URL Shortener - Architecture & System Overview

Complete Architecture Documentation for Presentation
Digital Egypt Pioneers Initiative - DevOps Track

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Project Overview

What is This Project?

A **URL Shortener** web application that transforms long URLs into short, shareable links. The system is built using a **microservices architecture** with comprehensive monitoring capabilities.

Key Features

Feature	Description
URL Shortening	Convert long URLs to short, shareable links
File Sharing	Upload and share images and PDF files
Note Sharing	Create and share text notes
User Authentication	Secure registration and login
Click Tracking	Monitor link usage statistics
Real-time Monitoring	Prometheus metrics + Grafana dashboards

Team Members

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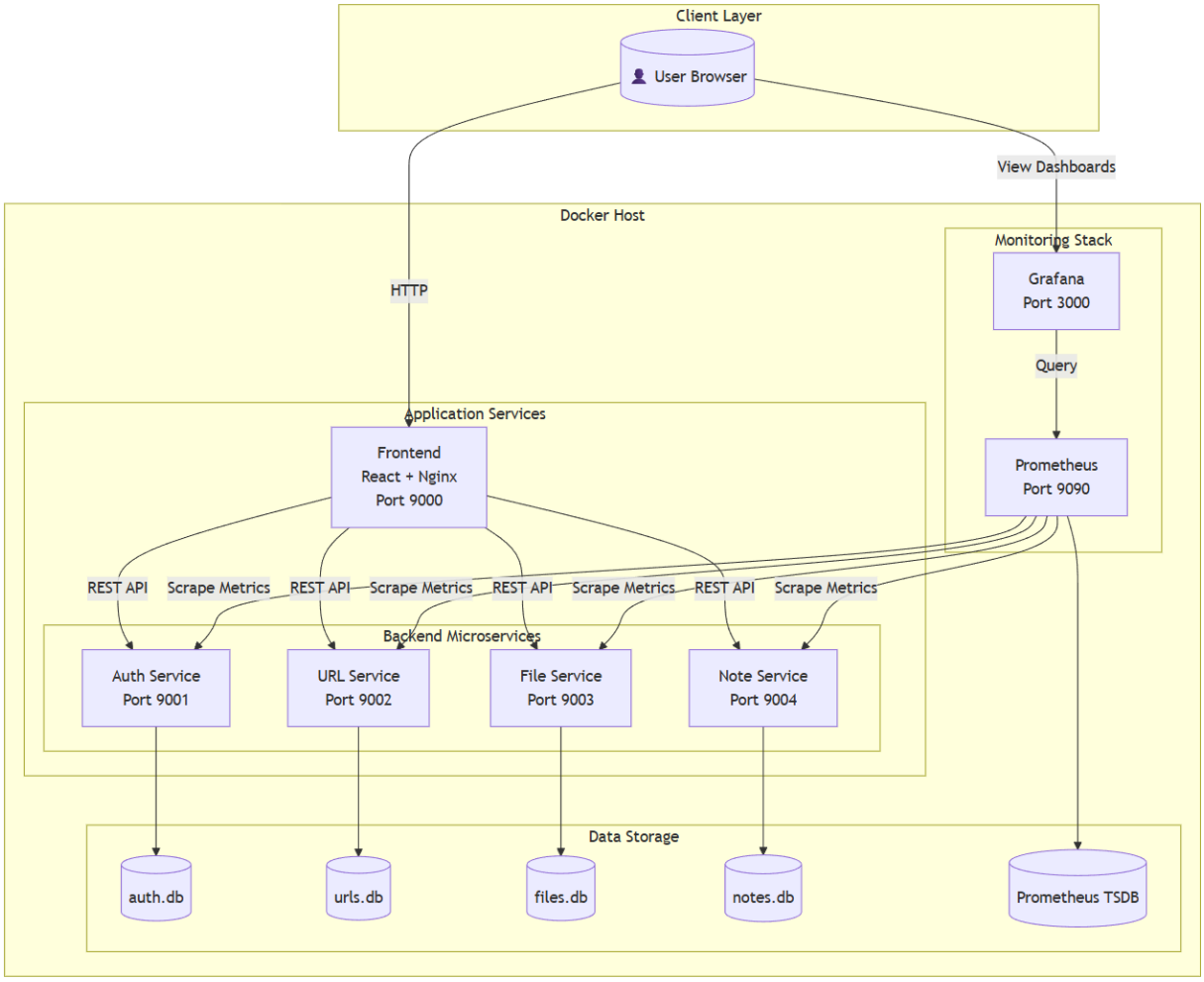
System Architecture

