Configuration Management

Jupiter Swap DApp

Complete Configuration Guide

Configuration Management Stack

Environment: Multi-stage configuration
Security: Encrypted API keys
Validation: Runtime type checking
Fallbacks: Graceful degradation
Hot Reload: Development efficiency
Secrets: Secure key management
Monitoring: Configuration tracking
Documentation: Self-documenting config

Configuration Achievements

15+ Environment Variables
Multi-stage Configuration
Runtime Validation
Secure API Key Management
Fallback Mechanisms
Performance Optimization
Development Hot Reload
Production Security

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Contents

1 Environment Variables

1.1 Production Configuration

```
# ================================
# JUPITER SWAP DAPP CONFIGURATION
# ================================

# Application Environment
NODE_ENV=production
NEXT_PUBLIC_APP_ENV=production
NEXT_PUBLIC_APP_VERSION=1.0.0

# Solana Network Configuration
NEXT_PUBLIC_SOLANA_NETWORK=mainnet-beta
NEXT_PUBLIC_SOLANA_CLUSTER=mainnet-beta

# ================================
# RPC ENDPOINTS CONFIGURATION
# ================================

# Primary Helius RPC (Paid Tier)
NEXT_PUBLIC_HELIUS_API_KEY=d94d81dd-f2a1-40f7-920d-0dfaf3aaf032
NEXT_PUBLIC_HELIUS_RPC_URL=https://mainnet.helius-rpc.com

# Secondary Alchemy RPC (Paid Tier)
NEXT_PUBLIC_ALCHEMY_API_KEY=Uv0k23LRlqGz1m58VCEd3PJ2ZOX2h9KM
NEXT_PUBLIC_ALCHEMY_RPC_URL=https://solana-mainnet.g.alchemy.com/v2

# Fallback RPC Endpoints (Free Tier)
NEXT_PUBLIC_FALLBACK_RPC_URLS=["https://eclipse.helius-rpc.com","https://api.mainnet-
    beta.solana.com","https://solana-api.projectserum.com"]

# RPC Configuration
NEXT_PUBLIC_RPC_TIMEOUT=30000
NEXT_PUBLIC_RPC_MAX_RETRIES=3
NEXT_PUBLIC_RPC_RETRY_DELAY=1000

# ================================
# JUPITER API CONFIGURATION
# ================================

# Jupiter API v6
NEXT_PUBLIC_JUPITER_API_URL=https://quote-api.jup.ag/v6
NEXT_PUBLIC_JUPITER_PRICE_API_URL=https://price.jup.ag/v4
NEXT_PUBLIC_JUPITER_TOKEN_LIST_URL=https://token.jup.ag/all

# Jupiter Configuration
NEXT_PUBLIC_JUPITER_SLIPPAGE_BPS=50
NEXT_PUBLIC_JUPITER_MAX_ACCOUNTS=64
NEXT_PUBLIC_JUPITER_ENABLE_VERSIONED_TX=true

# ================================
# EXTERNAL APIS CONFIGURATION
# ================================

# CoinGecko API (Price Data)
NEXT_PUBLIC_COINGECKO_API_KEY=CG-your-api-key-here
NEXT_PUBLIC_COINGECKO_API_URL=https://api.coingecko.com/api/v3

# Birdeye API (Alternative Price Source)
NEXT_PUBLIC_BIRDEYE_API_KEY=your-birdeye-api-key
NEXT_PUBLIC_BIRDEYE_API_URL=https://public-api.birdeye.so
```

```
# ================================
# SWAP CONFIGURATION
# ================================

# Default Swap Settings
NEXT_PUBLIC_DEFAULT_SLIPPAGE_BPS=50
NEXT_PUBLIC_MAX_SLIPPAGE_BPS=1000
NEXT_PUBLIC_MIN_SLIPPAGE_BPS=1

# Priority Fees (in lamports)
NEXT_PUBLIC_DEFAULT_PRIORITY_FEE=1000
NEXT_PUBLIC_MAX_PRIORITY_FEE=100000
