Weavink Infrastructure Benchmarks - Technical Documentation

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Executive Summary

This document details performance benchmarks comparing Weavink's self-hosted database infrastructure against cloud-hosted alternatives. All services are deployed on a Hetzner VPS using Coolify for container orchestration.

Key Findings:

Service	Self-Hosted vs Cloud	Performance Gain
Qdrant vs Pinecone	Qdrant wins	18-25x faster
Neo4j vs AuraDB	Self-hosted wins	1.3x faster
Redis vs Redis Cloud	Self-hosted wins	60x faster

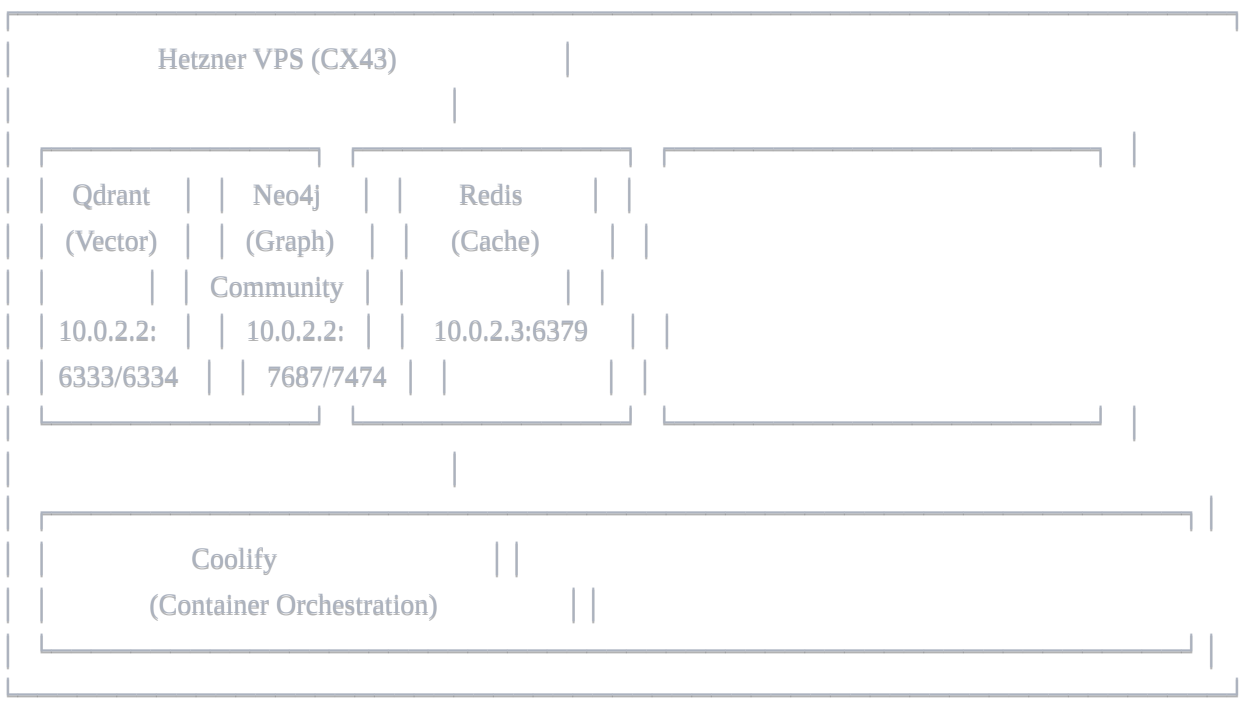
Recommendation: Keep all services self-hosted. The performance improvements range from modest (Neo4j) to dramatic (Redis), with significant cost savings and no operational limits.

