

# @push.rocks/smartv m

fast vms

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# readme.md for @push.rocks/smartvm

A TypeScript module that wraps Amazon's [Firecracker VMM](#) to create, configure, and manage lightweight microVMs with a clean, type-safe API.

## Issue Reporting and Security

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## Install

```
pnpm install @push.rocks/smartvm
```

“ **Prerequisites:** Firecracker requires a Linux host with KVM support ( `/dev/kvm` ). Networking features (TAP devices, bridges, NAT) require root privileges.

## Quick Start

```
import { SmartVM } from '@push.rocks/smartvm';

// 1. Create the orchestrator
const smartvm = new SmartVM({
  dataDir: '/opt/smartvm', // where binaries, kernels, rootfs are cached
```

```
firecrackerVersion: 'v1.7.0', // or omit for latest
arch: 'x86_64',
});

// 2. Download Firecracker if not already present
await smartvm.ensureBinary();

// 3. Create a MicroVM
const vm = await smartvm.createVM({
  bootSource: {
    kernelImagePath: '/opt/smartvm/kernels/vmlinux',
    bootArgs: 'console=ttyS0 reboot=k panic=1 pci=off',
  },
  machineConfig: {
    vcpuCount: 2,
    memSizeMib: 256,
  },
  drives: [
    {
      driveId: 'rootfs',
      pathOnHost: '/opt/smartvm/rootfs/ubuntu.ext4',
      isRootDevice: true,
      isReadOnly: false,
    },
  ],
  networkInterfaces: [
    { ifaceId: 'eth0' }, // TAP device and MAC auto-generated
  ],
});

// 4. Start it ☐☐
await vm.start();

// 5. Inspect
console.log(vm.state); // 'running'
console.log(await vm.getInfo()); // Firecracker instance info

// 6. Pause / Resume
await vm.pause(); // state → 'paused'
```

```
await vm.resume(); // state → 'running'
```

