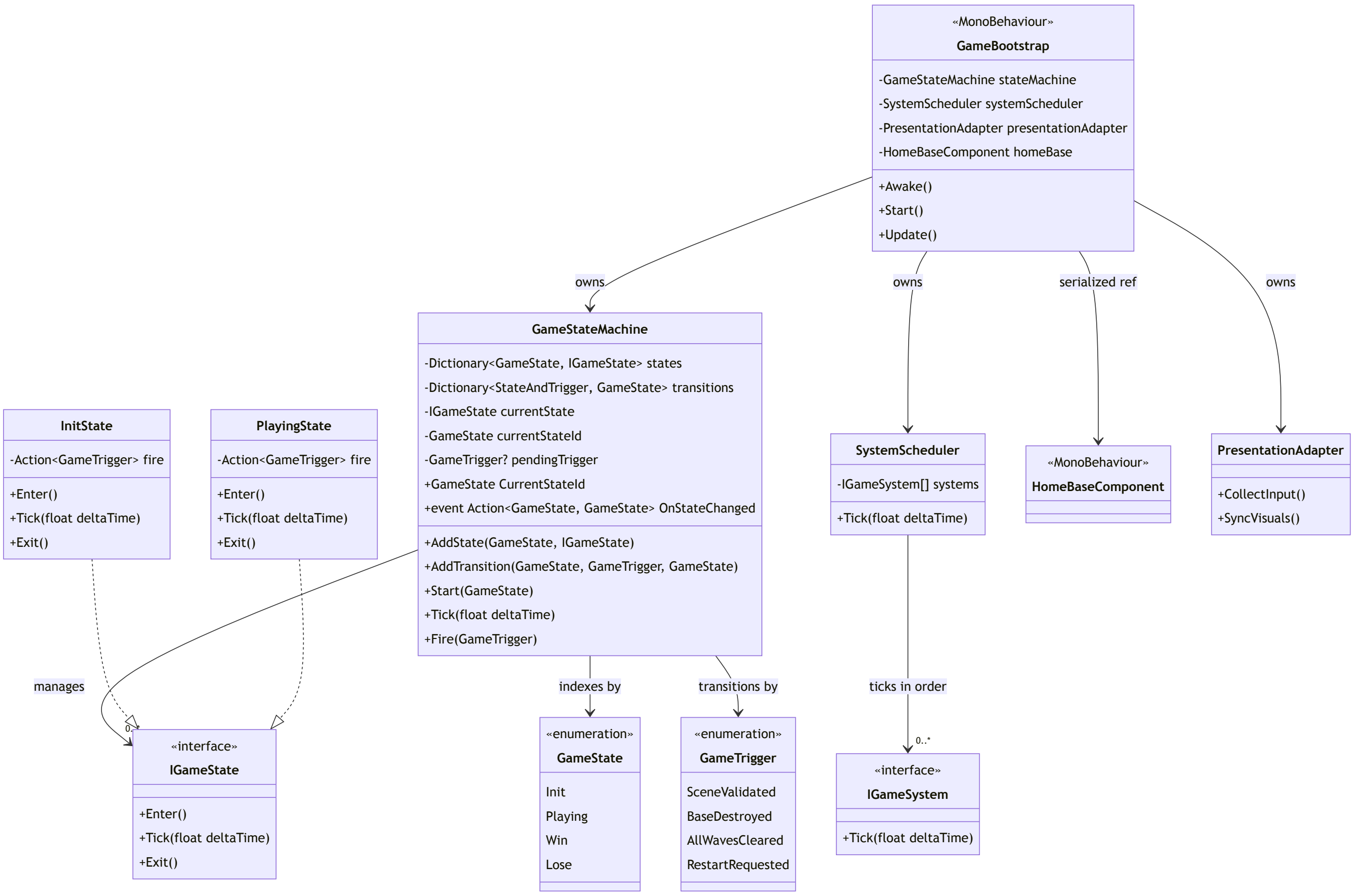
Architecture Diagrams

Visual companion to TDD.md Section 2 (Detailed Design). Render with any Mermaid-capable viewer.

