



ND ESTATES

Advanced Analytics & Marketing Intelligence

Architecture & Design Document

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■■■ IMPORTANT: INTERNAL-USE ONLY

- Access Restriction: Staff members and authorized personnel only
- Deployment: Private network with restricted authentication
- Data Scope: Internal analytics and marketing metrics
- Security Level: Enterprise-grade security for internal operations
- Backup & Recovery: Internal systems, no public data handling

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System Overview

Purpose

NDE-Stats-GA is a comprehensive internal analytics and marketing tool that aggregates data from multiple sources:

- Google Analytics 4 (GA4)
- Google Ads API
- Google Search Console (GSC)

Target Users

- Internal Staff: ND Estates data analysts, marketing team, management
- Administrators: System operators, developers
- Not Intended For: Public users, external partners (unless explicitly granted access)
- Restricted Access: Staff members only, requires authentication

Key Objectives

- Real-time analytics dashboarding for internal decision-making
- Automated report generation (daily, weekly, monthly)
- Multi-channel marketing performance tracking
- Audience segmentation and management
- Trend analysis and insights delivery

Architecture Layers

1. **Presentation Layer** (User Interface)

Web Dashboard (Primary)

- Technology: PHP 5.7+ with Bootstrap 5
- Location: "/web/" directory
- Components:
 - "index.php" - Main dashboard interface
 - "run_report.php" - Script execution handler
 - "documentation.php" - In-app documentation
 - "css/" - Styling assets
 - "js/" - Client-side logic (minimal)

Alternative Flask Interface (Secondary)

- Technology: Python Flask
- Location: Root "app.py"
- Purpose: Alternative Python-based web interface
- Status: Secondary to PHP frontend

Access Control

- Authentication: Session-based with bcrypt password hashing

- Authorization: Role-based access (admin/user roles)
- Timeout: Automatic session expiration
- HTTPS Only: All traffic encrypted in production

2. **Application Layer** (Business Logic)

Analysis Scripts (`scripts/` directory)

20+ specialized Python scripts for specific analytics tasks:

- "hourly_traffic_analysis.py" - Hourly traffic patterns
- "page_traffic_analysis.py" - Per-page performance
- "yesterday_report.py" - Daily report generation
- "top_pages_report.py" - Best performing pages
- "channel_report.py" - Channel grouping analysis
- "google_ads_performance.py" - Campaign effectiveness
- "create_ad.py" - Programmatic ad creation
- "audience_management.py" - GA4 audience operations
- "social_media_timing.py" - Optimal posting times
- "keyword_analysis.py" - Combined GSC/GA4 insights
- "conversion_funnel_analysis.py" - User journey tracking

Core Module Library (`src/` directory)

- Environment variable management
- Credential loading and validation
- Property ID and customer ID definitions
- API key initialization
- GA4 API wrapper and utilities
- Query builder for GA4 reports
- Date range helpers
- Response parsing and validation
- Retry logic for API resilience
- PDF report generation
- Template rendering
- Data visualization in PDFs
- Export formatting

Application Server

- Technology: PHP-FPM (production) or Flask development server
- Port: 80/443 (web) or 5000 (Flask)
- Concurrency: Handles multiple simultaneous requests
- Logging: Centralized application logging

3. **Data Layer** (Storage & Caching)

File-Based Report Storage

- Location: "/reports/" directory
- Format: CSV files with date-stamped naming
- Naming Convention: "{report_type}_{start_date}_to_{end_date}.csv"
- Retention: Indefinite (local storage)
- Purpose: Archival and historical analysis

Temporary Data

- Location: "/tmp/" (system temp)
- Purpose: Intermediate processing
- Lifecycle: Cleaned up after each script execution

Configuration Storage

- Location: ".env" file (gitignored)
- Purpose: Environment-specific credentials and settings
- Security: Never committed to version control

