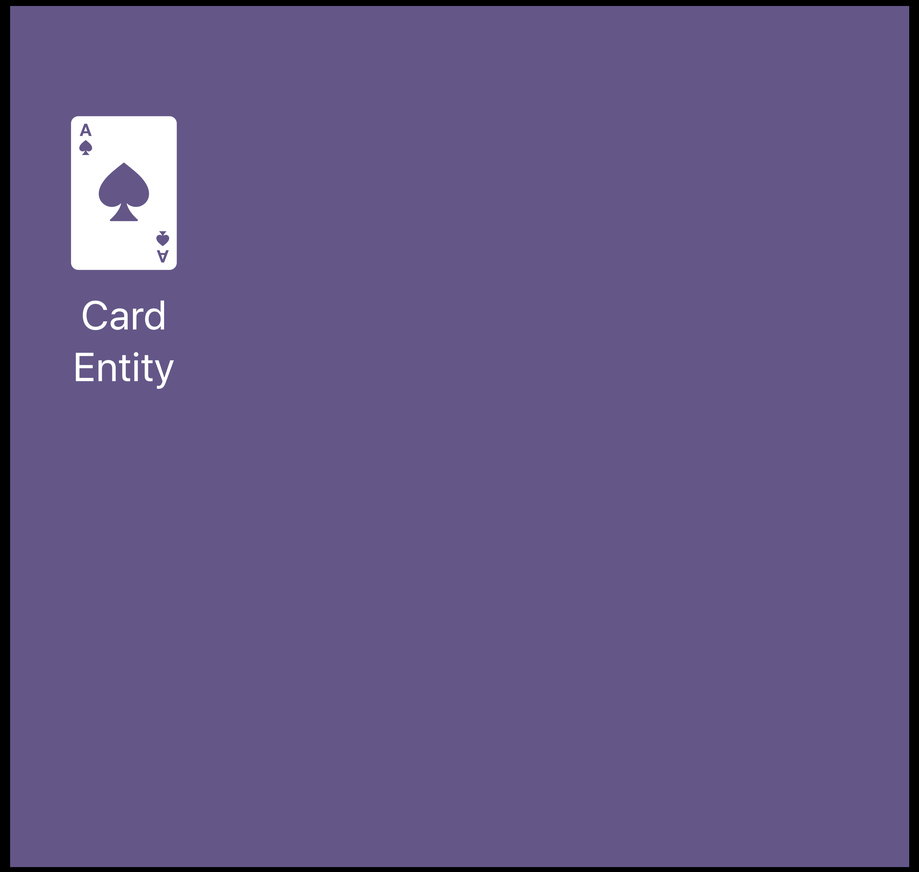
Create class derived from Entity



Creating a Custom Entity

Create class derived from Entity

Include RealityKit components



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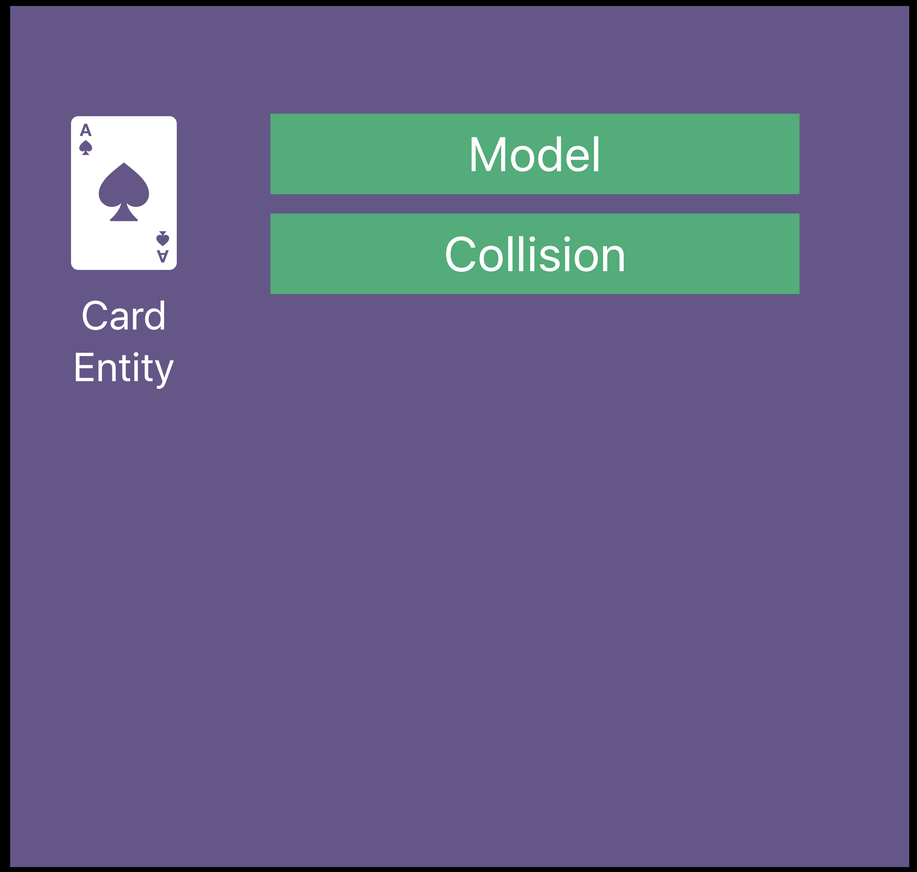
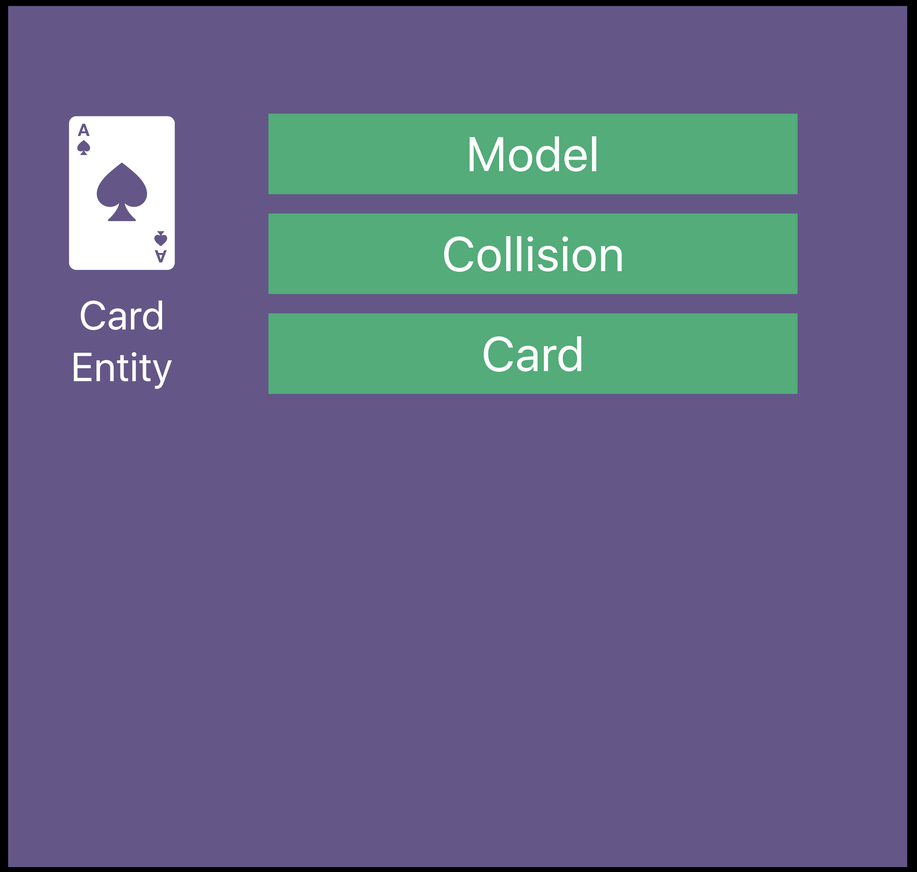


Creating a Custom Entity

Create class derived from Entity

Include RealityKit components

Add property for custom component



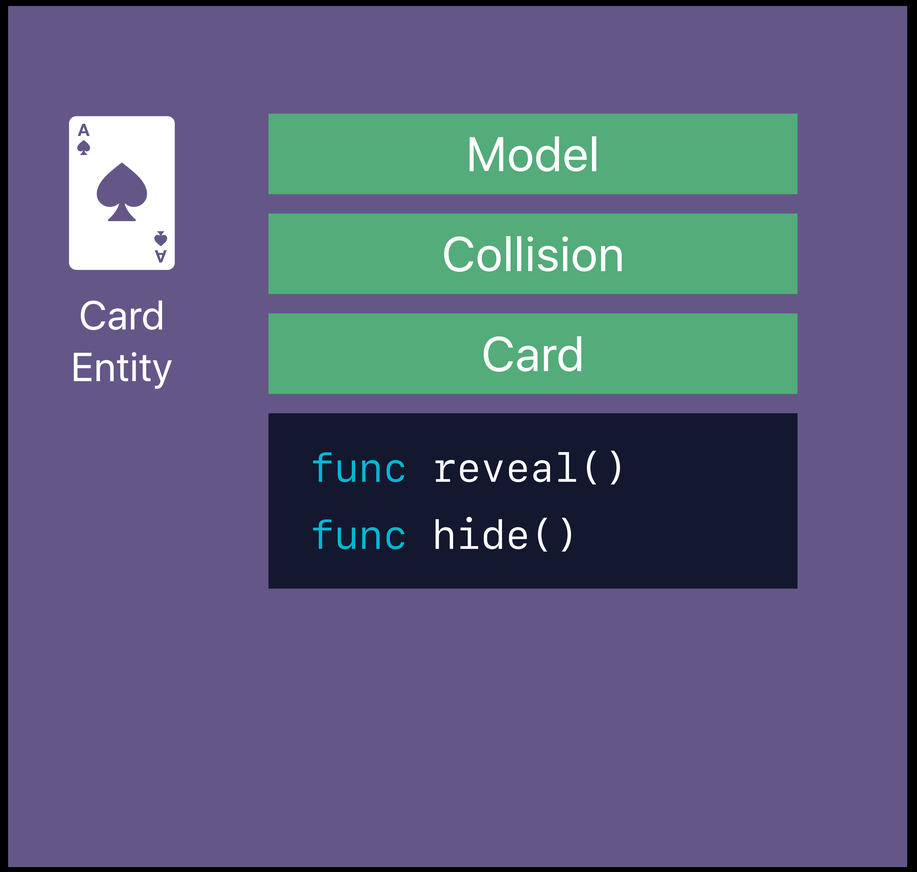
Creating a Custom Entity

Create class derived from Entity

Include RealityKit components

Add property for custom component

Extend with methods



Create Entity Class

Card
Entity

- Model
- Collision
- Card

```
// Declare custom entity
class CardEntity: Entity, HasModel, HasCollision {

    // Card property for convenient access to card state
    public var card: CardComponent {
        get { return components[CardComponent.self] ?? CardComponent() }
        set { components[CardComponent.self] = newValue }
    }
}
```

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}
```

```
// Extend CardEntity with additional methods
extension CardEntity {

  // Animate, change state
  func reveal() {

    // Update revealed property
    card.revealed = true

    // Flip card over to reveal contents
    var transform = self.transform
    transform.rotation = simd_quatf(angle: .pi, axis: [1, 0, 0])
    move(to: transform, relativeTo: parent, duration: 0.25, timingFunction: .easeInOut)
  }
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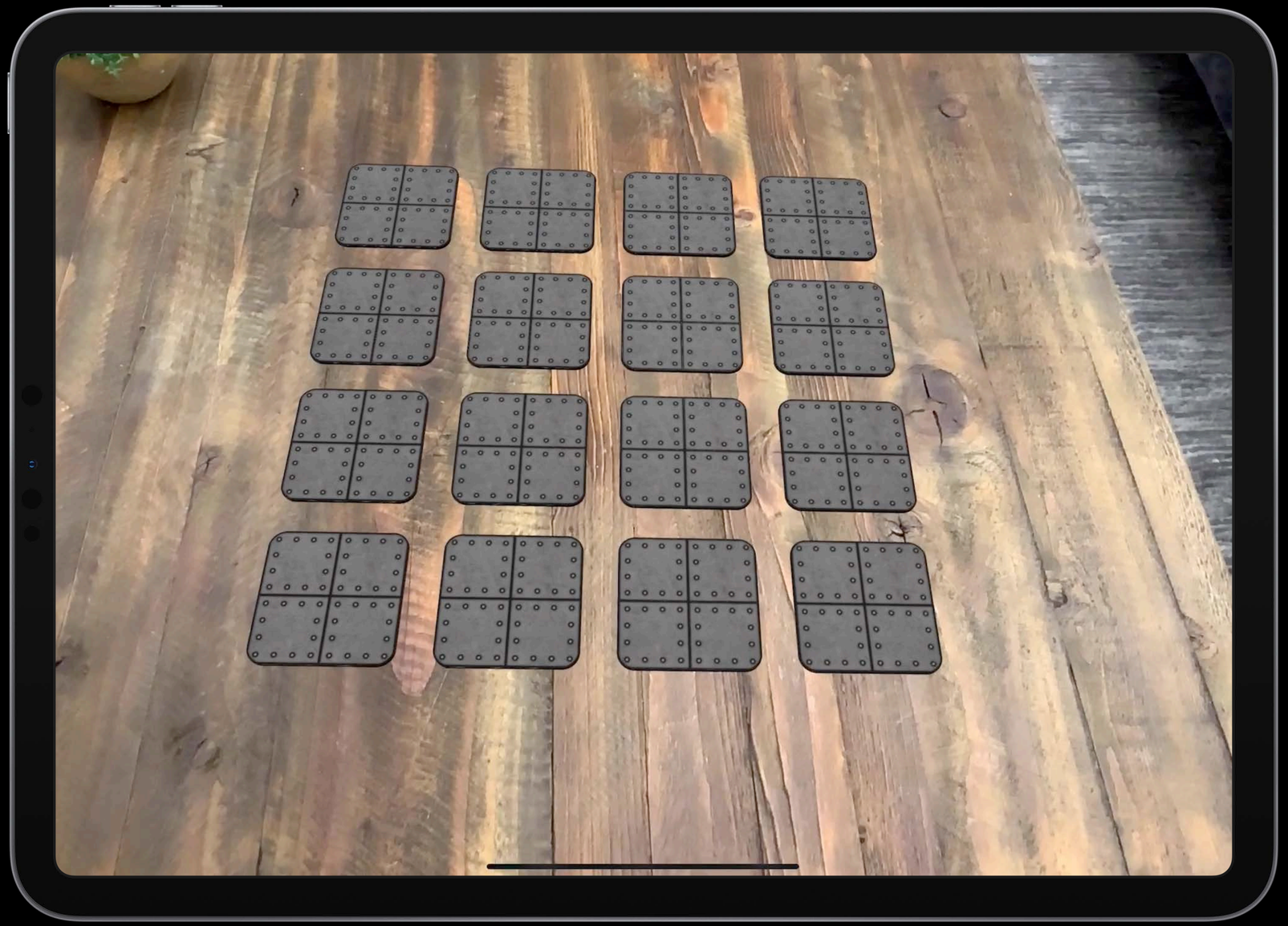
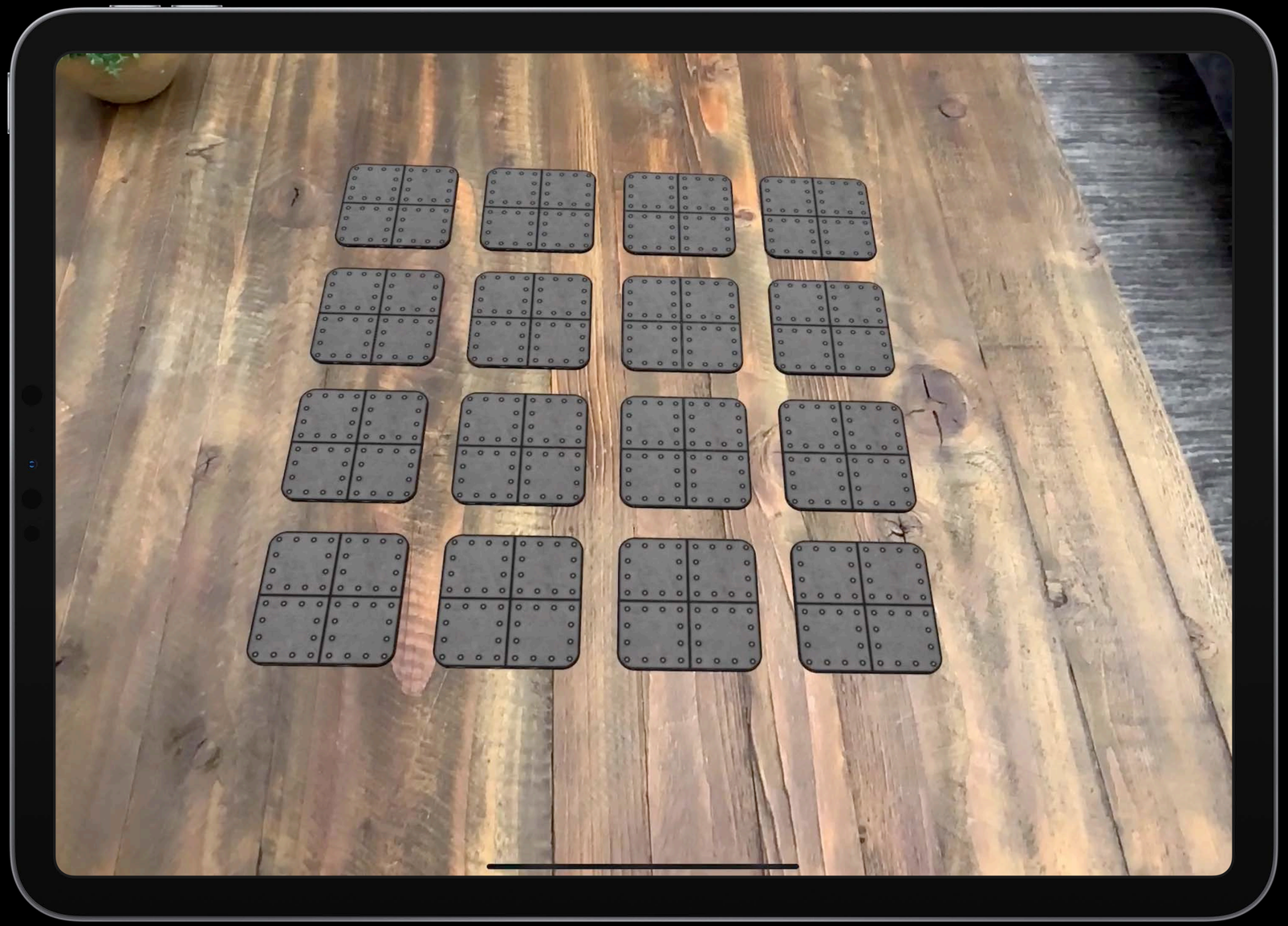
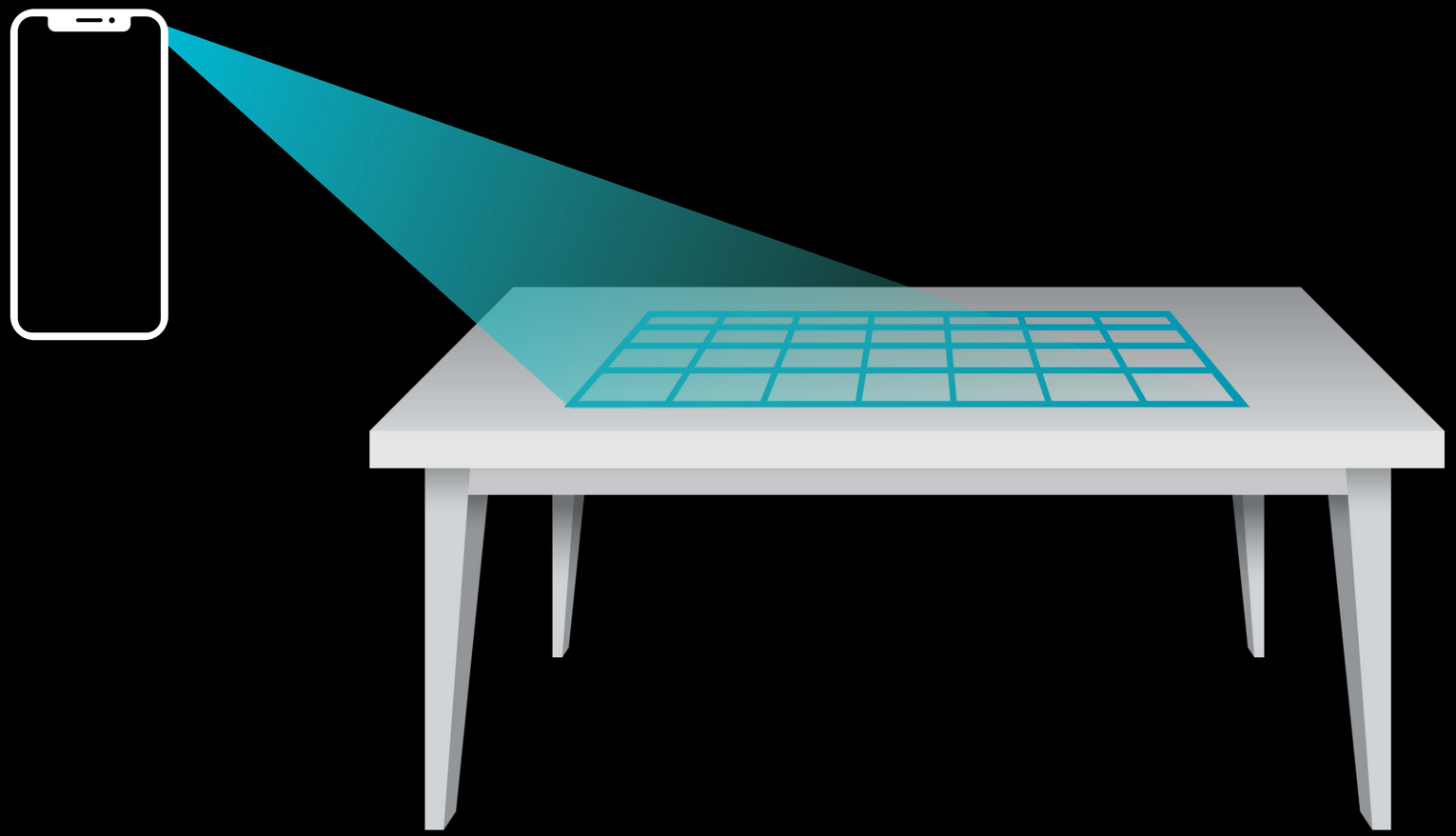