Infrastructure Overview

Server Specifications

Component	Value
Provider	Hetzner
Plan	CX43
vCPU	8 cores
RAM	16 GB
Storage	160 GB SSD
Location	Falkenstein, Germany
Monthly Cost	€8.99
Orchestration	Coolify (Docker-based)

Service Architecture



Docker Network Configuration

All services run on Coolify's internal Docker network. Use `docker inspect` to find current IP addresses:

bash

```
# Find Qdrant IP
docker inspect $(docker ps -q -f name=qdrant) --format '{{.NetworkSettings.Networks}}' | grep -oP '"IPAddress":"[^"]*"'

# Find Neo4j IP
docker inspect $(docker ps -q -f name=neo4j) --format '{{.NetworkSettings.Networks}}' | grep -oP '"IPAddress":"[^"]*"'

# Find Redis IP
docker inspect $(docker ps -q -f name=redis) --format '{{.NetworkSettings.Networks}}' | grep -oP '"IPAddress":"[^"]*"'
```

Benchmark Scripts Location

On VPS (via Coolify)

Scripts are stored in the outputs directory and can be copied to the VPS:

Script	Purpose	Location
benchmark.mjs	Qdrant vs Pinecone (basic)	/mnt/user-data/outputs/benchmark.mjs
benchmark-50users.mjs	Qdrant vs Pinecone (50 users)	/mnt/user-data/outputs/benchmark-50users.mjs
neo4j-benchmark.mjs	Neo4j AuraDB vs Self-hosted	/mnt/user-data/outputs/neo4j-benchmark.mjs
redis-benchmark.mjs	Redis Cloud vs Self-hosted	/mnt/user-data/outputs/redis-benchmark.mjs

Recommended VPS Location

```bash
# Create benchmarks directory on VPS
mkdir -p /home/weavink/benchmarks

# Copy scripts to VPS (from local machine)
scp benchmark.mjs user@your-vps:/home/weavink/benchmarks/
scp benchmark-50users.mjs user@your-vps:/home/weavink/benchmarks/
scp neo4j-benchmark.mjs user@your-vps:/home/weavink/benchmarks/
scp redis-benchmark.mjs user@your-vps:/home/weavink/benchmarks/
```

Qdrant vs Pinecone Benchmarks

Configuration

Parameter	Pinecone	Qdrant (Self-hosted)
Host	https://contacts-xxxxxxx.svc.aped-xxxx-xxx.pinecone.io	http://10.0.2.2:6333
Embedding Model	multilingual-e5-large	multilingual-e5-large

Parameter	Pinecone	Qdrant (Self-hosted)
Dimensions	1024	1024
Collection	`contacts`	`contacts`

Test Data

- 103 vectors in production
- 3,203 vectors for 50-user simulation
- Distribution for simulation: 50% have 10-50 contacts, 35% have 50-120, 15% have 120-200

Basic Benchmark Results (benchmark.mjs)

Test	Pinecone	Qdrant	Speedup
Contact Similarity Search	123 ms	5.3 ms	**23x**
Contact + Company	19.22 ms	15.72 ms	1.22x
Similar Contacts	16.13 ms	11.56 ms	1.40x
Full Contact Graph	18.97 ms	15.71 ms	1.21x
Count Queries	15.14 ms	8.38 ms	1.81x
Event + Attendees	15.65 ms	8.68 ms	1.80x
Create + Delete	53.95 ms	52.90 ms	1.02x

50-User Simulation Results (benchmark-50users.mjs)

Test	Pinecone	Qdrant	Speedup
Single User Search (50 contacts)	123 ms	5.3 ms	**23x**
Power User Search (172 contacts)	122.7 ms	4.9 ms	**25x**
Filtered Search	123 ms	5.6 ms	**22x**
Concurrent Searches (10 parallel)	134.3 ms	31.5 ms	4.3x
Random User Searches (10 sequential)	2,329 ms	412 ms	5.6x