High-Level Overview

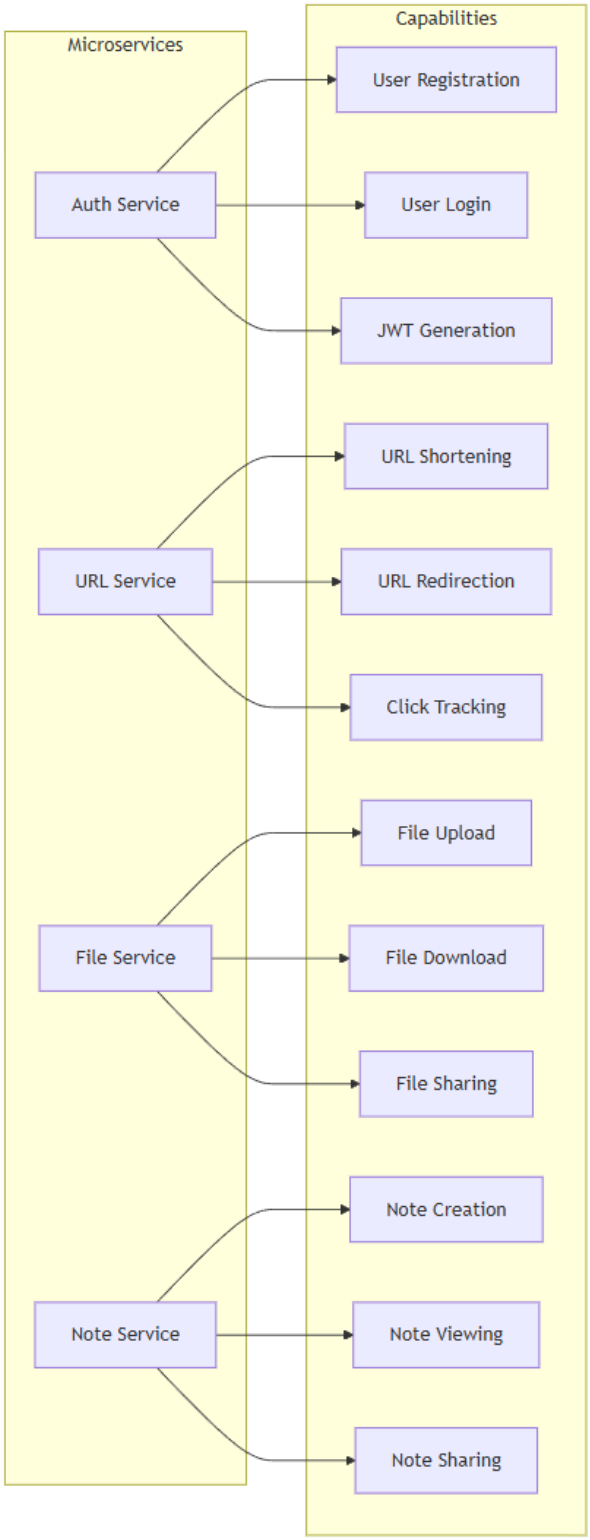


Architecture Principles

1. **Microservices Pattern**: Each service is independent and focused on a single domain
2. **Containerization**: All services run in Docker containers
3. **Service Isolation**: Each service has its own database
4. **Shared Authentication**: JWT tokens validated across all services
5. **Centralized Monitoring**: Single Prometheus instance scrapes all services

Microservices Design

Service Overview



Service Details

Service	Port	Technology	Database	Primary Responsibility
Auth Service	9001	Spring Boot + Kotlin	auth.db (SQLite)	User authentication & JWT management
URL Service	9002	Spring Boot + Kotlin	urls.db (SQLite)	URL shortening & redirection
File Service	9003	Spring Boot + Kotlin	files.db (SQLite)	File upload & sharing
Note Service	9004	Spring Boot + Kotlin	notes.db (SQLite)	Note creation & sharing
Frontend	9000	React + Nginx	-	User interface

API Endpoints Summary

Auth Service (Port 9001)

```
POST /api/auth/register  → Register new user
POST /api/auth/login     → Login and get JWT token
GET  /actuator/prometheus → Metrics endpoint
```

URL Service (Port 9002)

```
POST /shorten            → Create short URL
GET  /{shortCode}        → Redirect to original URL
GET  /api/urls/my-urls   → Get user's URLs
GET  /actuator/prometheus → Metrics endpoint
```

File Service (Port 9003)

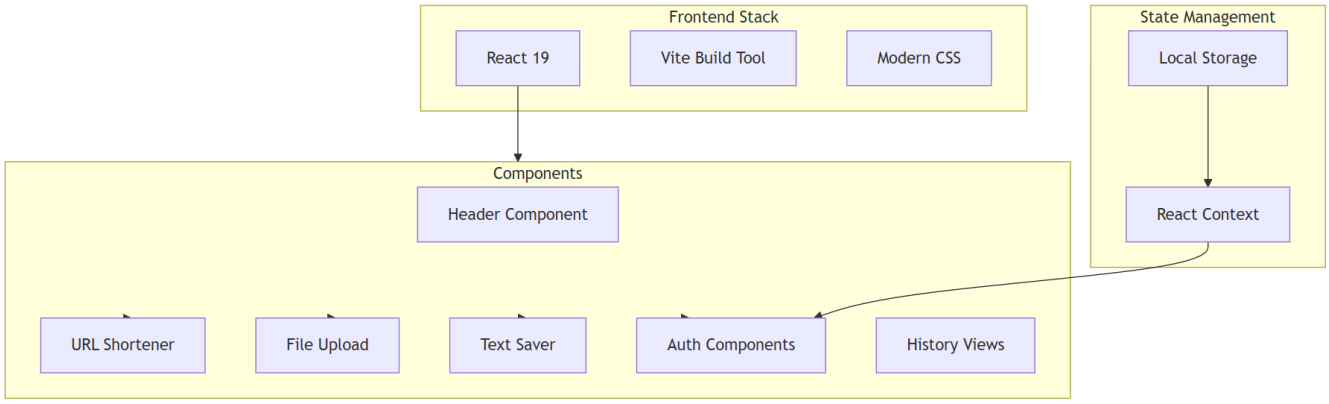
```
POST /api/files/upload    → Upload file
GET  /f/{shortCode}       → Download/view file
GET  /api/files/my-files  → Get user's files
GET  /actuator/prometheus → Metrics endpoint
```

Note Service (Port 9004)

```
POST /api/notes/save      → Save note
GET  /n/{shortCode}       → View note
GET  /api/notes/my-notes → Get user's notes
GET  /actuator/prometheus → Metrics endpoint
```

