Securaa Custom Utils - Low Level Design

Document Information

- **Service Name**: Securaa Custom Utils Service
- **Version**: 1.0
- **Date**: September 2025
- **Author**: Development Team
- **Related Documents**: High Level Design

Table of Contents

Technical Implementation

Technology Stack

- **Programming Language**: Python 3.9+
- **Web Framework**: FastAPI
- **Database**: MongoDB with Motor (async driver)
- **Cache**: Redis with aioredis
- **Container Runtime**: Docker
- **Authentication**: JWT with custom middleware

- **Validation**: Pydantic models
- **Testing**: pytest with async support

Project Structure

Copy

```
securaa_custom_utils/
├── app/
│   ├── __init__.py
│   ├── main.py                 # FastAPI application entry point
│   ├── config.py               # Configuration management
│   ├── dependencies.py         # Dependency injection setup
│   │
│   ├── api/
│   │   ├── __init__.py
│   │   ├── v1/
│   │   │   ├── __init__.py
│   │   │   ├── endpoints/
│   │   │   │   ├── __init__.py
│   │   │   │   ├── utils.py    # Utils management endpoints
│   │   │   │   ├── execution.py # Code execution endpoints
│   │   │   │   └── health.py   # Health check endpoints
│   │   │   └── api.py          # API router
│   │   └── deps.py             # API dependencies
│   │
│   ├── core/
│   │   ├── __init__.py
│   │   ├── config.py           # Core configuration
│   │   ├── security.py         # Security utilities
│   │   ├── logging.py          # Logging configuration
│   │   └── exceptions.py       # Custom exceptions
│   │
│   ├── models/
│   │   ├── __init__.py
│   │   ├── base.py             # Base Pydantic models
│   │   ├── utils.py            # Utils domain models
│   │   ├── execution.py        # Execution models
│   │   └── user.py             # User models
│   │
│   ├── schemas/
│   │   ├── __init__.py
│   │   ├── utils.py            # Utils API schemas
│   │   ├── execution.py        # Execution API schemas
│   │   └── common.py           # Common response schemas
│   │
│   ├── services/
│   │   ├── __init__.py
│   │   ├── utils_service.py    # Utils business logic
│   │   ├── execution_service.py # Execution business logic
│   │   ├── validation_service.py # Code validation service
│   │   ├── container_service.py # Container management
│   │   └── audit_service.py    # Audit logging service
│   │
```

```
│   ├── repositories/
│   │   ├── __init__.py
│   │   ├── base.py              # Base repository pattern
│   │   ├── utils_repository.py # Utils data access
│   │   ├── execution_repository.py # Execution data access
│   │   └── cache_repository.py # Cache operations
│   │
│   ├── utils/
│   │   ├── __init__.py
│   │   ├── security.py          # Security utilities
│   │   ├── validation.py        # Code validation utilities
│   │   ├── container.py         # Container utilities
│   │   └── file_manager.py      # File management utilities
│   │
│   └── middleware/
│       ├── __init__.py
│       ├── auth.py              # Authentication middleware
│       ├── tenant.py            # Multi-tenant middleware
│       └── logging.py           # Request logging middleware
│
├── tests/
├── deployment/
├── docs/
├── requirements.txt
├── pyproject.toml
└── README.md
```