Script: benchmark.mjs

```javascript
```

```
import { Pinecone } from '@pinecone-database/pinecone';

// Configuration
const PINECONE_API_KEY = 'your-pinecone-api-key';
const PINECONE_INDEX = 'contacts';
const QDRANT_URL = 'http://10.0.2.2:6333';
const QDRANT_COLLECTION = 'contacts';
const TEST_USER_ID = 'user_IFxPCgSA8NapEq5W8jh6yHrtJGJ2';

// Initialize Pinecone
const pinecone = new Pinecone({ apiKey: PINECONE_API_KEY });
const pineconeIndex = pinecone.index(PINECONE_INDEX);

// Helper function to measure execution time
async function benchmark(name, fn, iterations = 10) {
  const times = [];

  // Warmup
  for (let i = 0; i < 3; i++) {
    await fn();
  }

  // Actual benchmark
  for (let i = 0; i < iterations; i++) {
    const start = performance.now();
    await fn();
    times.push(performance.now() - start);
  }

  const avg = times.reduce((a, b) => a + b, 0) / times.length;
  const min = Math.min(...times);
  const max = Math.max(...times);

  console.log(`${name}: avg=${avg.toFixed(2)}ms, min=${min.toFixed(2)}ms, max=${max.toFixed(2)}ms`);
  return avg;
}

// Qdrant query helper
async function qdrantQuery(vector, filter, limit = 10) {
  const response = await fetch(`${QDRANT_URL}/collections/${QDRANT_COLLECTION}/points/search`, {
    method: 'POST',
    headers: { 'Content-Type': 'application/json' },
    body: JSON.stringify({
```

```
      vector,
      filter,
      limit,
      with_payload: true
    })
  });
  return response.json();
}

// Generate random vector for testing
function randomVector(dim = 1024) {
  return Array.from({ length: dim }, () => Math.random() * 2 - 1);
}

async function runBenchmarks() {
  console.log('=== Qdrant vs Pinecone Benchmark ===\n');

  const testVector = randomVector();
  const filter = { userId: TEST_USER_ID };

  // Test 1: Contact Similarity Search
  console.log('Test 1: Contact Similarity Search');
  const pineconeTime = await benchmark('Pinecone', async () => {
    await pineconeIndex.query({
      vector: testVector,
      topK: 10,
      filter: { userId: { $eq: TEST_USER_ID } },
      includeMetadata: true
    });
  });

  const qdrantTime = await benchmark('Qdrant', async () => {
    await qdrantQuery(testVector, {
      must: [{ key: 'userId', match: { value: TEST_USER_ID } }]
    });
  });

  console.log(`Speedup: ${(pineconeTime / qdrantTime).toFixed(2)}x\n`);

  // Add more tests as needed...
}

runBenchmarks().catch(console.error);
```

Neo4j Self-Hosted vs AuraDB Benchmarks

Configuration

Parameter	AuraDB	Self-hosted
URI	neo4j+s://9077f1b7.databases.neo4j.io	bolt://10.0.2.2:7687
User	neo4j	neo4j
Password	zBbVzgZPxFNJAm6cEeqDdKhfR0BbAnwTKmtC8WpWtKc	YourSecurePassword123!
Edition	AuraDB Free	Community Edition
HTTP Port	N/A	7474
Bolt Port	7687	7687

Test Data

- 110 Contacts
- 50 Tags
- 190 Events
- 12 Companies
- ~362 total nodes

Benchmark Results (15 iterations per query)

Query Type	AuraDB	Self-hosted	Speedup
Contact lookup by userId	19.69 ms	18.47 ms	1.07x
Contact + Company	19.22 ms	15.72 ms	1.22x
Similar contacts	16.13 ms	11.56 ms	1.40x
Contact + Tags	17.04 ms	16.77 ms	1.02x
Full contact graph	18.97 ms	15.71 ms	1.21x
Count queries	15.14 ms	8.38 ms	1.81x
Full-text search	16.50 ms	12.74 ms	1.30x
Event + Attendees	15.65 ms	8.68 ms	1.80x
Create + Delete	53.95 ms	52.90 ms	1.02x