Frontend Architecture

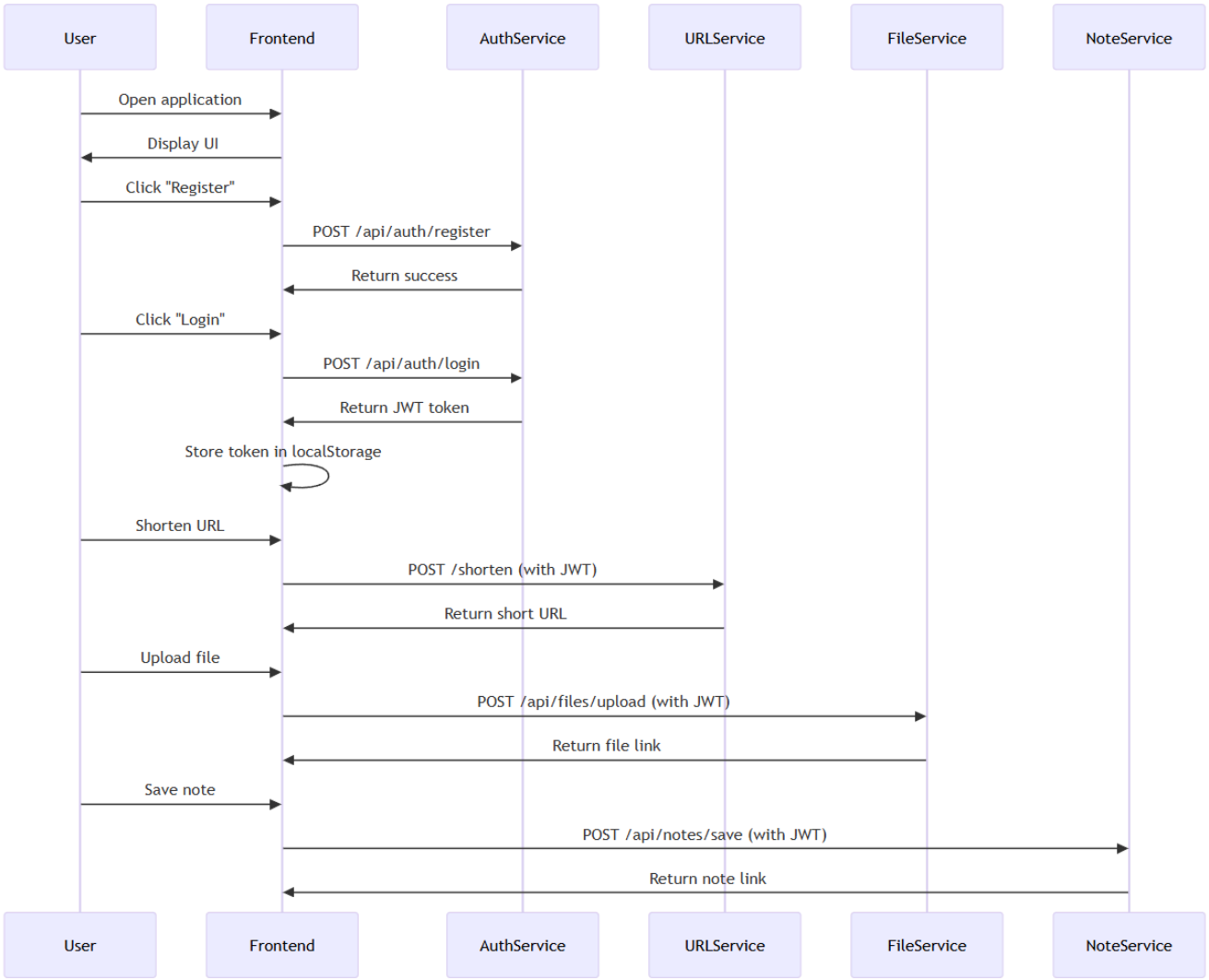
Technology Stack



Component Structure

```
frontend/
├── src/
│   ├── App.jsx              # Main application component
│   ├── main.jsx             # Application entry point
│   ├── components/
│   │   ├── Header.jsx       # Navigation & theme toggle
│   │   ├── UrlShortener.jsx # URL shortening form
│   │   ├── FileUpload.jsx   # File upload component
│   │   ├── TextSaver.jsx    # Note saving component
│   │   ├── Login.jsx        # Login modal
│   │   ├── Register.jsx     # Registration modal
│   │   ├── UrlHistory.jsx   # Recent URLs list
│   │   └── UserHistory.jsx  # User's saved items
│   ├── config/
│   │   └── api.js           # API endpoint configuration
│   └── context/
│       └── AuthContext.jsx  # Authentication state
├── Dockerfile               # Multi-stage Docker build
└── package.json             # Dependencies
```