Log Files

- Location: "/logs/" directory
- Types:
 - "web_interface.log" - PHP application logs
 - "{script_name}.log" - Individual script execution logs
 - "rate_limits.json" - API rate limiting state
- Rotation: Manual cleanup (recommended weekly)
- Retention: Last 30 days recommended

Database (Optional)

- Technology: MariaDB 10.3+
- Purpose: Optional persistence layer
- Status: Available but not required for core functionality
- Use Cases: Long-term metric storage, user preferences

Core Components

GA4 Integration Module

GA4 Data Analysis Scripts | | (uses) v ga4_client.py (Core Module) - API authentication - Query building - Response parsing - Error handling & retries | | (calls) v Google Analytics Data API (Google Cloud)

- Dimension selection (page, source, medium, campaign, etc.)
- Metric calculation (users, sessions, engagement, conversions)
- Date range filtering (custom ranges)
- Aggregation and rollups
- Real-time data access (up to ~30 minutes latency)

Google Ads Integration Module

```
Google Ads Management & Analytics | | (uses) v Service Account Authentication (JWT-based) | | (calls) v
Google Ads API (v14+) - Campaign management - Ad creation/modification - Performance metrics Scripts: -
google_ads_performance.py (read-only) - create_ad.py (write operations) - manage_google_ads.py (CRUD
operations)
```

- Email: Defined in Google Cloud Console
- Manager Account ID: Login credentials for MCC access
- Customer Account ID: Target account to manage
- Developer Token: Required for production access
- Permissions: Admin role on manager account

Search Console Integration Module

```
Google Search Console (GSC) Integration | | (uses) v Service Account (same as GA4) | | (calls) v Search
Console API - Keyword queries - Click metrics - Impression data Scripts: - keyword_analysis.py
(combined GA4 + GSC) - search_console_report.py
```

Technology Stack

Backend Framework

Component	Technology	Version	Purpose
-----	-----	-----	-----
Web Server	Nginx	1.24+	Reverse proxy, load balancing
App Server	PHP-FPM	7.4+	Primary request handler
Alt Framework	Python Flask	2.3+	Alternative app interface
Language	Python	3.11	Script execution, automation
Task Runner	DDEV	1.22+	Local development environment

Python Libraries

Library	Version	Purpose
-----	-----	-----
`google-analytics-data`	0.17+	GA4 API client
`google-ads`	22.0+	Google Ads API client
`google-auth`	2.25+	OAuth/JWT authentication
`pandas`	1.5+	Data manipulation & analysis
`requests`	2.31+	HTTP client for APIs
`reportlab`	4.0+	PDF generation

`python-dotenv`	1.0+	Environment variable loading
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Frontend Libraries

Library	Version	Purpose
-----	-----	-----
Bootstrap	5.3+	CSS framework
jQuery	3.6+	DOM manipulation
Chart.js	3.9+	Data visualization
DataTables	1.13+	Sortable tables

Infrastructure

Component	Technology	Environment
-----	-----	-----
Containerization	Docker	Local + Production
Orchestration	Docker Compose	Local + Production
Hosting	DigitalOcean App Platform	Production
DNS	AWS Route53	Domain management
Secrets	Environment Variables	Encrypted storage
CI/CD	GitHub Actions	Automated testing/deployment

Security & Compliance

Tool	Purpose
-----	-----
bcrypt	Password hashing
OpenSSL	TLS encryption
AES-256	Credential encryption
Rate Limiting	API protection
HTTPS/TLS 1.3	Transport security

Data Flow

Report Generation Workflow

```
User Request (Web Dashboard or CLI) ↓ Script Execution (Python) ████ Parse arguments ████ Load environment variables ████ Initialize API clients ↓ Data Collection ████ GA4 API queries ████
```

```
Multi-dimensional requests → API error handling & retries → Data Processing (Pandas) → DataFrame transformation → Aggregations & rollups → Metric calculations → Data validation → Output Generation → CSV export (primary) → PDF report generation → Console display → Database insertion (optional) → File Storage → Location: /reports/ directory → Format: CSV with date stamping → Retention: Indefinite
```