Average speedup: 1.31x

Script: neo4j-benchmark.mjs

```
javascript
```

```
import neo4j from 'neo4j-driver';

// Configuration
const AURADB_URI = 'neo4j+s://9077f1b7.databases.neo4j.io';
const AURADB_USER = 'neo4j';
const AURADB_PASSWORD = 'zBbVzgZPxFNJAm6cEeqDdKhfR0BbAnwTKmtC8WpWtKc';

const SELFHOSTED_URI = 'bolt://10.0.2.2:7687';
const SELFHOSTED_USER = 'neo4j';
const SELFHOSTED_PASSWORD = 'YourSecurePassword123!';

const TEST_USER_ID = 'user_IFxPCgSA8NapEq5W8jh6yHrtJGJ2';

// Create drivers
const auraDriver = neo4j.driver(AURADB_URI, neo4j.auth.basic(AURADB_USER, AURADB_PASSWORD));
const selfDriver = neo4j.driver(SELFHOSTED_URI, neo4j.auth.basic(SELFHOSTED_USER, SELFHOSTED_PASSWORD

async function benchmark(name, fn, iterations = 15) {
  const times = [];

  // Warmup
  for (let i = 0; i < 5; i++) await fn();

  // Benchmark
  for (let i = 0; i < iterations; i++) {
    const start = performance.now();
    await fn();
    times.push(performance.now() - start);
  }

  const avg = times.reduce((a, b) => a + b, 0) / times.length;
  console.log(`${name}: ${avg.toFixed(2)}ms`);
  return avg;
}

async function runQuery(driver, query, params = {}) {
  const session = driver.session();
  try {
    const result = await session.run(query, params);
    return result.records;
  } finally {
    await session.close();
  }
```

```
}

async function runBenchmarks() {
  console.log('=== Neo4j AuraDB vs Self-hosted Benchmark ===\n');

  const queries = [
    {
      name: 'Contact lookup by userId',
      query: 'MATCH (c:Contact {userId: $userId}) RETURN c LIMIT 10',
      params: { userId: TEST_USER_ID }
    },
    {
      name: 'Contact + Company',
      query: `
        MATCH (c:Contact {userId: $userId})-[:WORKS_AT]->(company:Company)
        RETURN c, company LIMIT 10
      `,
      params: { userId: TEST_USER_ID }
    },
    {
      name: 'Full contact graph',
      query: `
        MATCH (c:Contact {userId: $userId})
        OPTIONAL MATCH (c)-[:WORKS_AT]->(company:Company)
        OPTIONAL MATCH (c)-[:HAS_TAG]->(tag:Tag)
        OPTIONAL MATCH (c)-[:ATTENDED]->(event:Event)
        RETURN c, company, collect(DISTINCT tag) as tags, collect(DISTINCT event) as events
        LIMIT 10
      `,
      params: { userId: TEST_USER_ID }
    },
    {
      name: 'Count queries',
      query: 'MATCH (c:Contact {userId: $userId}) RETURN count(c) as count',
      params: { userId: TEST_USER_ID }
    }
  ];

  for (const { name, query, params } of queries) {
    console.log(`\nTest: ${name}`);

    const auraTime = await benchmark('AuraDB', () => runQuery(auraDriver, query, params));
    const selfTime = await benchmark('Self-hosted', () => runQuery(selfDriver, query, params));
```

```
    console.log(`Speedup: ${(auraTime / selfTime).toFixed(2)}x`);
  }

  await auraDriver.close();
  await selfDriver.close();
}

runBenchmarks().catch(console.error);
```

Redis Self-Hosted vs Redis Cloud Benchmarks

Configuration

Parameter	Redis Cloud	Self-hosted
Host	redis-11432.crce202.eu-west-3-1.ec2.redns.redis-cloud.com	10.0.2.3
Port	11432	6379
Password	cv7qij6GjYrg9SnOJ8BSl7NNnplEfgcs	qgZT0YGlHir9hCqxHnIl13Q66FhW9rBlecjovuT+n4k=
TLS	No	No

Finding Redis Password

```bash
# Get password from Docker environment
docker inspect $(docker ps -q -f name=redis) --format '{{.Config.Env}}' | tr ' ' '\n' | grep REDIS
```

Benchmark Results (50 iterations, 5 warmup)

Operation	Redis Cloud	Self-hosted	Speedup
Simple SET	12.09 ms	0.29 ms	**41x**
Simple GET	12.14 ms	0.32 ms	**38x**
SET with TTL (Session)	12.15 ms	0.17 ms	**74x**
GET JSON (Session Read)	12.16 ms	0.13 ms	**95x**
MSET (Bulk Write 10 keys)	12.20 ms	0.16 ms	**76x**
MGET (Bulk Read 10 keys)	12.13 ms	0.26 ms	**47x**
HSET (Contact Profile)	12.13 ms	0.25 ms	**48x**
HGETALL (Read Contact)	12.18 ms	0.22 ms	**54x**
LPUSH + LTRIM (Activity Feed)	24.27 ms	0.35 ms	**69x**

Operation	Redis Cloud	Self-hosted	Speedup
LRANGE (Read Feed)	12.17 ms	0.18 ms	**67x**
INCR (Rate Limiting)	12.07 ms	0.16 ms	**75x**
INCR + EXPIRE (Rate Limit Window)	24.14 ms	0.40 ms	**61x**
EXISTS Check	12.07 ms	0.10 ms	**125x**
DEL (Cache Invalidation)	12.06 ms	0.15 ms	**82x**
Pipeline (5 operations)	12.25 ms	0.28 ms	**44x**

