GAME-SPECIFIC SUBSYSTEMS

| Weapons | Power-Ups | Vehicles | Puzzles | etc. |

Game-Specific Rendering

etc.

| Terrain Rendering | Water Simulation & Rendering |

Player Mechanics

| State Machine & Animation | Camera-Relative Controls (HID) |
| Collision Manifold | Movement |

Game Cameras

| Fixed Cameras | Scripted/Animated Cameras |
| Player-Follow Camera | Debug Fly-Through Cam |

AI

| Goals & Decision-Making | Actions (Engine Interface) |
| Sight Traces & Perception | Path Finding (A*) |

Front End

| Heads-Up Display (HUD) | Full-Motion Video (FMV) | In-Game Cinematics (IGC) |
| In-Game GUI | In-Game Menus | Wrappers / Attract Mode |

Gameplay Foundations

High-Level Game Flow System/FSM

Scripting System

| Static World Elements | Dynamic Game Object Model | Real-Time Agent-Based Simulation | Event/Messaging System | World Loading / Streaming |

Hierarchical Object Attachment

Visual Effects

| Light Mapping & Dynamic Shadows | HDR Lighting | PRT Lighting, Subsurf. Scatter |
| Particle & Decal Systems | Post Effects | Environment Mapping |

Skeletal Animation

Animation State Tree & Layers	Inverse Kinematics (IK)	Game-Specific Post-Processing
LERP and Additive Blending	Animation Playback	Sub-skeletal Animation
	Animation Decompression	

Online Multiplayer

| Match-Making & Game Mgmt. |
| Object Authority Policy |
| Game State Replication |

Audio

| DSP/Effects |
| 3D Audio Model |
| Audio Playback / Management |

Scene Graph / Culling Optimizations

| Spatial Hash (BSP Tree, kd-Tree, …) | Occlusion & PVS | LOD System |

Skeletal Mesh Rendering

Ragdoll Physics

Low-Level Renderer

| Materials & Shaders | Static & Dynamic Lighting | Cameras | Text & Fonts |
| Primitive Submission | Viewports & Virtual Screens | Texture and Surface Mgmt. | Debug Drawing (Lines etc.) |

Graphics Device Interface

Profiling & Debugging

| Recording & Playback |
| Memory & Performance Stats |
| In-Game Menus or Console |

Collision & Physics

Forces & Constraints	Ray/Shape Casting (Queries)
Rigid Bodies	Phantoms
Shapes/Collidables	Physics/Collision World

Human Interface Devices (HID)

| Game-Specific Interface |
| Physical Device I/O |

Resources (Game Assets)

| 3D Model Resource | Texture Resource | Material Resource | Font Resource | Skeleton Resource | Collision Resource | Physics Parameters | Game World/Map | etc. |

Resource Manager

Core Systems

| Module Start-Up and Shut-Down | Assertions | Unit Testing | Memory Allocation | Math Library | Strings and Hashed String Ids | Debug Printing and Logging | Localization Services | Movie Player |
| Parsers (CSV, XML, etc.) | Profiling / Stats Gathering | Engine Config (INI files etc.) | Random Number Generator | Curves & Surfaces Library | RTTI / Reflection & Serialization | Object Handles / Unique Ids | Asynchronous File I/O | Memory Card I/O (Older Consoles) |

Platform Independence Layer

| Platform Detection | Atomic Data Types | Collections and Iterators | File System | Network Transport Layer (UDP/TCP) | Hi-Res Timer | Threading Library | Graphics Wrappers | Physics/Coll. Wrapper |

3rd Party SDKs

| DirectX, OpenGL, libgcm, Edge, etc. | Havok, PhysX, ODE etc. | Boost++ | STL / STLPort | Kynapse | Granny, Havok Animation, etc. | Euphoria | etc. |

OS

Drivers

Hardware (PC, XBOX360, PS3, etc.)

Figure 1.15. Runtime game engine architecture.