Claude-Flow WhatsApp AI Chatbot - Vollständige Ablaufdokumentation

Inhaltsverzeichnis

Executive Summary

Projektübersicht

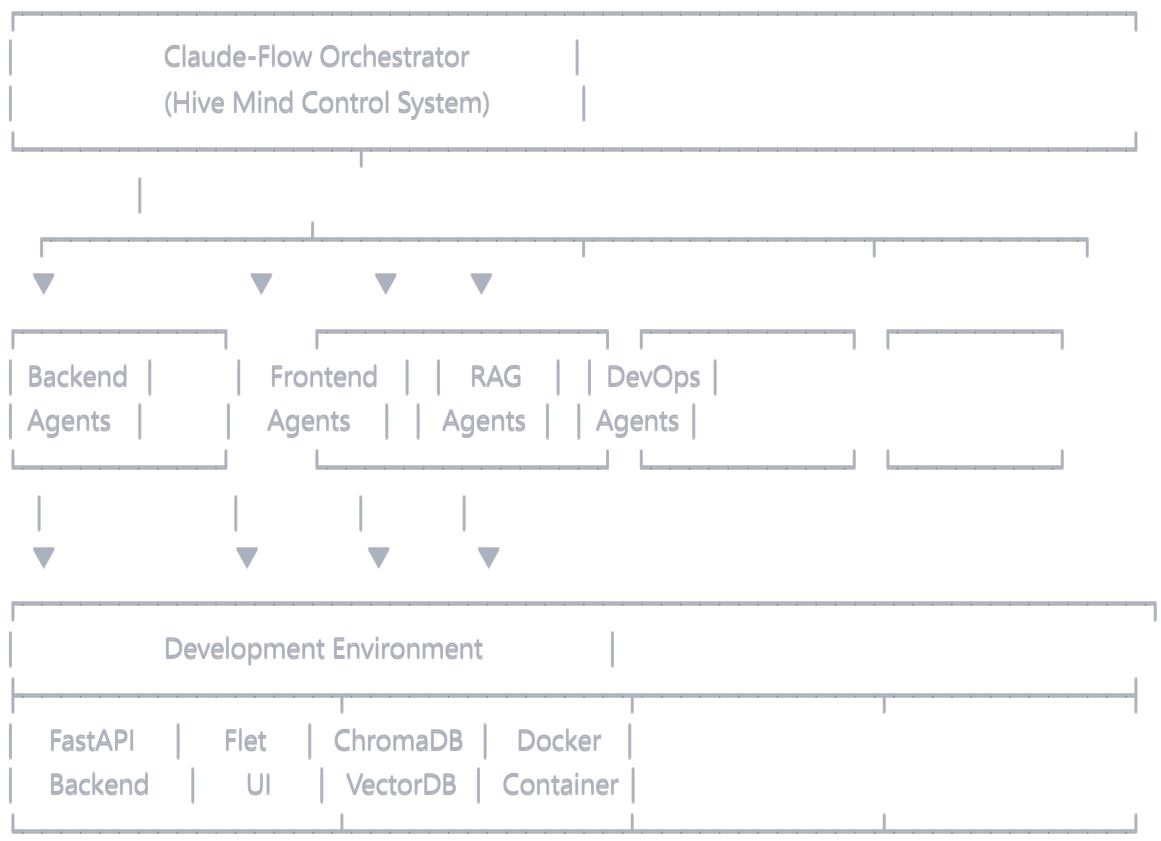
- **Projekt:** WhatsApp-ähnlicher AI Chatbot mit RAG-System
- **Entwicklungsdauer:** 6-8 Wochen
- **Technologie-Stack:** Python 3.12, FastAPI, Flet, ChromaDB, SQLite
- **Orchestrierung:** Claude-Flow Hive Mind System
- **Agenten:** 10 spezialisierte AI-Agenten
- **Entwicklungsansatz:** 4-Phasen Sequential Development