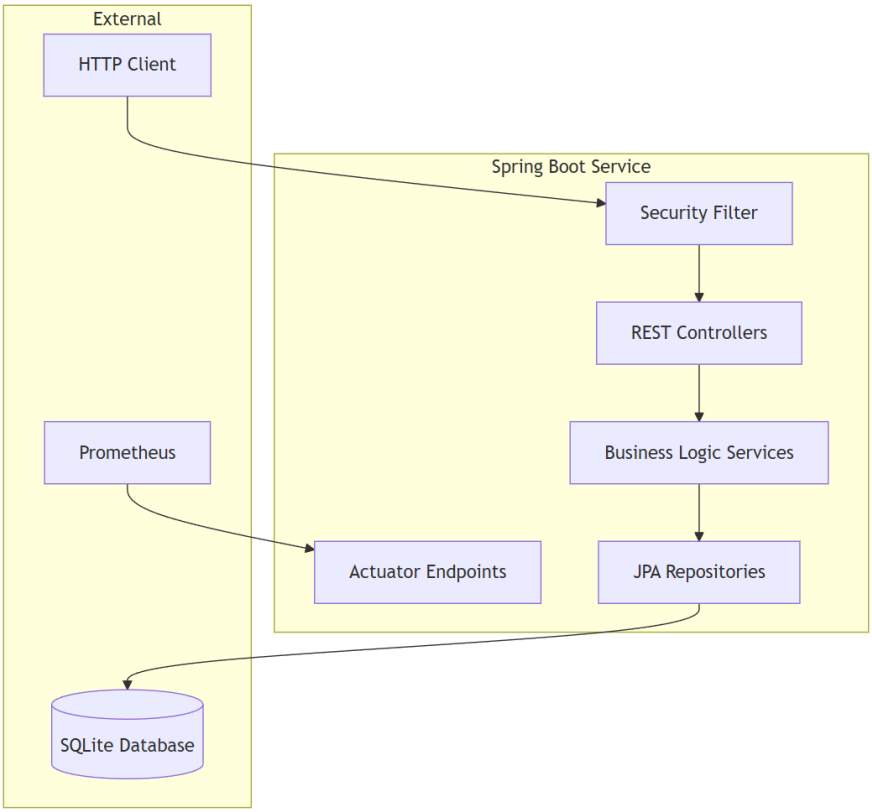
Frontend-to-Backend Communication



Backend Architecture

Spring Boot Service Structure

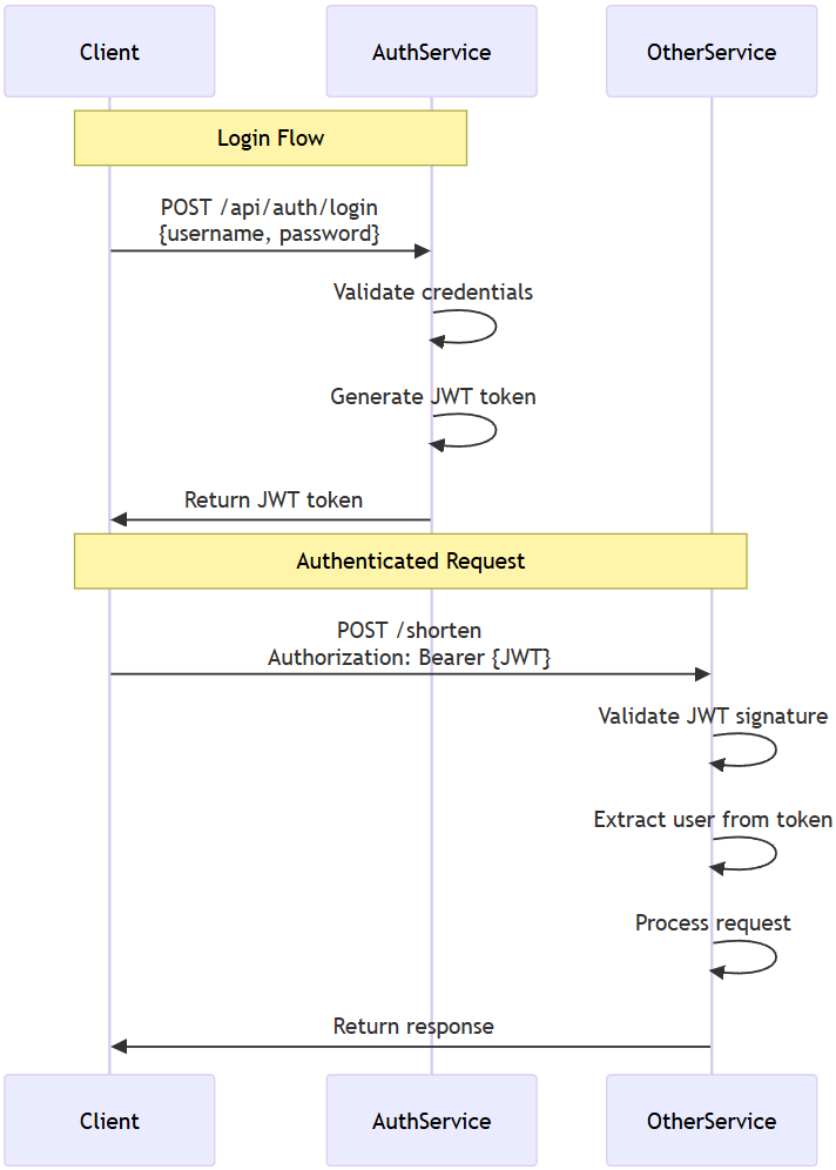
Each microservice follows the same architectural pattern:



Service Architecture Pattern

```
microservices/
├── auth-service/
│   ├── src/main/kotlin/
│   │   └── com/urlshortener/auth/
│   │       ├── AuthApplication.kt       # Main class
│   │       ├── controller/              # REST endpoints
│   │       ├── service/                 # Business logic
│   │       ├── repository/              # Data access
│   │       ├── model/                   # Domain entities
│   │       ├── security/                # JWT handling
│   │       └── config/                  # Configuration
│   ├── build.gradle.kts
│   └── Dockerfile
├── url-service/
├── file-service/
└── note-service/
```

Security Flow (JWT Authentication)