Database Design

MongoDB Collections

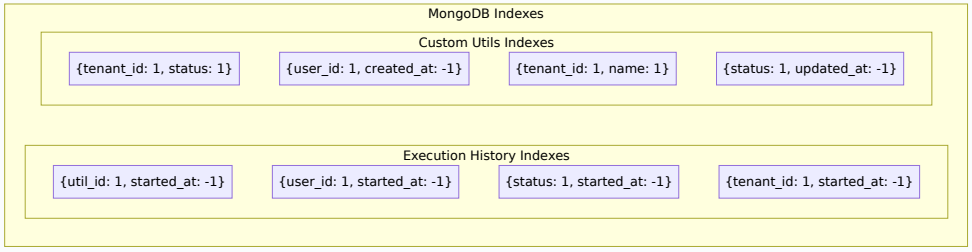
Custom Utils Collection

Copy

```
{
  "_id": "ObjectId",
  "util_id": "string (UUID)",
  "tenant_id": "string",
  "user_id": "string",
  "name": "string",
  "description": "string",
  "code": "string",
  "language": "python",
  "parameters": {
    "input_schema": {},
    "output_schema": {},
    "dependencies": []
  },
  "metadata": {
    "version": "string",
```

```
    "tags": [],
    "category": "string"
  },
  "validation": {
    "is_valid": "boolean",
    "validation_errors": [],
    "security_score": "number"
  },
  "execution_config": {
    "timeout_seconds": "number",
    "memory_limit_mb": "number",
    "cpu_limit": "number"
  },
  "status": "active|inactive|deleted",
  "created_at": "datetime",
  "updated_at": "datetime",
  "created_by": "string",
  "updated_by": "string"
}
```

Database Indexes



API Specifications

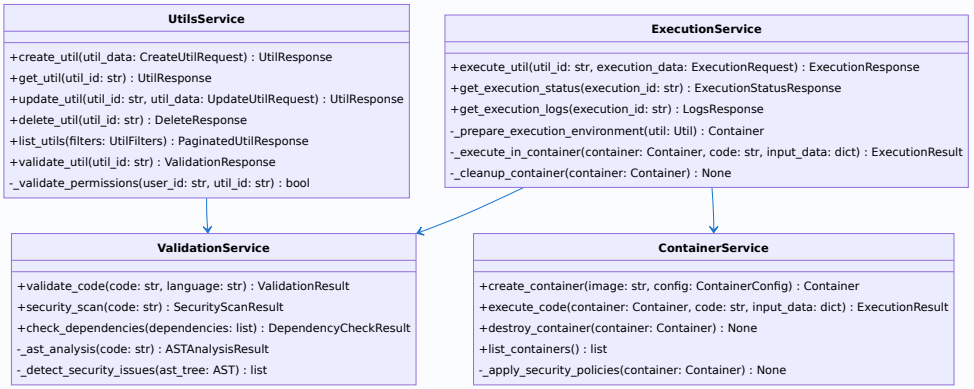
REST API Endpoints

Utils Management APIs

ENDPOINT	METHOD	DESCRIPTION	REQUEST BODY	RESPONSE
/api/v1/utils	POST	Create custom utility	CreateUtilRequest	UtilResponse
/api/v1/utils	GET	List utilities (paginated)	Query parameters	PaginatedUtilResponse
/api/v1/utils/{util_id}	GET	Get utility details	None	UtilResponse
/api/v1/utils/{util_id}	PUT	Update utility	UpdateUtilRequest	UtilResponse
/api/v1/utils/{util_id}	DELETE	Delete utility	None	DeleteResponse
/api/v1/utils/{util_id}/execute	POST	Execute utility	ExecutionRequest	ExecutionResponse