Kernziele

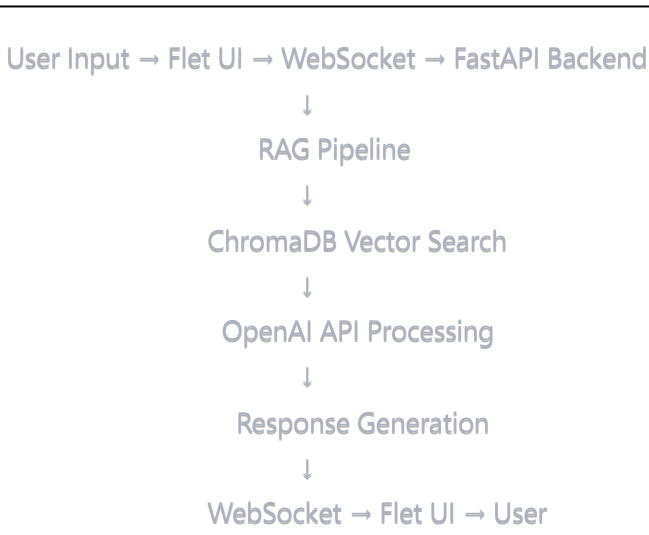
1. Produktionsreifer WhatsApp-Clone mit AI-Integration
2. Fortgeschrittenes RAG-System für 525MB+ Dokumentation
3. Multi-Projekt-Unterstützung mit isolierten Wissensdatenbanken
4. Echtzeit-Synchronisation mit <1s Latenz
5. Vollständige Test-Coverage (>80%)

Systemarchitektur

Technische Komponenten



Datenfluss-Architektur



Claude-Flow Orchestrierung

Hauptbefehl

bash

```
npx claude-flow@alpha hive-mind spawn \
  "Entwicklung WhatsApp AI Chatbot gemäß Umsetzungsplan" \
  --agents "queen-orchestrator,architect-1,coder-backend,coder-frontend,\
        tester-1,devops-1,documenter-1,sparc-coord,code-analyzer,api-docs" \
  --tools "mcp_filesystem,sql,database,code_executor,test_runner,docker,terminal" \
  --mode "sequential-phases" \
  --claude --verbose \
  --output ".AI_Exchange/whatsapp_chatbot"
```

Agent-Rollen und Verantwortlichkeiten

Agent ID	Rolle	Hauptverantwortung	Phasen
queen-orchestrator	Orchestrator	Zentrale Koordination, Task-Verteilung	Alle
architect-1	System Architect	Architektur-Design, Technologie-Entscheidungen	Phase 1
coder-backend	Backend Dev	FastAPI, RAG-System, Database	Phase 1-3
coder-frontend	Frontend Dev	Flet UI, WhatsApp-Design	Phase 2-3
tester-1	Test Engineer	Unit Tests, Integration Tests	Phase 3-4
devops-1	DevOps	Docker, Deployment, CI/CD	Phase 4
documenter-1	Tech Writer	Dokumentation, API Docs	Phase 4
sparc-coord	SPARC Lead	Methodologie-Einhaltung	Alle
code-analyzer	Analyzer	Code-Qualität, Performance	Phase 3-4
api-docs	API Specialist	OpenAPI Spec, Endpoints	Phase 2-3