“Just add multiplayer…”

Augmented Reality Mapping



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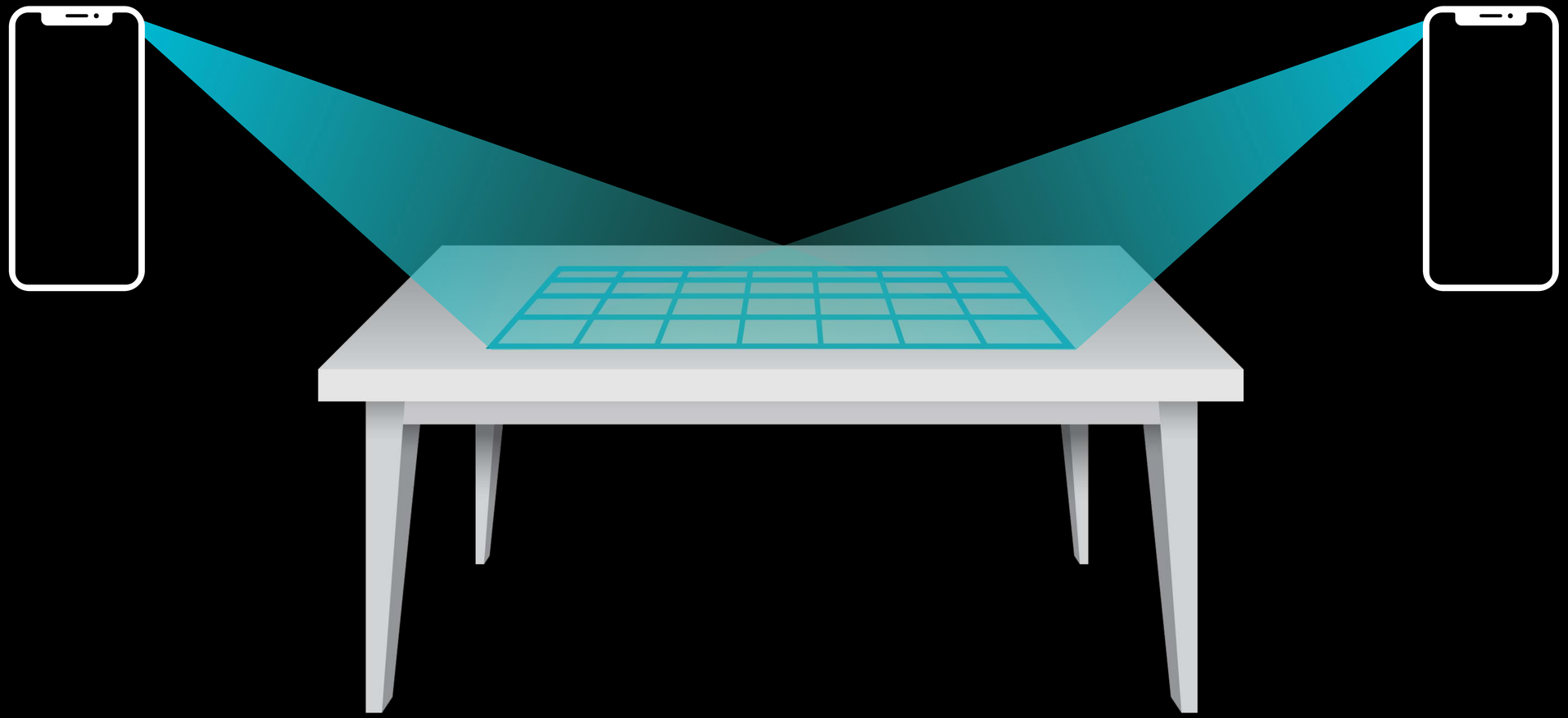
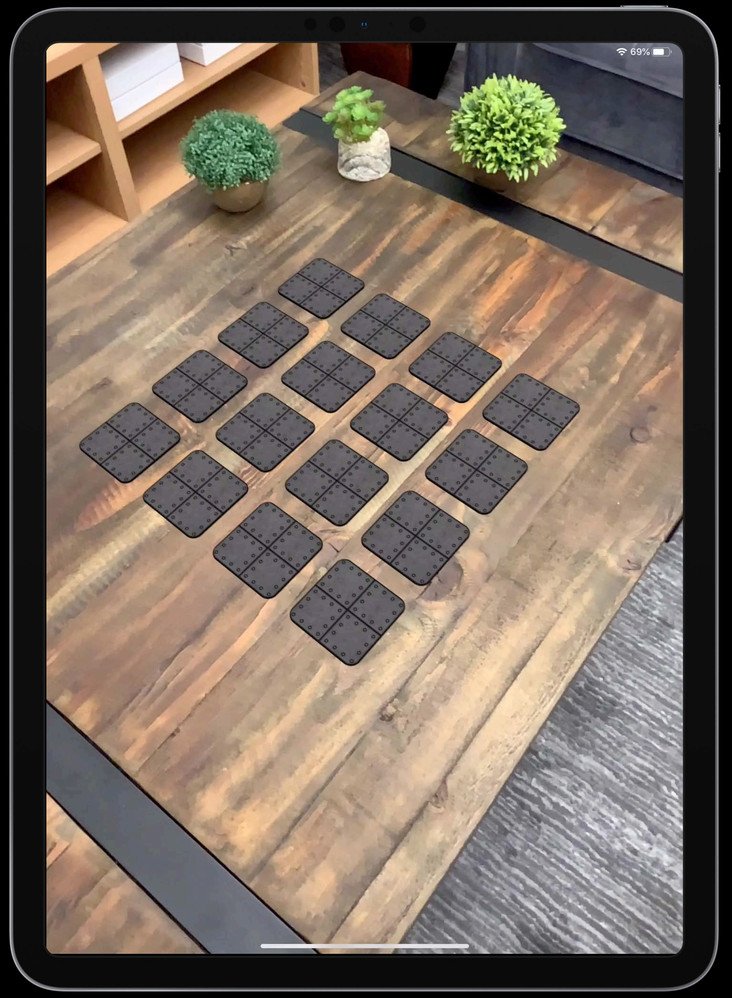
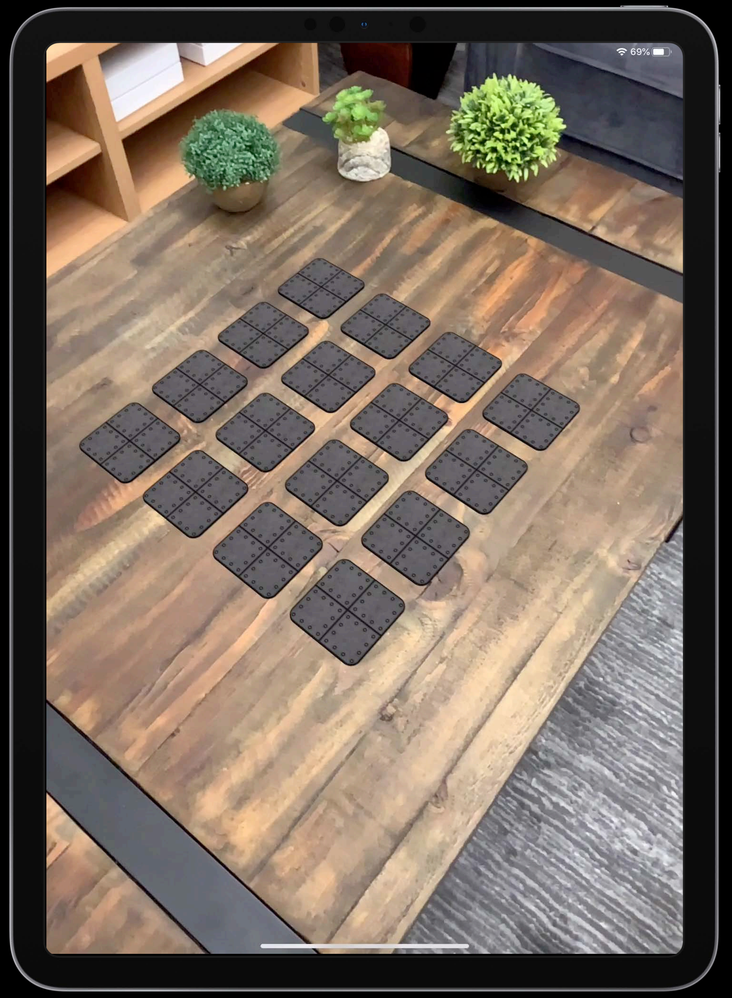