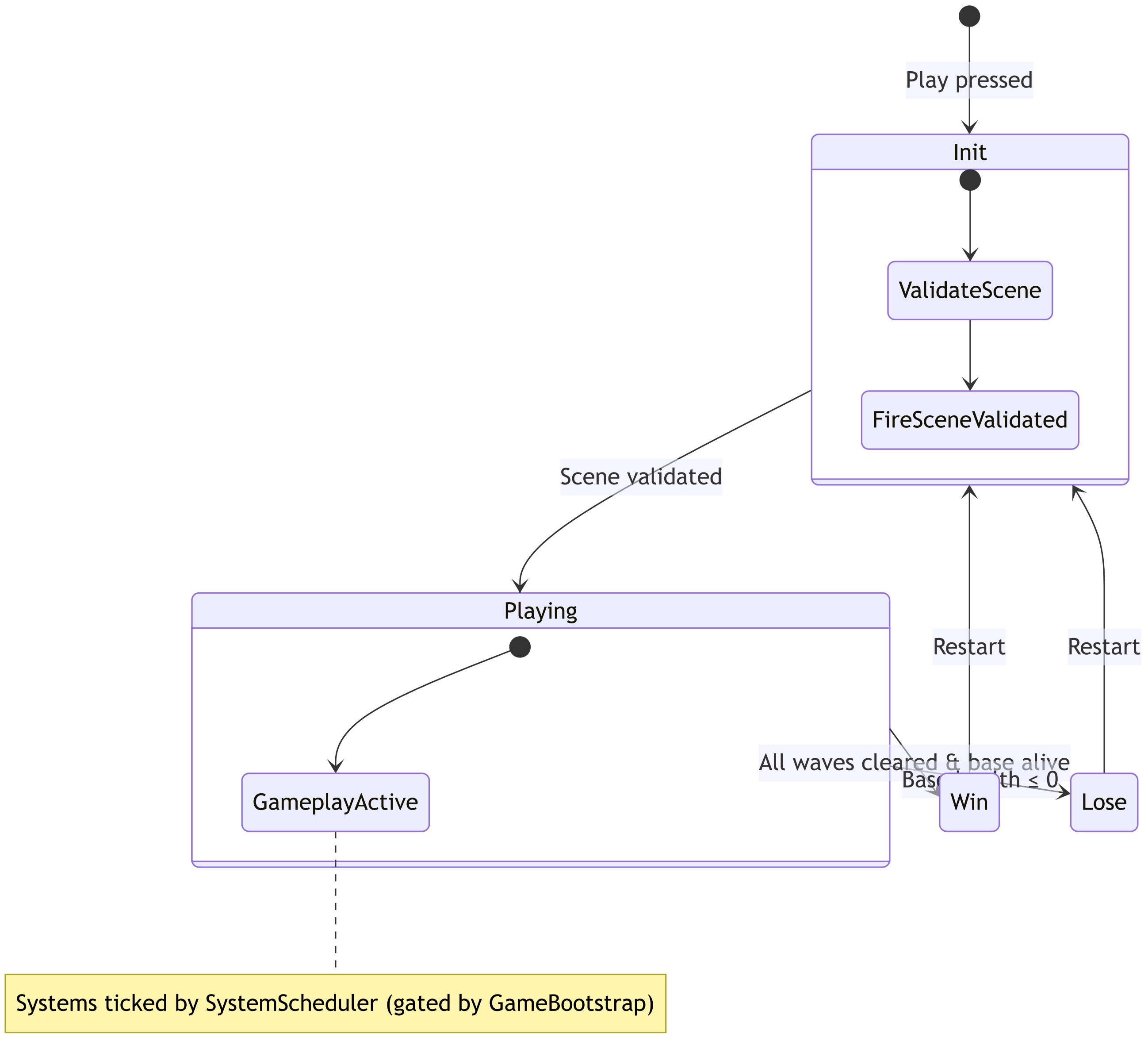
Class Diagram — Story 1 Foundation



Notes:

- `GameBootstrap` is the only "god-level" MonoBehaviour. It is the composition root — creates the state machine, system scheduler, states, and systems. Configures the transition table and wires references.
- `GameStateMachine` and all `IGameState` implementations are **plain C# classes**, not MonoBehaviours.
- `HomeBaseComponent` is a thin MonoBehaviour on the Base GameObject in the scene. It holds no logic — just identifies the object for system discovery.
- States receive an `Action<GameTrigger>` delegate at construction. They fire semantic triggers (`SceneValidated` , `BaseDestroyed` , etc.) without knowing which state the trigger leads to. The transition table in `GameBootstrap` maps `(state, trigger) → destination` .
- **States are flow-only** — they manage enter/exit lifecycle and fire triggers. States do not own or tick systems.
- `SystemScheduler` is a **plain C# class** owned by `GameBootstrap` . It holds the ordered `IGameSystem[]` array and ticks them sequentially. `GameBootstrap.Update()` gates the scheduler — systems only tick when the state machine is in a gameplay state (e.g., `Playing`). This separates flow control (states) from system execution (scheduler).
- `IGameSystem` provides a uniform `Tick()` contract for gameplay systems. Systems are global — they exist independently of game states.
- `PresentationAdapter` is a **plain C# class** owned by `GameBootstrap` . It is the only place that calls Unity input and rendering APIs. Systems never reference it directly — they read input structs it produces and write sim data it consumes. Stub in Story 1; gains responsibilities as systems are added.
- `Win` and `Lose` states appear in the enum but are implemented in later stories.
- `GameTrigger` values are added incrementally as stories introduce new transitions.