Ablaufdiagramm

Hauptprozess-Flow

```
mermaid
```

```
graph TD
    Start([Start: Claude-Flow Initialisierung]) --> Init[Hive Mind Spawn]
    Init --> Queen[Queen Orchestrator Aktivierung]

    Queen --> Phase1{Phase 1: Foundation}

    %% Phase 1 Branch
    Phase1 --> P1_Arch[architect-1: System Design]
    P1_Arch --> P1_Backend[coder-backend: SQLite Schema]
    P1_Backend --> P1_API[coder-backend: FastAPI Setup]
    P1_API --> P1_RAG[coder-backend: ChromaDB Integration]
    P1_RAG --> P1_Check1{Quality Check}

    P1_Check1 -->|Pass| Phase2{Phase 2: Core Features}
    P1_Check1 -->|Fail| P1_Fix[SPARC-coord: Fix Issues]
    P1_Fix --> P1_Arch

    %% Phase 2 Branch
    Phase2 --> P2_Multi[coder-backend: Multi-Projekt System]
    P2_Multi --> P2_Frontend[coder-frontend: Flet UI]
    P2_Frontend --> P2_Github[coder-backend: GitHub Integration]
    P2_Github --> P2_Watch[coder-backend: File Watching]
    P2_Watch --> P2_Check{Quality Check}

    P2_Check -->|Pass| Phase3{Phase 3: Advanced RAG}
    P2_Check -->|Fail| P2_Fix[code-analyzer: Optimize]
    P2_Fix --> P2_Multi

    %% Phase 3 Branch
    Phase3 --> P3_Hybrid[coder-backend: Hybrid Search]
    P3_Hybrid --> P3_Query[coder-backend: Query Decomposition]
    P3_Query --> P3_Rerank[coder-backend: Reranking System]
    P3_Rerank --> P3_Test[tester-1: Test Suite]
    P3_Test --> P3_Check{Test Coverage >80%?}

    P3_Check -->|Yes| Phase4{Phase 4: Production}
    P3_Check -->|No| P3_More[tester-1: More Tests]
    P3_More --> P3_Test

    %% Phase 4 Branch
    Phase4 --> P4_Security[devops-1: Security Layer]
    P4_Security --> P4_Perf[code-analyzer: Performance Opt]
    P4_Perf --> P4_Docker[devops-1: Containerization]
    P4_Docker --> P4_Docs[documenter-1: Documentation]
    P4_Docs --> Final{Final Review}
```

```
Final -->|Approved| Deploy[Deployment Ready]
Final -->|Issues| P4_Refine[Team: Refinement]
P4_Refine --> P4_Security

Deploy --> End([End: Production Ready])

style Start fill:#e1f5fe
style End fill:#c8e6c9
style Queen fill:#fff3e0
style Phase1 fill:#f3e5f5
style Phase2 fill:#f3e5f5
style Phase3 fill:#f3e5f5
style Phase4 fill:#f3e5f5
style Deploy fill:#a5d6a7
```

Agent-Kommunikationsflow

mermaid

```
sequenceDiagram
    participant User
    participant CLI as Claude-Flow CLI
    participant Queen as Queen Orchestrator
    participant Arch as Architect
    participant Backend as Backend Coder
    participant Frontend as Frontend Coder
    participant Tester as Tester
    participant DevOps as DevOps

    User->>CLI: npx claude-flow hive-mind spawn
    CLI->>Queen: Initialize Orchestration
    Queen->>Queen: Parse umsetzungsplan.md

    rect rgb(200, 230, 255)
        Note over Queen,Arch: Phase 1: Foundation
        Queen->>Arch: Design System Architecture
        Arch->>Backend: Implement SQLite Schema
        Backend->>Backend: Create FastAPI Backend
        Backend->>Backend: Setup ChromaDB
        Backend->>Queen: Report Phase 1 Complete
    end

    rect rgb(230, 255, 200)
        Note over Queen,Frontend: Phase 2: Core Features
        Queen->>Backend: Multi-Project System
        Queen->>Frontend: Create Flet UI
        Frontend->>Frontend: WhatsApp Layout
        Backend->>Backend: GitHub Integration
        Backend->>Queen: Report Phase 2 Complete
    end

    rect rgb(255, 230, 200)
        Note over Queen,Tester: Phase 3: Advanced RAG
        Queen->>Backend: Implement Hybrid Search
        Backend->>Backend: Query Decomposition
        Backend->>Backend: Reranking System
        Queen->>Tester: Run Test Suite
        Tester->>Queen: Coverage Report
    end

    rect rgb(255, 200, 230)
        Note over Queen,DevOps: Phase 4: Production
        Queen->>DevOps: Security Implementation
        DevOps->>DevOps: Docker Setup
        Queen->>Tester: Final Validation
```

```
    Tester->>Queen: Production Ready
end

Queen->>CLI: Project Complete
CLI->>User: Success Report
```

Phasen-Details

Phase 1: Foundation (Woche 1-2, 60 Stunden)

1.1 Projekt-Setup (8 Stunden)

Lead Agent: architect-1
Support: sparc-coord

```python
# Automatisch generierte Struktur
.AI_Exchange/whatsapp_chatbot/
├── src/
│   ├── api/          # FastAPI endpoints
│   ├── core/         # RAG system, business logic
│   ├── database/     # SQLite models, migrations
│   ├── ui/           # Flet components
│   └── utils/        # Helper functions
├── tests/            # Test suite
├── docs/             # Documentation
├── brain/            # ChromaDB storage
├── migrations/       # Database migrations
└── docker/           # Container configs
```

