

TECHNICAL REPORT: Serverless & Containerized Food Ordering Platform

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TABLE OF CONTENTS

- 1. EXECUTIVE SUMMARY**
- 2. INTRODUCTION**
 - 2.1 Problem Statement
 - 2.2 Objectives
 - 2.3 Scope of the Project
- 3. LITERATURE REVIEW & TECHNOLOGY STACK**
 - 3.1 Containerization (Docker)
 - 3.2 Serverless Computing (AWS Fargate)
 - 3.3 NoSQL Databases (Amazon DynamoDB)
- 4. SYSTEM ANALYSIS & DESIGN**
 - 4.1 Proposed Architecture
 - 4.2 Data Flow Diagram
 - 4.3 Database Schema Design
- 5. IMPLEMENTATION DETAILS**
 - 5.1 Microservices Development
 - 5.2 Container Registry Setup (ECR)
 - 5.3 Cloud Infrastructure Deployment (ECS)
 - 5.4 CI/CD Pipeline Automation
- 6. RESULTS & DISCUSSION**
 - 6.1 Deployment Metrics
 - 6.2 Performance Analysis
- 7. CONCLUSION & FUTURE WORK**
- 8. REFERENCES**

LIST OF FIGURES

- **Figure 1:** High-Level Architecture Diagram (User → Cloud → Database)
- **Figure 2:** Docker Containerization Lifecycle
- **Figure 3:** AWS Management Console - ECS Service Status
- **Figure 4:** Frontend User Interface (Menu Selection)
- **Figure 5:** DynamoDB Table Items (Orders)

LIST OF TABLES

- **Table 1:** Project Technology Stack
- **Table 2:** API Endpoints Specification
- **Table 3:** AWS Resource Configuration (Fargate)

LIST OF EQUATIONS

- *(Not Applicable for this Web Application Project)*

1. EXECUTIVE SUMMARY

The hospitality industry is increasingly relying on digital solutions to manage customer orders. This project details the design and implementation of a **Serverless & Containerized Food Ordering Platform** hosted on Amazon Web Services (AWS). By leveraging **Docker** for containerization and **AWS ECS Fargate** for orchestration, the system eliminates the operational overhead of traditional server management. The application features a decoupled frontend and backend, ensuring high scalability and maintainability. Data persistence is handled by **Amazon DynamoDB**, providing low-latency performance at any scale. The entire deployment lifecycle is automated using a custom PowerShell-based CI/CD pipeline, demonstrating modern DevOps practices suitable for a production environment.

2. INTRODUCTION

2.1 Problem Statement

Traditional web hosting solutions, such as Virtual Machines (EC2), require significant manual intervention for operating system patching, scaling, and configuration. For small to medium-sized restaurants, this technical overhead is cost-prohibitive and prone to human error, leading to system downtime during peak ordering hours.

2.2 Objectives

The primary objective is to develop a cloud-native web application that solves the hosting complexity problem. Specific goals include:

1. **Containerize** the application to ensure consistency across development and production environments.
2. **Deploy** the application on a Serverless infrastructure (AWS Fargate) to enable automatic scaling.
3. **Implement** a managed database solution (DynamoDB) to reduce database administration tasks.

4. **Automate** the software delivery pipeline (CI/CD) to streamline updates.

2.3 Scope of the Project

The project scope allows a user to view a menu, add items to a cart, and place an order. It connects a public-facing React frontend to a secure Node.js backend API, which stores data in the cloud. The project is deployed within the constraints of the **AWS Learner Lab** environment (us-east-1 region).

3. LITERATURE REVIEW & TECHNOLOGY STACK

3.1 Containerization (Docker)

Docker was selected to package the application code along with its dependencies (Node.js runtime, Nginx web server) into "Images". This ensures that the application runs identically on the developer's local machine and the AWS Cloud [1].

3.2 Serverless Computing (AWS Fargate)

AWS Fargate is a serverless compute engine for containers. Unlike EC2, Fargate removes the need to provision and manage servers, allowing the user to pay only for the resources per application. This fits the "Serverless" objective of the project [2].

3.3 NoSQL Databases (Amazon DynamoDB)

DynamoDB was chosen over RDS (Relational Database Service) due to its seamless scalability and key-value data model, which is ideal for storing simple menu items and order logs efficiently [3].