Host



Client

Host



Client

Multiplayer Overview

Automatic scene synchronization

Multiplayer Overview

Automatic scene synchronization

Built on MultipeerConnectivity

Multiplayer Overview

Automatic scene synchronization

Built on MultipeerConnectivity

Easy to use ownership model

Multiplayer Overview

Automatic scene synchronization

Built on MultipeerConnectivity

Easy to use ownership model

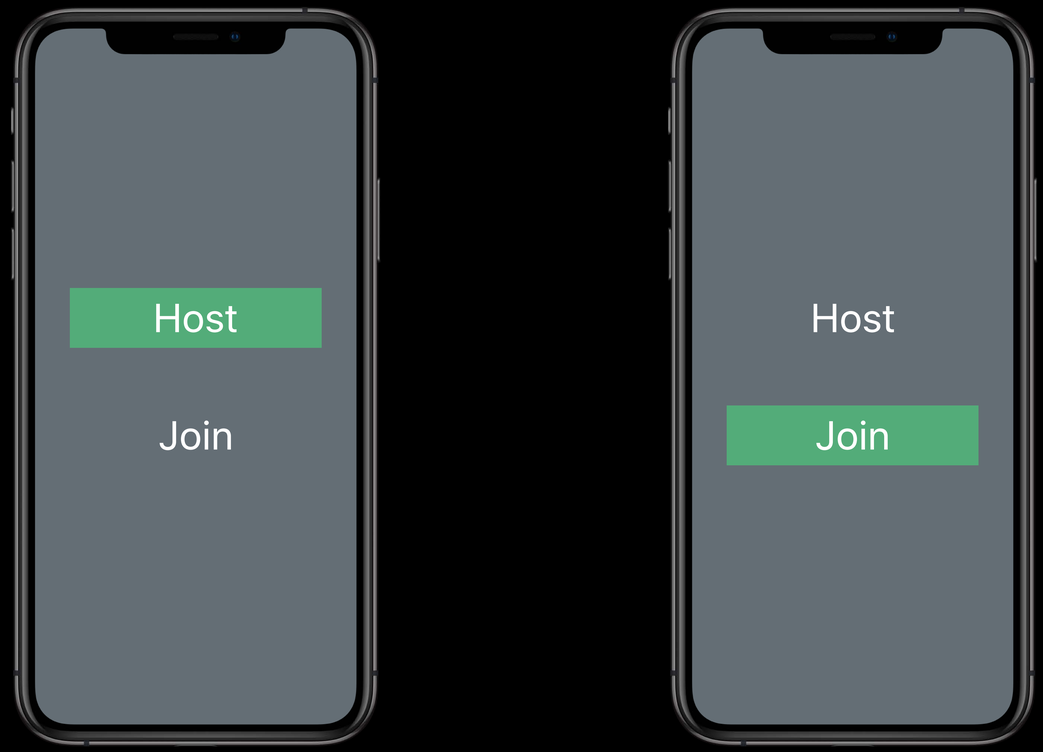
Optimized for AR

Adopting Multiplayer

Designate host, client

Adopting Multiplayer

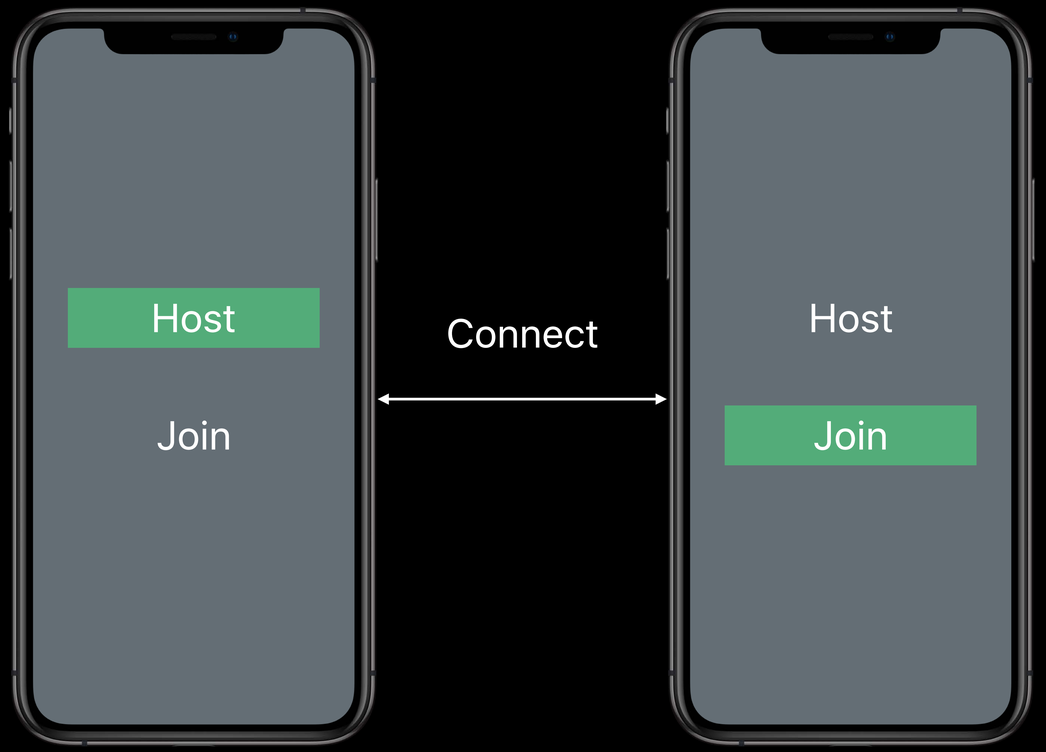
Designate host, client



Adopting Multiplayer

Designate host, client

Establish connection

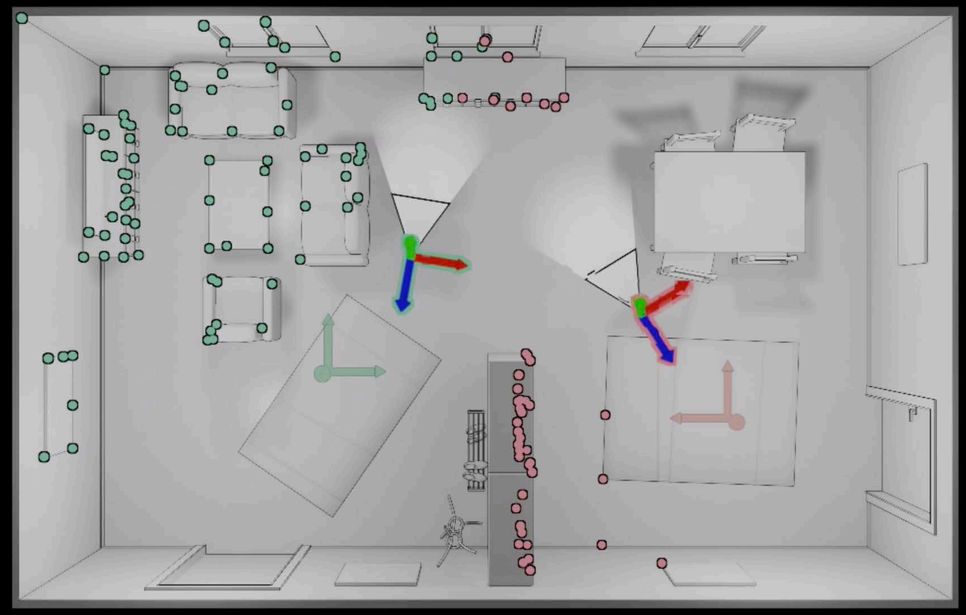


Adopting Multiplayer

Designate host, client

Establish connection

Enable Collaborative Session



Adopting Multiplayer

Designate host, client

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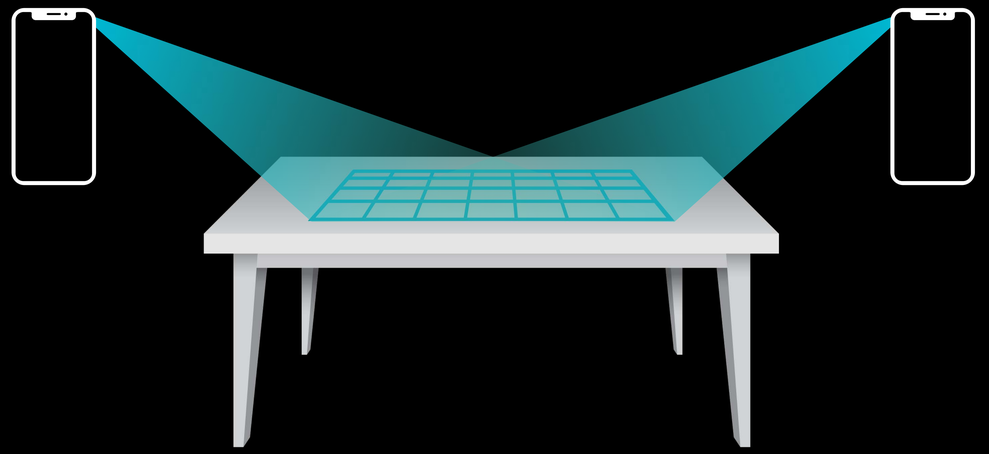
Enable Collaborative Session

Place synchronized Anchor



Adopting Multiplayer

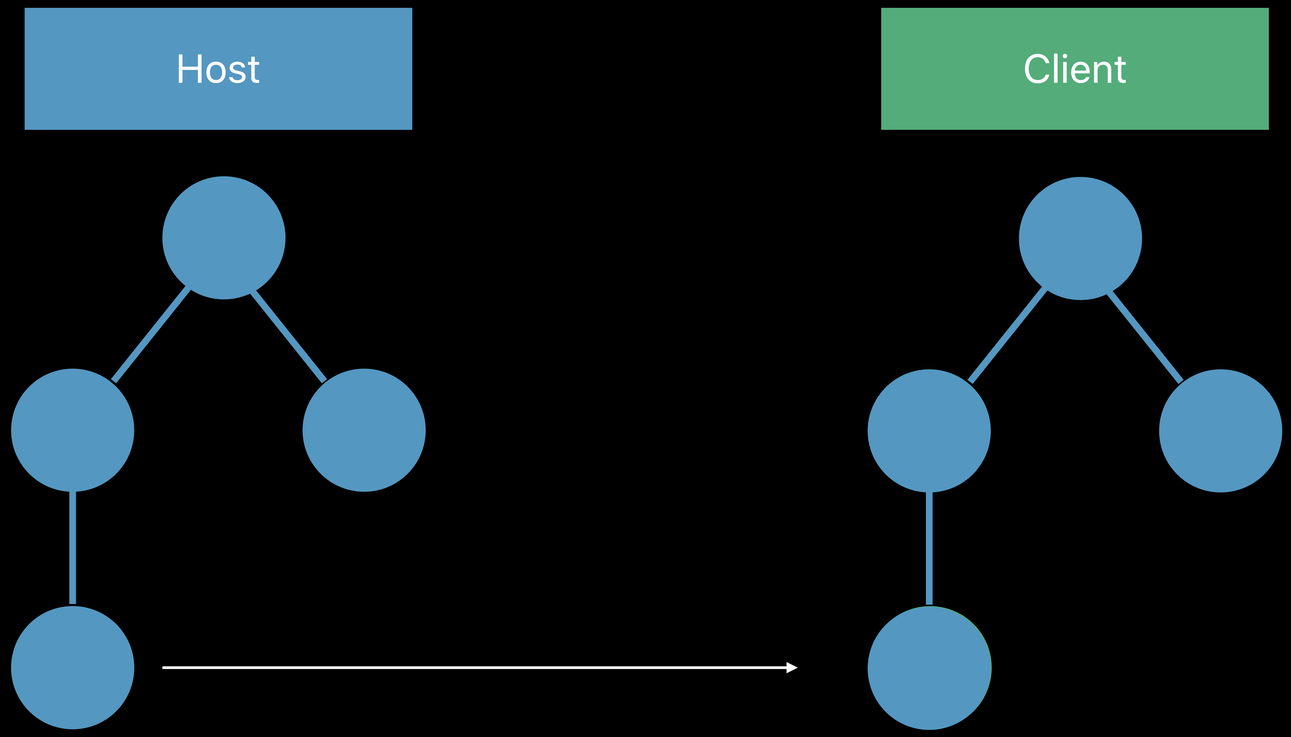
Designate host, client

Establish connection

Enable Collaborative Session

Place synchronized Anchor

Manage ownership



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// MultipeerConnectivity Session Setup
import MultipeerConnectivity

// Create Multipeer Session
let myPeerID = MCPeerID(displayName: "Memory Game")
let mcSession = MCSession(peer: myPeerID, securityIdentity: nil,
                          encryptionPreference: .required)

// Advertise or Browse, depending on role
if role == .host {
  // Host Creates MCNearbyServiceAdvertiser and Starts Advertising
} else {
  // Client Creates MCNearbyServiceBrowser and Starts Browsing
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// Use Multipeer session to Synchronize RealityKit scene
arView.scene.synchronizationService = try? MultipeerConnectivityService(session: mcSession)
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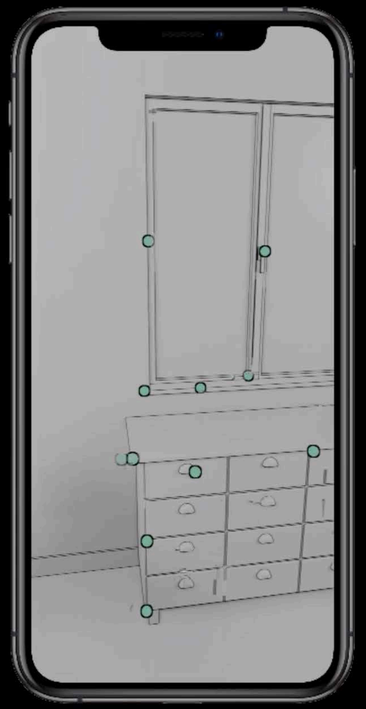
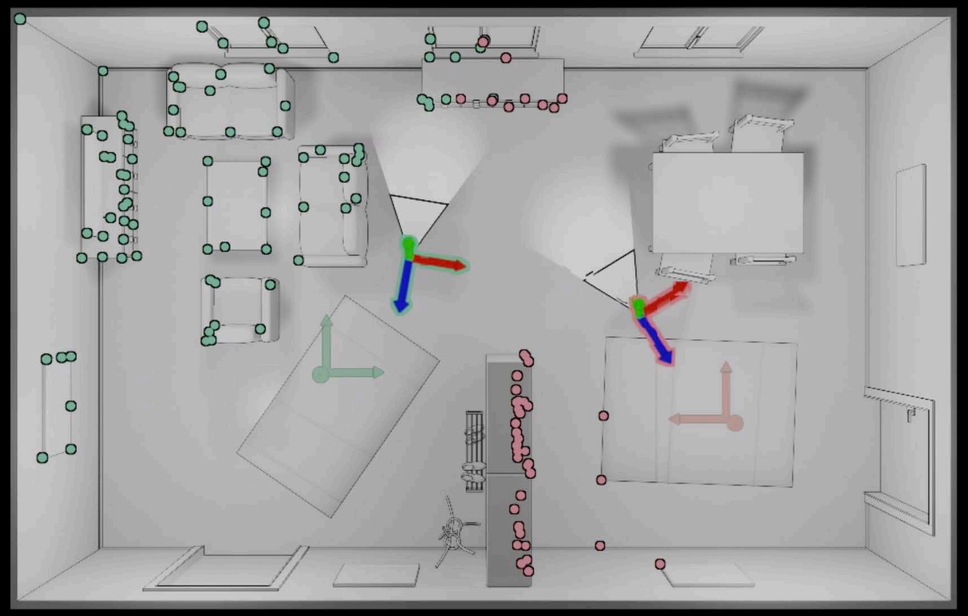
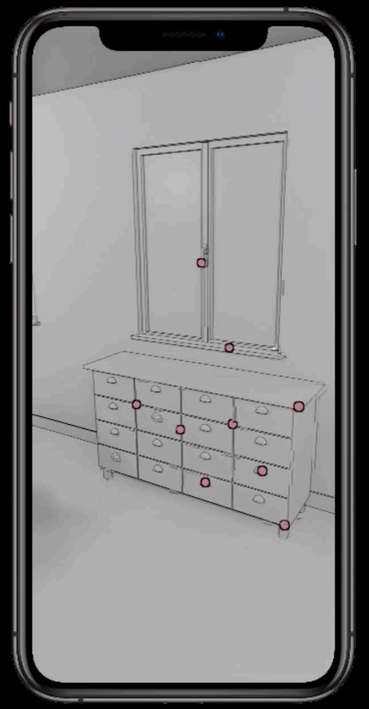
AR Collaborative Session

Introduced in ARKit 3

Enable on AR Session







```
// Create a new tracking configuration
let config = ARWorldTrackingConfiguration()

// Enable collaboration
config.isCollaborationEnabled = true

// Instruct ARKit to use the configuration
arView.session.run(config, options: [])
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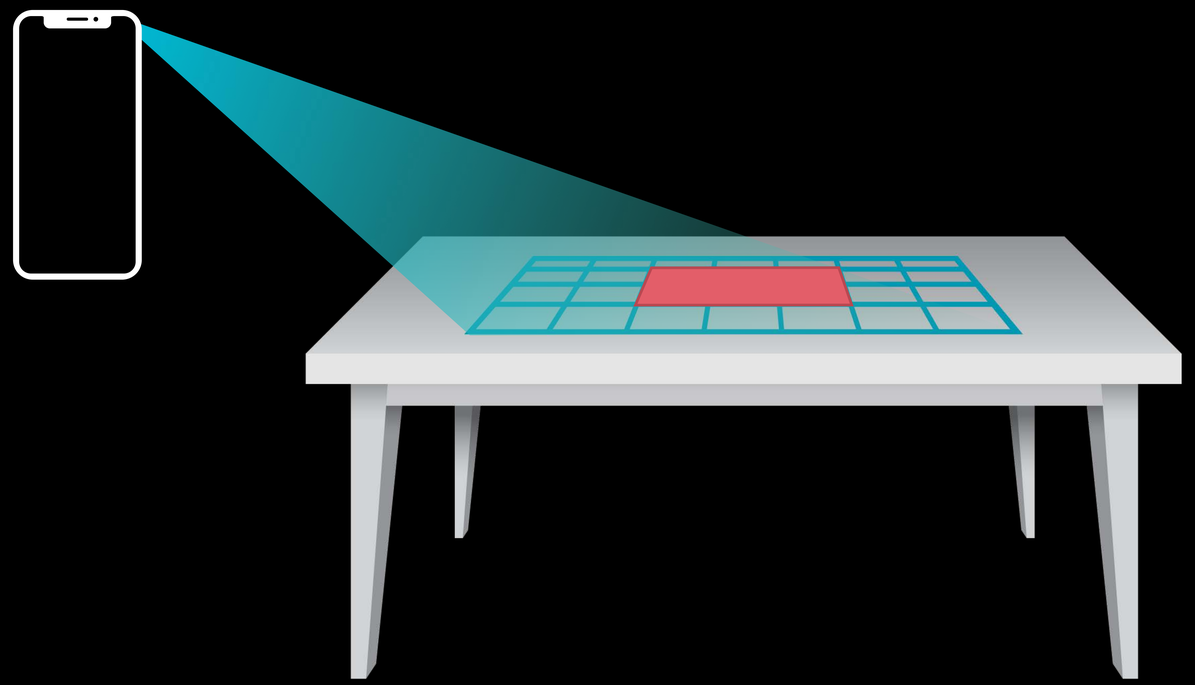
Synchronized Anchor

Allow player to choose

Same world location



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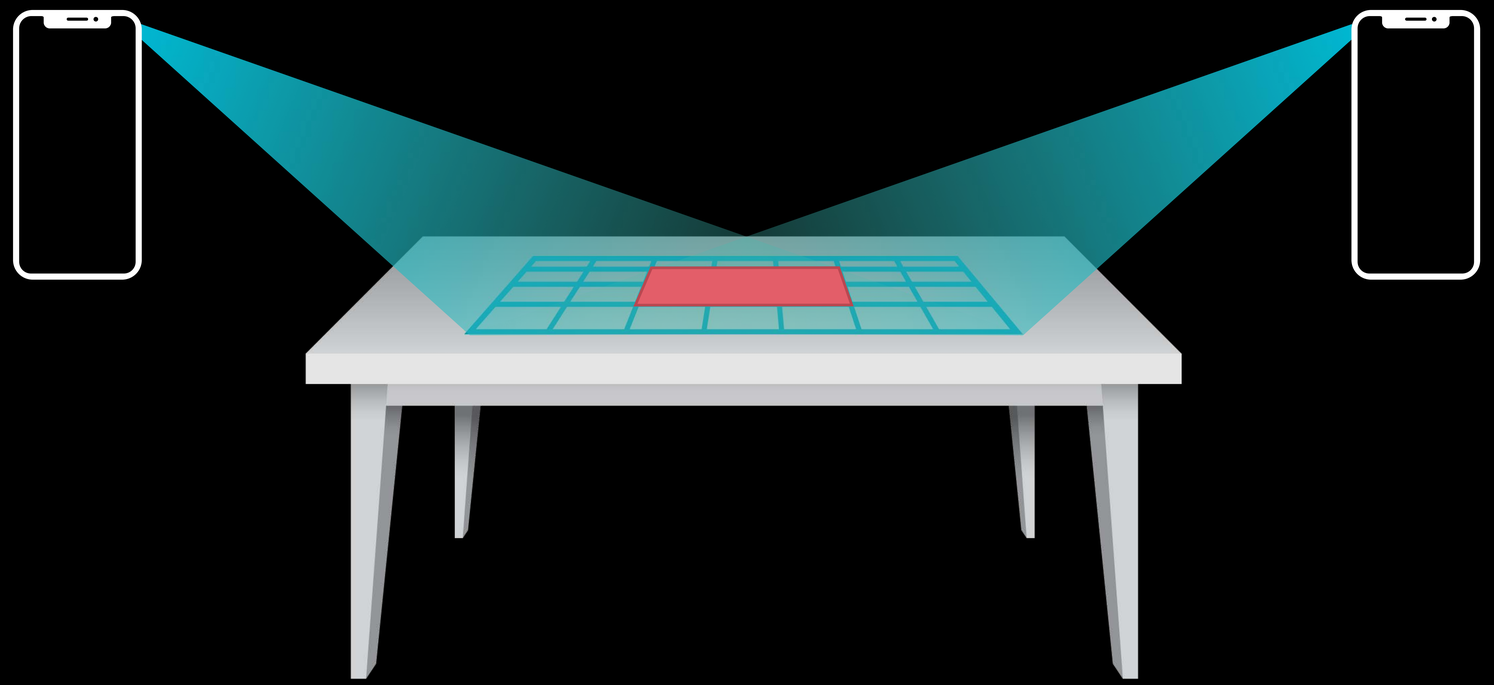