1.2 Datenbank-Implementation (12 Stunden)

Lead Agent: coder-backend
Tools: sql, database

- Erstellung SQLite Schema
- Foreign Keys und Indizes
- Trigger für automatische Updates
- Migration Scripts

1.3 FastAPI Backend (16 Stunden)

Lead Agent: coder-backend
Support: api-docs

- REST API Endpoints
- WebSocket für Real-time Chat
- Authentication Middleware
- Error Handling

1.4 RAG Foundation (16 Stunden)

Lead Agent: coder-backend
Tools: mcp_filesystem

- ChromaDB Setup
- OpenAI Integration
- Text Splitting Pipeline
- Basic Retrieval

1.5 Basic UI (8 Stunden)

Lead Agent: coder-frontend

- WhatsApp-Layout
- Message Bubbles
- Input Area
- Project Sidebar

Phase 2: Core Features (Woche 3-4, 80 Stunden)

2.1 Multi-Projekt System (20 Stunden)

Lead Agent: coder-backend
Support: architect-1

- Projekt-Isolation
- Collection Management
- Context Switching
- Settings per Project

2.2 GitHub Integration (16 Stunden)

Lead Agent: coder-backend
Tools: terminal

- Repository Cloning
- File Indexing
- Commit History
- Issue Tracking

2.3 File Watching (20 Stunden)

Lead Agent: coder-backend

- Watchdog Implementation
- Real-time Updates
- Incremental Indexing
- Change Detection

2.4 Advanced UI (24 Stunden)

Lead Agent: coder-frontend

- Search Functionality
- File Upload
- Settings Panel
- Responsive Design

Phase 3: Advanced RAG (Woche 5, 40 Stunden)

3.1 Hybrid Search (12 Stunden)

Lead Agent: coder-backend
Support: code-analyzer

- Semantic Search (Embeddings)
- BM25 Keyword Search
- Score Fusion
- Result Ranking

3.2 Query Decomposition (8 Stunden)

Lead Agent: coder-backend

- Multi-hop Reasoning
- Sub-query Generation
- Answer Synthesis
- Context Management

3.3 Context Compression (8 Stunden)

Lead Agent: coder-backend

- Token Optimization
- Relevant Passage Extraction
- Summary Generation
- Context Window Management

3.4 Reranking (12 Stunden)

Lead Agent: coder-backend
Support: tester-1

- Cross-Encoder Models
- Relevance Scoring
- Result Optimization
- Performance Tuning

Phase 4: Production (Woche 6, 40 Stunden)

4.1 Security (12 Stunden)

Lead Agent: devops-1

- Input Validation
- SQL Injection Prevention
- Rate Limiting
- API Key Management

4.2 Performance (12 Stunden)

Lead Agent: code-analyzer

- Query Optimization
- Caching Strategy
- Async Processing
- Load Testing

4.3 Testing (10 Stunden)

Lead Agent: tester-1
Tools: test_runner

- Unit Tests (>80% Coverage)
- Integration Tests
- E2E Tests
- Performance Benchmarks

4.4 Deployment (6 Stunden)

Lead Agent: devops-1
Support: documenter-1 **Tools:** docker

- Docker Container
- Environment Config
- Deployment Scripts
- Documentation

Agent-Koordination

Kommunikationsprotokolle

1. Task Distribution

```json
{
  "from": "queen-orchestrator",
  "to": "coder-backend",
  "task": {
    "id": "task-001",
    "type": "implementation",
    "description": "Create SQLite schema",
    "priority": "high",
    "deadline": "2025-01-23T18:00:00Z",
    "requirements": [
      "Full schema from umsetzungsplan.md",
      "All indexes and triggers",
      "Migration scripts"
    ]
  }
}
```

2. Progress Reporting

```json
```

```
{
  "from": "coder-backend",
  "to": "queen-orchestrator",
  "report": {
    "task_id": "task-001",
    "status": "completed",
    "timestamp": "2025-01-23T16:30:00Z",
    "output": {
      "files_created": [
        "src/database/models.py",
        "migrations/001_initial.sql"
      ],
      "tests_passed": 12,
      "coverage": 95.2
    }
  }
}
```