Class Design

Core Service Classes



Security Implementation

Authentication & Authorization

JWT Authentication Middleware

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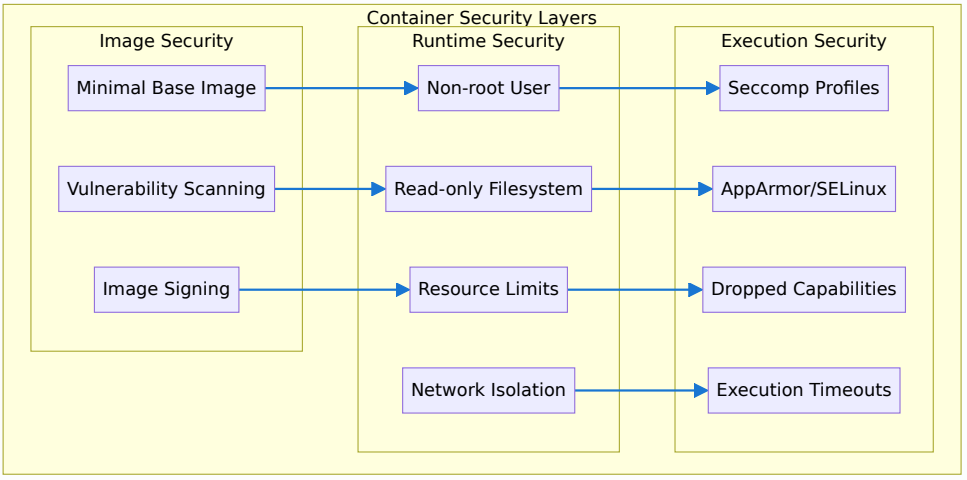
```
class JWTAuthMiddleware:
    def __init__(self, secret_key: str, algorithm: str = "HS256"):
        self.secret_key = secret_key
        self.algorithm = algorithm
        self.jwt_decoder = JWTDecoder(secret_key, algorithm)

    async def __call__(self, request: Request, call_next):
        # Skip authentication for health check endpoints
        if request.url.path in SKIP_AUTH_PATHS:
            return await call_next(request)

        # Extract JWT token from Authorization header
        auth_header = request.headers.get("Authorization")
        if not auth_header or not auth_header.startswith("Bearer "):
            raise HTTPException(
                status_code=401,
                detail="Missing or invalid authorization header"
            )

        token = auth_header.split(" ")[1]

        try:
            # Decode and validate JWT token
            payload = self.jwt_decoder.decode(token)

            # Extract user and tenant information
            user_id = payload.get("user_id")
            tenant_id = payload.get("tenant_id")
            permissions = payload.get("permissions", [])

            # Add user context to request state
            request.state.user_id = user_id
            request.state.tenant_id = tenant_id
            request.state.permissions = permissions

        except JWTError as e:
            raise HTTPException(
                status_code=401,
                detail=f"Invalid token: {str(e)}"
            )

        return await call_next(request)
```

Container Security



Performance Optimization

Caching Strategy Implementation

Multi-Level Cache

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```
class CacheManager:
    def __init__(self, redis_client: Redis):
        self.redis = redis_client
        self.local_cache = {}
        self.cache_stats = CacheStats()

    async def get(self, key: str, fetch_func: callable = None) -> any:
        """Multi-level cache get with fallback"""

        # L1: Check local cache first
        if key in self.local_cache:
            self.cache_stats.l1_hits += 1
            return self.local_cache[key]

        # L2: Check Redis cache
        redis_value = await self.redis.get(key)
        if redis_value:
            self.cache_stats.l2_hits += 1
            # Store in local cache for future requests
            self.local_cache[key] = json.loads(redis_value)
            return self.local_cache[key]
```

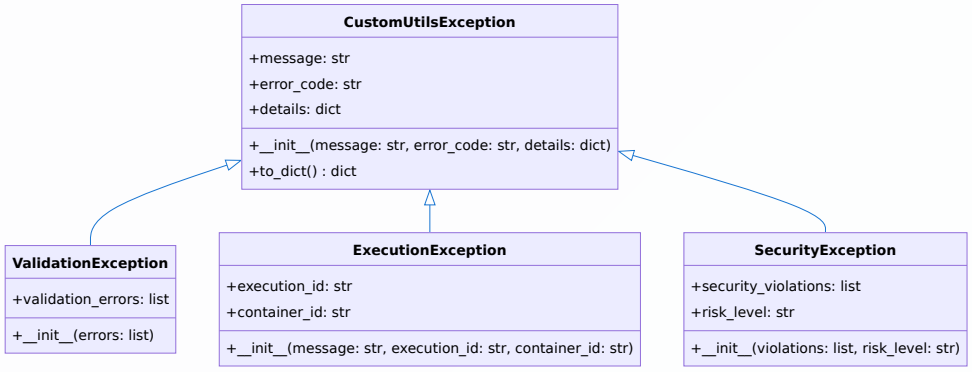
```
        # L3: Fetch from source if fetch function provided
        if fetch_func:
            self.cache_stats.cache_misses += 1
            value = await fetch_func()