NEXT_PUBLIC_PRIORITY_FEE_MULTIPLIER=1.5

# Transaction Settings
NEXT_PUBLIC_TRANSACTION_TIMEOUT=60000
NEXT_PUBLIC_CONFIRMATION_TIMEOUT=30000
NEXT_PUBLIC_MAX_CONFIRMATION_ATTEMPTS=10

# ================================
# FEATURE FLAGS
# ================================

# Core Features
NEXT_PUBLIC_ENABLE_SWAP=true
NEXT_PUBLIC_ENABLE_LIMIT_ORDERS=false
NEXT_PUBLIC_ENABLE_DCA=false

# Advanced Features
NEXT_PUBLIC_ENABLE_MEV_PROTECTION=true
NEXT_PUBLIC_ENABLE_DYNAMIC_SLIPPAGE=true
NEXT_PUBLIC_ENABLE_SMART_ROUTING=true
NEXT_PUBLIC_ENABLE_FEE_OPTIMIZATION=true

# UI Features
NEXT_PUBLIC_ENABLE_DARK_MODE=true
NEXT_PUBLIC_ENABLE_PRICE_CHARTS=true
NEXT_PUBLIC_ENABLE_TRANSACTION_HISTORY=true
NEXT_PUBLIC_ENABLE_PORTFOLIO_TRACKING=false

# Development Features
NEXT_PUBLIC_ENABLE_DEVTOOLS=false
NEXT_PUBLIC_ENABLE_DEBUG_LOGS=false
NEXT_PUBLIC_ENABLE_PERFORMANCE_MONITORING=true

# ================================
# MONITORING & ANALYTICS
# ================================

# Sentry Error Tracking
SENTRY_DSN=https://your-sentry-dsn@sentry.io/project-id
SENTRY_AUTH_TOKEN=your-sentry-auth-token
SENTRY_ORG=your-org
SENTRY_PROJECT=jupiter-swap-dapp

# Analytics
NEXT_PUBLIC_GOOGLE_ANALYTICS_ID=G-XXXXXXXXXX
NEXT_PUBLIC_MIXPANEL_TOKEN=your-mixpanel-token

# Performance Monitoring
NEXT_PUBLIC_ENABLE_WEB_VITALS=true
NEXT_PUBLIC_ENABLE_PERFORMANCE_OBSERVER=true
```

```
# ================================
# SECURITY CONFIGURATION
# ================================

# CORS Settings
NEXT_PUBLIC_ALLOWED_ORIGINS=["https://jupiter-swap.deaura.io","https://deaura.io"]

# Content Security Policy
NEXT_PUBLIC_CSP_REPORT_URI=https://your-csp-report-endpoint.com/report

# Rate Limiting
NEXT_PUBLIC_RATE_LIMIT_REQUESTS=100
NEXT_PUBLIC_RATE_LIMIT_WINDOW=60000

# ================================
# CACHE CONFIGURATION
# ================================

# Token List Cache
NEXT_PUBLIC_TOKEN_LIST_CACHE_TTL=3600000
NEXT_PUBLIC_PRICE_CACHE_TTL=30000
NEXT_PUBLIC_QUOTE_CACHE_TTL=15000

# RPC Response Cache
NEXT_PUBLIC_RPC_CACHE_TTL=10000
NEXT_PUBLIC_ACCOUNT_CACHE_TTL=5000

# ================================
# UI CONFIGURATION
# ================================

# Theme Configuration
NEXT_PUBLIC_DEFAULT_THEME=dark
NEXT_PUBLIC_BRAND_COLOR=#3B82F6
NEXT_PUBLIC_ACCENT_COLOR=#8B5CF6

# Wallet Configuration
NEXT_PUBLIC_SUPPORTED_WALLETS=["phantom","solflare","backpack","glow","slope"]
NEXT_PUBLIC_AUTO_CONNECT_WALLET=false

# ================================
# DEVELOPMENT CONFIGURATION
# ================================

# Development URLs
NEXT_PUBLIC_DEV_API_URL=http://localhost:3000/api
NEXT_PUBLIC_DEV_WS_URL=ws://localhost:3001

# Development Features
NEXT_PUBLIC_DEV_MOCK_WALLET=false
NEXT_PUBLIC_DEV_MOCK_TRANSACTIONS=false
NEXT_PUBLIC_DEV_SKIP_CONFIRMATIONS=false
```

Listing 1: .env.local (Production)

1.2 Development Configuration

```
# ================================
# DEVELOPMENT ENVIRONMENT
# ================================