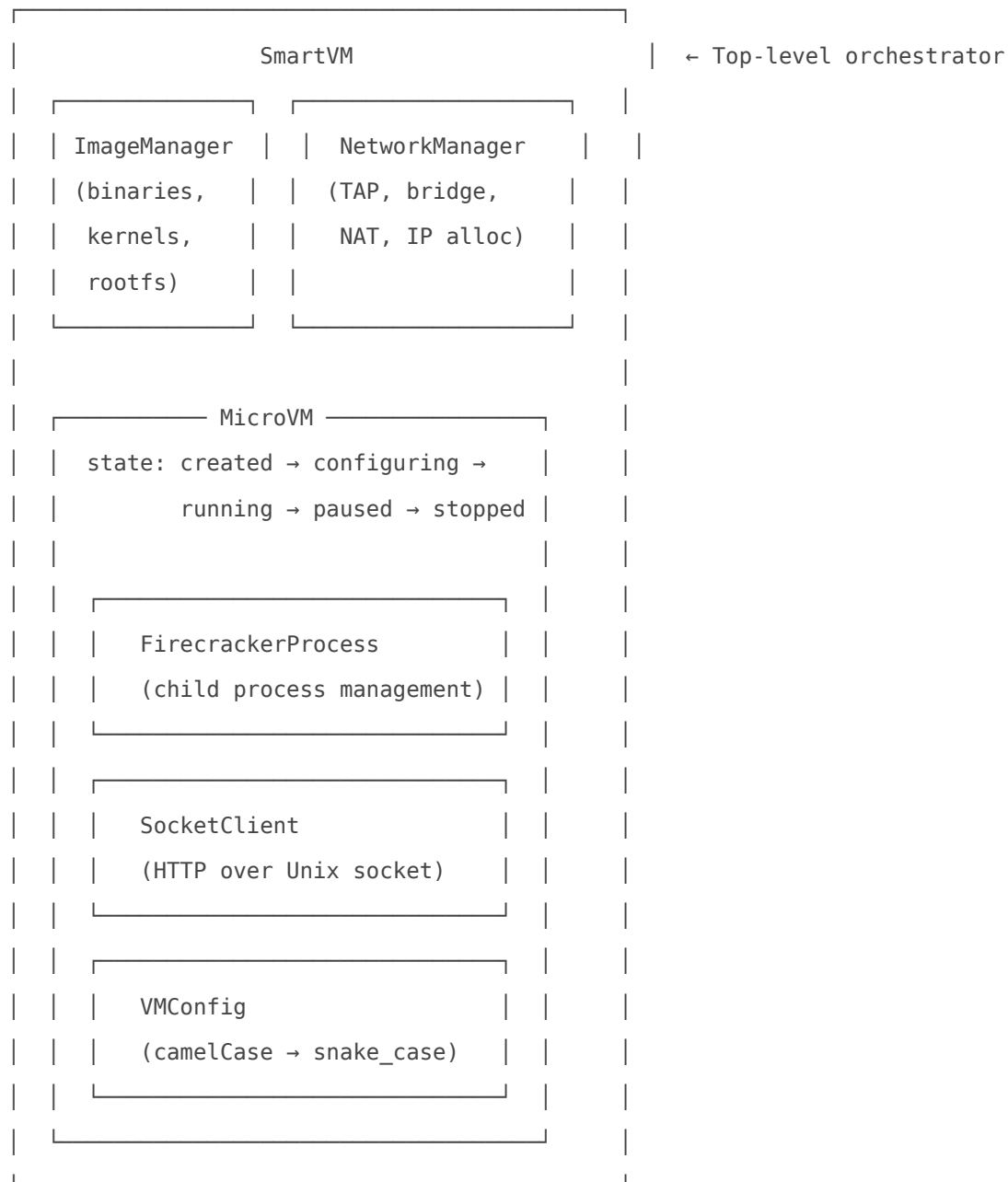
```
// 7. Stop and clean up
```

```
await vm.stop();
```

```
await vm.cleanup();
```

```
await smartvm.cleanup();
```

# Architecture Overview



Firecracker exposes a REST API over a Unix domain socket. This module handles all the plumbing: spawning the process, waiting for the socket, translating your TypeScript config into Firecracker's snake\_case API payloads, managing TAP devices, and tearing everything down on exit.

# API Reference

## SmartVM — The Orchestrator

The entry point for everything. Manages binary downloads, VM creation, and global cleanup.

```
import { SmartVM } from '@push.rocks/smartvm';
import type { ISmartVMOptions } from '@push.rocks/smartvm';

const smartvm = new SmartVM({
  dataDir: '/tmp/.smartvm', // default: /tmp/.smartvm
  firecrackerVersion: 'v1.7.0', // default: latest from GitHub
  arch: 'x86_64', // default: x86_64 (also: aarch64)
  firecrackerBinaryPath: '/usr/bin/firecracker', // optional: skip download
  bridgeName: 'svbr0', // default: svbr0
  subnet: '172.30.0.0/24', // default: 172.30.0.0/24
});
```

Method	Description
<code>ensureBinary()</code>	Downloads Firecracker from GitHub if not cached. Returns path to binary.
<code>createVM(config)</code>	Creates a <code>MicroVM</code> instance (not yet started). Returns the VM.
<code>getVM(id)</code>	Look up an active VM by ID.
<code>listVMs()</code>	Returns an array of active VM IDs.
<code>vmCount</code>	Number of active VMs.
<code>stopAll()</code>	Stops all running/paused VMs in parallel.
<code>cleanup()</code>	Stops all VMs, removes TAP devices and bridge.