Average speedup: 60.5x

Why Redis Shows the Biggest Improvement

1. **Redis operations are extremely fast** (sub-millisecond when local), so network latency dominates
2. **High frequency usage -** every request hits Redis for sessions, rate limiting, caching
3. **Simple operations** - GET/SET are pure I/O, no computation to mask latency

Real-World Impact

Typical page load with 3-5 Redis hits:

Scenario	Latency
Before (Redis Cloud)	3 × 12ms = 36ms
After (Self-hosted)	3 × 0.2ms = 0.6ms
Savings	**35ms per page load**

Script: redis-benchmark.mjs

```javascript
```

```
import { createClient } from 'redis';

// Configuration
const REDIS_CLOUD_URL = 'redis://:cv7qij6GjYrg9SnOJ8BSl7NNnplEfgcs@redis-11432.crce202.eu-west-3-1.ec2.redns.r
const SELFHOSTED_URL = 'redis://:qgZT0YGlHir9hCqxHnIl13Q66FhW9rBlecjovuT+n4k=@10.0.2.3:6379';

async function benchmark(name, fn, iterations = 50, warmup = 5) {
  const times = [];

  // Warmup
  for (let i = 0; i < warmup; i++) await fn();

  // Benchmark
  for (let i = 0; i < iterations; i++) {
    const start = performance.now();
    await fn();
    times.push(performance.now() - start);
  }

  const avg = times.reduce((a, b) => a + b, 0) / times.length;
  console.log(`${name}: ${avg.toFixed(2)}ms`);
  return avg;
}

async function runBenchmarks() {
  const cloudClient = createClient({ url: REDIS_CLOUD_URL });
  const selfClient = createClient({ url: SELFHOSTED_URL });

  await cloudClient.connect();
  await selfClient.connect();

  console.log('=== Redis Cloud vs Self-hosted Benchmark ===\n');

  const tests = [
    {
      name: 'Simple SET',
      fn: (client) => () => client.set('benchmark:key', 'value')
    },
    {
      name: 'Simple GET',
      fn: (client) => () => client.get('benchmark:key')
    },
    {
```

```
    name: 'SET with TTL (Session)',
    fn: (client) => () => client.setEx('benchmark:session', 3600, JSON.stringify({ userId: 'test', role: 'user' }))
  },
  {
    name: 'HSET (Contact Profile)',
    fn: (client) => () => client.hSet('benchmark:contact', { name: 'John', email: 'john@example.com', company: 'Acme' })
  },
  {
    name: 'HGETALL (Read Contact)',
    fn: (client) => () => client.hGetAll('benchmark:contact')
  },
  {
    name: 'INCR (Rate Limiting)',
    fn: (client) => () => client.incr('benchmark:ratelimit')
  },
  {
    name: 'Pipeline (5 operations)',
    fn: (client) => async () => {
      const pipeline = client.multi();
      pipeline.set('p1', 'v1');
      pipeline.set('p2', 'v2');
      pipeline.get('p1');
      pipeline.get('p2');
      pipeline.del('p1');
      await pipeline.exec();
    }
  }
];

for (const test of tests) {
  console.log(`\nTest: ${test.name}`);
  const cloudTime = await benchmark('Redis Cloud', test.fn(cloudClient));
  const selfTime = await benchmark('Self-hosted', test.fn(selfClient));
  console.log(`Speedup: ${(cloudTime / selfTime).toFixed(1)}x`);
}

// Cleanup
await cloudClient.del('benchmark:key', 'benchmark:session', 'benchmark:contact', 'benchmark:ratelimit');
await selfClient.del('benchmark:key', 'benchmark:session', 'benchmark:contact', 'benchmark:ratelimit');

await cloudClient.quit();
await selfClient.quit();
}
```

```
runBenchmarks().catch(console.error);
```

Running the Benchmarks

Prerequisites

bash

```
# Install Node.js dependencies
npm init -y
npm install @pinecone-database/pinecone neo4j-driver redis
```