Web Request Flow

```
Browser ↓ (HTTP/S Request) Nginx Reverse Proxy ↓ (Forward to App Server) PHP-FPM Application ↓ (Route & Execute) index.php → Authenticate → Authorize → Display UI ↓ (User selects report) run_report.php → Validate args → Execute script → Capture output ↓ (Exec Python script) Python Script (analysis) → Fetch data → Process data → Generate CSV ↓ (Return results) Display Results → CSV download → Visual chart → Archive link
```

API Integration

Google Analytics 4 (GA4) API

- Service Account JSON key (JWT-based)
- OAuth 2.0 Refresh Token (OAuth-based)
- Scopes: "https://www.googleapis.com/auth/analytics.readonly"
- 10,000 requests per day (free tier)
- 1,000,000 requests per day (Basic access)
- Concurrent request limit: 10
- Real-time data: ~30 minutes latency
- Intraday data: ~4 hours latency
- Complete data: Next day at ~10:30 AM PT

```
# Dimensions (breakdown attributes) dimensions = ['date', 'sourceMedium', 'pageTitle', 'eventName'] # Metrics (measurements) metrics = ['activeUsers', 'sessions', 'engagementRate', 'conversions'] # Filters (conditions) filters = {'stringFilter': {'value': '/product'}} # Date ranges date_ranges = [{"startDate": 'YYYY-MM-DD', 'endDate': 'YYYY-MM-DD'}]
```

Google Ads API

- Basic Ads access API required for account management
- Developer Token (required for production access)
- Service Account (for read-only access via MCC structure)
- OAuth 2.0 (for account-level operations)
- Manager Account (MCC) - Service account added here
- Child Accounts - Managed through manager account
- Target Account - Specific account to operate on
- Daily budget: ~15,000 operations/day
- Hourly limit: ~2,500 operations/hour
- Burst capacity: Limited
- Read campaigns, ad groups, keywords

- Create/update ads and keywords
- Manage audience lists
- Retrieve performance metrics

Google Search Console API

- Service Account (same as GA4)
- Scopes: "https://www.googleapis.com/auth/webmasters.readonly"
- Search queries & performance
- Click metrics
- Impressions
- Average position
- Crawl statistics
- Coverage reports
- 600 requests per minute
- 200,000 requests per day

Security Architecture

Authentication & Access Control

Internal-Only Access

- VPN/Network Restriction: Access only from internal network
- IP Whitelisting: Only authorized staff IPs allowed
- Firewall Rules: DigitalOcean firewall configured

User Authentication

- Session-Based: Cookie-based sessions with secure flags
- Two-Factor Authentication (2FA): Required for all frontend access
- Password Hashing: bcrypt with configurable rounds
- Password Requirements:
 - Minimum 12 characters
 - Mixed case, numbers, special characters
 - No common patterns
- Account Lockout: 5 failed attempts → 30-minute lockout
- Session Timeout: 1 hour inactivity expiration

Role-Based Authorization

- Admin: Full system access, user management
- Analyst: Report access, limited configuration
- Viewer: Read-only access to specific reports
- Custom Roles: Define as needed

Credential Management

API Keys & Secrets

```
Environment Variables (.env) ■■■■■ GOOGLE_ADS_CUSTOMER_ID ■■■■■ GOOGLE_ADS_CLIENT_ID ■■■■■  
GOOGLE_ADS_CLIENT_SECRET ■■■■■ GOOGLE_ADS_DEVELOPER_TOKEN ■■■■■ GOOGLE_ADS_JSON_KEY_PATH ■■■■■  
GA4_PROPERTY_ID ■■■■■ GA4_KEY_PATH ■■■■■ DATABASE_PASSWORD ↓ (File Not in Git) Encrypted Storage (AES-256  
Encryption)
```