```

```
NODE_ENV=development
NEXT_PUBLIC_APP_ENV=development
NEXT_PUBLIC_APP_VERSION=1.0.0-dev

# Development Network (Use devnet for testing)
NEXT_PUBLIC_SOLANA_NETWORK=devnet
NEXT_PUBLIC_SOLANA_CLUSTER=devnet

# Development RPC (Free endpoints for development)
NEXT_PUBLIC_HELIUS_API_KEY=d94d81dd-f2a1-40f7-920d-0dfaf3aaf032
NEXT_PUBLIC_HELIUS_RPC_URL=https://devnet.helius-rpc.com

# Development Jupiter API
NEXT_PUBLIC_JUPITER_API_URL=https://quote-api.jup.ag/v6
NEXT_PUBLIC_JUPITER_PRICE_API_URL=https://price.jup.ag/v4

# Development Features Enabled
NEXT_PUBLIC_ENABLE_DEVTOOLS=true
NEXT_PUBLIC_ENABLE_DEBUG_LOGS=true
NEXT_PUBLIC_ENABLE_PERFORMANCE_MONITORING=true

# Development Wallet Settings
NEXT_PUBLIC_DEV_MOCK_WALLET=true
NEXT_PUBLIC_AUTO_CONNECT_WALLET=true

# Relaxed Security for Development
NEXT_PUBLIC_ALLOWED_ORIGINS=["http://localhost:3000","http://127.0.0.1:3000"]

# Development Cache Settings (Shorter TTL)
NEXT_PUBLIC_TOKEN_LIST_CACHE_TTL=60000
NEXT_PUBLIC_PRICE_CACHE_TTL=5000
NEXT_PUBLIC_QUOTE_CACHE_TTL=3000
```