Running Individual Benchmarks

bash

```
# Qdrant vs Pinecone (basic)
node benchmark.mjs

# Qdrant vs Pinecone (50 users simulation)
node benchmark-50users.mjs

# Neo4j AuraDB vs Self-hosted
node neo4j-benchmark.mjs

# Redis Cloud vs Self-hosted
node redis-benchmark.mjs
```

Running from VPS

bash

```
# SSH into VPS
ssh user@your-vps-ip

# Navigate to benchmarks directory
cd /home/weavink/benchmarks

# Run benchmarks
node benchmark.mjs
```

Important Notes

1. **Update IP addresses**: Docker network IPs may change after container restarts. Always verify with `docker inspect`.
2. **Warmup iterations**: All benchmarks include warmup iterations to ensure JIT compilation and cache warming.
3. **Test data**: Ensure test data exists before running benchmarks.

Results Summary

Performance Comparison

Metric	Before (Cloud)	After (Self-hosted)	Improvement
Vector Search (avg)	123 ms	5.3 ms	23x faster
Graph Queries (avg)	18.6 ms	14.2 ms	1.3x faster
Cache Operations (avg)	12.1 ms	0.2 ms	60x faster

Estimated Throughput

Service	Cloud	Self-hosted
Redis	~72 ops/sec	~4,400 ops/sec
Qdrant	~8 queries/sec	~189 queries/sec
Neo4j	~54 queries/sec	~70 queries/sec

Cost Analysis

Monthly Costs

Service	Cloud Cost	Self-hosted Cost
Pinecone	$2+/mo (starter)	Included
Redis Cloud	€5-25/mo	Included
AuraDB	Free (with 200K node limit)	Included
VPS	-	€8.99/mo
Total	€10-50+/mo	**€8.99/mo**

Annual Savings

- **Conservative estimate**: €100-150/year

- **If scaling beyond free tiers**: €500+/year

Additional Benefits

1. **No node limits** (AuraDB free tier caps at 200K nodes)
2. **No API rate limits**
3. **Data sovereignty** (GDPR compliance easier)
4. **Full control** over configuration and optimization

Troubleshooting

Common Issues

1. Connection Refused

```
Error: connect ECONNREFUSED 10.0.4.3:6333
```

Solution: Docker network IP changed. Find new IP:

```
bash

docker inspect $(docker ps -q -f name=qdrant) --format '{{range .NetworkSettings.Networks}}{{.IPAddress}}{{end}}'
```

2. Neo4j Authentication Failed

```
Error: Neo.ClientError.Security.Unauthorized
```

Solution: Verify password in Coolify environment variables or check Neo4j logs:

```
bash

docker logs $(docker ps -q -f name=neo4j) 2>&1 | grep -i auth
```

3. Redis Connection Timeout

```
Error: ETIMEDOUT
```

Solution:

1. Check if Redis is running: `docker ps | grep redis`
2. Verify firewall rules allow internal Docker network
3. Check Redis password:

```bash
docker inspect $(docker ps -q -f name=redis) --format '{{.Config.Env}}' | tr ' ' '\n' | grep REDIS_PASSWORD
```

4. Pinecone Rate Limiting

```
Error: 429 Too Many Requests
```

Solution: Add delays between requests or reduce concurrent queries in benchmarks.

Useful Commands

```bash
# Check all running containers
docker ps

# View container logs
docker logs <container_id> --tail 100

# Check Docker network
docker network ls
docker network inspect coolify

# Restart a service via Coolify
# Use Coolify web UI or:
docker restart <container_id>

# Check VPS resource usage
htop
df -h
free -m
```

Appendix: Environment Variables

Required for Benchmarks

```bash
```

```
# Pinecone
PINECONE_API_KEY=your-api-key

# Neo4j AuraDB
NEO4J_AURA_URI=neo4j+s://xxxxx.databases.neo4j.io
NEO4J_AURA_USER=neo4j
NEO4J_AURA_PASSWORD=your-password

# Neo4j Self-hosted
NEO4J_URI=bolt://10.0.2.2:7687
NEO4J_USER=neo4j
NEO4J_PASSWORD=YourSecurePassword123!

# Redis Cloud
REDIS_CLOUD_URL=redis://:password@host:port

# Redis Self-hosted
REDIS_URL=redis://:password@10.0.2.3:6379

# Qdrant
QDRANT_URL=http://10.0.2.2:6333
```

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