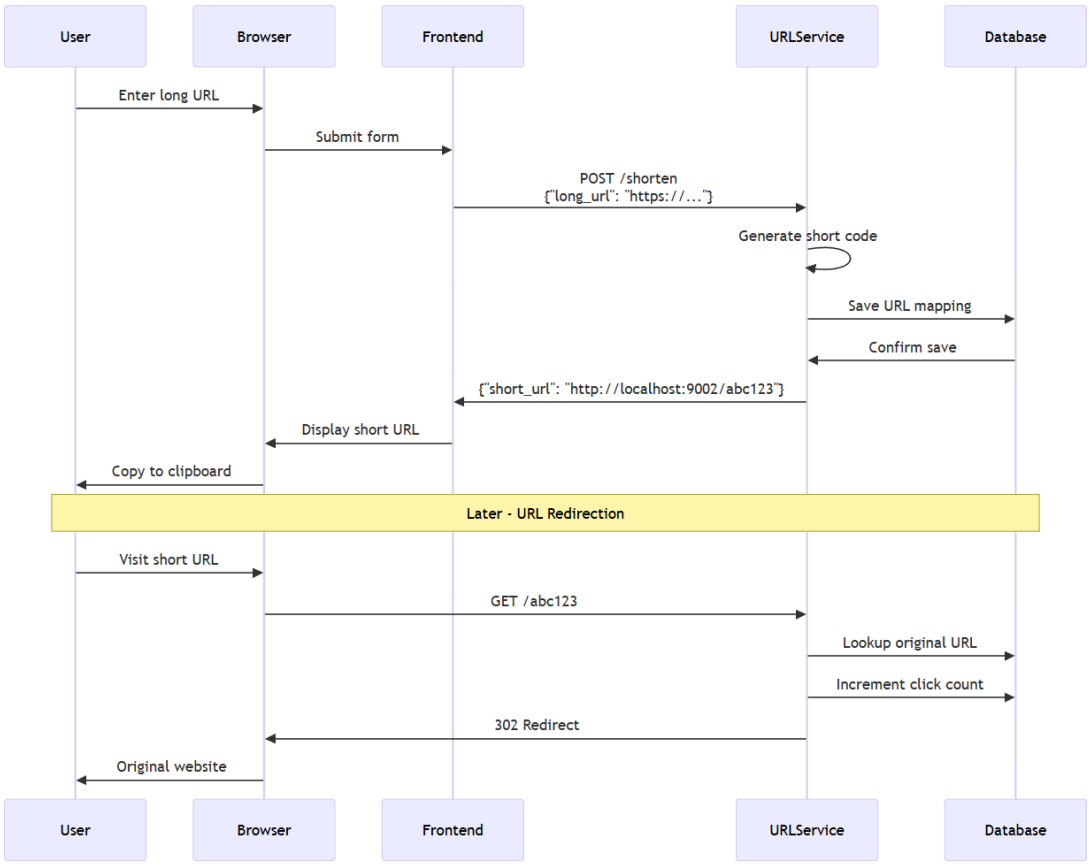
Shared JWT Secret

All services share the same `JWT_SECRET` environment variable to validate tokens:

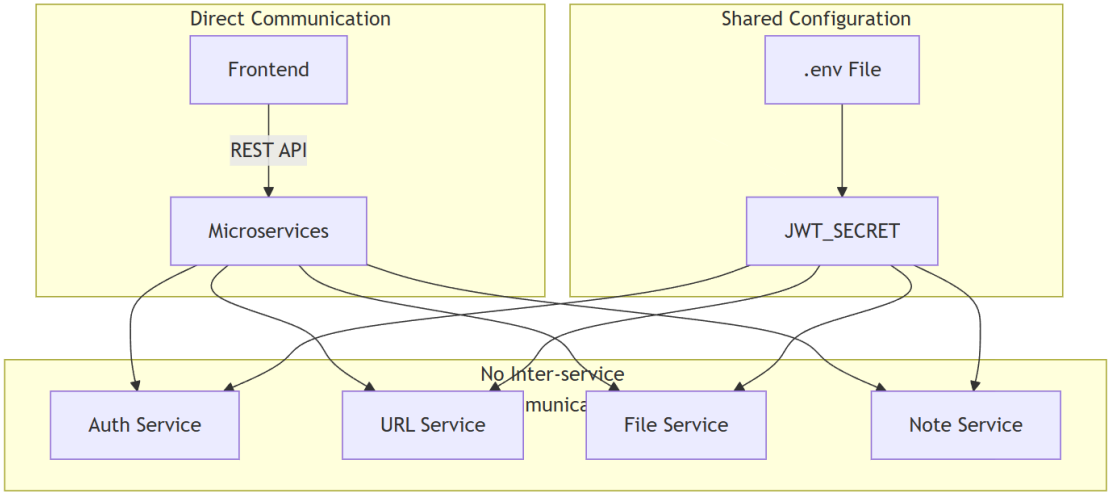
```
┌─────────────────────────────────────────────────────────────┐
│                        JWT_SECRET                           │
│              (Shared across all microservices)              │
├──────────────┬──────────────┬──────────────┬────────────────┤
│ Auth Service │ URL Service  │ File Service │ Note Service   │
│ (generates)  │ (validates)  │ (validates)  │ (validates)    │
└──────────────┴──────────────┴──────────────┴────────────────┘
```