```
// Host — Tap to place board
@IBAction func onTap(_ sender: UITapGestureRecognizer) {
  // Find position under cursor
  guard let result = arView.raycast(sender.location(in: arView),
                  allowing: .existingPlaneGeometry, alignment: .horizontal).first else {
    return
  }









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  // Create ARKit ARAnchor and add to ARSession
  let arAnchor = ARAnchor(name: "Memory Game Board", transform: result.worldTransform)
  arView.session.add(anchor: arAnchor)

  // Create a RealityKit AnchorEntity and add to the scene
  let anchorEntity = AnchorEntity(anchor: arAnchor)
  arView.scene.addAnchor(anchorEntity)

   // Add the game board to the scene here
}
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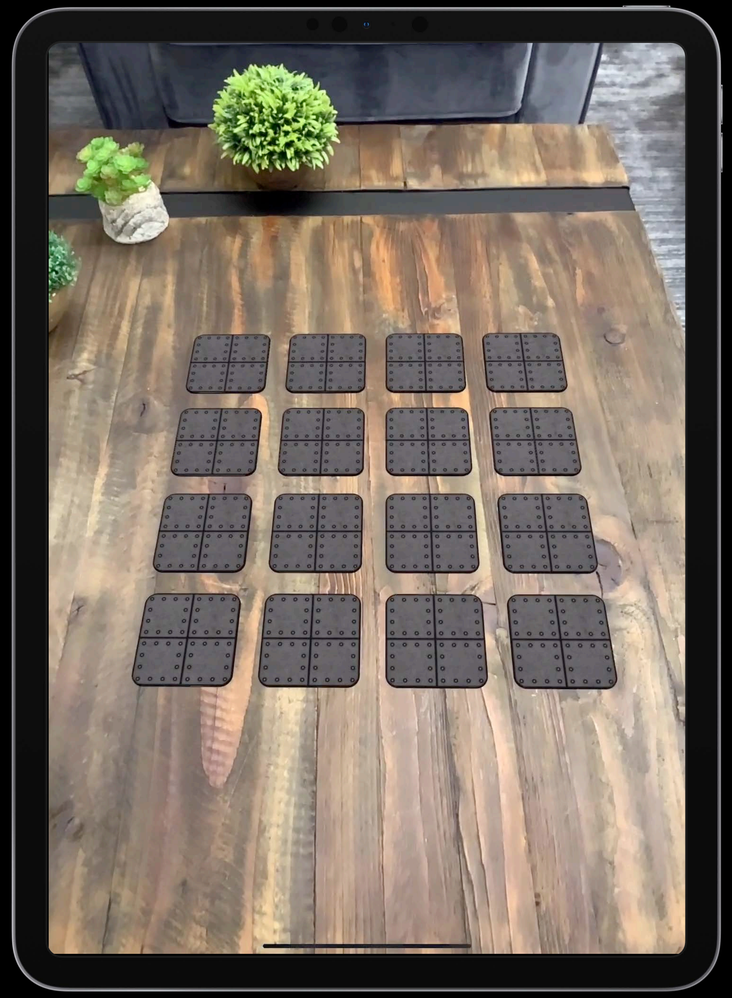
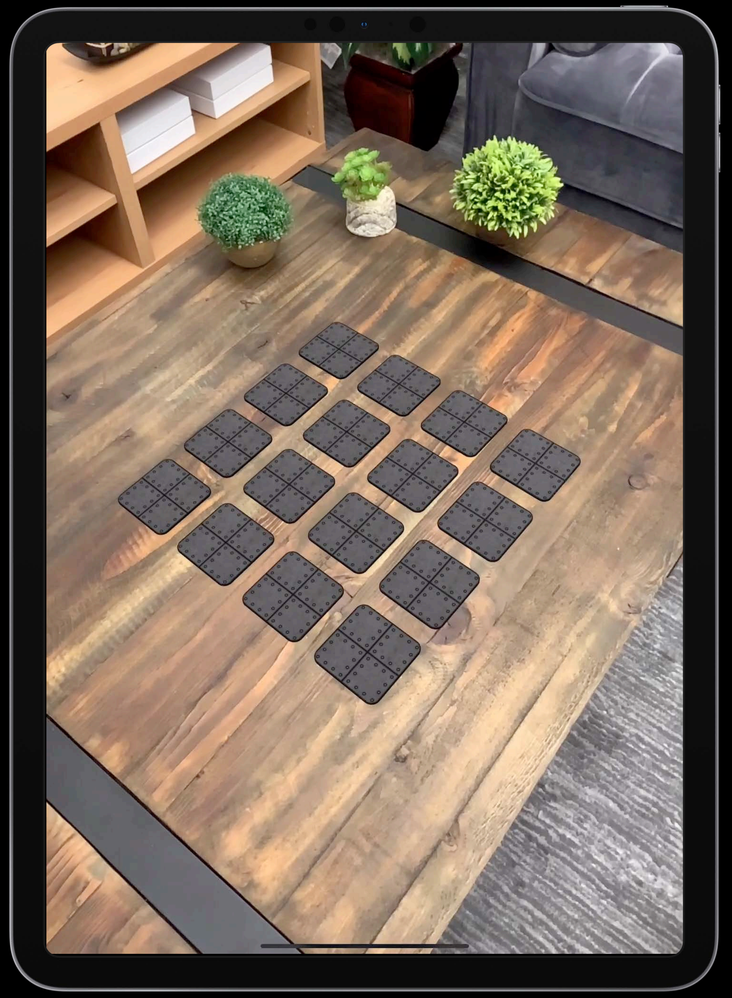
  // Create ARKit ARAnchor and add to ARSession
  let arAnchor = ARAnchor(name: "Memory Game Board", transform: result.worldTransform)
  arView.session.add(anchor: arAnchor)

  // Create a RealityKit AnchorEntity and add to the scene
  let anchorEntity = AnchorEntity(anchor: arAnchor)
  arView.scene.addAnchor(anchorEntity)

