

# Technical Design Document 03: The Hybrid Modding Engine

Version: 1.0.0

Source Material: "Hybrid Mod System Design".

## 1. Architectural Overview

The engine treats the "Core Game" as simply the first Mod loaded. This ensures 100% API coverage for community modders.

- **In-Repo Mods:** Compiled via Vite (Core).
- **Sideloaded Mods:** Loaded at runtime via ZIP/JSON (Community).

## 2. Server-Side Security (isolated-vm)

We explicitly reject vm2 due to security vulnerabilities. We utilize isolated-vm to execute mod logic in a separate V8 heap.

### 2.1 The Sandbox Pattern

Mods cannot access fs, net, or process. They can only access a strict "Jail API" exposed by the engine.

```
// server/sandbox/ModExecutor.ts
import ivm from 'isolated-vm';
```

```
export class ModExecutor {
  private isolate: ivm.Isolate;
  private context: ivm.Context;
```

```
  constructor() {
    // 128MB Memory Limit per Mod to prevent DoS
    this.isolate = new ivm.Isolate({ memoryLimit: 128 });
    this.context = this.isolate.createContextSync();
  }
```

```
  exposeGameAPI(gameInstance: any) {
    const jail = this.context.global;
```

```
    // Expose specific, safe functions
    jail.setSync('spawnUnit', new ivm.Reference((type: string, x: number, y: number) => {
      // Validate input on Host side before execution
      if (gameInstance.isValidType(type)) {
```

```
        gamelInstance.spawnEntity(type, x, y);
    }
    }));
}
}
```

## 3. Asset Loading Pipeline

Phaser 3 cannot bundle assets that don't exist at build time. We use the **Asset Pack** pattern.

### 3.1 The Flow

1. **Discovery:** Server scans /mods folder using chokidar.
2. **Manifest Parsing:** Server reads manifest.json from each mod.
3. **Route Generation:** Express serves static files at /static/mods/{mod\_id}/...
4. **Client Loading:** Client requests the generated Asset Pack JSON and feeds it to `this.load.pack()`.

## 4. Data Merging Strategy

When a mod modifies a Core Unit, we use a **Deep Merge with ID-Upsert**.

- Standard merging (Lodash) often corrupts Arrays.
- Our merger treats Arrays of Objects as Maps (keyed by id) to ensure specific units are updated, not duplicated.