3. Quality Check Request

json

```
{
  "from": "queen-orchestrator",
  "to": "code-analyzer",
  "request": {
    "type": "quality_check",
    "target": "src/database/",
    "criteria": [
      "no_placeholders",
      "full_error_handling",
      "docstrings_present",
      "type_hints_complete"
    ]
  }
}
```

Konsens-Mechanismen

Raft Consensus für kritische Entscheidungen

- **Leader Election:** queen-orchestrator als Primary
- **Log Replication:** Alle Agenten erhalten Task-Updates
- **Commit Phase:** Bestätigung von Mehrheit erforderlich

Byzantine Fault Tolerance

- **Validator Nodes:** tester-1, code-analyzer
- **Verification:** Doppelte Code-Reviews
- **Conflict Resolution:** SPARC-coord als Mediator

Tool-Integration

MCP (Model Context Protocol) Tools

1. Filesystem Access

```javascript
// Automatisch verfügbar für alle Agenten
mcp_filesystem.read_file("src/main.py")
mcp_filesystem.write_file("src/api/endpoints.py", content)
mcp_filesystem.list_directory("src/")
```

2. SQL Operations

```sql
-- Direkte SQL-Ausführung via MCP
mcp_sql.execute("""
  CREATE TABLE projects (
    id INTEGER PRIMARY KEY,
    name TEXT NOT NULL
  )
""")
```

3. Code Execution

```python
# Test Runner Integration
result = code_executor.run_tests("tests/test_rag.py")
assert result.coverage > 80
```

External Tool Integration

Tool	Zweck	Integration	Agent
Docker	Containerization	CLI Commands	devops-1
Git	Version Control	GitPython	coder-backend
OpenAI	LLM API	Python SDK	coder-backend
ChromaDB	Vector Store	Native Python	coder-backend
SQLite	Database	sqlite3	coder-backend
Pytest	Testing	Test Runner	tester-1

Qualitätssicherung

Automatische Checks (§3-§7 Compliance)

Code-Vollständigkeits-Check

python

```python
def check_code_completeness(file_path):
    """Prüft auf verbotene Patterns"""
    forbidden = [
        r"#\s*TODO",
        r"pass\s*$",
        r"\.\.\..*#.*placeholder",
        r"raise NotImplementedError"
    ]

    with open(file_path, 'r') as f:
        content = f.read()

    violations = []
    for pattern in forbidden:
        if re.search(pattern, content):
            violations.append(pattern)

    return len(violations) == 0, violations
```

Error Handling Validation

python

```python
def validate_error_handling(ast_tree):
    """Prüft comprehensives Error Handling"""

    for node in ast.walk(ast_tree):
        if isinstance(node, ast.FunctionDef):
            has_try_except = False
            has_input_validation = False

            for child in ast.walk(node):
                if isinstance(child, ast.Try):
                    has_try_except = True
                if isinstance(child, ast.Assert):
                    has_input_validation = True

            if not (has_try_except and has_input_validation):
                return False

    return True
```

Progress Tracking

Automatisches Update der Checkliste

markdown

```
## Progress Checklist - Auto-Updated

### Phase 1: Foundation ✅
- [x] **1.1 Project Setup**
  Status: ✅ Completed (2025-01-23 10:00)
  Agent: architect-1
  Files: 15 created

- [x] **1.2 Database Schema**
  Status: ✅ Completed (2025-01-23 14:30)
  Agent: coder-backend
  Tests: 12/12 passed

- [x] **1.3 FastAPI Backend**
  Status: ✅ Completed (2025-01-23 18:00)
  Agent: coder-backend
  Coverage: 92%

### Phase 2: Core Features 🔄
- [x] **2.1 Multi-Project System**
  Status: ✅ Completed (2025-01-24 12:00)

- [ ] **2.2 GitHub Integration**
  Status: 🔄 In Progress
  Agent: coder-backend
  Progress: 60%
```

Ausführungsanleitung

Voraussetzungen

System Requirements

- **OS:** Windows 11 (WSL2 optional)
- **Node.js:** >=18.0.0
- **Python:** 3.12
- **RAM:** Minimum 8GB
- **Storage:** 10GB free space