## MicroVM — VM Lifecycle

Each VM follows a strict state machine: **created** → **configuring** → **running** → **paused** → **stopped**

```
const vm = await smartvm.createVM({
  id: 'my-vm', // optional, auto-generated UUID if omitted
  bootSource: {
    kernelImagePath: '/path/to/vmlinuz',
    bootArgs: 'console=ttyS0 reboot=k panic=1',
    initrdPath: '/path/to/initrd', // optional
  },
  machineConfig: {
    vcpuCount: 4,
    memSizeMib: 512,
    smt: false,
    cpuTemplate: 'T2', // optional: C3, T2, T2S, T2CL, T2A, V1N1
    trackDirtyPages: true,
  },
  drives: [
    {
      driveId: 'rootfs',
      pathOnHost: '/path/to/rootfs.ext4',
      isRootDevice: true,
      isReadOnly: false,
      cacheType: 'Unsafe', // or 'Writeback'
      rateLimiter: {
        bandwidth: { size: 100_000_000, refillTime: 1_000_000_000 },
        ops: { size: 1000, refillTime: 1_000_000_000 },
      },
    },
  ],
  networkInterfaces: [
    {
      ifaceId: 'eth0',
      // hostDevName and guestMac auto-generated if omitted
    },
  ],
  vsock: {
    guestCid: 3,
    udsPath: '/tmp/vsock.sock',
  },
});
```

```

balloon: {
  amountMib: 128,
  deflateOnOom: true,
  statsPollingIntervalS: 5,
},
mmds: {
  version: 'V2',
  networkInterfaces: ['eth0'],
},
logger: {
  logPath: '/tmp/firecracker.log',
  level: 'Debug',
  showLogOrigin: true,
},
metrics: {
  metricsPath: '/tmp/firecracker-metrics.fifo',
},
});

```

Method	Valid States	Description
<code>start()</code>	<code>created</code>	Spawns Firecracker, applies config, boots the VM
<code>pause()</code>	<code>running</code>	Pauses VM execution
<code>resume()</code>	<code>paused</code>	Resumes a paused VM
<code>stop()</code>	<code>running</code> , <code>paused</code>	Graceful shutdown (Ctrl+Alt+Del), then force kill
<code>cleanup()</code>	any	Full cleanup: kill process, remove socket, remove TAPs
<code>getInfo()</code>	any (after start)	Returns Firecracker instance info
<code>getVersion()</code>	any (after start)	Returns Firecracker version
<code>createSnapshot(params)</code>	<code>paused</code>	Create a VM snapshot
<code>loadSnapshot(params)</code>	<code>created</code> , <code>configuring</code>	Load a VM from snapshot
<code>setMetadata(data)</code>	<code>running</code> , <code>paused</code>	Set MMDS metadata
<code>getMetadata()</code>	<code>running</code> , <code>paused</code>	Get MMDS metadata
<code>updateDrive(id, path)</code>	<code>running</code> , <code>paused</code>	Hot-update a drive path
<code>updateBalloon(mib)</code>	<code>running</code> , <code>paused</code>	Resize the balloon device

Method	Valid States	Description
<code>getTapDevices()</code>	any	Returns TAP devices associated with this VM

# ImageManager — Binary & Image Management

Handles downloading and caching Firecracker binaries, kernels, and rootfs images.

```
const imageManager = smartvm.imageManager;

// Auto-download the latest Firecracker release
const version = await imageManager.getLatestVersion(); // e.g. 'v1.7.0'
const binaryPath = await imageManager.downloadFirecracker(version);

// Download kernel and rootfs images
const kernelPath = await imageManager.downloadKernel(
  'https://example.com/vmlinux-5.10',
  'vmlinux-5.10',
);
const rootfsPath = await imageManager.downloadRootfs(
  'https://example.com/ubuntu-22.04.ext4',
  'ubuntu-22.04.ext4',
);

// Create a blank rootfs or clone an existing one
const blankPath = await imageManager.createBlankRootfs('scratch.ext4', 1024);
const clonePath = await imageManager.cloneRootfs(rootfsPath, 'ubuntu-clone.ext4');
```