Service Account Keys

- Location: ".ddev/keys/" (gitignored)
- Type: JSON key files from Google Cloud
- Rotation: Quarterly (recommended)
- Backup: Secure offline backup maintained
- Revocation: Immediate if compromised

OAuth Tokens

- Refresh Tokens: Long-lived, securely stored
- Access Tokens: Short-lived (1 hour), auto-refreshed
- Token Rotation: Automatic on each refresh
- Revocation: Can be revoked via Google Dashboard

Data Protection

In-Transit

- HTTPS/TLS 1.3: All network traffic encrypted
- Certificate Management: Auto-renewal via Let's Encrypt
- HSTS: HTTP Strict Transport Security enabled
- Pinning: Certificate pinning for critical endpoints

At-Rest

- CSV Files: File permissions 0600 (owner read-write only)
- Database: Encrypted columns for sensitive data
- Backups: Encrypted offsite backups
- Temporary Files: Secure cleanup after processing

API Communication

- TLS Verification: All SSL/TLS certs verified
- Request Signing: JWT signing for service accounts
- Response Validation: Checksum verification
- Replay Prevention: Timestamp/nonce validation

Monitoring & Logging

Security Logging

```
/logs/security.log ■■■ Login attempts (success/failure) ■■■ Authorization failures ■■■ API credential  
access ■■■ Permission changes ■■■ Data export operations ■■■ Suspicious activity
```

Audit Trail

- What: Who did what, when, where
- Retention: 12 months minimum
- Access: Admin-only review
- Immutability: Write-once, read-many (WORM)

Real-Time Alerts

- Failed Logins: >3 in 5 minutes
- Rate Limit Hits: API quota exceeded
- Permission Errors: Unauthorized access attempts
- Configuration Changes: Any system setting modification

Network Security

Firewall Configuration

```
Inbound Rules: ■■■ Port 443 (HTTPS) - Allow staff IPs only ■■■ Port 22 (SSH) - Allow admin IPs only ■■■  
Port 80 (HTTP) - Redirect to HTTPS only ■■■ All other - DENY Outbound Rules: ■■■ Port 443 (HTTPS) -  
Allow (Google APIs, etc.) ■■■ Port 5432 (PostgreSQL) - Allow (internal DB only) ■■■ All others - DENY
```

DDoS Protection

- Rate Limiting: 100 requests/minute per IP
- Request Size Limit: 50MB maximum
- Connection Timeout: 30 seconds idle
- Cloudflare: Optional CDN/DDoS protection

Deployment Architecture

Local Development Environment

```
DDEV Multi-Container Setup ■■■■■ Web Container (PHP-FPM) - Port: 80/443 ■■■■■ Python 3.11 (isolated) -  
Port: 5000 ■■■■■ MariaDB (Optional) - Port: 3306 ■■■■■ Redis (Optional) - Port: 6379 Volumes: ■■■■■ Code  
(bind mount) ■■■■■ Database data ■■■■■ Reports & Logs
```

Production Deployment

```
DigitalOcean App Platform ■■■■■ Nginx - Reverse Proxy & Load Balancer ■■■■■ TLS Termination (Let's  
Encrypt) ■■■■■ Rate Limiting ■■■■■ IP Whitelisting ■■■■■ Request Logging ■■■■■ PHP-FPM Application  
Container(s) ■■■■■ Multiple instances (auto-scaled) ■■■■■ Health checks (HTTP 200 response) ■■■■■  
Session storage (Redis or Memcache) ■■■■■ Environment variable injection ■■■■■ Persistent Storage  
■■■■■ PostgreSQL Database ■■■■■ Object Storage (for reports) ■■■■■ Encrypted Backups
```

- Let's Encrypt certificates
- Auto-renewal 30 days before expiry
- HSTS headers enabled
- TLS 1.2+ minimum