            # Store in both caches
            await self.set(key, value, ttl=300)  # 5 minutes TTL
            return value

        return None
```

Error Handling

Exception Hierarchy



Deployment Configuration

Docker Configuration

Application Dockerfile

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```
FROM python:3.9-slim as builder

# Install build dependencies
RUN apt-get update && apt-get install -y \
    gcc \
    && rm -rf /var/lib/apt/lists/*

# Copy requirements and install Python dependencies
COPY requirements.txt .
```

```
RUN pip install --no-cache-dir -r requirements.txt

# Production stage
FROM python:3.9-slim

# Create non-root user
RUN groupadd -r appuser && useradd -r -g appuser appuser

# Install runtime dependencies
RUN apt-get update && apt-get install -y \
    curl \
    && rm -rf /var/lib/apt/lists/*

# Copy Python packages from builder stage
COPY --from=builder /usr/local/lib/python3.9/site-packages /usr/local/lib/python3.9/site-
packages
COPY --from=builder /usr/local/bin /usr/local/bin

# Create app directory
WORKDIR /app

# Copy application code
COPY app/ ./app/
COPY deployment/scripts/ ./scripts/

# Set ownership and permissions
RUN chown -R appuser:appuser /app
USER appuser

# Health check
HEALTHCHECK --interval=30s --timeout=10s --start-period=5s --retries=3 \
    CMD curl -f http://localhost:8000/health || exit 1

# Expose port
EXPOSE 8000

# Start application
CMD ["python", "-m", "app.main"]
```

Monitoring & Logging

Metrics Collection

Application Metrics

```
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from prometheus_client import Counter, Histogram, Gauge

# Define metrics
utils_created_total = Counter(
```

```
    'utils_created_total',
    'Total number of utilities created',
    ['tenant_id', 'user_id']
)

utils_executed_total = Counter(
    'utils_executed_total',
    'Total number of utility executions',
    ['tenant_id', 'util_id', 'status']
)

execution_duration_seconds = Histogram(
    'execution_duration_seconds',
    'Time spent executing utilities',
    ['tenant_id', 'util_id']
)

active_containers = Gauge(
    'active_containers',
    'Number of active execution containers'
)
```

Structured Logging

Log Format

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```
{
  "timestamp": "2025-09-30T10:30:00.123Z",
  "level": "INFO",
  "service": "securaa-custom-utils",
  "version": "1.0.0",
  "logger": "app.services.execution_service",
  "message": "Utility execution completed successfully",
  "context": {
    "tenant_id": "tenant_123",
    "user_id": "user_456",
    "util_id": "util_789",
    "execution_id": "exec_101112",
    "execution_time_ms": 1250,
    "memory_used_mb": 45,
    "container_id": "container_abc123"
  },
  "request_id": "req_987654321",
  "trace_id": "trace_555666777"
}
```

Conclusion

This low-level design provides a comprehensive technical implementation guide for the Securaa Custom Utils Service. The design emphasizes security, performance, and maintainability through:

- **Secure Architecture**: Multi-layered security with container isolation and code validation
- **Scalable Design**: Microservice architecture with horizontal scaling capabilities
- **Performance Optimization**: Multi-level caching and optimized database queries
- **Comprehensive Monitoring**: Detailed metrics collection and structured logging
- **Maintainable Codebase**: Clear separation of concerns and well-defined interfaces

The implementation follows industry best practices for microservice development, security, and DevOps, ensuring a production-ready solution that can scale with business requirements.