## Data directory layout:

```
/tmp/.smartvm/
  bin/<version>/firecracker
  bin/<version>/jailer
  kernels/<name>
  rootfs/<name>
  sockets/<vmId>.sock
```

# NetworkManager — Host Networking

Automatically manages TAP devices, a Linux bridge, and iptables NAT masquerade rules so VMs get internet access out of the box.

```
const networkManager = smartvm.networkManager;

// Manually create a TAP device (usually handled by MicroVM.start())
const tap = await networkManager.createTapDevice('vm-id', 'eth0');
console.log(tap);
// {
//   tapName: 'svvmideth0',
//   guestIp: '172.30.0.2',
//   gatewayIp: '172.30.0.1',
//   subnetMask: '255.255.255.0',
//   mac: '02:a3:b1:c4:d2:e5'
// }

// Generate kernel boot args for the guest
const bootArgs = networkManager.getGuestNetworkBootArgs(tap);
// 'ip=172.30.0.2::172.30.0.1:255.255.255.0::eth0:off'
```

## Networking architecture:

- Creates a Linux bridge (default: `svbr0`) with gateway at `.1`
- Each VM gets a TAP device attached to the bridge
- Sequential IP allocation from `.2` onwards
- iptables NAT masquerade for outbound internet
- Deterministic MAC generation (`02:xx:xx:xx:xx:xx` locally-administered)
- TAP names fit Linux's 15-char IFNAMSIZ limit

# VMConfig — Config Transformer

Converts your camelCase TypeScript config into Firecracker's snake\_case API payloads. Also validates configuration before boot.

```
import { VMConfig } from '@push.rocks/smartvm';

const vmConfig = new VMConfig({
  bootSource: { kernelImagePath: '/path/to/vmlinux' },
```

```
machineConfig: { vcpuCount: 2, memSizeMib: 256 },
});

// Validate
const result = vmConfig.validate();
// { valid: true, errors: [] }

// Generate API payloads
vmConfig.toBootSourcePayload();
// { kernel_image_path: '/path/to/vmlinux' }

vmConfig.toMachineConfigPayload();
// { vcpu_count: 2, mem_size_mib: 256 }
```

## SocketClient — Low-Level HTTP Client

Direct HTTP-over-Unix-socket communication with Firecracker. You typically don't need this directly — `MicroVM` handles it — but it's available if you want raw API access.

```
import { SocketClient } from '@push.rocks/smartvm';

const client = new SocketClient({ socketPath: '/tmp/firecracker.sock' });

const info = await client.get('/');
const putResult = await client.put('/machine-config', { vcpu_count: 2, mem_size_mib: 256 });
const patchResult = await client.patch('/vm', { state: 'Paused' });

// Check if socket is alive (polls with timeout)
const ready = await client.isReady(5000);
```

## SmartVMError — Error Handling

All errors thrown by this module are `SmartVMError` instances with structured error codes.

```
import { SmartVMError } from '@push.rocks/smartvm';

try {
  await vm.start();
}
```

```

} catch (err) {
  if (err instanceof SmartVMError) {
    console.log(err.code);          // 'INVALID_CONFIG', 'SOCKET_TIMEOUT', 'API_ERROR', etc.
    console.log(err.statusCode);    // HTTP status from Firecracker (if applicable)
    console.log(err.details);      // Raw error body from Firecracker (if applicable)
  }
}