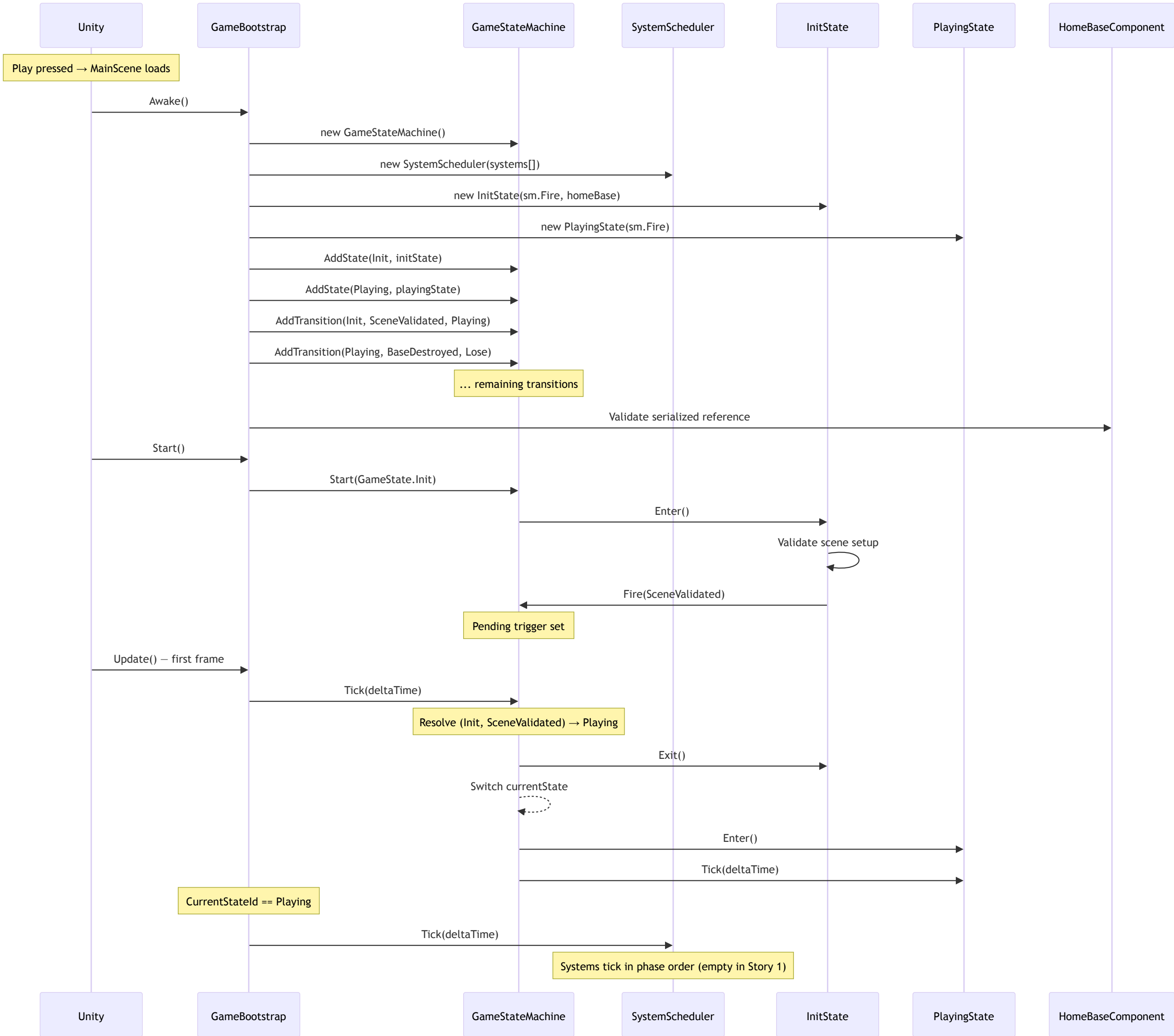
Game State Diagram



Story 1 scope: Only `Init` and `Playing` are implemented. `Win` and `Lose` are placeholders in the enum — their `IGameState` classes come in Stories 3 and 9.

Reset path: Restart from Win/Lose transitions back to `Init`. `PlayingState.Exit()` tears down spawned objects and system state. `InitState.Enter()` re-validates and sets up a fresh game. No residual state.