Installation

```bash
```

```
# 1. Claude-Flow installieren
npm install -g claude-flow@alpha

# 2. Python Environment setup
python -m venv venv
source venv/bin/activate  # Windows: venv\Scripts\activate

# 3. Dependencies installieren
pip install -r requirements.txt

# 4. MCP Server Setup
npm install -g @modelcontextprotocol/server-sqlite
npm install -g @modelcontextprotocol/server-filesystem
```

Schritt-für-Schritt Ausführung

1. Projekt initialisieren

bash

```
# Arbeitsverzeichnis erstellen
mkdir -p .AI_Exchange/whatsapp_chatbot
cd .AI_Exchange/whatsapp_chatbot

# Umsetzungsplan kopieren
cp ../../whatsapp_chatbot_umsetzungsplan.md .
```

2. Claude-Flow starten

bash

```
# Hauptbefehl ausführen
npx claude-flow@alpha hive-mind spawn \
  "$(cat whatsapp_chatbot_umsetzungsplan.md)" \
  --agents "queen-orchestrator,architect-1,coder-backend,coder-frontend,tester-1,devops-1,documenter-1,sparc-coord
  --tools "mcp_filesystem,sql,database,code_executor,test_runner,docker,terminal" \
  --mode "sequential-phases" \
  --claude \
  --verbose \
  --output "."
```

3. Monitoring

bash

```
# In separatem Terminal
tail -f progress_checklist.md

# Agent Status
npx claude-flow status --live

# Performance Metrics
npx claude-flow metrics --dashboard
```

4. Manuelle Intervention (falls nötig)

bash

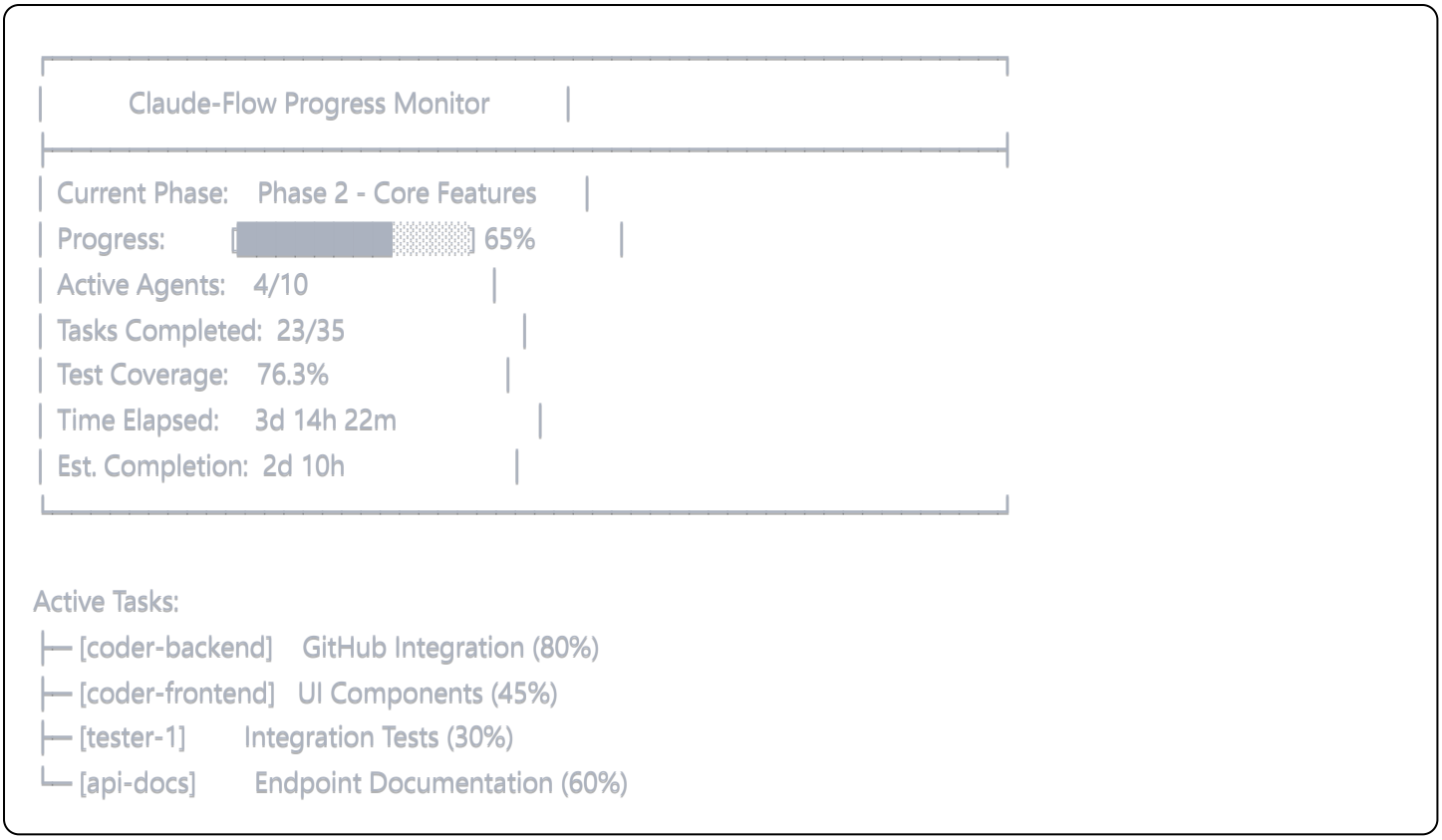
```
# Specific Agent Task
npx claude-flow task \
  --agent "coder-backend" \
  --task "Fix database connection issue" \
  --priority "high"

# Restart Phase
npx claude-flow phase restart --phase 2
```