Data Flow & Communication

User Journey - URL Shortening



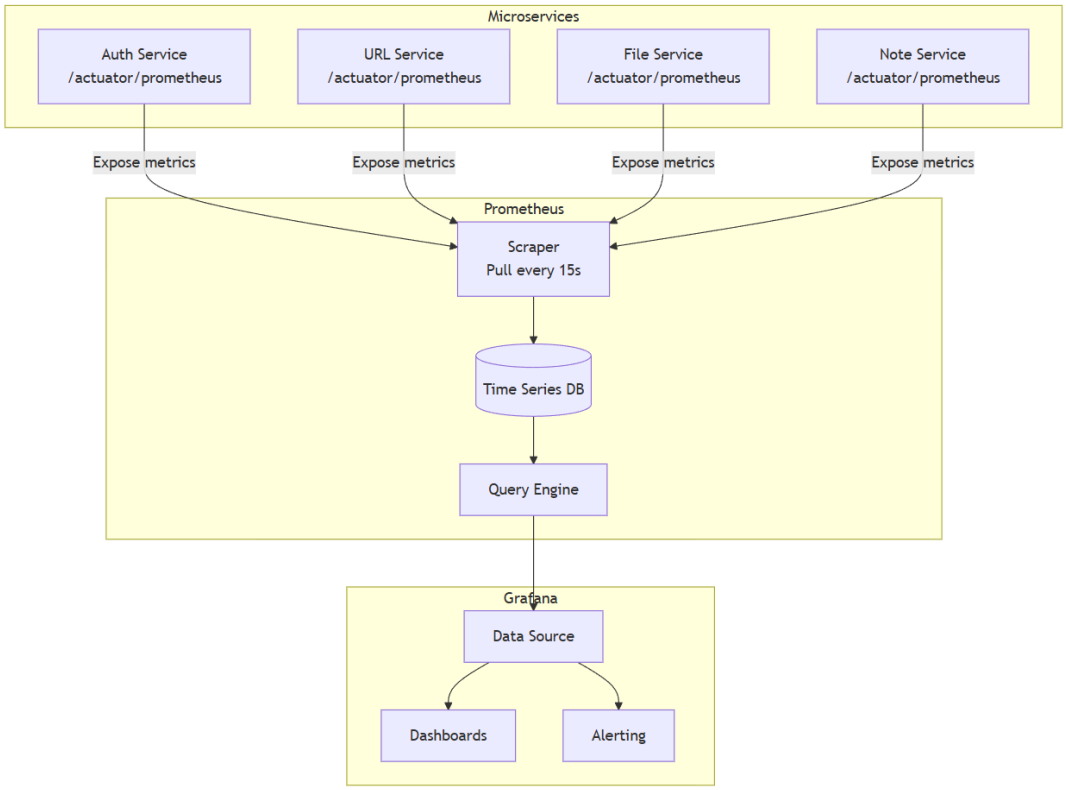
Service Communication Pattern



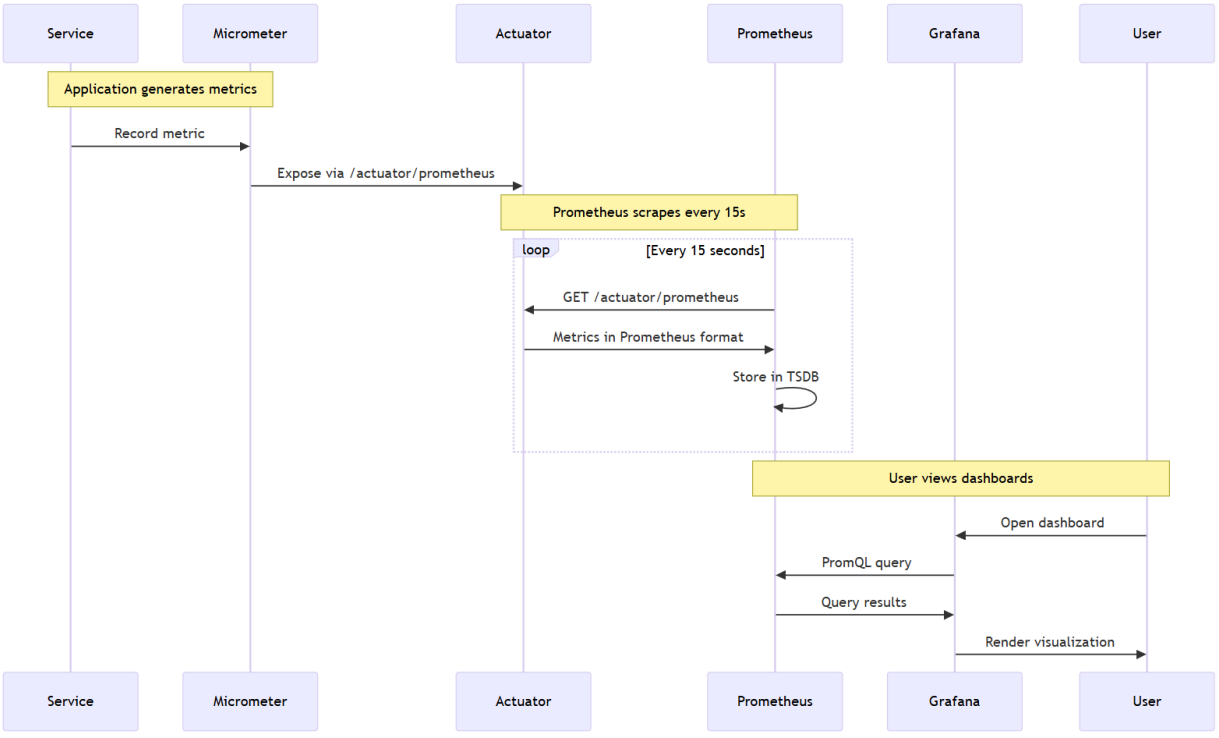
Key Design Decision: Services do not communicate with each other directly. Each service validates JWT tokens independently using the shared secret.

Monitoring Stack

Prometheus Architecture



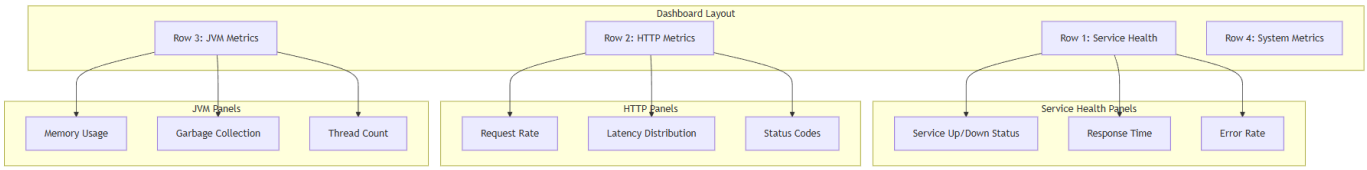
Metrics Flow



Prometheus Configuration

```yaml
# prometheus.yml
global:
  scrape_interval: 15s      # How often to scrape
  evaluation_interval: 15s   # How often to evaluate rules

scrape_configs:
  - job_name: 'auth-service'
    metrics_path: '/actuator/prometheus'
    static_configs:
      - targets: ['auth-service:9001']
        labels:
          service: 'auth'

  - job_name: 'url-service'
    metrics_path: '/actuator/prometheus'
    static_configs:
      - targets: ['url-service:9002']
        labels:
          service: 'url'

  # ... file-service and note-service similar
```