CI/CD Pipeline

```
Git Push ↓ [1] Run Tests ■■■ Unit tests ■■■ Integration tests ■■■ Code quality checks ↓ [2] Build Artifacts ■■■ Docker image creation ■■■ Asset compilation ■■■ Version tagging ↓ [3] Security Scan ■■■ Dependency vulnerabilities ■■■ Secret detection ■■■ Container image scan ↓ [4] Stage Deployment (Staging) ■■■ Deploy to staging environment ■■■ Run smoke tests ■■■ Performance benchmarks ↓ [5] Production Deployment (Manual) ■■■ Manual approval required ■■■ Blue-green deployment ■■■ Health checks ■■■ Rollback capability
```

Backup & Disaster Recovery

- Frequency: Daily automated backups
- Retention: 30-day rolling window
- Location: Encrypted offsite storage
- Verification: Weekly restore tests

```
1. Detect failure (automated alerts) 2. Assess impact (manual review) 3. Restore from backup (automated script) 4. Verify data integrity (automated tests) 5. Resume operations (manual activation) 6. Post-mortem analysis (documented)
```

- RTO (Recovery Time Objective): 4 hours
- RPO (Recovery Point Objective): 24 hours

Scalability & Performance

Horizontal Scaling

- Nginx as reverse proxy
- Round-robin distribution
- Session persistence (sticky sessions)
- Health check monitoring

```
CPU Usage: ■■■ < 30% - Scale down (remove instances) ■■■ 30-70% - Maintain current ■■■ > 70% - Scale up (add instances) Memory Usage: ■■■ < 40% - Scale down ■■■ 40-80% - Maintain current ■■■ > 80% - Scale up Max Instances: 5 Min Instances: 2
```

Vertical Scaling

- PHP-FPM: 2 CPU, 2GB RAM per container
- Database: 4 CPU, 8GB RAM
- Total: Scalable based on demand

Caching Strategy

```
Browser Cache ■■■■■ CSS, JS, Images ■■■■■ TTL: 1 week ↓ CDN Cache (optional) ■■■■■ Reports, Static files ■■■■■ TTL: 24 hours ↓ Application Cache (Redis) ■■■■■ Session, API responses ■■■■■ TTL: 1 hour ↓ Database Query Cache ■■■■■ TTL: 30 minutes
```

Performance Optimization

- Batch requests when possible
 - Use appropriate time granularity
 - Limit dimensions per query
 - Implement exponential backoff for retries
 - Stream processing for large datasets
 - Chunked DataFrame operations
 - Lazy evaluation where possible
 - Memory-efficient CSV writing
 - Gzip compression (enabled)
 - CSS/JS minification
 - Image optimization
 - Lazy loading for tables
-

Development Patterns

Standard Script Structure

```
#!/usr/bin/env python3 """ Script description and purpose. """
import sys
import os
from datetime import datetime
# Add parent directory to path for imports
sys.path.insert(0, os.path.join(os.path.dirname(__file__), '..'))
from src.config import GA4_PROPERTY_ID, REPORTS_DIR
from src.ga4_client import run_report, create_date_range, get_yesterday_date
def main():
    """ Main execution function. """
    try:
        # 1. Set up date ranges
        start_date = get_yesterday_date()
        end_date = get_yesterday_date()
        date_range = create_date_range(start_date, end_date)
        # 2. Query GA4 API response
        response = run_report(dimensions=['date', 'sourceMedium'],
                              metrics=['activeUsers', 'sessions'],
                              date_ranges=[date_range])
        # 3. Validate response if response.row_count == 0:
        if response.row_count == 0:
            print("No data found for the specified date range.")
            return
        # 4. Process with pandas
        import pandas as pd
        data = []
        for row in response.rows:
            data.append({
                'date': row.dimension_values[0].value,
                'source_medium': row.dimension_values[1].value,
                'users': int(row.metric_values[0].value),
                'sessions': int(row.metric_values[1].value),
            })
        df = pd.DataFrame(data)
        # 5. Save to CSV
        filename = f"report_{start_date}_to_{end_date}.csv"
        filepath = os.path.join(REPORTS_DIR, filename)
        df.to_csv(filepath, index=False)
        print(f"Report saved: {filepath}")
    except Exception as e:
        print(f"Error: {e}")
        import traceback
        traceback.print_exc()
    return 0
if __name__ == "__main__":
    sys.exit(main())
```