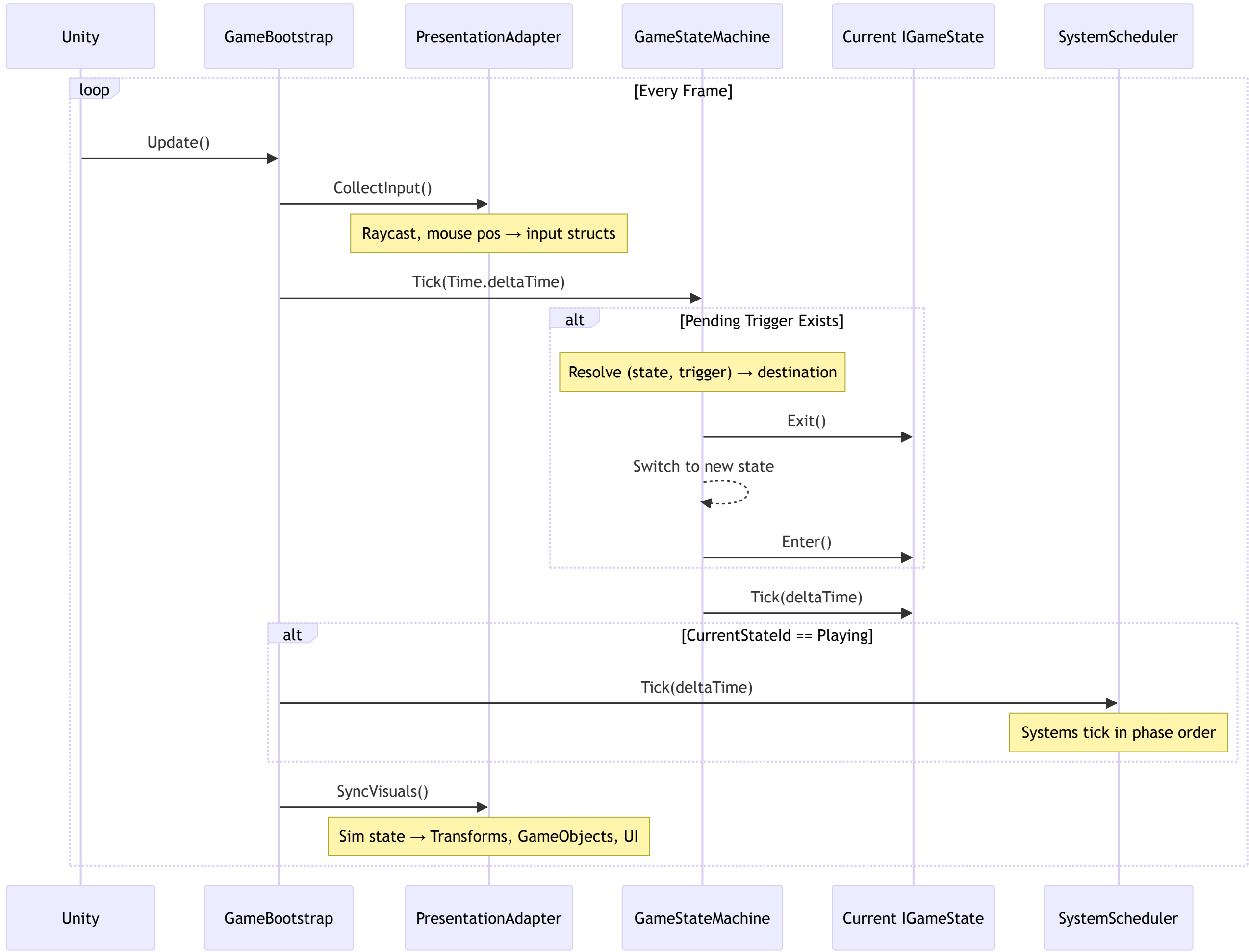
Startup Sequence



Key points:

- `GameBootstrap.Awake()` constructs everything — state machine, system scheduler, states — and configures the transition table. `Start()` kicks off the state machine.
- `InitState.Enter()` fires `SceneValidated` — it does not know the destination. The trigger is **pending** — not resolved until the next `Tick()` .
- The state machine resolves triggers at the **start** of `Tick()` : lookup `(currentState, trigger)` in transition table → `Exit()` old → switch → `Enter()` new → `Tick()` new. This guarantees one clean frame boundary between states.
- States only depend on `Action<GameTrigger>` — no reference to other states or to `GameStateMachine` itself. This makes states independently testable.
- System ticking is separate from state ticking. `GameBootstrap` gates the scheduler based on the current state — systems only run during gameplay.

Per-Frame Tick Flow



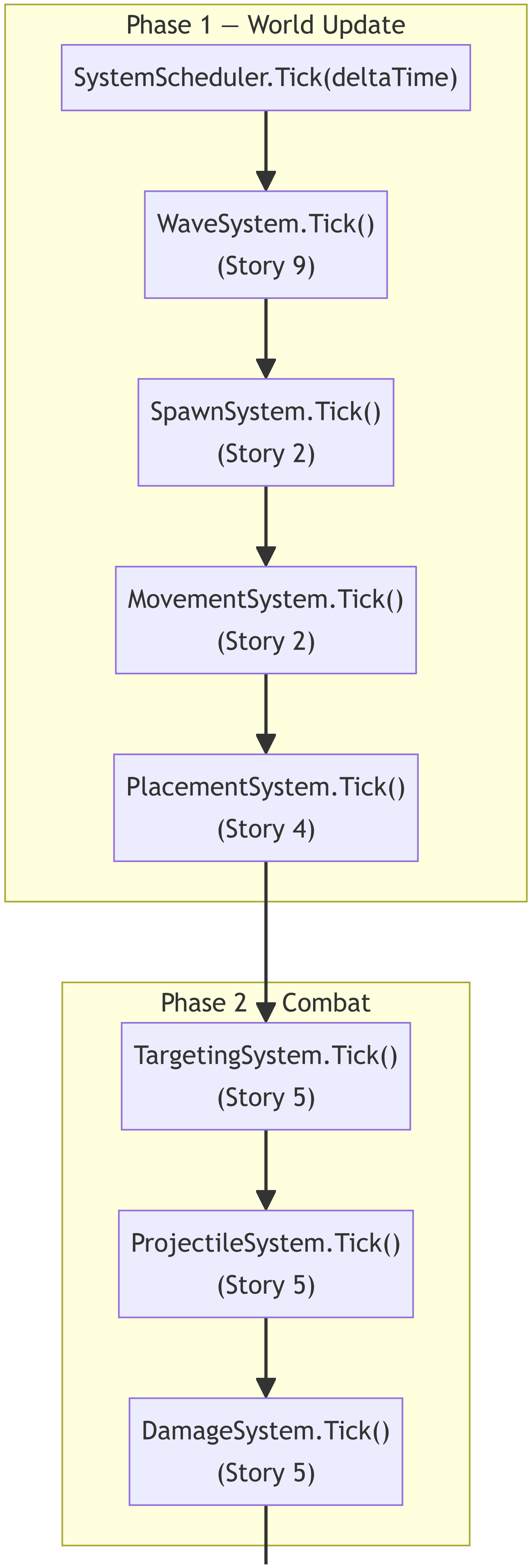
Frame boundary contract: Each frame has four phases with unidirectional data flow:

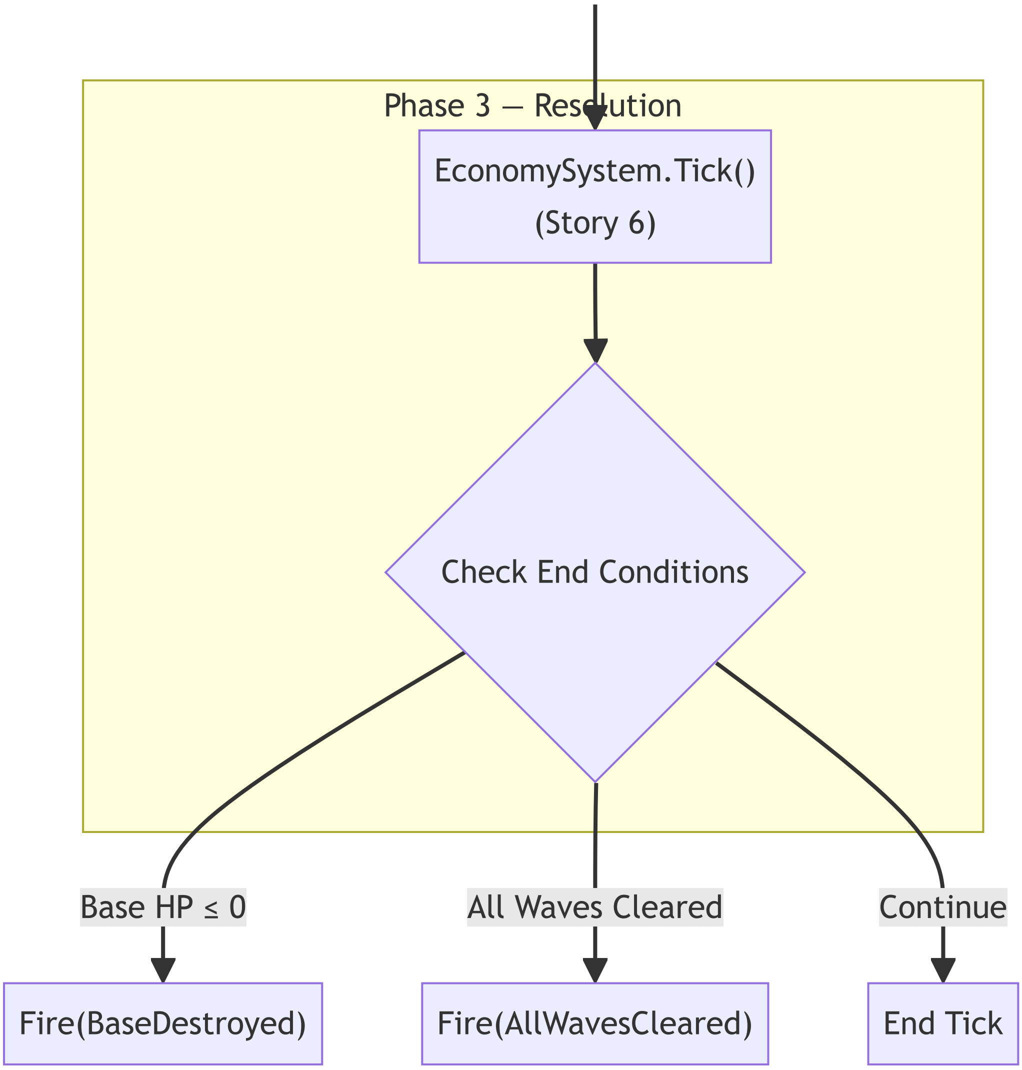
1. **Input collection** — `PresentationAdapter.CollectInput()` reads Unity inputs (mouse position, raycasts, keyboard) and writes them into sim-readable input structs. Systems never call Unity input APIs directly.
2. **State tick** — The state machine resolves pending triggers and ticks the current state. States manage flow (enter/exit, fire triggers) — not system execution.
3. **System tick** — `GameBootstrap` gates the `SystemScheduler` based on the current state. Systems tick in deterministic phase order. Systems read/write only simulation data (structs, arrays). No Unity API calls.
4. **Visual sync** — `PresentationAdapter.SyncVisuals()` reads simulation state and writes to Unity objects (`Transform.position` , enable/disable GameObjects, UI updates). The sim is unaware this step exists.