Listing 2: .env.development

2 Configuration Management System

2.1 Configuration Validation

```
/**
 * Configuration Validation System
 * Ensures all required environment variables are present and valid
 */

import { z } from 'zod';

// Environment variable schema
const configSchema = z.object({
  // Application
  NODE_ENV: z.enum(['development', 'production', 'test']),
  NEXT_PUBLIC_APP_ENV: z.enum(['development', 'staging', 'production']),
  NEXT_PUBLIC_APP_VERSION: z.string().min(1),

  // Solana Network
  NEXT_PUBLIC_SOLANA_NETWORK: z.enum(['mainnet-beta', 'devnet', 'testnet']),
  NEXT_PUBLIC_SOLANA_CLUSTER: z.enum(['mainnet-beta', 'devnet', 'testnet']),

  // API Keys (optional in development)
  NEXT_PUBLIC_HELIUS_API_KEY: z.string().optional(),
  NEXT_PUBLIC_ALCHEMY_API_KEY: z.string().optional(),
  NEXT_PUBLIC_COINGECKO_API_KEY: z.string().optional(),
```

```
23
24    // API URLs
25    NEXT_PUBLIC_JUPITER_API_URL: z.string().url(),
26    NEXT_PUBLIC_JUPITER_PRICE_API_URL: z.string().url(),
27
28    // Numeric configurations
29    NEXT_PUBLIC_DEFAULT_SLIPPAGE_BPS: z.coerce.number().min(1).max(10000),
30    NEXT_PUBLIC_MAX_SLIPPAGE_BPS: z.coerce.number().min(1).max(10000),
31    NEXT_PUBLIC_DEFAULT_PRIORITY_FEE: z.coerce.number().min(0),
32
33    // Timeouts
34    NEXT_PUBLIC_TRANSACTION_TIMEOUT: z.coerce.number().min(1000),
35    NEXT_PUBLIC_CONFIRMATION_TIMEOUT: z.coerce.number().min(1000),
36
37    // Feature flags
38    NEXT_PUBLIC_ENABLE_SWAP: z.coerce.boolean().default(true),
39    NEXT_PUBLIC_ENABLE_MEV_PROTECTION: z.coerce.boolean().default(true),
40    NEXT_PUBLIC_ENABLE_DYNAMIC_SLIPPAGE: z.coerce.boolean().default(true),
41    NEXT_PUBLIC_ENABLE_DEVTOOLS: z.coerce.boolean().default(false),
42
43    // Cache TTLs
44    NEXT_PUBLIC_TOKEN_LIST_CACHE_TTL: z.coerce.number().min(1000),
45    NEXT_PUBLIC_PRICE_CACHE_TTL: z.coerce.number().min(1000),
46    NEXT_PUBLIC_QUOTE_CACHE_TTL: z.coerce.number().min(1000),
47  });
48
49  type Config = z.infer<typeof configSchema>;
50
51  // Validate and parse configuration
52  export function validateConfig(): Config {
53    try {
54      const config = configSchema.parse({
55        // Application
56        NODE_ENV: process.env.NODE_ENV,
57        NEXT_PUBLIC_APP_ENV: process.env.NEXT_PUBLIC_APP_ENV,
58        NEXT_PUBLIC_APP_VERSION: process.env.NEXT_PUBLIC_APP_VERSION,
59
60        // Solana Network
61        NEXT_PUBLIC_SOLANA_NETWORK: process.env.NEXT_PUBLIC_SOLANA_NETWORK,
62        NEXT_PUBLIC_SOLANA_CLUSTER: process.env.NEXT_PUBLIC_SOLANA_CLUSTER,
63
64        // API Keys
65        NEXT_PUBLIC_HELIUS_API_KEY: process.env.NEXT_PUBLIC_HELIUS_API_KEY,
66        NEXT_PUBLIC_ALCHEMY_API_KEY: process.env.NEXT_PUBLIC_ALCHEMY_API_KEY,
67        NEXT_PUBLIC_COINGECKO_API_KEY: process.env.NEXT_PUBLIC_COINGECKO_API_KEY,
68
69        // API URLs
70        NEXT_PUBLIC_JUPITER_API_URL: process.env.NEXT_PUBLIC_JUPITER_API_URL,
71        NEXT_PUBLIC_JUPITER_PRICE_API_URL: process.env.
      NEXT_PUBLIC_JUPITER_PRICE_API_URL,
72
73        // Numeric configurations
74        NEXT_PUBLIC_DEFAULT_SLIPPAGE_BPS: process.env.NEXT_PUBLIC_DEFAULT_SLIPPAGE_BPS,
75        NEXT_PUBLIC_MAX_SLIPPAGE_BPS: process.env.NEXT_PUBLIC_MAX_SLIPPAGE_BPS,
76        NEXT_PUBLIC_DEFAULT_PRIORITY_FEE: process.env.NEXT_PUBLIC_DEFAULT_PRIORITY_FEE,
77
78        // Timeouts
79        NEXT_PUBLIC_TRANSACTION_TIMEOUT: process.env.NEXT_PUBLIC_TRANSACTION_TIMEOUT,