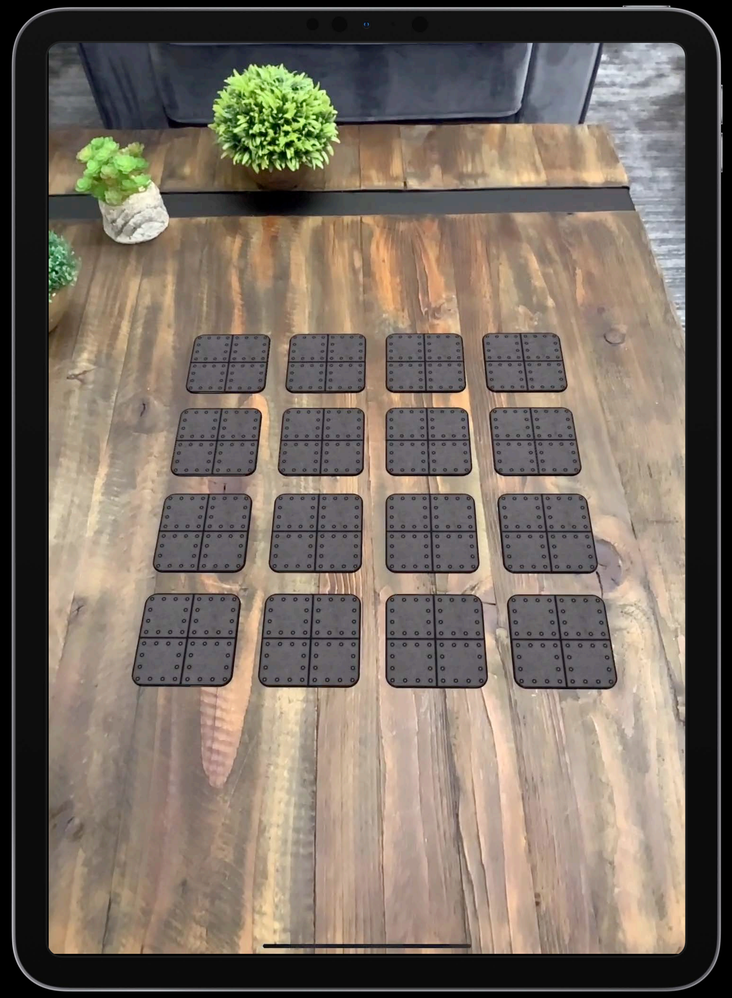
   // Add the game board to the scene here
}
```



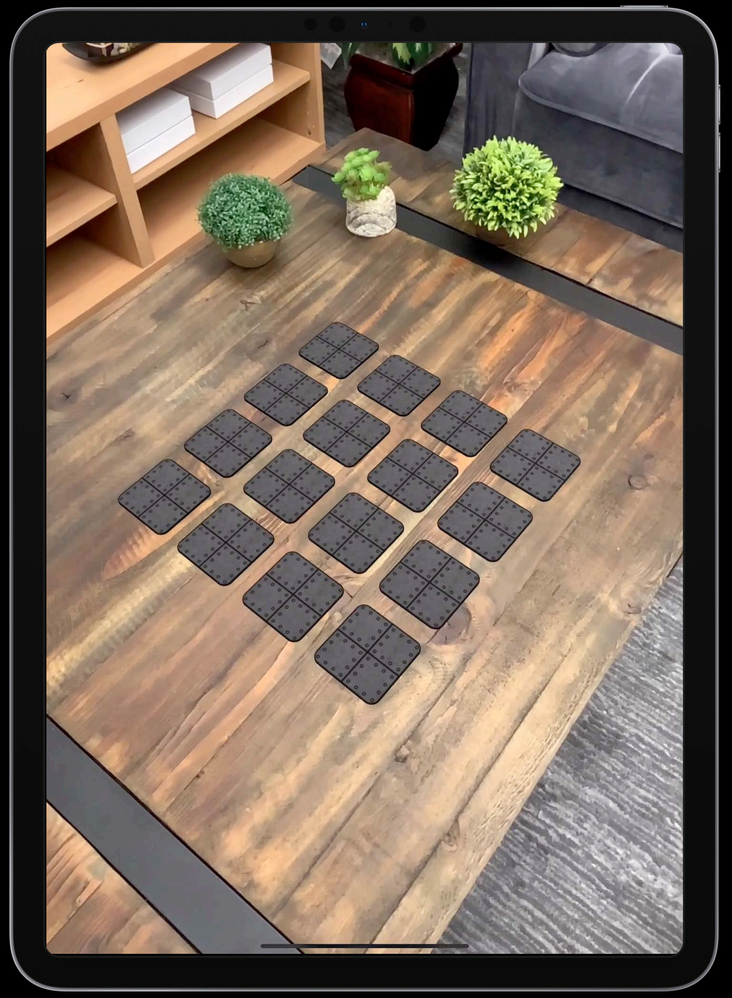
Host



Client



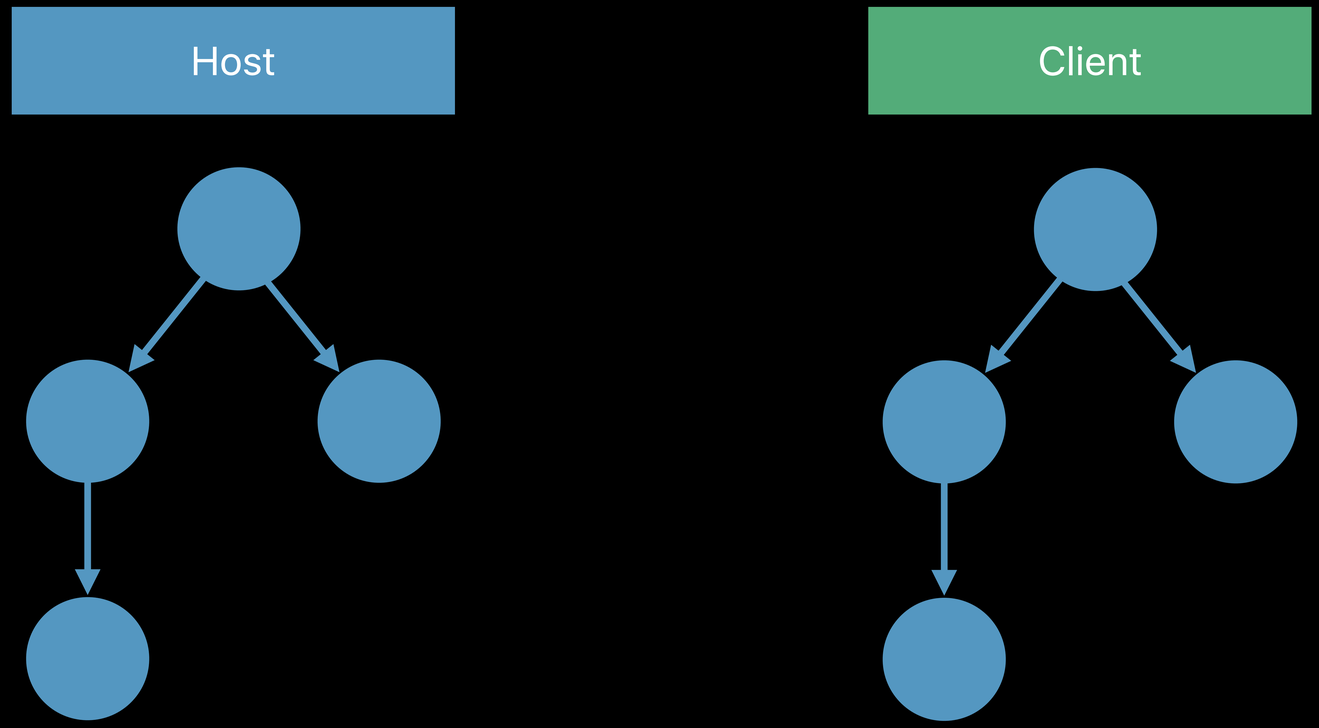
Host



Client

Entity Ownership

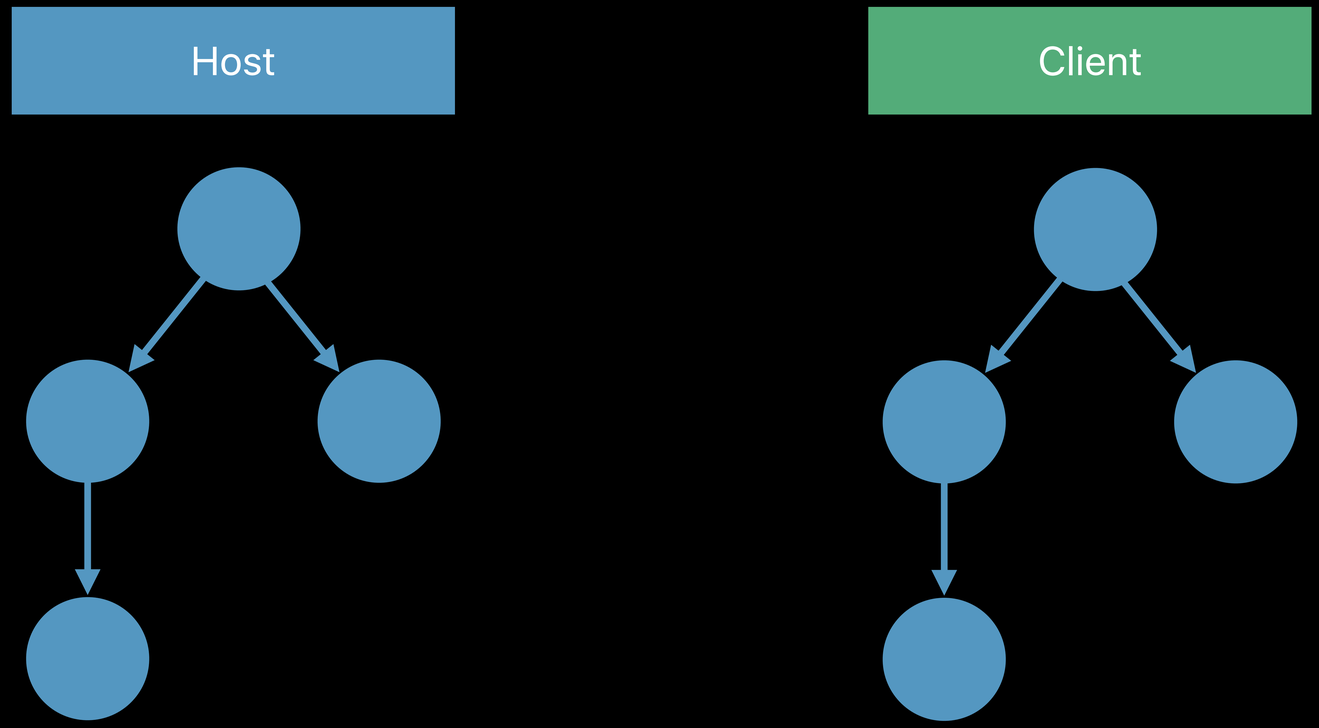
Right to modify an Entity



Entity Ownership

Right to modify an Entity

One owner at a time

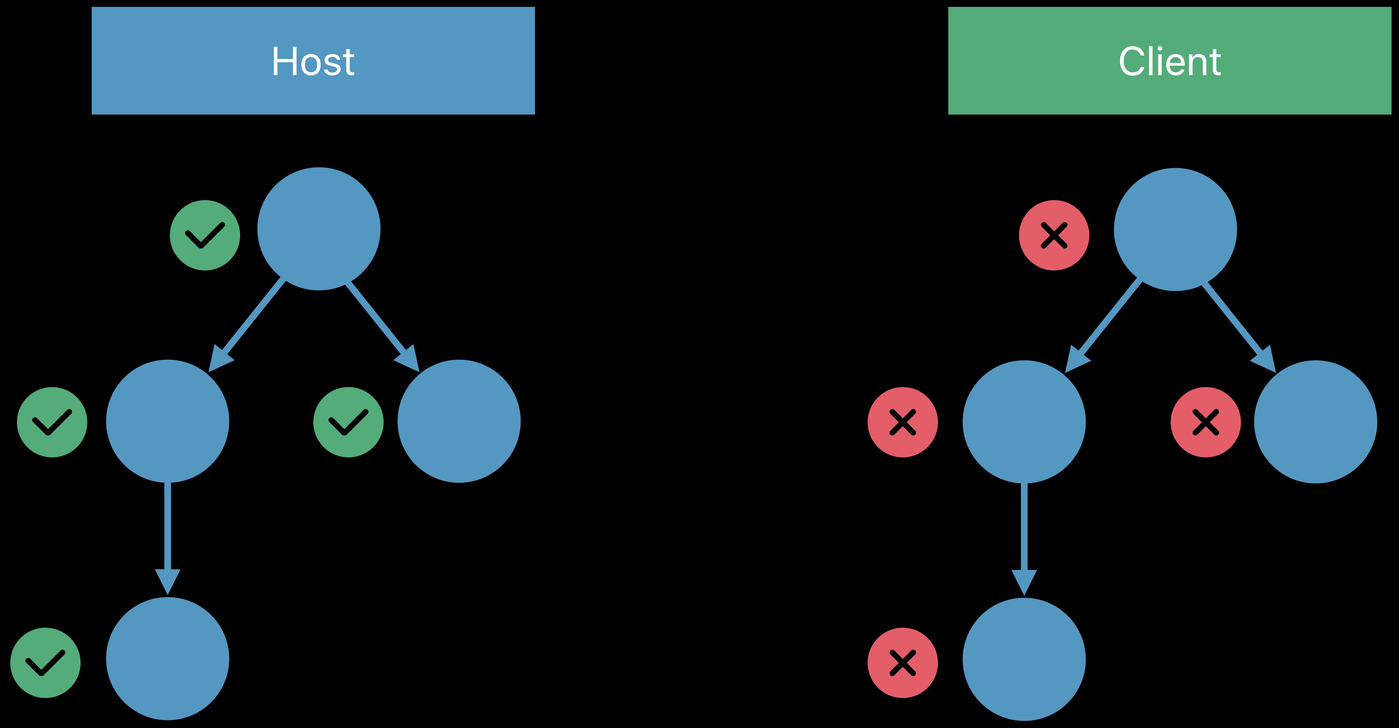


Entity Ownership

Right to modify an Entity

One owner at a time

Defaults to Entity creator



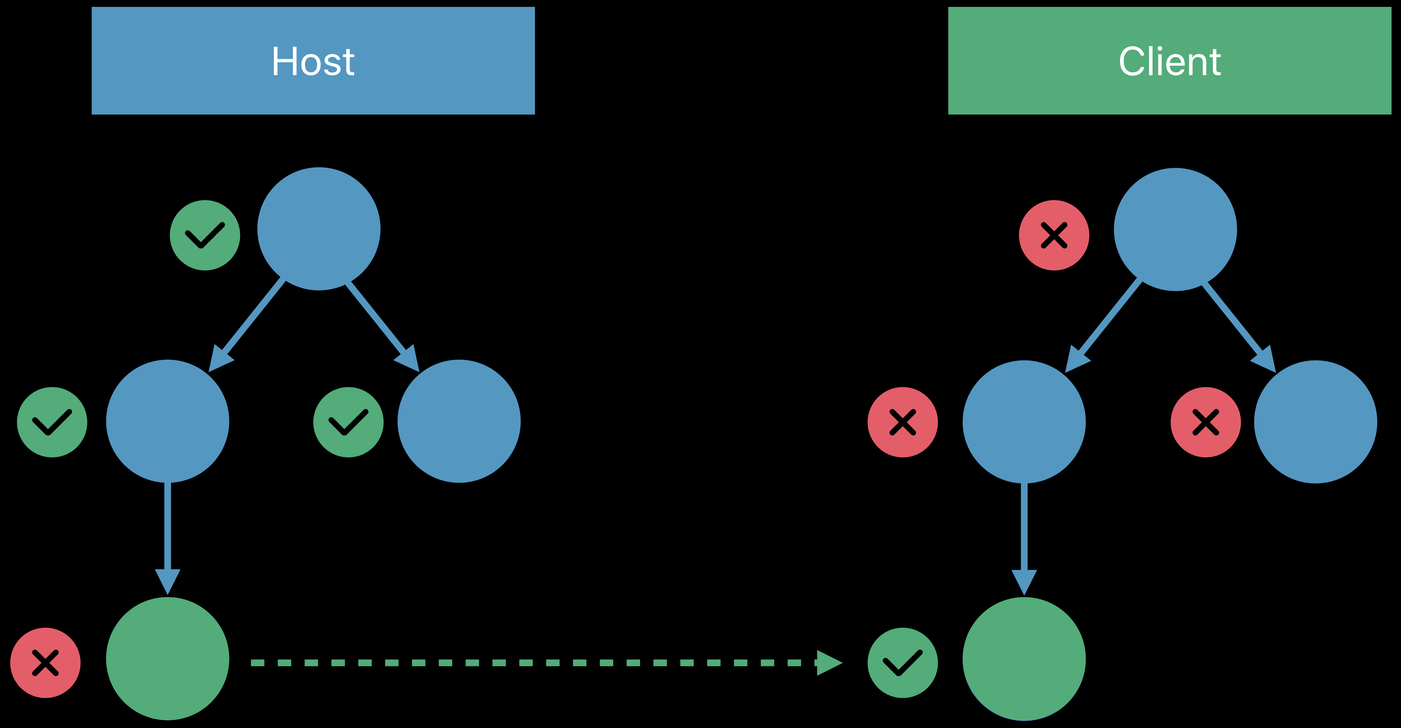
Entity Ownership

Right to modify an Entity

One owner at a time

Defaults to Entity creator

Transferrable



Entity Ownership

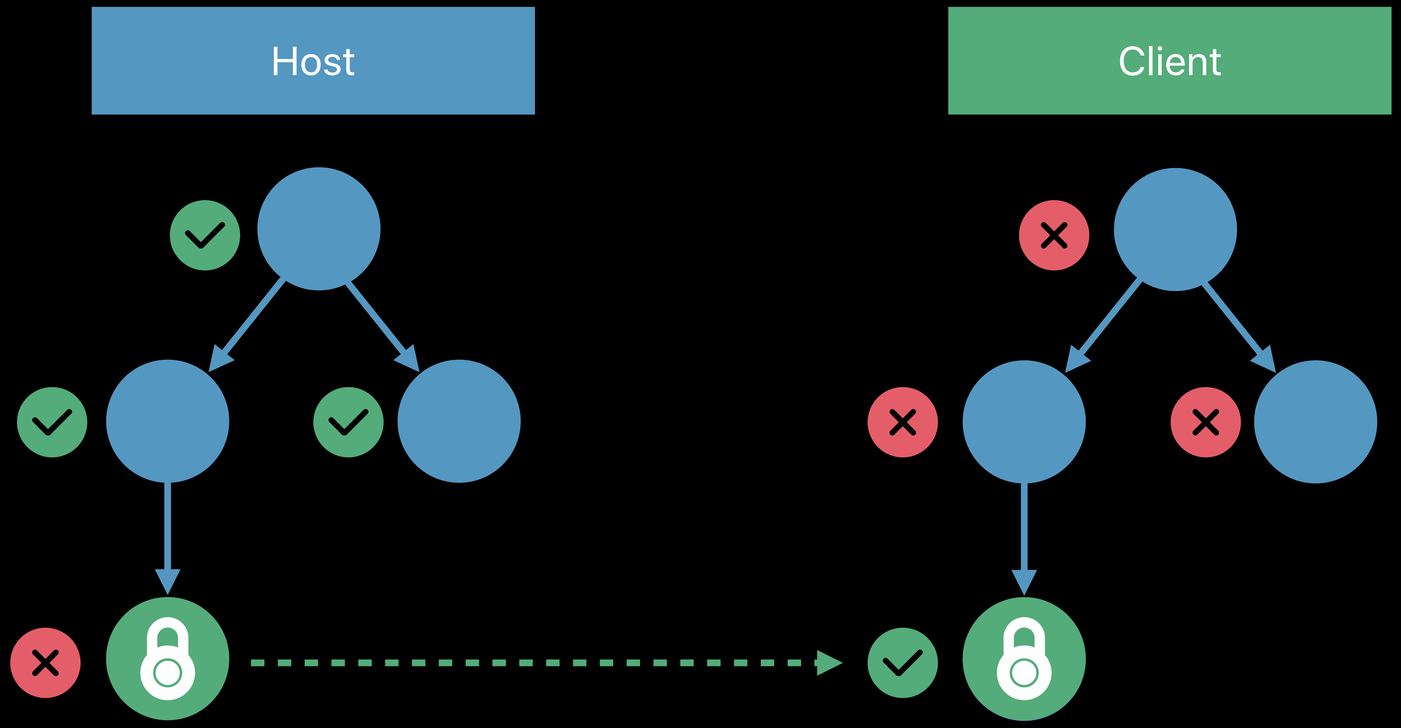
