

Milestone 3: Practical Implementation of LowTech GmbH Webshop in CSP Platform

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Abstract LowTech GmbH Cloud Transformation Project, building upon the previous analyses and migration strategies. In this phase, the focus is on optimizing cloud operations, performance monitoring, and cost efficiency after the transition to Microsoft Azure. The objective is to ensure system reliability, security, and scalability while fine-tuning the deployed infrastructure. The report outlines key post-migration strategies, including performance assessment, security enhancements, and cost analysis. It introduces automation techniques using tools like Terraform and Ansible for infrastructure management and GitHub Actions for continuous integration and deployment (CI/CD). Special attention is given to monitoring solutions like Azure Monitor and Prometheus to track system performance and detect potential issues in real time. Furthermore, we evaluate cloud cost management techniques by analyzing usage patterns and identifying areas for optimization. The report also discusses future scalability strategies, ensuring that LowTech GmbH is well-equipped to handle growing business demands. This phase serves as the foundation for long-term cloud sustainability, enabling the company to leverage cloud-native solutions efficiently while maintaining operational resilience.

1 Introduction

1.1 Overview of the Project

Brief recap of previous milestones and progression to current implementation phase

1.2 Objectives of the Cloud Implementation of Webshop

2 Application Design

2.1 Architectural Overview

Detailed description of the three-tier structure with CSP service mapping

2.1.1 Presentation-Tier (Frontend) - User Interface (UI)

Technology Stack

- Frontend Framework : React.js (JavaScript)
- State Management : React Context API
- Communication with Backend : FastAPI
- Hosting & Deployment : Azure Static Web Apps

component-based architecture

1. Navigation & Routing Users can easily navigate between different sections of application, such as viewing product lists, accessing product details, and managing their shopping cart. React Router enables seamless client-side navigation, keeping your app as a single-page application (SPA).
 - React Router Setup
 - React Router (react-router-dom) to handle the routing of different components, allowing users to navigate through pages like the homepage (/), product detail pages (/product/:id), and potentially a shopping cart or checkout page.
 - For product detail pages, you're using dynamic routes with product/:id to fetch and display specific product data based on the product's unique id. For instance:
 - When a user clicks on a product in the catalog, the URL changes to something like /product/123, and the ProductDetail component is rendered with data for product 123.
 - This is achieved using useNavigate and useParams hooks provided by React Router to capture the dynamic part of the URL.
 - Navigation Links
 - On the homepage (Home component), displaying a list of products. Each product has an image and name that users can click. When clicked, the app navigates to the product detail page using the navigate(/product/\$prod.id) function.
2. API Communication
 - API communication in app is responsible for sending and receiving data from the backend server. This includes fetching product data to populate catalog, handling cart actions (adding or removing items), and processing payments during checkout.
 - The app communicates with the backend to update the cart whenever an item is added or removed. When a user clicks "Add to Cart" or "Remove from Cart," an API call might be made to update the user's cart data on the server. This interaction is handled by **CartContext**, which uses **dispatch** to update the cart state and might also send a request to the backend to keep the cart in sync.
 - For payment, we use PayPal to securely handle credit card transactions. The app makes API calls to PayPal's backend to process the payment once the user submits their payment details.
3. Data Fetching

Data fetching refers to the process of retrieving data from external sources (your backend API) to populate app with dynamic information, such as product details, cart contents, and order history.

 - The product data, which includes the list of products with details such as images, names, prices, and categories, is fetched when the homepage or product catalog page loads. This is done using **useEffect** to trigger an API call and update the state with the fetched data.

Key Features of the UI

1. UI Components & Design

The UI components in your app are designed to provide an intuitive and engaging shopping experience. Each component serves a specific role, ensuring modularity, reusability, and maintainability.

 - Key Features
 - Reusable Components: Components like SingleProduct.js, ProductDetail.js, and Cart.js ensure a structured and modular UI.
 - Bootstrap Integration: react-bootstrap is used to style UI components such as Card, Button, and Container, ensuring a consistent and responsive design.

- Dark & Light Theme Support: A theme context (ThemeProvider) dynamically adjusts UI styles based on user preference.

2. Product Display & Interaction

The UI effectively displays products with details, allowing users to browse, select, and view product specifications before making a purchase.

– Key Features

- Product Catalog: Displays a grid of available products with images, names, and prices.
- Product Cards (SingleProduct.js):
 - * Clickable product images navigate to the product details page.
 - * Shows product information such as name, category, description, and price.
 - * “Add to Cart” and “Remove from Cart” buttons enable quick cart management.
- Product Details Page (ProductDetail.js):
 - * Displays full product details, including stock availability.
 - * Users can add/remove items from the cart.