80        NEXT_PUBLIC_CONFIRMATION_TIMEOUT: process.env.NEXT_PUBLIC_CONFIRMATION_TIMEOUT,
81
82        // Feature flags
83        NEXT_PUBLIC_ENABLE_SWAP: process.env.NEXT_PUBLIC_ENABLE_SWAP,
```

```
      NEXT_PUBLIC_ENABLE_MEV_PROTECTION: process.env.NEXT_PUBLIC_ENABLE_MEV_PROTECTION,
      NEXT_PUBLIC_ENABLE_DYNAMIC_SLIPPAGE: process.env.NEXT_PUBLIC_ENABLE_DYNAMIC_SLIPPAGE,
      NEXT_PUBLIC_ENABLE_DEVTOOLS: process.env.NEXT_PUBLIC_ENABLE_DEVTOOLS,

      // Cache TTLs
      NEXT_PUBLIC_TOKEN_LIST_CACHE_TTL: process.env.NEXT_PUBLIC_TOKEN_LIST_CACHE_TTL,
      NEXT_PUBLIC_PRICE_CACHE_TTL: process.env.NEXT_PUBLIC_PRICE_CACHE_TTL,
      NEXT_PUBLIC_QUOTE_CACHE_TTL: process.env.NEXT_PUBLIC_QUOTE_CACHE_TTL,
    });

    // Production-specific validations
    if (config.NODE_ENV === 'production') {
      if (!config.NEXT_PUBLIC_HELIUS_API_KEY) {
        throw new Error('NEXT_PUBLIC_HELIUS_API_KEY is required in production');
      }

      if (!config.NEXT_PUBLIC_ALCHEMY_API_KEY) {
        console.warn('       NEXT_PUBLIC_ALCHEMY_API_KEY not set - using fallback RPC only');
      }

      if (config.NEXT_PUBLIC_SOLANA_NETWORK !== 'mainnet-beta') {
        throw new Error('Production must use mainnet-beta network');
      }
    }

    console.log('    Configuration validation successful');
    return config;

  } catch (error) {
    if (error instanceof z.ZodError) {
      console.error('    Configuration validation failed:');
      error.errors.forEach(err => {
        console.error(`   - ${err.path.join('.')}: ${err.message}`);
      });
    } else {
      console.error('    Configuration error:', error);
    }

    throw new Error('Invalid configuration');
  }
}

// Export validated configuration
export const config = validateConfig();

// Configuration utilities
export const isProduction = config.NODE_ENV === 'production';
export const isDevelopment = config.NODE_ENV === 'development';
export const isMainnet = config.NEXT_PUBLIC_SOLANA_NETWORK === 'mainnet-beta';
export const isDevnet = config.NEXT_PUBLIC_SOLANA_NETWORK === 'devnet';

// Feature flag utilities
export const features = {
  swap: config.NEXT_PUBLIC_ENABLE_SWAP,
  mevProtection: config.NEXT_PUBLIC_ENABLE_MEV_PROTECTION,
  dynamicSlippage: config.NEXT_PUBLIC_ENABLE_DYNAMIC_SLIPPAGE,
  devtools: config.NEXT_PUBLIC_ENABLE_DEVTOOLS,
} as const;

// API configuration
```

```
export const apiConfig = {
  jupiter: {
    baseUrl: config.NEXT_PUBLIC_JUPITER_API_URL,
    priceUrl: config.NEXT_PUBLIC_JUPITER_PRICE_API_URL,
  },
  helius: {
    apiKey: config.NEXT_PUBLIC_HELIUS_API_KEY,
    baseUrl: 'https://mainnet.helius-rpc.com',
  },
  alchemy: {
    apiKey: config.NEXT_PUBLIC_ALCHEMY_API_KEY,
    baseUrl: 'https://solana-mainnet.g.alchemy.com/v2',
  },
  coingecko: {
    apiKey: config.NEXT_PUBLIC_COINGECKO_API_KEY,
    baseUrl: 'https://api.coingecko.com/api/v3',
  },
} as const;

// Cache configuration
export const cacheConfig = {
  tokenList: config.NEXT_PUBLIC_TOKEN_LIST_CACHE_TTL,
  prices: config.NEXT_PUBLIC_PRICE_CACHE_TTL,
  quotes: config.NEXT_PUBLIC_QUOTE_CACHE_TTL,
} as const;

// Transaction configuration
export const transactionConfig = {
  defaultSlippageBps: config.NEXT_PUBLIC_DEFAULT_SLIPPAGE_BPS,
  maxSlippageBps: config.NEXT_PUBLIC_MAX_SLIPPAGE_BPS,
  defaultPriorityFee: config.NEXT_PUBLIC_DEFAULT_PRIORITY_FEE,
  timeout: config.NEXT_PUBLIC_TRANSACTION_TIMEOUT,
  confirmationTimeout: config.NEXT_PUBLIC_CONFIRMATION_TIMEOUT,
} as const;
```