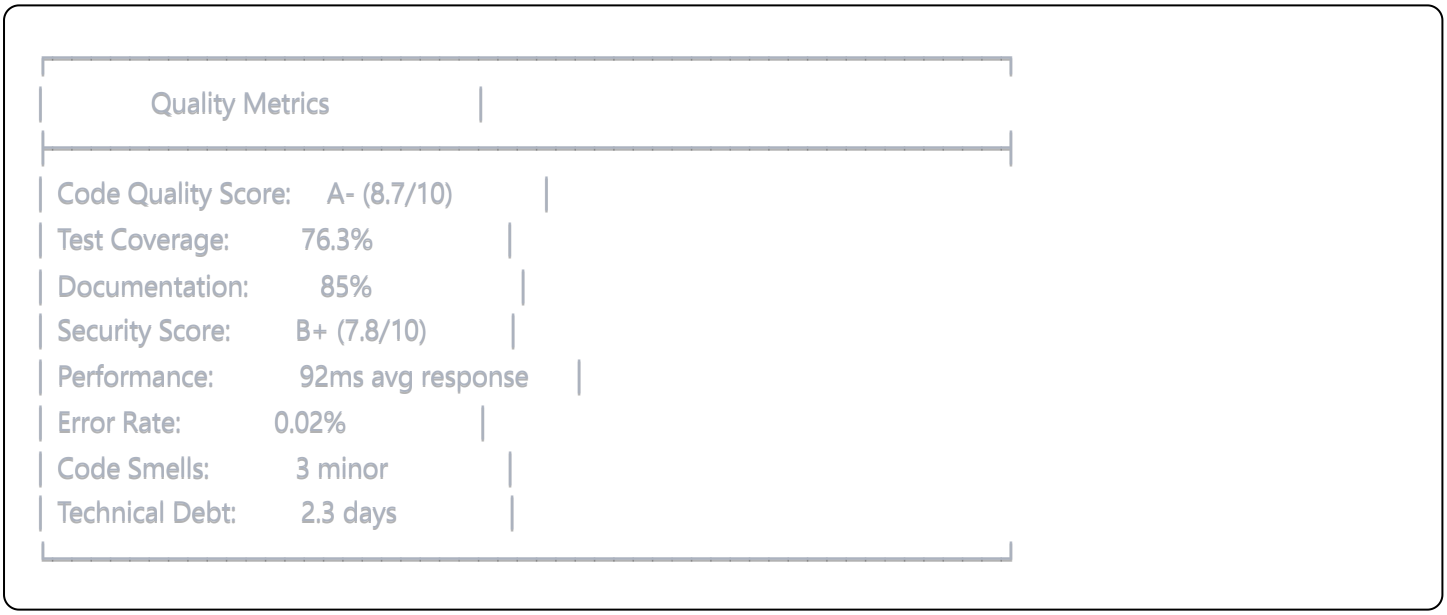
Monitoring & Tracking

Real-time Dashboards

1. Progress Dashboard



2. Quality Metrics



Log Files

Struktur

```
logs/
├── claude-flow.log        # Hauptlog
├── agents/
│   ├── queen.log          # Orchestrator logs
│   ├── backend.log        # Backend coder logs
│   └── ...
├── phases/
│   ├── phase1.log         # Phase 1 complete log
│   ├── phase2.log         # Phase 2 in progress
│   └── ...
└── errors/
    └── errors.log         # Alle Fehler
```

Log Format

```
[2025-01-23 14:30:22] [INFO] [coder-backend] Starting SQLite schema creation
[2025-01-23 14:30:23] [DEBUG] [coder-backend] Creating table: projects
[2025-01-23 14:30:24] [DEBUG] [coder-backend] Adding indexes to messages table
[2025-01-23 14:35:10] [SUCCESS] [coder-backend] Schema creation complete
[2025-01-23 14:35:11] [INFO] [queen-orchestrator] Task completed: database-schema
```

Fehlerbehandlung

Automatische Recovery

python

```
class AgentRecovery:
    def handle_agent_failure(self, agent_id, error):
        """Automatische Fehlerbehandlung"""

        if error.type == "TIMEOUT":
            # Restart agent
            self.restart_agent(agent_id)

        elif error.type == "RESOURCE_EXHAUSTED":
            # Scale down task
            self.reduce_task_complexity(agent_id)

        elif error.type == "DEPENDENCY_ERROR":
            # Fix dependencies
            self.resolve_dependencies(agent_id)

        else:
            # Escalate to Queen
            self.escalate_to_orchestrator(agent_id, error)
```

Anhang

A. Befehlsreferenz

bash

```
# Basis-Befehle
npx claude-flow@alpha hive-mind spawn    # Start orchestration
npx claude-flow@alpha status             # Show status
npx claude-flow@alpha logs               # View logs