```

## Error codes:

Code	Description
INVALID_STATE	Operation not valid for current VM state
INVALID_CONFIG	Config validation failed
SOCKET_TIMEOUT	Firecracker socket didn't become ready
API_TIMEOUT	Firecracker API didn't respond in time
SOCKET_REQUEST_FAILED	HTTP request to socket failed
API_ERROR	Firecracker returned a non-2xx response
BINARY_NOT_FOUND	Firecracker binary not at expected path
DOWNLOAD_FAILED	Failed to download binary/kernel/rootfs
VERSION_FETCH_FAILED	Couldn't query GitHub for latest version
BRIDGE_SETUP_FAILED	Failed to create network bridge
TAP_CREATE_FAILED	Failed to create TAP device
ROOTFS_CREATE_FAILED	Failed to create blank rootfs
ROOTFS_CLONE_FAILED	Failed to clone rootfs image
START_FAILED	VM start sequence failed
NO_CLIENT	Socket client not initialized

# Snapshots

Create and restore VM snapshots for fast cold-start or live migration:

```

// Pause first (required for snapshots)
await vm.pause();

```

```
// Create a snapshot
await vm.createSnapshot({
  snapshotPath: '/tmp/snapshot.bin',
  memFilePath: '/tmp/snapshot-mem.bin',
  snapshotType: 'Full', // or 'Diff' for incremental
});

// Later: restore from snapshot
const freshVm = await smartvm.createVM({
  bootSource: { kernelImagePath: '/path/to/vmlinux' },
  machineConfig: { vcpuCount: 2, memSizeMib: 256 },
});
await freshVm.loadSnapshot({
  snapshotPath: '/tmp/snapshot.bin',
  memFilePath: '/tmp/snapshot-mem.bin',
  resumeVm: true,
});
```

# MMDS (Metadata Service)

Pass metadata to your guest VM via Firecracker's Microvm Metadata Service:

```
const vm = await smartvm.createVM({
  bootSource: { /* ... */ },
  machineConfig: { /* ... */ },
  networkInterfaces: [{ ifaceId: 'eth0' }],
  mmds: {
    version: 'V2',
    networkInterfaces: ['eth0'],
  },
});

await vm.start();

// Set metadata from host
await vm.setMetadata({
  instance: { id: 'my-instance', region: 'eu-central-1' },
```

```
secrets: { apiKey: 'sk-...' },
});

// Guest can access via: curl http://169.254.169.254/latest/meta-data/
const data = await vm.getMetadata();
```

# Graceful Cleanup

The module registers cleanup handlers via `@push.rocks/smartexit` so resources are released even if your process crashes:

- `firecracker` child processes are killed
- Unix socket files are removed
- TAP devices are deleted
- Bridge and NAT rules are torn down

You can also trigger cleanup manually:

```
// Stop one VM
await vm.stop();
await vm.cleanup();

// Stop all VMs and clean everything
await smartvm.stopAll();
await smartvm.cleanup();
```

# TypeScript Interfaces

All configuration interfaces are fully exported for type-safe usage:

```
import type {
  ISmartVMOptions,
  IMicroVMConfig,
  IBootSource,
  IMachineConfig,
  IDriveConfig,
  INetworkInterfaceConfig,
```

```
IVsockConfig,  
IBalloonConfig,  
IMmdsConfig,  
ILoggerConfig,  
IMetricsConfig,  
ISnapshotCreateParams,  
ISnapshotLoadParams,  
IRateLimiter,  
INetworkManagerOptions,  
ITapDevice,  
ISocketClientOptions,  
IApiResponse,  
TVMState,  
TFirecrackerArch,  
TCacheType,  
TSnapshotType,  
TLogLevel,  
} from '@push.rocks/smartvm';
```

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# changelog.md for @push.rocks/smartvm

## 2026-02-08 - 1.1.0 - feat(release)

add release configuration with npm registries and public access; add @ship.zone/szci placeholder

- Added release.registries including <https://verdaccio.lossless.digital> and <https://registry.npmjs.org>
- Set release.accessLevel to 'public' in npmextra.json
- Added an empty @ship.zone/szci entry to npmextra.json

## 2026-02-08 - 1.0.0 - initial release

Initial commit: repository and project scaffold.

- Project initialized with the first commit.
- Added baseline project structure and configuration.
- Establishes repository for future development.