3. Shopping Cart UI & Checkout

The cart and checkout sections provide an intuitive way for users to review their selected products, manage quantities, and complete purchases.

– Key Features

- Cart UI (Cart.js)
 - * Displays a list of selected products with prices and a “Remove from Cart” button.
 - * Updates total price dynamically based on the cart’s contents.
 - * Navigates users to checkout when ready.
- Checkout UI (CheckoutForm.js)
 - * Collects user details (name, email).
 - * Integrates Stripe and PayPal for secure payment processing.
 - * Uses emailjs to send order confirmation emails.
 - * Displays success messages with reference numbers for placed orders.

4. Notifications

Notifications is crucial to enhancing the shopping experience. The app uses toast notifications and error messages to keep users informed.

– Key Features

- Toast Notifications (react-toastify)
 - * Displays success messages when products are added/removed from the cart.
 - * Shows error messages if something goes wrong (e.g., out-of-stock products, payment failures).

2.1.2 Application-Tier (Backend) - Business Logic

Technology Stack

- FastAPI
- SQLAlchemy with PostgreSQL
- Asyncio

Product Management

The Product Management module handles the lifecycle of products in the system. This includes operations for adding new products, updating product details, and retrieving product information. The core business logic ensures that products are categorized correctly, their stock levels are managed, and prices are updated as needed.

– Key Operations:

- Add, update, and delete products.
- Manage product details such as descriptions, prices, and categories.
- Track stock availability and reorder levels.
- Calculate the public unit price and manage suppliers’ pricing.

Order Management

The Order Management module manages customer orders, from order creation to order completion. It tracks the order status and ensures that orders are processed correctly, including payment validation, stock management, and shipping.

- Key Operations:
 - Create and update orders with customer and product information.
 - Monitor order statuses (e.g., processing, dispatched, delivered).
 - Validate inventory and ensure product availability during order processing.
 - Handle refunds, cancellations, and partial shipments.

Payment Processing

The Payment Processing module integrates with third-party payment gateways (e.g., Stripe) to securely process customer payments. This module validates payment details, checks for fraud, and ensures payment is successfully processed before confirming orders.

- Key Operations:
 - Process payments securely through APIs like Stripe and PayPal.
 - Validate payment information (e.g., credit card details).
 - Handle refunds, cancellations, and partial shipments.

Inventory Management

The Inventory Management module tracks the stock levels of all products, ensuring that inventory is updated in real-time based on orders placed and products received from suppliers. It also tracks reorder levels and alerts the system to restock low inventory.

- Key Operations:
 - Monitor and update product stock levels after each sale.
 - Track the supplier's stock and delivery lead times.
 - Generate reports on product availability, low-stock items, and reorder recommendations.

Email Notification

The Email Notification module sends emails to customers and administrators for various events in the system, such as order confirmations, shipment tracking updates, and payment status notifications. It integrates with FastMail to send HTML-formatted emails with dynamic content.

- Key Operations:
 - Send order confirmation emails to customers.
 - Notify customers of order status updates, such as dispatched or delivered.
 - Alert administrators of low stock levels and other system alerts.
 - Provide a user-friendly email template system for various types of notifications.

2.1.3 Data-Tier (Database) - Databases

2.2 Technology Stack

- Frontend:
- Backend:
- Database:

2.3 System Diagrams

3 Implementation Process

3.1 Cloud Environment Setup

Step-by-step account configuration and resource provisioning

3.2 Service Integration

- Azure Load Balancer configuration
- Database replication setup
- Blob storage integration patterns

3.3 Development Challenges

- State management in scaled environments
- Database connection pooling
- CSP-specific limitations encountered

4 Operational Characteristics

4.1 Performance Metrics

4.1.1 Functional Test Cases

Test Case ID	Test Scenario	Expected Outcome	Status (Pass/Fail)
TC-001	Load homepage and verify product listing	Homepage loads with products displayed correctly.	
TC-002	Apply Price Filter (Ascending/Descending)	Products reorder correctly based on selected price.	
TC-003	Apply Out of Stock Filter	Only out-of-stock items are displayed.	
TC-004	Apply Fast Delivery Filter	Only products eligible for fast delivery show up.	
TC-005	Filter by Category	Products are filtered correctly by selected category.	
TC-006	Search Product by Name or Category	Products matching search are shown correctly.	
TC-007	Clear Filter functionality	All filters are removed, showing the full product list.	
TC-008	Product Detail Page - Click Product	Clicking a product opens its detailed page.	
TC-009	Product Detail Page - Load Product Details	Product Details (name, description, price) are displayed.	
TC-010	Add a Product to Cart	Product appears in cart with correct details.	
TC-011	Increase Product Quantity in Cart	Quantity updates and is reflected in the cart.	
TC-012	Remove product from cart	Product is removed from the cart immediately.	
TC-013	Proceed to checkout	Checkout page loads with the correct order summary.	