Configuration Pattern

```
# src/config.py
import os
from dotenv import load_dotenv # Load environment variables
load_dotenv() # GA4 Configuration
GA4_PROPERTY_ID = os.getenv('GA4_PROPERTY_ID')
GA4_KEY_PATH = os.getenv('GA4_KEY_PATH') # Google Ads Configuration
GOOGLE_ADS_CUSTOMER_ID = os.getenv('GOOGLE_ADS_CUSTOMER_ID')
GOOGLE_ADS_LOGIN_CUSTOMER_ID = os.getenv('GOOGLE_ADS_LOGIN_CUSTOMER_ID')
GOOGLE_ADS_DEVELOPER_TOKEN = os.getenv('GOOGLE_ADS_DEVELOPER_TOKEN')
GOOGLE_ADS_JSON_KEY_PATH = os.getenv('GOOGLE_ADS_JSON_KEY_PATH') # Application Configuration
REPORTS_DIR = os.path.join(os.path.dirname(__file__), '..', 'reports')
LOGS_DIR = os.path.join(os.path.dirname(__file__), '..', 'logs') # Validate critical configuration if not set
if not GA4_PROPERTY_ID or not GA4_KEY_PATH:
    raise ValueError("GA4_PROPERTY_ID and GA4_KEY_PATH must be set in .env")
if not os.path.exists(GA4_KEY_PATH):
    raise FileNotFoundError(f"GA4 key file not found: {GA4_KEY_PATH}")
```

Error Handling Pattern

```

from google.api_core.exceptions import ( GoogleAPIError, ServiceUnavailable, TooManyRequests ) import
time def run_report_with_retry(request, max_retries=3): """Run report with exponential backoff
retry.""" for attempt in range(max_retries): try: return
client.get_service(...).search(request=request) except (ServiceUnavailable, TooManyRequests) as e: if
attempt < max_retries - 1: wait_time = 2 ** attempt # Exponential backoff print(f"■ Rate limited.
Retrying in {wait_time}s...") time.sleep(wait_time) else: raise except GoogleAPIError as e: print(f"■
API Error: {e.message}") raise

```

Testing Pattern

```

# tests/test_scripts/test_hourly_traffic.py import unittest from unittest.mock import patch, MagicMock
import sys import os sys.path.insert(0, os.path.join(os.path.dirname(__file__), '..', '..')) from
scripts.hourly_traffic_analysis import main class TestHourlyTrafficAnalysis(unittest.TestCase):
@patch('src.ga4_client.run_report') def test_no_data_handling(self, mock_run_report): """Test handling
when no data is returned.""" mock_response = MagicMock() mock_response.row_count = 0
mock_run_report.return_value = mock_response result = main() self.assertEqual(result, 0) # Should
handle gracefully @patch('src.ga4_client.run_report') def test_successful_report_generation(self,
mock_run_report): """Test successful report generation.""" # Setup mock response mock_response =
MagicMock() mock_response.row_count = 1 # ... setup mock data mock_run_report.return_value =
mock_response result = main() self.assertEqual(result, 0) if __name__ == '__main__': unittest.main()

```

Testing Strategy

Unit Testing

- Framework: unittest (Python standard library)
- Coverage Target: 80%+ code coverage
- Scope: Individual functions, helper utilities
- Mocking: API responses, file I/O, external services