Right to modify an Entity

One owner at a time

Defaults to Entity creator

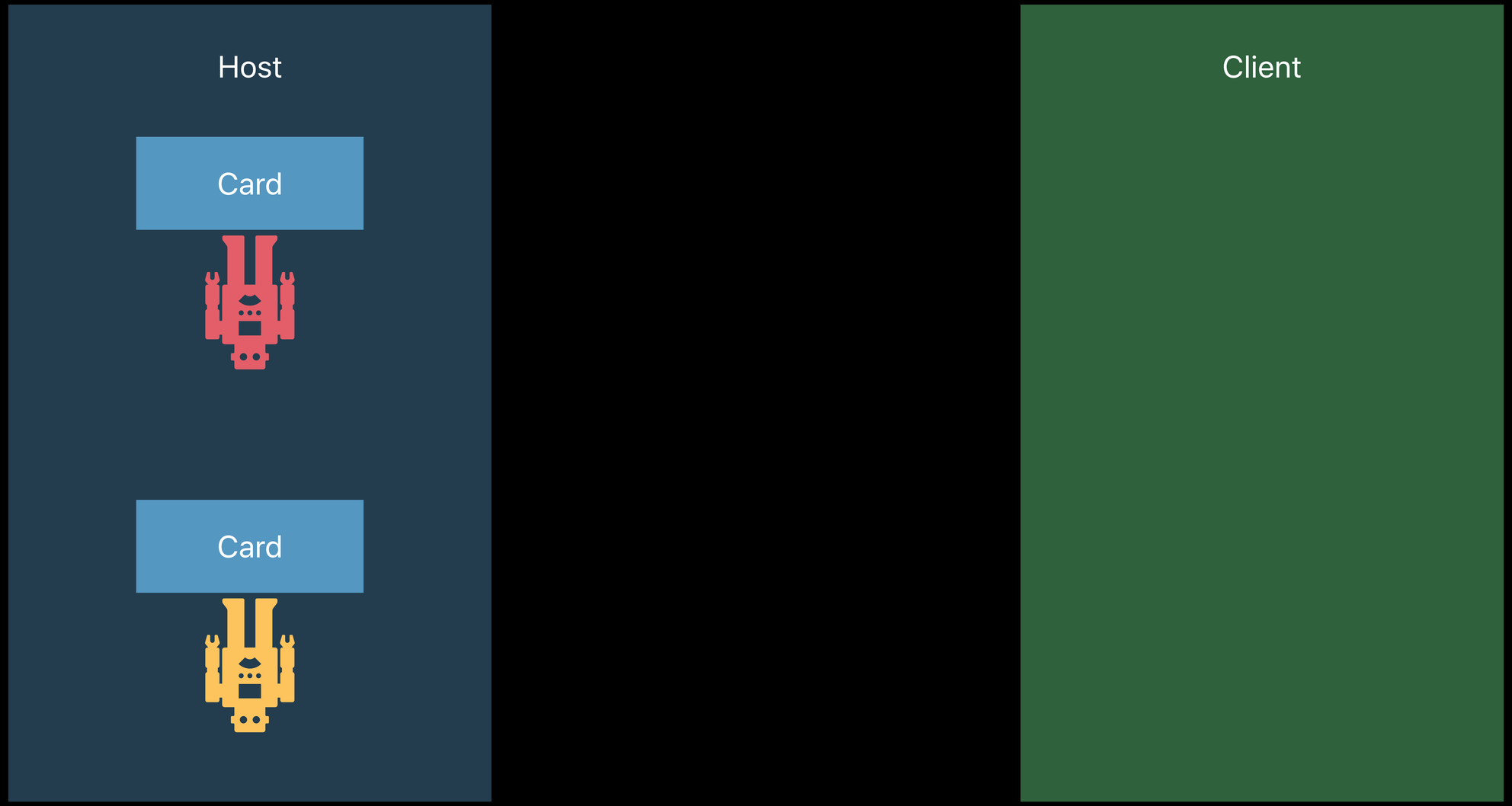
Transferrable

Configurable

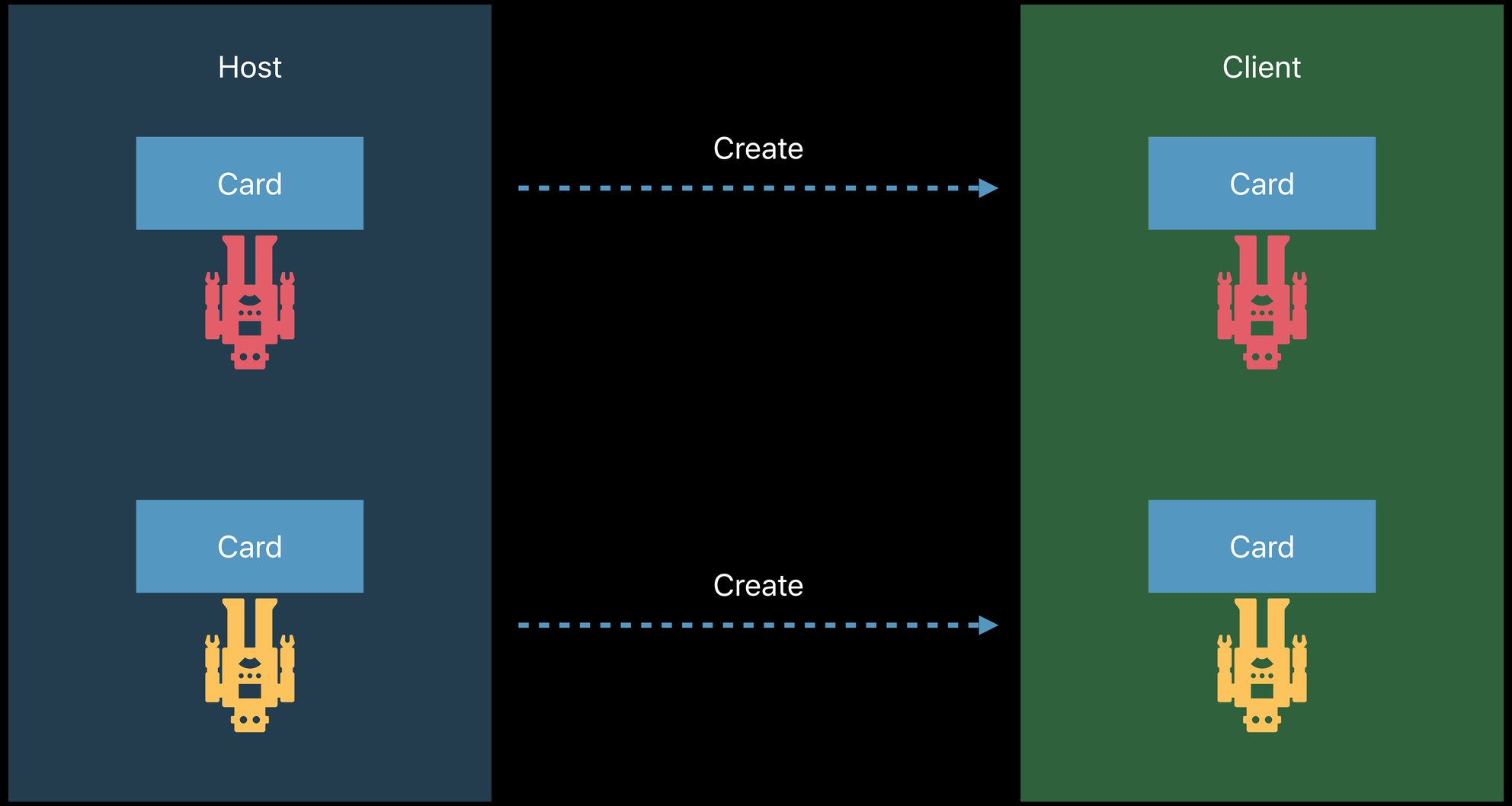


Entity Ownership

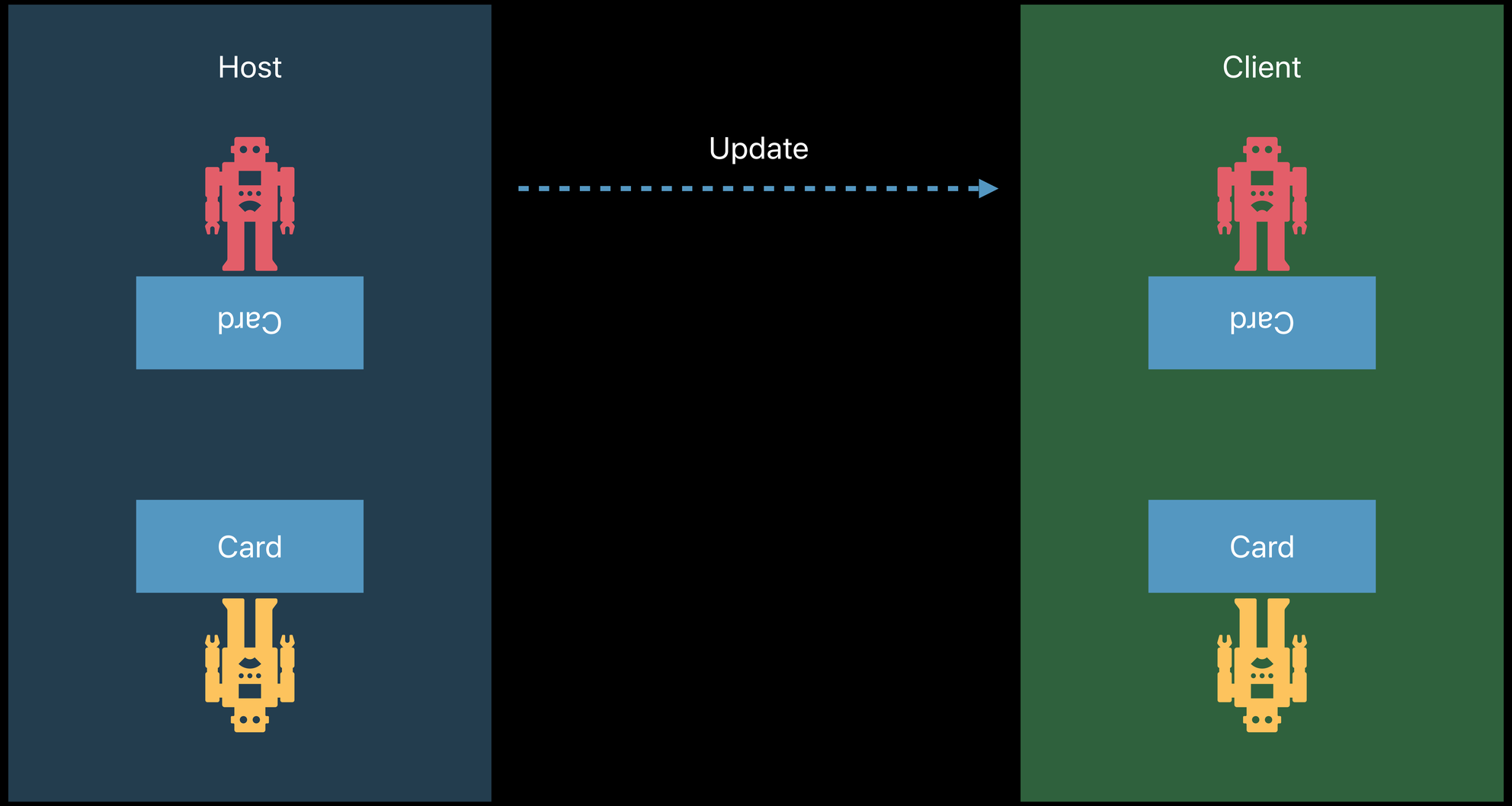
Entity Ownership



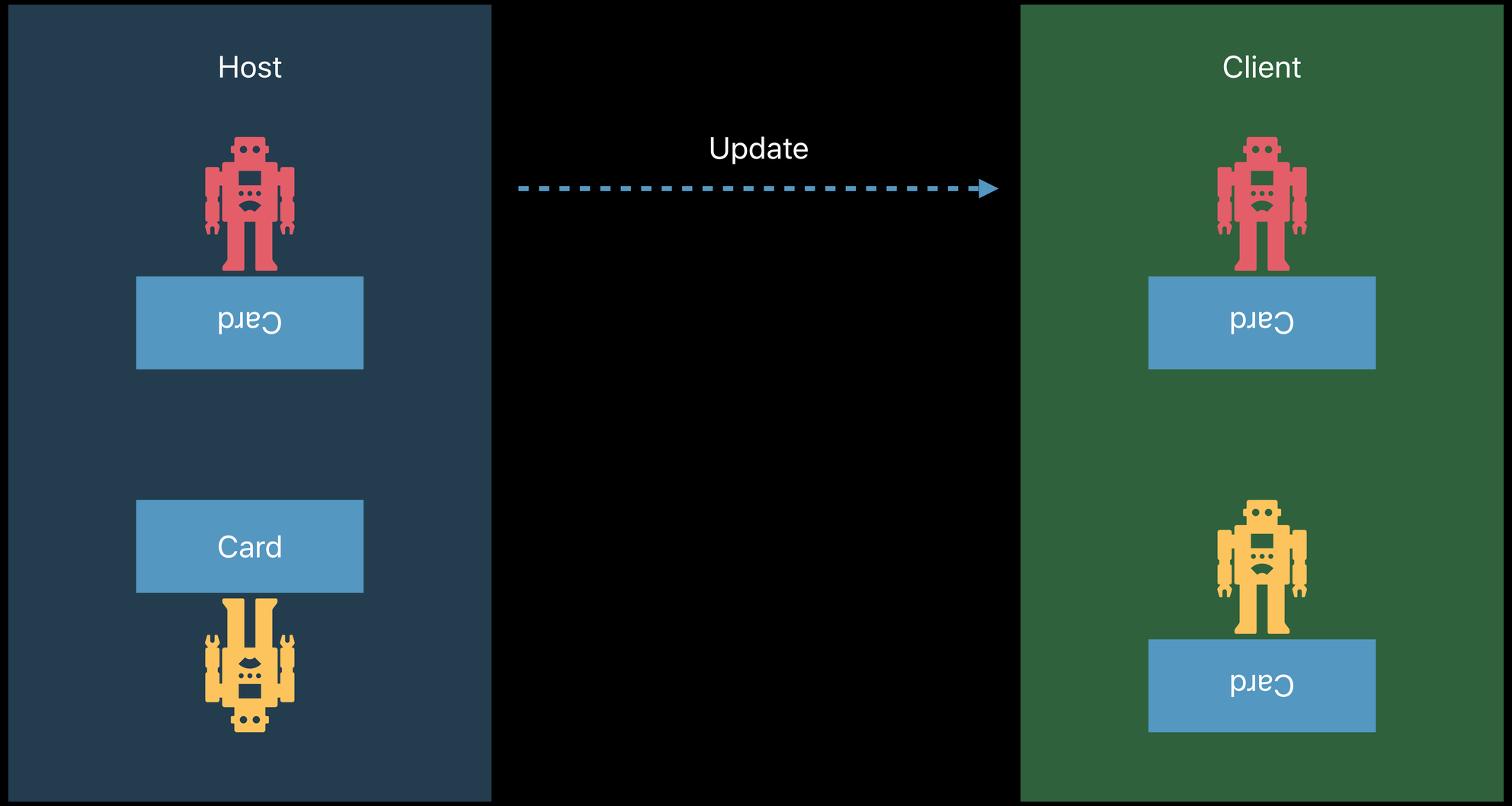
Entity Ownership



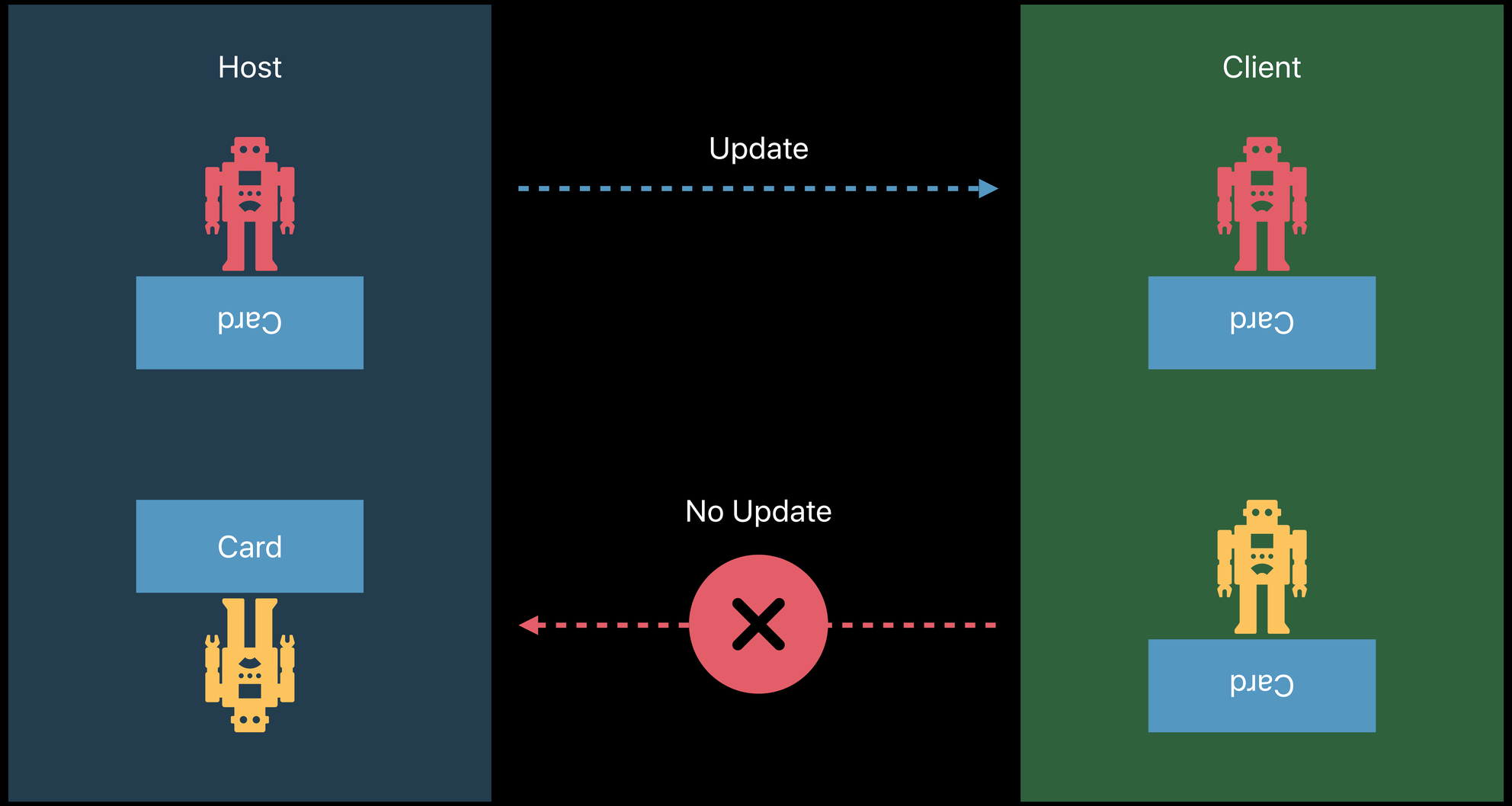
Entity Ownership



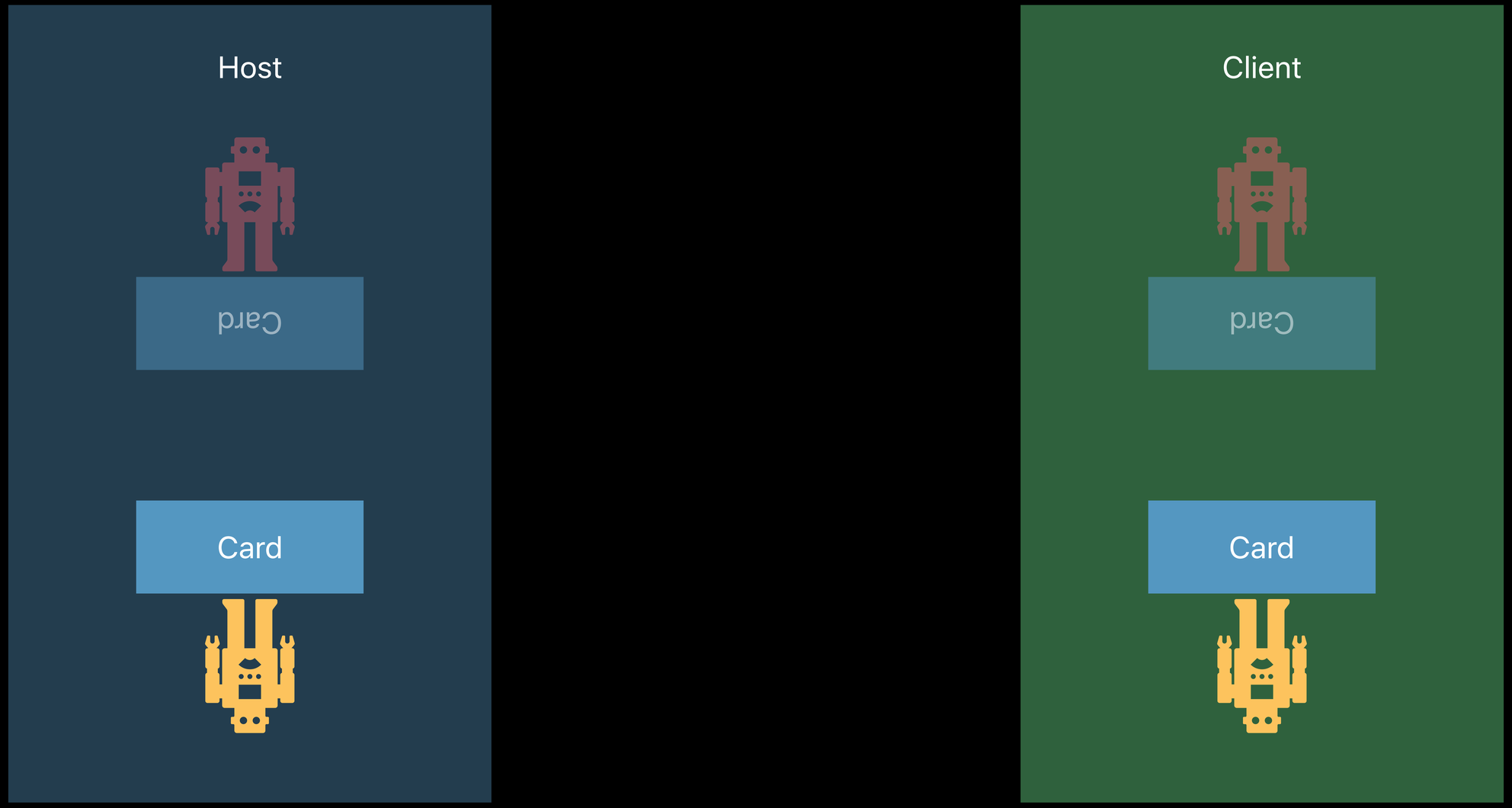
Entity Ownership



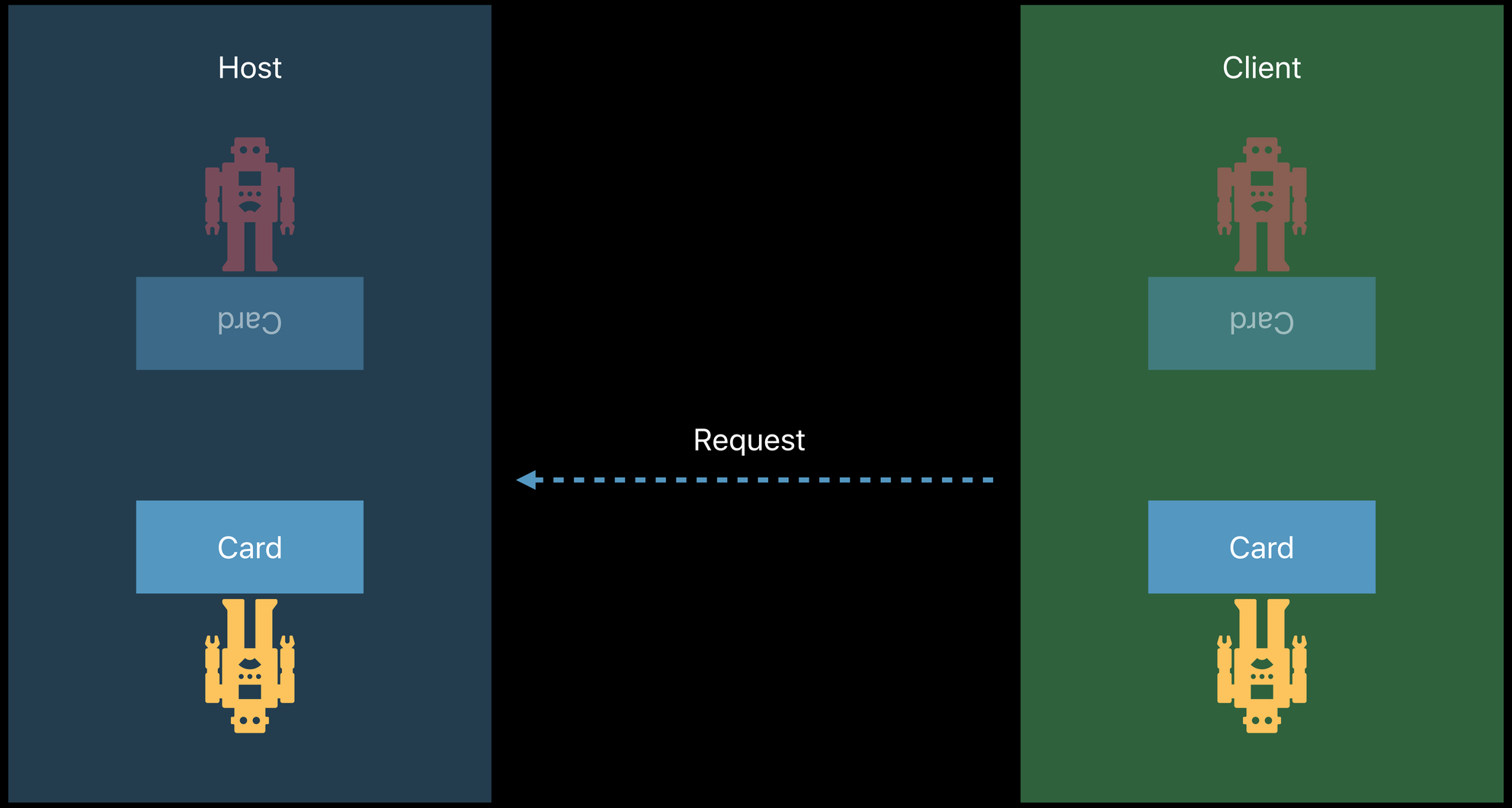
Entity Ownership



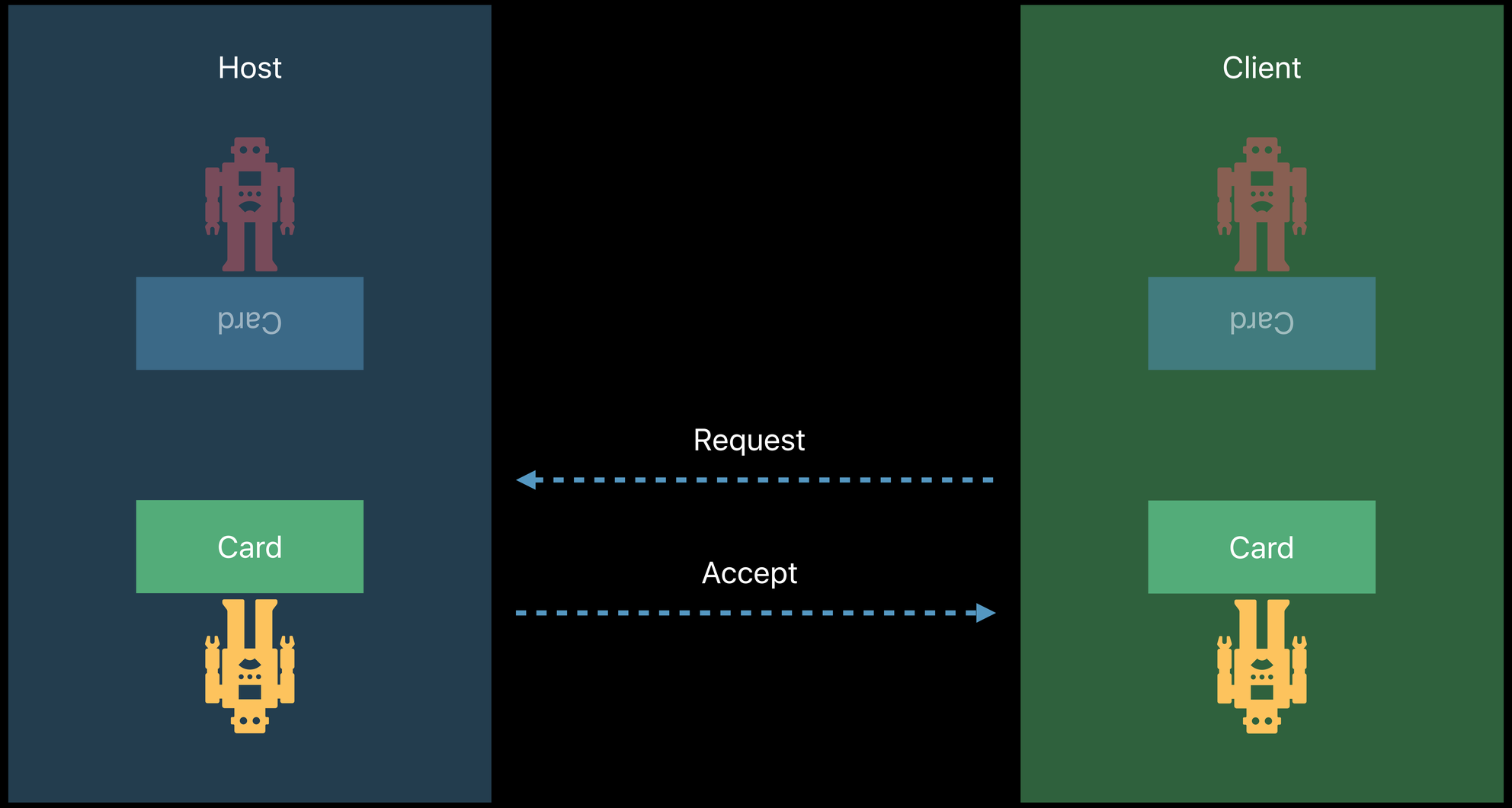
Ownership Transfer



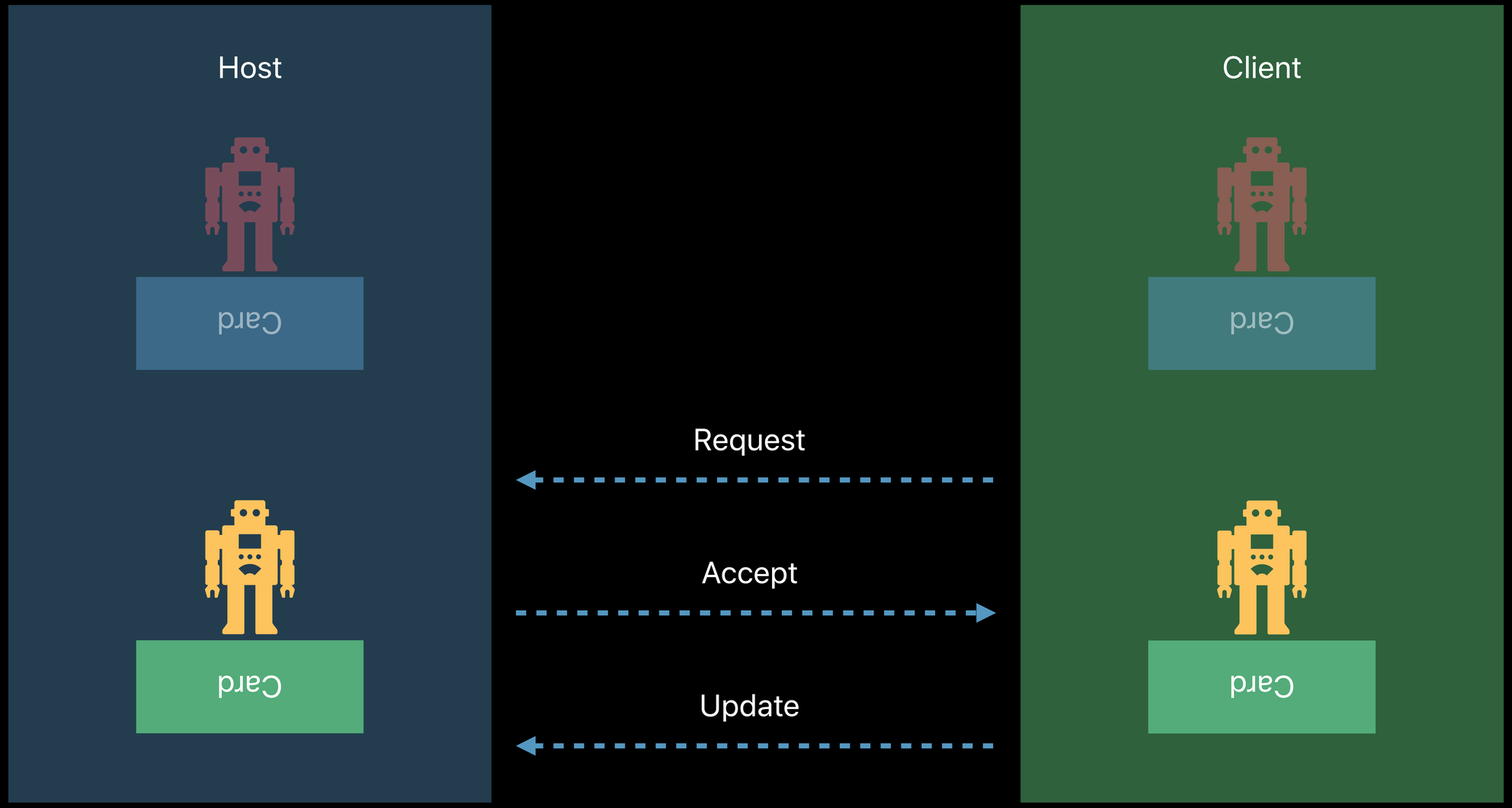
Ownership Transfer



Ownership Transfer



Ownership Transfer



