Evolution of Metal, ARKit, and RealityKit

2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
iOS 8 iPhone 6 A8 iPad Air 2 A8X iPad mini 3 A7	**iOS 9** iPhone 6s A9 iPad Pro 12.9 (1st) A9X iPad mini 4 A8	**iOS 10** iPhone 7 A10 Fusion iPad Pro 9.7 A9X	**iOS 11** iPhone 8/X A11 Bionic iPad (5th) A9 iPad Pro 10.5 A10X iPad Pro 12.9 (2nd) A10X	**iOS 12** iPhone XS/XR A12 Bionic iPad (6th) A10 iPad Pro 11 A12X iPad Pro 12.9 (3rd) A12X	**iOS / iPadOS 13** iPhone 11 A13 Bionic iPad Air (3rd) A12 iPad mini (5th) A12 iPad (7th) A10	**iOS / iPadOS 14** iPhone 12 A14 Bionic iPhone 12 Pro LiDAR iPad Pro 11(2nd) A12Z/LiDAR iPad Pro 12.9 (4th) A12Z/LiDAR iPad (8th) A12 iPad Air (4th) A14	**iOS / iPadOS 15** iPhone 13 A15 Bionic iPhone 13 Pro LiDAR iPad Pro 12.9 (5th) M1/LiDAR iPad Pro 11 (3rd) M1/LiDAR iPad (9th) A13 iPad mini (6th) A15	**iOS / iPadOS 16** iPhone SE (3rd) A15 Bionic iPhone 14 A15 Bionic iPhone 14 Pro A16 Bionic iPad Air (5th) M1 iPad Pro 12.9 (6th) M2/LiDAR iPad Pro 11 (4th) M2/LiDAR	**iOS / iPadOS 17** iPhone 15 A16 Bionic iPhone 15 Pro A17 Pro

Metal

- MSL: C++ 11 subset
- Pre-compile GPU commands
- Unified shader for compute and render

Metal

- MetalKit
- Metal Performance Shader (MPS)
- Model I/O: assets import/export, subdivision, AO/light map texture generation

Metal

Metal 2

- Argument Buffer
- MPS: Graph API, CNN/RNN
- Model I/O: Baking
- CIKernel with MSL
- SKRenderer: SpriteKit, SceneKit, ARKit

Metal 2

- OpenGL/ES, OpenCL: deprecated
- MPS: Ray-tracing APIs
- MPS: CNN/RNN training on Device
- Metal debugger
- Metal for VR
- CI Kernel Language deprecated

Metal 2

- GPU driven rendering
- MPS: Ray-tracing, De-noising API
- Xcode Simulator support
- MPS: ML support advancement

Metal 2

- Apple Silicon on Mac: TBDR
- Ray tracing pipeline integration: generate rays, intersector, shading
- Metal Function pointers
- Metal Binary Archive/Dynamic Library
- Debug: 150+ GPU counters
- MPSGraph framework

Metal 2

- Ray Tracing: single pipeline, hybrid rendering
- Dynamic Library: vertex shader, fragment shader, tile shader
- Function pointer: rendering, tiling
- Function stitching
- CIKernel: stichable functions, dynamic library (A11+)
- MPSGraph: loop operator, etc
- Texture Converter (Mac/Win)

Metal 3

- Fast resource loading
- Offline compilation
- MetalFX Upscaling(Spacial/Temporal AA)
- Mesh shader (Apple7+: A14+/M1+)
- Argument buffer API, Unbounded arrays
- Ray tracing: per-primitive data, Heap, Acceleration Structures, parallel AS build
- Accelerated machine learning
- Xcode: dependency viewer, validator
- metal-cpp: C++ wrapper library
- PyTorch acceleration
- MPSGraph: shared event

Metal 3

- Game Porting ToolKit : Windows/Intel/ DirectX12 => macOS/Apple Silicon/ Metal3
- Metal Shader Converter : DXIL => MetalLib
- MetalFX : iOS, Up to 3X Upscaling, Support in Metal-cpp
- Raytracing : Curves geometry descriptor, Indirect acceleration structure building by GPU, Multi-level instancing
- MPS: Brain floating (bfloat) point, Quantization API, PyToarch 2.0 Backend

Accelerate

- simd, vDSP, vImage, BLAS, etc

Accelerate

- Swift-like APIs

ARKit

- A9+
- WorldTracking, Plane detection
- Light estimation
- SceneKit, SpriteKit, Metal integration

ARKit 2

- Object detection
- Image / Face Tracking
- Environment Texturing
- World map save / load
- Sample: SwiftShot

ARKit 3

- People Occlusion (A12+)
- Motion Capture (A12+)
- Front + Back Camera (A12+)
- AR Coaching UI
- Multi-face tracking (up to 3)
- Ray-casting
- Motion Blur, Camera Grain, Depth of field, HDR Environment textures
- Record and Replay
- Collaborative Session
- Sample: SwiftStrike

ARKit 4

- Location Anchors : US cities, A12+
- Scene Geometry (LiDAR)
- Depth API (LiDAR)
- Face tracking: without TrueDepth

ARKit 5

- Location Anchors : + US cities / London, coaching overlay
- App Clip Code tracking (A12+)
- Face tracking: ultra-wide front camera
- Motion capture: enhanced (A14)

ARKit 6

- 4K video mode: 30fps, 16:9
- High-res background Photos, HDR mode, Exif tags
- Fine-grained camera control
- ARPlaneExtent class
- Motion Capture enhancement: Ear joint tracking (2D), better occlusion (3D)
- Location Anchors: +16 region

ARKit 6

RoomPlan

- Scanning experience API: realtime model generation, USDZ export
- Data API: live parametric data
- 30x30 ft, 50 lux, LiDAR iPhone/iPad

RoomPlan

- Custom ARSession
- MultiRoom, RoomBuilder/ StructureBuilder (single floor, < 2000 sq ft)
- Export - UUID mapping/Model Provider

PyCoreImage

- Python-based tool, Jupyter notebook
- inline CIKernel (MSL)

RealityKit

- ARView, Anchor, Scene, Entity
- Rendering, Animation, Physics, Synchronization, ECS, Audio
- Reality File

RealityKit

- Video Materials
- Scene Understanding with LiDAR: Object Occlusion, Receives Lighting, Physics, Collision
- Debug Options

RealityKit 2

- Custom Shader: Geometry Modifier, Surface Shader
- Custom Post Processing: Core Image, MPS, SpriteKit, MSL
- Dynamic Mesh: creation, inspection, modification at runtime
- ECS enhancement: systems, components
- Material advancements: Transparency Video Material, PBR material APIs
- Animation advancements
- Character controller
- Generated resources: Face mesh, AudioBufferResource
- Object Capture APIs (macOS)

RealityKit 2

Reality Converter

- Beta 5, new Lighting mode support
- Texture compression

RealityKit 2

- Image Capture/Reconstruction API on iOS (iPhone Pro 12+/iPad Pro 2021+)
- Camera pose output on macOS

USDZ converter

- Python-based command line tools

Reality Converter

- macOS app

USDZ converter

- Python 3, Apple Silicon support
- Upgraded USD version
- OBJ, glTF, FBX import improvement

Reality Composer

- iOS / macOS app

Reality Composer

- USDZ export, USD Schemas

Reality Composer

Reality Composer

AR QuickLook

- PBR shader
- Texture down-sampling

AR QuickLook

- People Occlusion
- Nested UDSZs

AR QuickLook

- Web Banner: Apple Pay

AR QuickLook

- new Lighting mode: brighter, enhanced contrast, shape definition

AR QuickLook