npx claude-flow@alpha stop               # Stop all agents

# Advanced Commands
npx claude-flow@alpha phase skip         # Skip current phase
npx claude-flow@alpha agent restart      # Restart specific agent
npx claude-flow@alpha rollback           # Rollback to checkpoint
npx claude-flow@alpha export             # Export project state
```

B. Troubleshooting

Problem	Lösung	Agent
Agent timeout	Increase max_tokens in config	queen-orchestrator
Database lock	Restart SQLite connection	coder-backend
UI not updating	Check WebSocket connection	coder-frontend
Test failures	Review error logs, fix code	tester-1
Deploy issues	Check Docker logs	devops-1

C. Performance Optimization

```python
# Empfohlene Einstellungen für optimale Performance
OPTIMIZATION_CONFIG = {
    "parallel_agents": 3,        # Max parallel agents
    "chunk_size": 500,           # Text chunk size
    "batch_size": 100,           # Document batch size
    "cache_ttl": 3600,           # Cache timeout (seconds)
    "max_retries": 3,            # API retry attempts
    "timeout": 30,               # Request timeout
    "rate_limit": 10,            # Requests per second
}
```

D. Glossar

Begriff	Beschreibung
RAG	Retrieval-Augmented Generation
MCP	Model Context Protocol
SPARC	Specification, Pseudocode, Architecture, Refinement, Code
Hive Mind	Multi-Agent Orchestration System
ChromaDB	Vector Database für Embeddings
Flet	Python UI Framework
WSL2	Windows Subsystem for Linux 2

Kontakt & Support

Projekt Repository: `.AI_Exchange/whatsapp_chatbot`
Documentation: `docs/`
Issue Tracking: Via integrated GitHub Issues
Progress Tracking: `progress_checklist.md`

Dokumentation erstellt am: 2025-01-23
Version: 1.0.0
Autor: Claude-Flow Hive Mind System
Status: Production Ready Documentation