```
// Client asks for ownership to reveal card

// Request ownership
card.requestOwnership { result in

  // Test if ownership was granted
  if result == .granted {

   // Reveal card
   card.reveal()

  } else {
    // Allow player to select a different card
  }
}
```

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```

```swift
// Reveal card and decline transfer requests
extension CardEntity {

  // Animate, change state
  func reveal() {

    // Update revealed property
    card.revealed = true

    // Don't automatically accept ownership requests
    synchronization?.ownershipTransferMode = .manual

    // Flip card over to reveal contents
  }
}
```

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    synchronization?.ownershipTransferMode = .manual

    // Flip card over to reveal contents
  }
}
```

```
// Hide card and accept transfer requests
extension CardEntity {

  // Animate, change state
  func hide() {

    // Update revealed property
    card.revealed = false

    // Automatically accept transfer requests
    synchronization?.ownershipTransferMode = .autoAccept

    // Flip card over to hide contents
  }
}
```

```swift
// Hide card and accept transfer requests
extension CardEntity {

    // Animate, change state
    func hide() {

        // Update revealed property
        card.revealed = false

        // Automatically accept transfer requests
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    }
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```
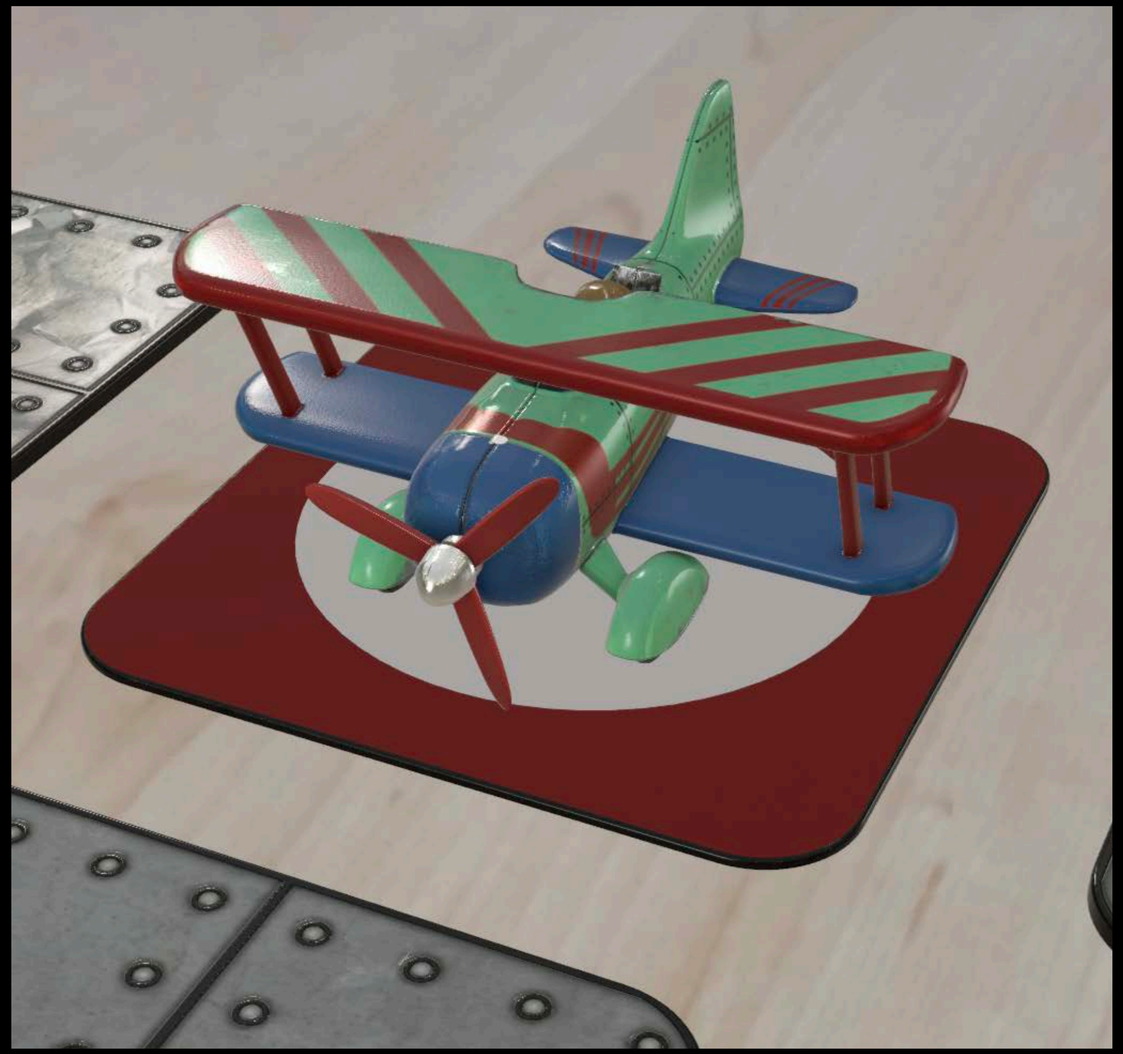
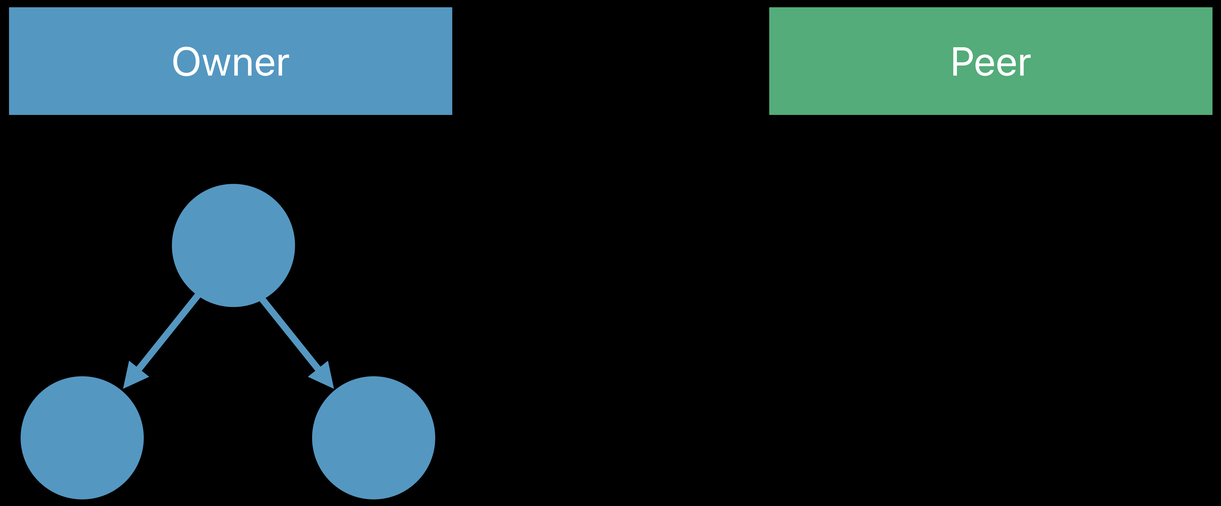
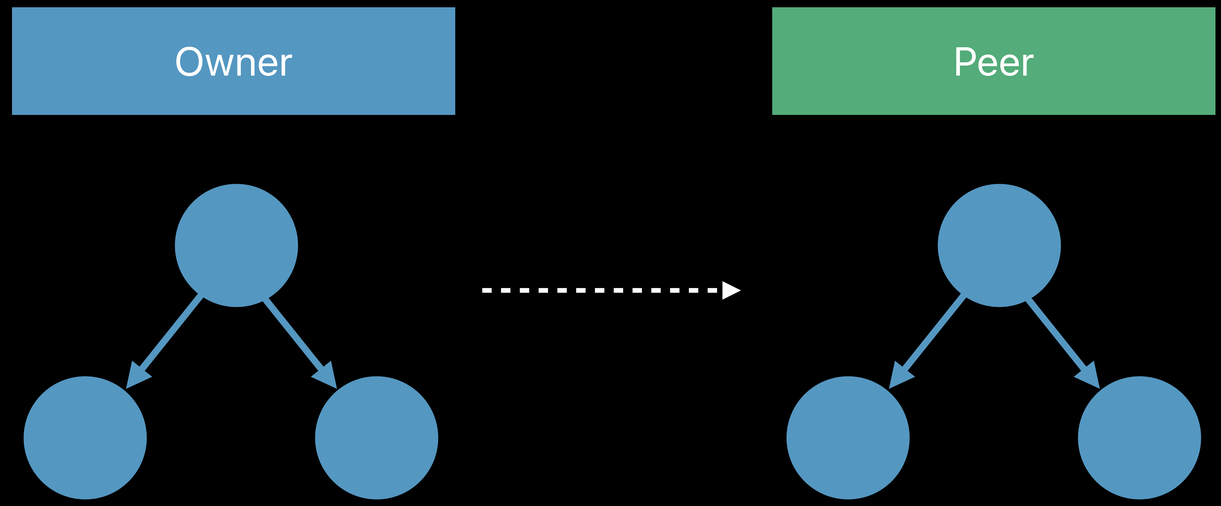

Selection Indication



Local-Only Entities

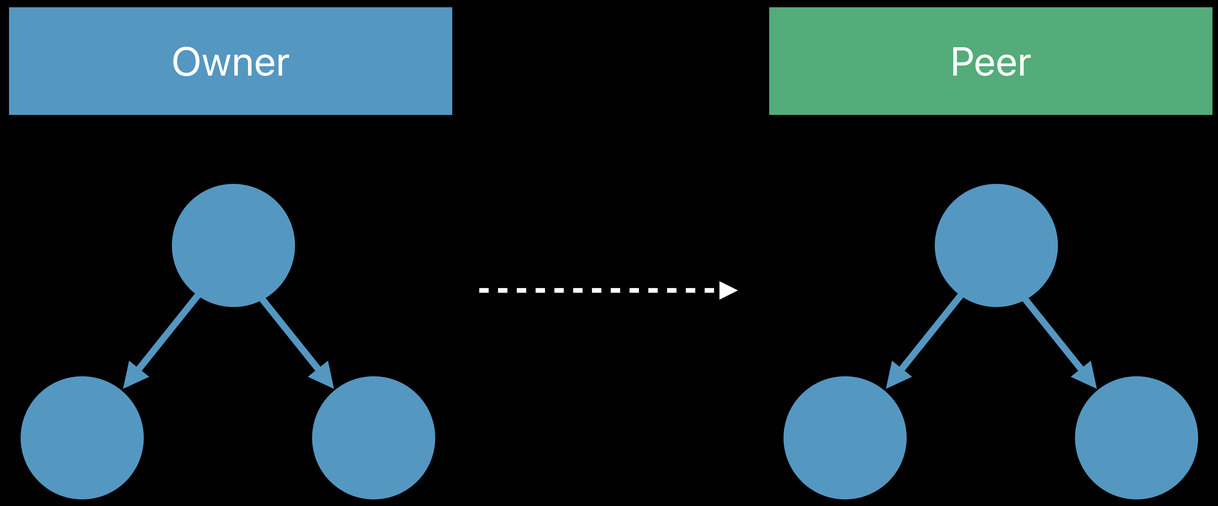


Local-Only Entities



Local-Only Entities

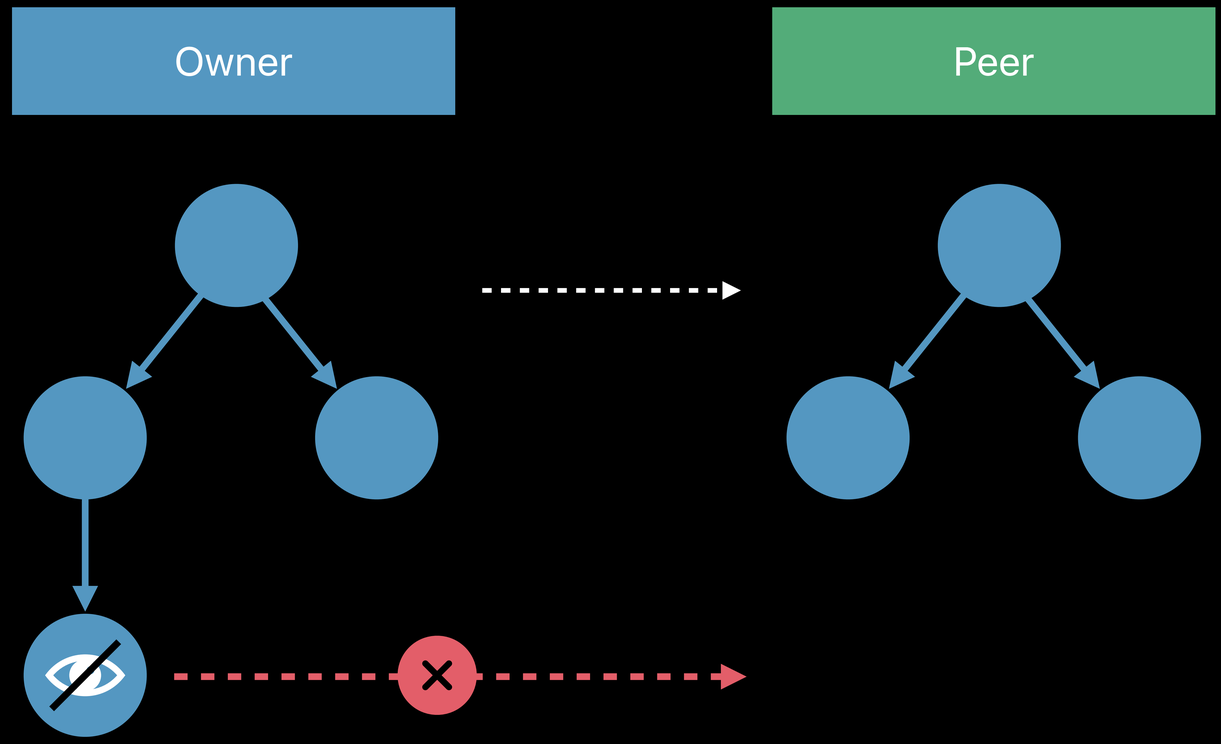
State only visible to local client



Local-Only Entities

State only visible to local client

Remove synchronization

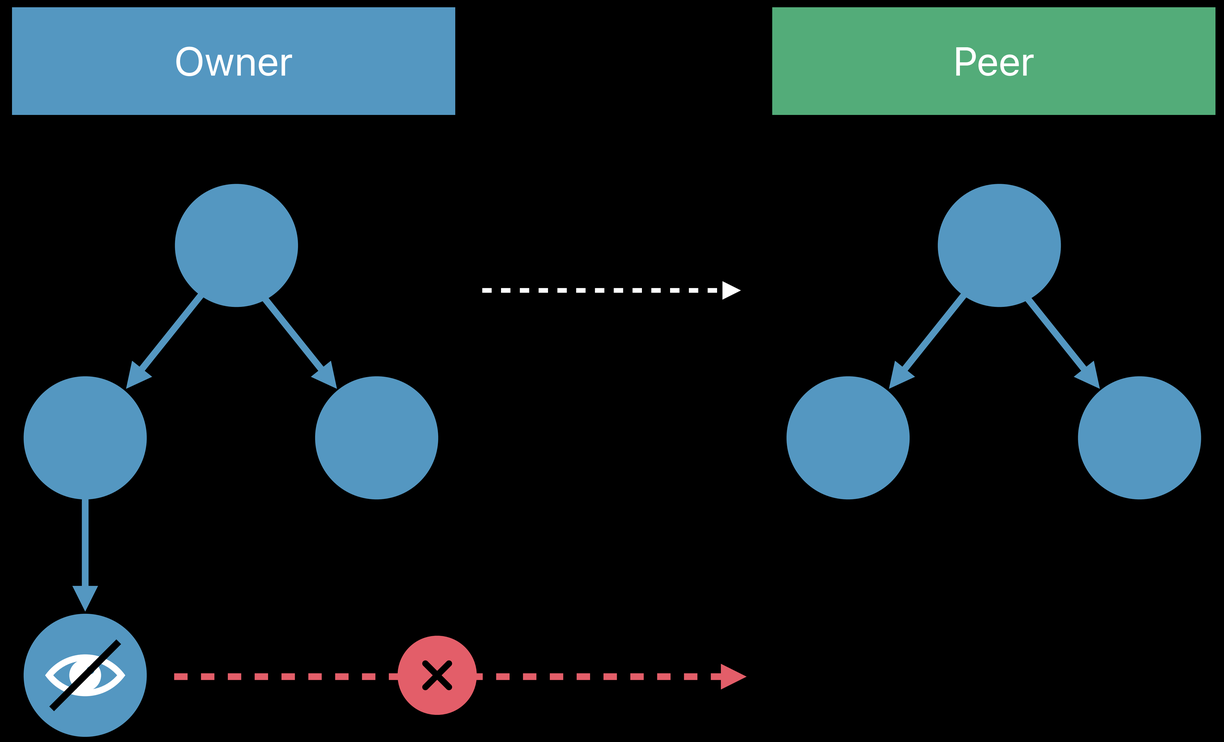


Local-Only Entities

State only visible to local client

Remove synchronization

Children are also unshared