Grafana Dashboard Structure

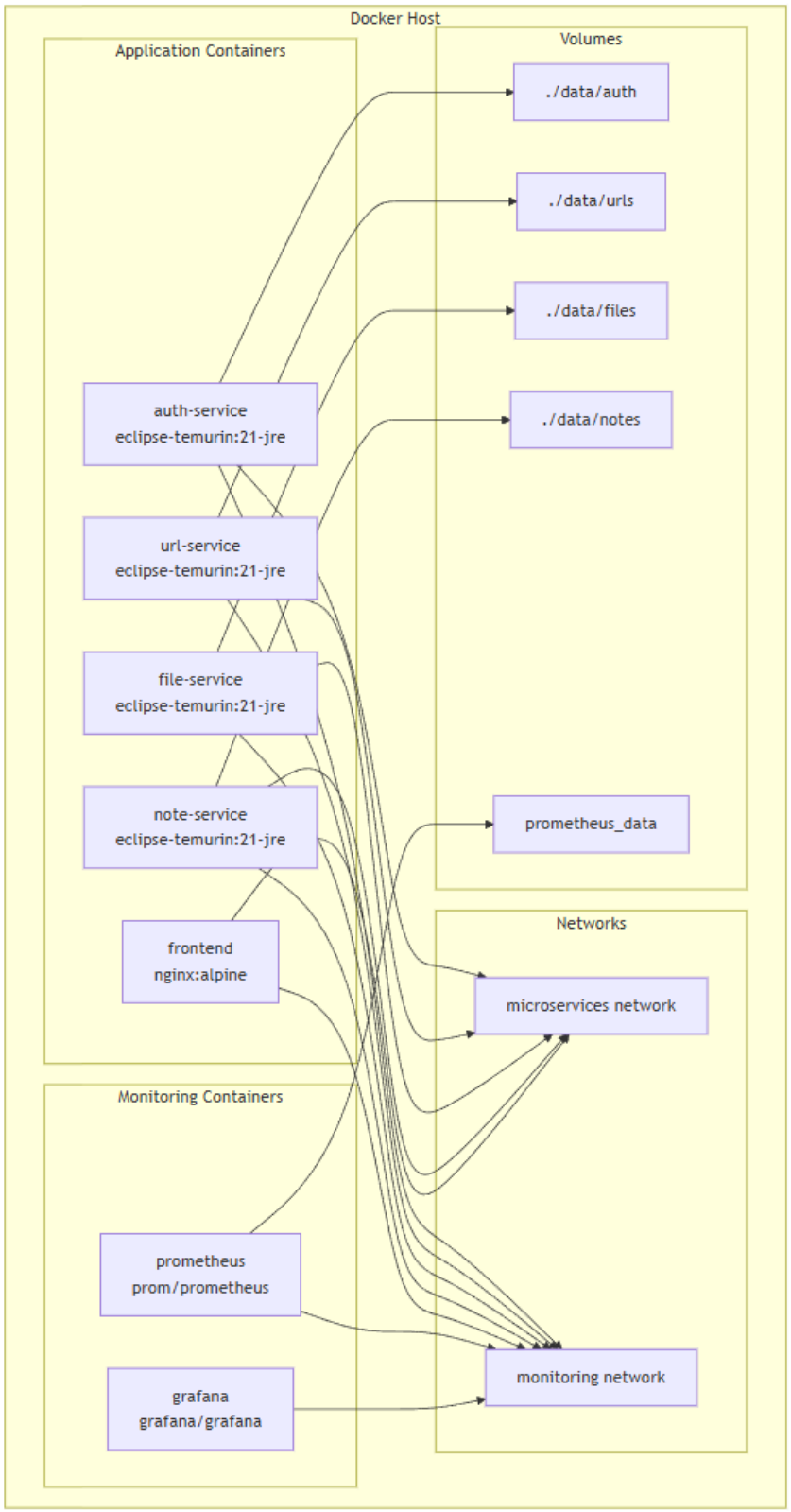


Key Metrics Monitored

Metric Category	Metric Name	Description
HTTP	`http_server_requests_seconds_count`	Total request count
HTTP	`http_server_requests_seconds_sum`	Total request time
HTTP	`http_server_requests_seconds_bucket`	Response time histogram
JVM	`jvm_memory_used_bytes`	Current memory usage
JVM	`jvm_gc_pause_seconds`	Garbage collection pauses
System	`system_cpu_usage`	CPU utilization
System	`process_uptime_seconds`	Service uptime

Docker Infrastructure

Container Architecture



Docker Compose Services

```yaml
services:
  # Application Services
  auth-service:     # Port 9001 → 9001
  url-service:      # Port 9002 → 9002
  file-service:     # Port 9003 → 9003
  note-service:     # Port 9004 → 9004
  frontend:         # Port 9000 → 80

  # Monitoring Services
  prometheus:       # Port 9090 → 9090
  grafana:          # Port 3000 → 3000

networks:
  microservices:    # Service-to-service communication
  monitoring:       # Prometheus scraping

volumes:
  prometheus_data:  # Named volume for Prometheus TSDB
```

Multi-Stage Build (Frontend)

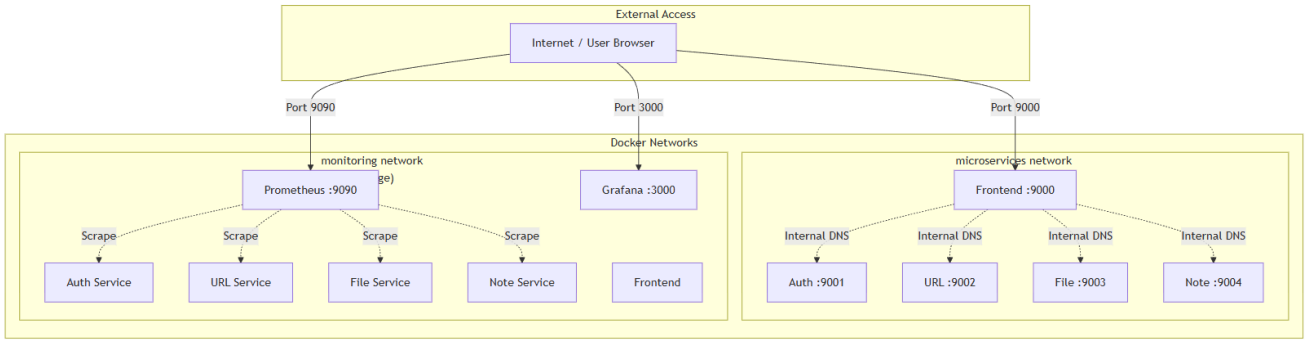
```dockerfile
# Stage 1: Build React application
FROM node:18-alpine AS build
WORKDIR /app
COPY frontend/package*.json ./
RUN npm install
COPY frontend/ .
RUN npm run build

# Stage 2: Serve with Nginx
FROM nginx:alpine
COPY --from=build /app/dist /usr/share/nginx/html
EXPOSE 80
CMD ["nginx", "-g", "daemon off;"]
```