Test Case ID	Test Scenario	Expected Outcome	Status (Pass/Fail)
TC-014	Select payment method - Stripe	Stripe payment option is selected and processed.	
TC-015	Select payment method - PayPal	PayPal payment option is selected and processed.	
TC-016	Complete Order Processing	Order confirmation message is displayed.	
TC-017	Order Confirmation Email is received	Email is sent after order is placed.	
TC-018	Shipment Notification Email is received	Email is sent when the order is shipped.	
TC-019	Toggle Dark/Light Theme	Application switches between themes successfully.	

4.1.2 API Performance Testing (Backend Response Validation)

Test Case ID	Test Scenario	Expected Outcome	Status (Pass/Fail)
API-001	Fetch all products ('GET /products/')	Returns a list of products with name, category, supplier, price, stock, and reorder level.	
API-002	Create a new product ('POST /products/')	Successfully adds a product with details (name, category, supplier, price, etc.).	
API-003	Fetch a product by ID ('GET /products/{id}')	Returns specific product details, including name, price, stock, and supplier info.	
API-004	Update a product ('PATCH /products/{id}')	Updates product details such as price, stock, and description.	
API-005	Delete a product ('DELETE /products/{id}')	Removes the product from the system and returns confirmation.	
API-006	Fetch all categories ('GET /categories/')	Returns all available product categories.	
API-007	Fetch a category by ID ('GET /categories/{id}')	Returns category details including name and description.	
API-008	Create a new category ('POST /categories/')	Successfully adds a new category and returns its details.	
API-009	Update category ('PATCH /categories/{id}')	Updates category details and returns confirmation.	
API-010	Fetch all orders ('GET /orders/')	Returns a list of orders with customer details, order total, and tracking status.	
API-011	Create an order ('POST /orders/')	Successfully places an order with customer info, payment method, and product list.	
API-012	Fetch all suppliers ('GET /suppliers/')	Returns a list of suppliers with name, address, email, and phone.	
API-013	Fetch supplier by ID ('GET /suppliers/{id}')	Returns supplier details including personal info and contact details.	

Test Case ID	Test Scenario	Expected Outcome	Status (Pass/Fail)
API-014	Create a new supplier ('POST/suppliers/')	Successfully adds a supplier with name, address, and contact details.	
API-015	Update supplier details ('PATCH/suppliers/{id}')	Updates supplier information and returns confirmation.	
API-016	Fetch stock details ('GET /stock/{product_id}')	Returns stock availability for a specific product.	
API-017	Update stock quantity ('PATCH/stock/{product_id}')	Updates stock levels and returns confirmation.	
API-018	Update order tracking status ('PATCH /tracking/{order_id}')	Updates order shipment status and returns updated tracking details.	

4.2 Security Considerations

- Network security groups configuration
- Database encryption implementation
- Access control mechanisms

5 Critical Analysis

5.1 Cloud Service Evaluation

Cost-benefit analysis of selected Azure services

5.2 Architectural Decisions

Trade-off discussion between containerized vs serverless approaches

6 Repository Documentation

6.1 GitHub Structure

- **Branching Strategy** The project follows a simple main branch strategy where all contributors work directly on the main branch. This ensures seamless integration without managing multiple branches. All changes should be committed with meaningful messages. Code should be reviewed and tested before pushing to the main branch.
- **CI/CD Pipeline Configuration** Continuous Integration and Continuous Deployment (CI/CD) is implemented to automate the software development lifecycle, ensuring that code changes are tested, built, and deployed efficiently.
 - ****Continuous Integration (CI)**:** Every code commit triggers an automated build and testing process. This includes:
 - * Running unit tests to validate individual components.
 - * Performing integration tests to ensure compatibility between different modules.
 - * Static code analysis for linting and security vulnerabilities.
 - ****Continuous Deployment (CD)**:** Once the CI stage passes successfully, the application is automatically deployed to the appropriate environment. This process includes:
 - * Deploying to a staging environment for final testing.
 - * Running automated acceptance tests before production deployment.
 - * Deploying to production with rollback mechanisms in case of failure.
 - Documentation standards

6.2 Contribution Tracking

Commit history analysis and individual contribution breakdown

7 Conclusion

7.1 Project Outcomes

Summary of achieved objectives and demo capabilities

7.2 Future Enhancements

Potential improvements for production readiness

References