Integration Testing

- Scope: Multi-component workflows (script → API → storage)
- Data: Test datasets with known outputs
- Environment: Isolated test environment with test API credentials
- Cleanup: Automatic cleanup after tests

End-to-End Testing

- Scope: Complete user workflows (web UI → script → report)
- Test Cases:
 - Report generation flow
 - Authentication & authorization
 - Data export & download
 - Error handling
- Frequency: Before each production release

Performance Testing

- Load Testing: Simulate 10+ concurrent users
- Stress Testing: Determine breaking point

- Endurance Testing: 24-hour sustained load
- Tool: Apache JMeter or k6

Security Testing

- Static Analysis: SAST (CodeQL, Semgrep)
- Dependency Scanning: Dependabot, Snyk
- Penetration Testing: Quarterly by external firm
- OWASP Top 10: Verified coverage

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Component Dependencies

Critical Path

```
Application Startup ■■■ Environment variables loaded (.env) ■■■ Google Cloud credentials validated ■■■  
Service account keys verified ■■■ Database connection established (if used) ■■■ Cache layer initialized  
(Redis) Script Execution ■■■ API client initialized ■■■ Authentication completed ■■■ Data query  
constructed ■■■ API request sent ■■■ Response validated ■■■ Data processing ■■■ Output written to  
storage
```

Dependency Management

- Specified in "requirements.txt"
- Pinned to minor version (e.g., "2.3.")
- Security patches auto-applied via Dependabot
- Monthly vulnerability scanning
- PHP 7.4+ or 8.1+
- Python 3.11+
- PostgreSQL 12+ (optional)
- Redis 6+ (optional)

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Monitoring & Observability

Metrics Collection

- Request count & latency
- Error rates (5xx, 4xx)
- API quota usage
- Database query performance
- Cache hit/miss rates
- Report generation success rate
- Data freshness (last update time)
- User engagement (logins, reports accessed)

- Data quality (missing data %)

Health Checks

```
{ "status": "ok", "timestamp": "2026-01-03T10:30:00Z", "checks": { "database": "ok", "ga4_api": "ok", "google_ads_api": "ok", "storage": "ok", "cache": "ok" } }
```

Alerting

- Application down
- Database connection lost
- Authentication failure
- API quota exceeded
- High error rates (>5%)
- Slow response times (>5s)
- Cache failure
- Low disk space (<10%)

Maintenance & Operations

Scheduled Maintenance

- Backup verification: Daily
- Security updates: Weekly
- Database optimization: Weekly
- Log rotation: Daily
- Dependency updates: Monthly

Runbook Examples

1. Stop application (graceful shutdown)
 2. Backup current database
 3. Restore from latest backup
 4. Verify data integrity
 5. Resume application
 6. Monitor error logs
 7. Document incident
-
1. Monitor CPU/Memory metrics
 2. Trigger manual scaling (if auto-scaling fails)
 3. Add new container instances
 4. Update load balancer configuration

5. Run health checks
 6. Monitor for 30 minutes
-

Glossary

Term	Definition
-----	-----
GA4	Google Analytics 4 - Latest analytics platform
MCC	Manager Customer Account - Manages multiple Google Ads accounts
JWT	JSON Web Token - Stateless authentication
TLS	Transport Layer Security - Encryption protocol
RTO	Recovery Time Objective - How fast to recover
RPO	Recovery Point Objective - How much data loss acceptable
WORM	Write-Once-Read-Many - Immutable storage
SAST	Static Application Security Testing
IAM	Identity & Access Management

Conclusion

NDE-Stats-GA is a secure, scalable internal analytics system designed specifically for ND Estates staff use. With robust API integrations, comprehensive security controls, and a modern deployment architecture, it provides the foundation for data-driven decision-making within the organization.

All access is restricted to authorized internal staff only, with enterprise-grade security measures in place to protect sensitive analytics and marketing data.