Backend Service Build

```dockerfile
FROM eclipse-temurin:21-jre-jammy
WORKDIR /app
COPY microservices/auth-service/build/libs/auth-service-0.0.1-SNAPSHOT.jar app.jar
RUN mkdir -p /app/data
EXPOSE 9001
CMD ["java", "-jar", "app.jar"]
```

Network Architecture

Network Topology



Port Mapping

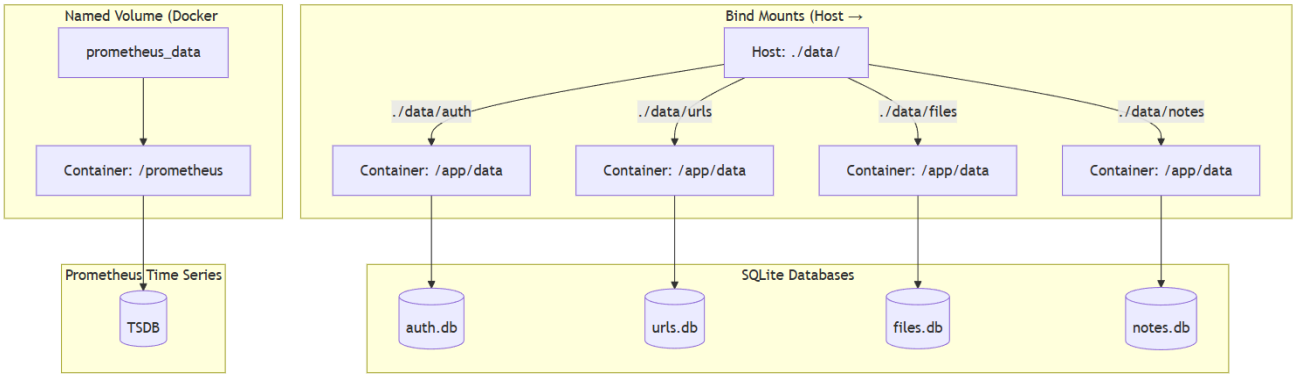
Service	Host Port	Container Port	Protocol
Frontend	9000	80	HTTP
Auth Service	9001	9001	HTTP
URL Service	9002	9002	HTTP
File Service	9003	9003	HTTP
Note Service	9004	9004	HTTP
Prometheus	9090	9090	HTTP
Grafana	3000	3000	HTTP

Service Discovery

Services communicate using Docker's internal DNS: - `auth-service:9001` (not localhost) - `url-service:9002` - `file-service:9003` - `note-service:9004` - `prometheus:9090`

Data Persistence

Storage Strategy



Data Directory Structure

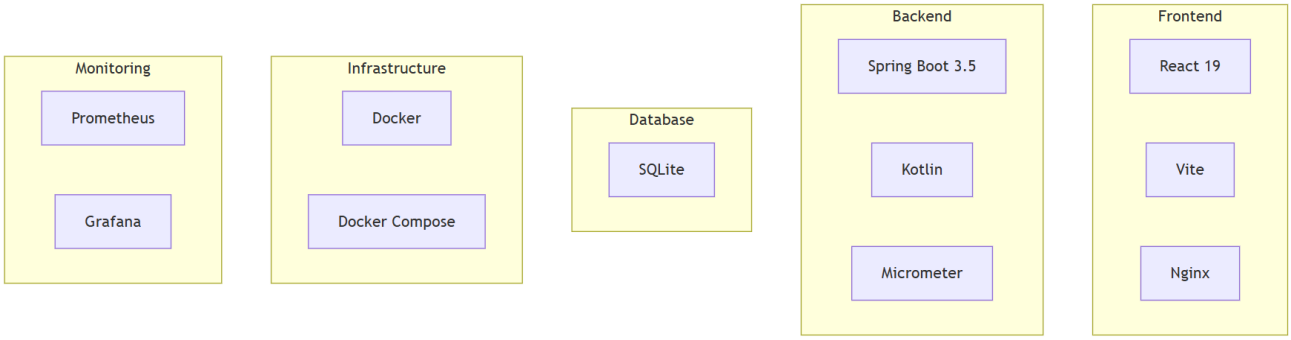
```
./data/
├── auth/
│   └── auth.db              # User accounts and credentials
├── urls/
│   └── urls.db              # Shortened URLs and click stats
├── files/
│   ├── files.db             # File metadata
│   └── uploads/             # Actual uploaded files
└── notes/
    └── notes.db             # Note content and metadata
```

Why SQLite?

Advantage	Description
Simplicity	No separate database server needed
Portability	Single file per database
Performance	Fast for read-heavy workloads
Zero Configuration	Works out of the box
Easy Backup	Just copy the .db files

Technology Stack Summary

Complete Technology Overview



Technology Details

Layer	Technology	Version	Purpose
Frontend	React	19	UI framework
Frontend	Vite	Latest	Build tool & dev server
Frontend	Nginx	Alpine	Production web server
Backend	Spring Boot	3.5	Application framework
Backend	Kotlin	Latest	Programming language
Backend	Micrometer	Latest	Metrics instrumentation
Database	SQLite	Latest	Data persistence
Container	Docker	Latest	Containerization
Orchestration	Docker Compose	Latest	Multi-container management
Metrics	Prometheus	Latest	Metrics collection
Visualization	Grafana	Latest	Dashboards & alerting
JRE	Eclipse Temurin	21	Java runtime

Architecture Benefits Summary

Principle	Benefit
Microservices	Independent scaling, fault isolation, team autonomy
Containerization	Consistent environments, easy deployment, portability
Monitoring	Real-time visibility, proactive issue detection
JWT Authentication	Stateless, scalable, secure
SQLite	Simple, fast, no external dependencies

Quick Access URLs

After running `docker compose up`:

Service	URL	Credentials
Frontend	http://localhost:9000	Create account
Prometheus	http://localhost:9090	None required
Grafana	http://localhost:3000	admin / admin

Deployment Commands

```
# 1. Build all services
./build.sh

# 2. Start everything
docker compose up -d

# 3. View logs
docker compose logs -f

# 4. Check service status
docker compose ps

# 5. Stop everything
docker compose down
```

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URL Shortener Microservices Project
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