Story 1: The `SystemScheduler` holds an empty `IGameSystem[]` array — no systems yet. The presentation adapter is a stub. Future stories add systems to the scheduler in `GameBootstrap` .

System Scheduler — System Phases & Tick Order

Shows how `IGameSystem` implementations will be ticked by `SystemScheduler` as stories are implemented. Systems are grouped into three conceptual phases. All systems are plain C# classes implementing `IGameSystem` , registered in order via `GameBootstrap` . The scheduler is gated by the state machine — systems only tick during gameplay states.


Phase 1 — World Update
SystemScheduler.Tick(deltaTime)
WaveSystem.Tick()
(Story 9)
SpawnSystem.Tick()
(Story 2)
MovementSystem.Tick()
(Story 2)
PlacementSystem.Tick()
(Story 4)
Phase 2 — Combat
TargetingSystem.Tick()
(Story 5)
ProjectileSystem.Tick()
(Story 5)
DamageSystem.Tick()
(Story 5)



System phases:

Phase	Systems	Purpose
1 — World Update	Wave, Spawn, Movement, Placement	Bring all entities to current-frame state; process player input
2 — Combat	Targeting, Projectile, Damage	Resolve attacks using positions settled in Phase 1
3 — Resolution	Economy, End Conditions	Process rewards and check win/lose after combat settles

Tick order within phases:

1. **Waves** decide what to spawn this frame
2. **Spawn** creates new creeps from wave data
3. **Movement** advances all creeps toward the base
4. **Placement** processes player turret placement input — placed turrets are available for targeting this frame
5. **Targeting** assigns turret targets using settled positions from Phase 1
6. **Projectiles** advance in-flight projectiles, check hits
7. **Damage** applies damage from hits, removes dead creeps, triggers base damage on arrival
8. **Economy** processes coin awards from kills
9. **Conditions** check win/lose after all systems have settled

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Folder Structure

```
Assets/
├── Scripts/
│   ├── Core/                   # Bootstrap, state machine, scheduler, game loop
│   │   ├── GameBootstrap.cs
│   │   ├── GameStateMachine.cs
│   │   ├── SystemScheduler.cs
│   │   ├── PresentationAdapter.cs
│   │   ├── GameState.cs        # enum
│   │   ├── GameTrigger.cs      # enum
│   │   ├── IGameState.cs       # interface
│   │   ├── IGameSystem.cs      # interface
│   │   ├── InitState.cs
│   │   └── PlayingState.cs
│   ├── HomeBase/               # Home base identification component
│   │   └── HomeBaseComponent.cs
│   ├── Creeps/                 # (Story 2+)
│   ├── Turrets/                # (Story 4+)
│   ├── Combat/                 # (Story 5+)
│   ├── Economy/                # (Story 6+)
│   ├── Waves/                  # (Story 9)
│   ├── Data/                   # ScriptableObject definitions
│   └── UI/                     # UI Toolkit binding
├── Tests/
│   ├── Editor/
│   │   ├── EditModeTests.asmdef
│   │   └── GameStateMachineTests.cs
│   └── Runtime/
│       └── RuntimeTests.asmdef
├── Prefabs/                    # (provided, unchanged)
├── Scenes/                     # (provided, unchanged)
├── Materials/                  # (provided, unchanged)
└── Terrain/                    # (provided, unchanged)
```

No project-wide namespace. Feature folders group related components, systems, and data.