```
// Add local only selection indicator when revealing
extension CardEntity {
  func reveal() {
    card.revealed = true
    synchronization?.ownershipTransferMode = .manual




  }
}
```

```
// Add local only selection indicator when revealing
extension CardEntity {
  func reveal() {
    card.revealed = true
    synchronization?.ownershipTransferMode = .manual

    // Create local-only selection indicator
    let selection = SelectionEntity()
    selection.position.y = 0.1

    // Remove synchronization component
    selection.synchronization = nil

    // Add as child
    addChild(selection)
  }
}
```

```
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extension CardEntity {
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  }
}
```

```
// Remove selection indicator on hide
extension CardEntity {
  func hide() {
    card.revealed = false
    synchronization?.ownershipTransferMode = .autoAccept




  }
}
```

```swift
// Remove selection indicator on hide
extension CardEntity {
  func hide() {
    card.revealed = false
    synchronization?.ownershipTransferMode = .autoAccept

    // Iterate children looking for Selection Entity
    for child in children where child is SelectionEntity {
      // Remove child and exit loop
      child.removeFromParent()
      break
    }
  }
}
```

```
// Remove selection indicator on hide
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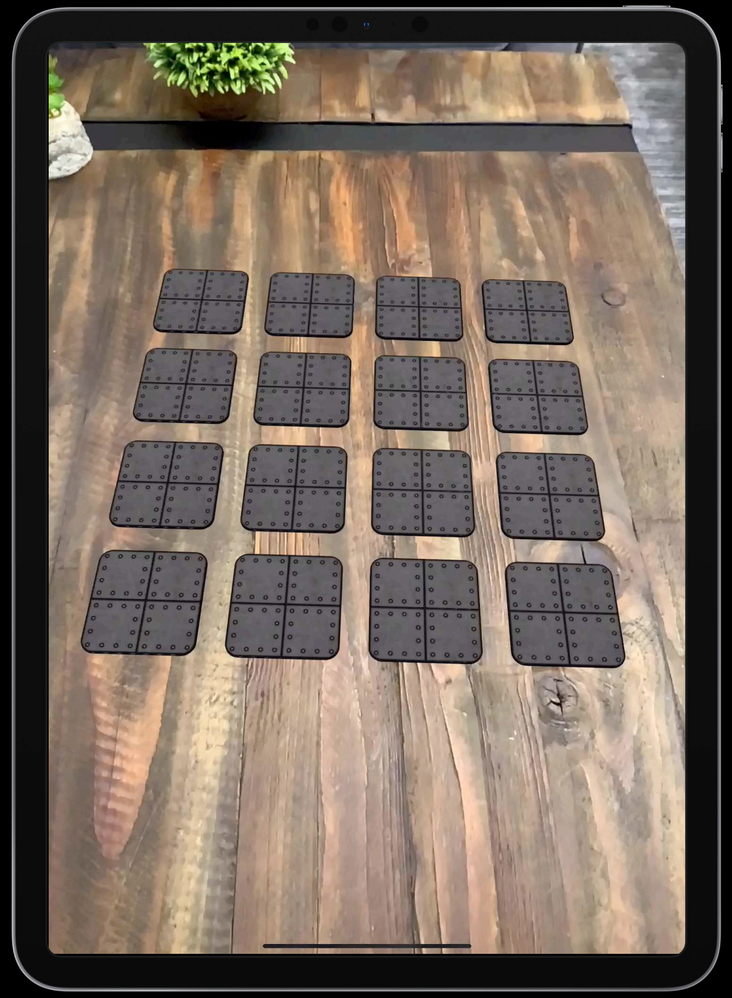
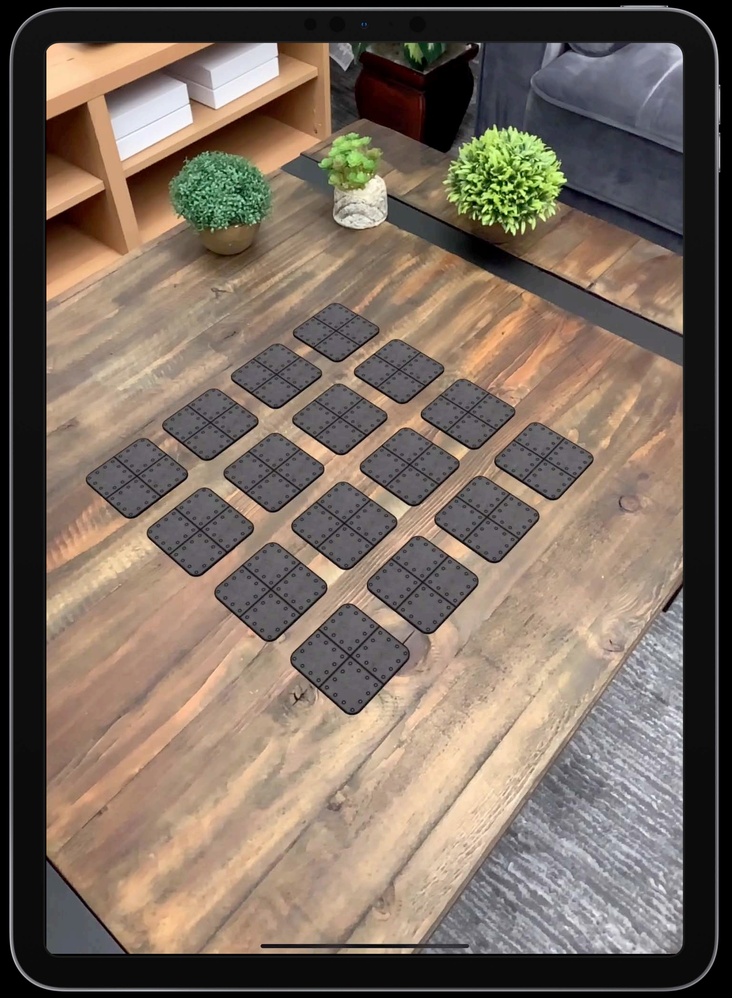
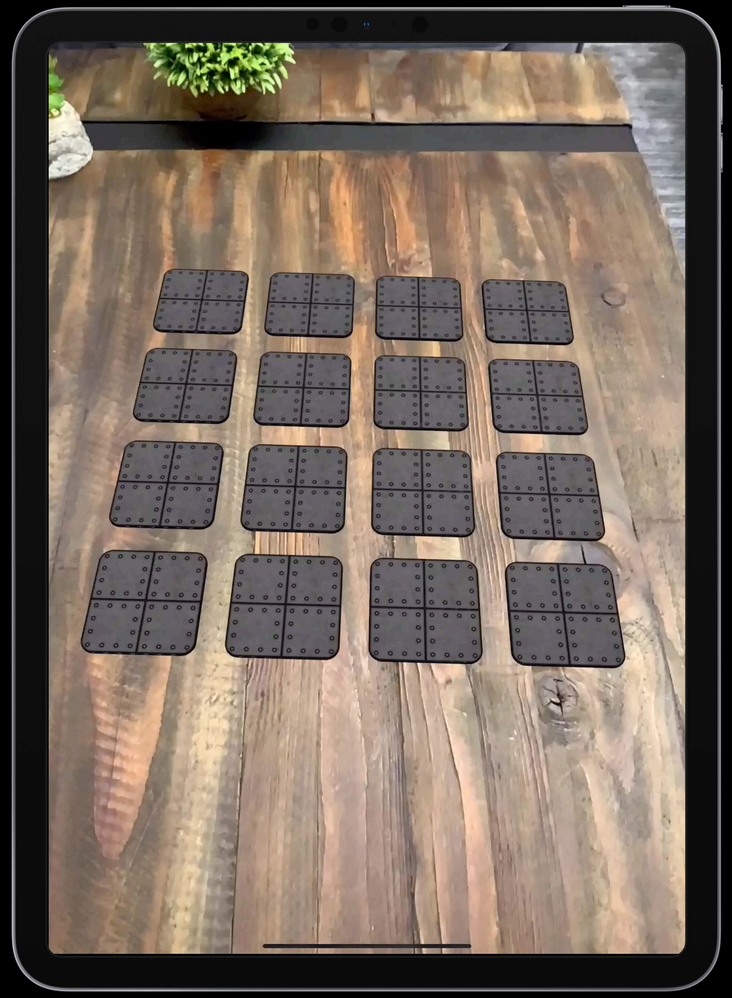


Host



Client



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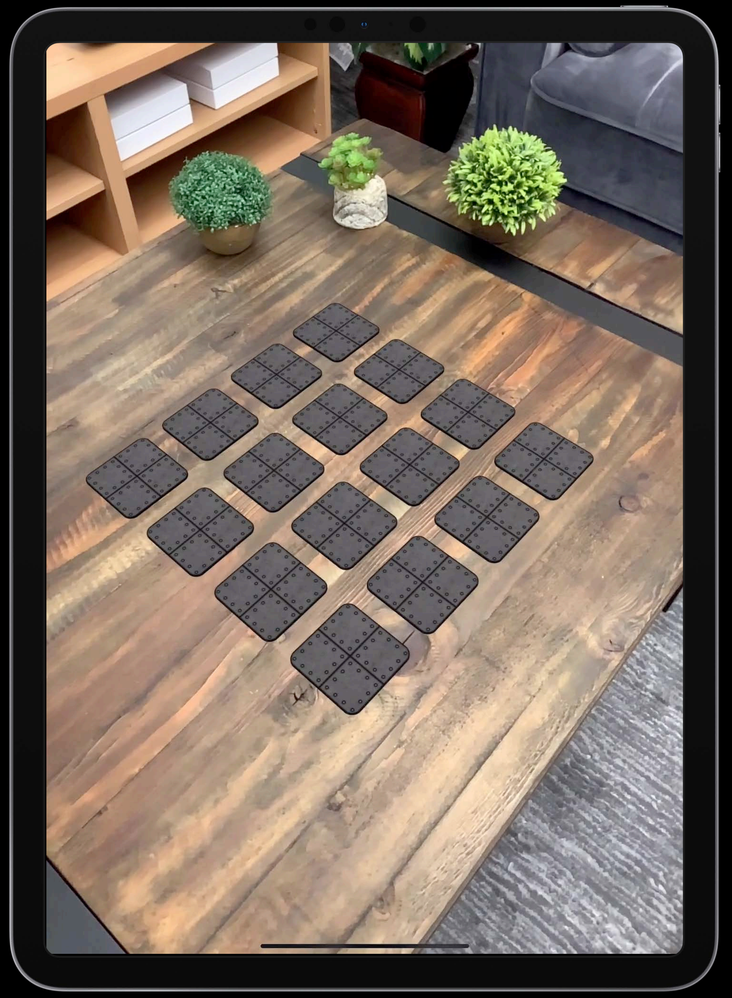

Client

Summary

Summary

Anchoring

Summary

Anchoring

Asset loading

Summary

Anchoring

Asset loading

Interaction

Summary

Anchoring

Asset loading

Interaction

Custom components and entities

Summary

Anchoring

Asset loading

Interaction

Custom components and entities

Multiplayer

More Information

developer.apple.com/wwdc19/605

Introducing RealityKit and Reality Composer	Tuesday, 4:00
Introducing ARKit 3	Tuesday, 5:00

More Information

developer.apple.com/wwdc19/605

RealityKit and Reality Composer Lab	Wednesday, 12:00
RealityKit and Reality Composer Lab	Thursday, 3:00


WWDC19