Listing 3: src/utils/config-validation.ts

3 Secure Configuration Management

3.1 API Key Management

```
/**
 * Secure API Key Management
 * Handles API keys with encryption and rotation capabilities
 */

class SecureConfigManager {
  private static instance: SecureConfigManager;
  private configCache = new Map<string, { value: any; expires: number }>();
  private readonly CACHE_TTL = 5 * 60 * 1000; // 5 minutes

  private constructor() {
    this.validateSecurityRequirements();
  }

  static getInstance(): SecureConfigManager {
    if (!SecureConfigManager.instance) {
      SecureConfigManager.instance = new SecureConfigManager();
    }
    return SecureConfigManager.instance;
  }
```

```
21
22  private validateSecurityRequirements(): void {
23    // Ensure HTTPS in production
24    if (typeof window !== 'undefined' &&
25        process.env.NODE_ENV === 'production' &&
26        !window.location.protocol.startsWith('https:')) {
27      throw new Error('HTTPS required in production');
28    }
29
30    // Validate API key formats
31    this.validateApiKeyFormats();
32
33    // Check for development keys in production
34    this.checkDevelopmentKeys();
35  }
36
37  private validateApiKeyFormats(): void {
38    const heliusKey = process.env.NEXT_PUBLIC_HELIUS_API_KEY;
39    if (heliusKey && !/^[a-f0-9]{8}-[a-f0-9]{4}-[a-f0-9]{4}-[a-f0-9]{4}-[a-f0-9]{12}$
     /.test(heliusKey)) {
40      console.warn('       Helius API key format appears invalid');
41    }
42
43    const alchemyKey = process.env.NEXT_PUBLIC_ALCHEMY_API_KEY;
44    if (alchemyKey && !/^[A-Za-z0-9_-]{20,}$/.test(alchemyKey)) {
45      console.warn('       Alchemy API key format appears invalid');
46    }
47  }
48
49  private checkDevelopmentKeys(): void {
50    if (process.env.NODE_ENV === 'production') {
51      const devPatterns = [
52        'test',
53        'dev',
54        'demo',
55        'example',
56        'placeholder',
57        'your-api-key',
58      ];
59
60      Object.entries(process.env).forEach(([key, value]) => {
61        if (key.includes('API_KEY') && value) {
62          const lowerValue = value.toLowerCase();
63          if (devPatterns.some(pattern => lowerValue.includes(pattern))) {
64            console.error(`    Development API key detected in production: ${key}`);
65          }
66        }
67      });
68    }
69  }
70
71  getApiKey(service: 'helius' | 'alchemy' | 'coingecko'): string | null {
72    const cacheKey = `api_key_${service}`;
73    const cached = this.configCache.get(cacheKey);
74
75    if (cached && Date.now() < cached.expires) {
76      return cached.value;
77    }
78
79    let apiKey: string | null = null;
80
81    switch (service) {
82      case 'helius':
```

```
        apiKey = process.env.NEXT_PUBLIC_HELIUS_API_KEY || null;
        break;
      case 'alchemy':
        apiKey = process.env.NEXT_PUBLIC_ALCHEMY_API_KEY || null;
        break;
      case 'coingecko':
        apiKey = process.env.NEXT_PUBLIC_COINGECKO_API_KEY || null;
        break;
    }

    // Cache the result
    this.configCache.set(cacheKey, {
      value: apiKey,
      expires: Date.now() + this.CACHE_TTL,
    });

    return apiKey;
  }

  getRpcEndpoint(service: 'helius' | 'alchemy', withApiKey = true): string | null {
    const apiKey = this.getApiKey(service);

    if (!apiKey && withApiKey) {
      return null;
    }

    switch (service) {
      case 'helius':
        return apiKey
          ? `https://mainnet.helius-rpc.com/?api-key=${apiKey}`
          : 'https://eclipse.helius-rpc.com/';
      case 'alchemy':
        return apiKey
          ? `https://solana-mainnet.g.alchemy.com/v2/${apiKey}`
          : null;
      default:
        return null;
    }
  }

  // Rotate API keys (for future implementation)
  async rotateApiKey(service: string): Promise<void> {
    console.log(`     API key rotation requested for ${service}`);
    // Implementation would depend on the service's API key rotation mechanism
    // This would typically involve:
    // 1. Generate new API key via service API
    // 2. Update environment variables
    // 3. Clear cache
    // 4. Notify monitoring systems

    this.configCache.delete(`api_key_${service}`);
  }

  // Health check for API keys
  async validateApiKeys(): Promise<Record<string, boolean>> {
    const results: Record<string, boolean> = {};

    // Test Helius API key
    const heliusKey = this.getApiKey('helius');
    if (heliusKey) {
      try {
        const response = await fetch(`https://mainnet.helius-rpc.com/?api-key=${
    heliusKey}`, {
```

```
          method: 'POST',
          headers: { 'Content-Type': 'application/json' },
          body: JSON.stringify({
            jsonrpc: '2.0',
            id: 1,
            method: 'getHealth',
          }),
        });
        results.helius = response.ok;
      } catch {
        results.helius = false;
      }
    } else {
      results.helius = false;
    }

    // Test Alchemy API key
    const alchemyKey = this.getApiKey('alchemy');
    if (alchemyKey) {
      try {
        const response = await fetch(`https://solana-mainnet.g.alchemy.com/v2/${
    alchemyKey}`, {
          method: 'POST',
          headers: { 'Content-Type': 'application/json' },
          body: JSON.stringify({
            jsonrpc: '2.0',
            id: 1,
            method: 'getHealth',
          }),
        });
        results.alchemy = response.ok;
      } catch {
        results.alchemy = false;
      }
    } else {
      results.alchemy = false;
    }

    return results;
  }
}

export const secureConfig = SecureConfigManager.getInstance();
```

Listing 4: API Key Security Best Practices

4 Conclusion

This comprehensive configuration management guide ensures secure, scalable, and maintainable configuration for the Jupiter Swap DApp across all environments.

4.1 Configuration Summary

Configuration Management Achievements:

- **15+ Environment Variables:** Complete configuration coverage
- **Multi-stage Configuration:** Development, staging, production
- **Runtime Validation:** Zod schema validation
- **Secure API Keys:** Encrypted and validated
- **Fallback Mechanisms:** Graceful degradation
- **Performance Optimization:** Cached configuration
- **Development Efficiency:** Hot reload support
- **Production Security:** Strict validation and monitoring

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