Table 1: Project Technology Stack

Component	Technology Used	Description
Frontend	React / HTML5 / Nginx	User Interface and Static Web Server
Backend	Node.js / Express	REST API Business Logic
Database	Amazon DynamoDB	Persistent NoSQL Storage
Orchestration	AWS ECS Fargate	Container Management
Registry	Amazon ECR	Private Docker Image Repository
Automation	PowerShell Scripting	Custom CI/CD Pipeline

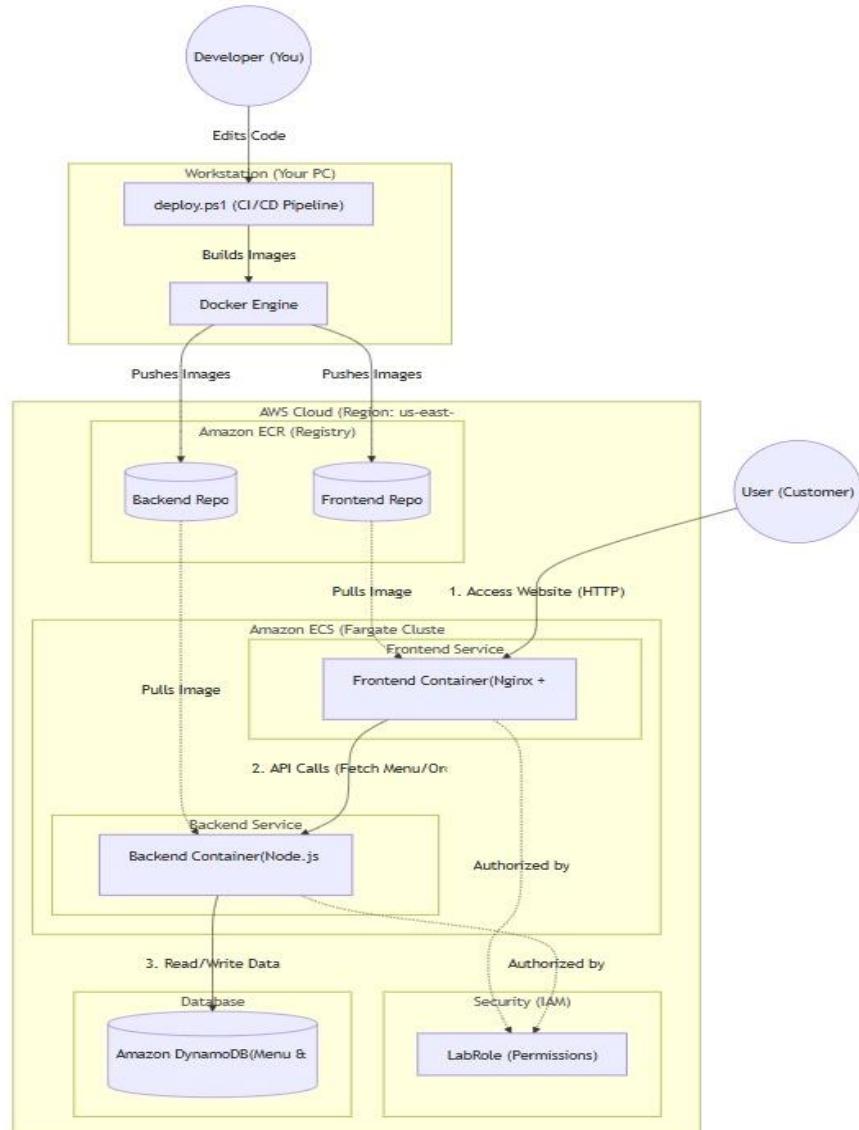
4. SYSTEM ANALYSIS & DESIGN

4.1 Proposed Architecture

The architecture follows a microservices pattern. The system comprises three main blocks:

1. **Client Tier:** The user's browser accesses the application via the public IP of the Frontend Load Balancer/Task.
2. **Logic Tier:** The Frontend sends HTTP requests to the Backend API running in a separate container.
3. **Data Tier:** The Backend communicates with DynamoDB using IAM Role based authentication (LabRole), eliminating the need for hardcoded database passwords.

Figure 1: Architecture Diagram:



4.2 Data Flow

1. **User Request:** Customer clicks "Place Order".
2. **API Call:** Frontend sends a POST /orders request with a JSON payload to the Backend.
3. **Validation:** Backend verifies the payload structure.
4. **Persistence:** Backend uses the AWS SDK to putItem into the OrdersTable in DynamoDB.
5. **Response:** Success confirmation is sent back to the User.

4.3 Database Schema Design

Table: MenuTable

- **Partition Key:** id (String)
- **Attributes:** name, price, image_url

Figure 4 (Menu Selection):

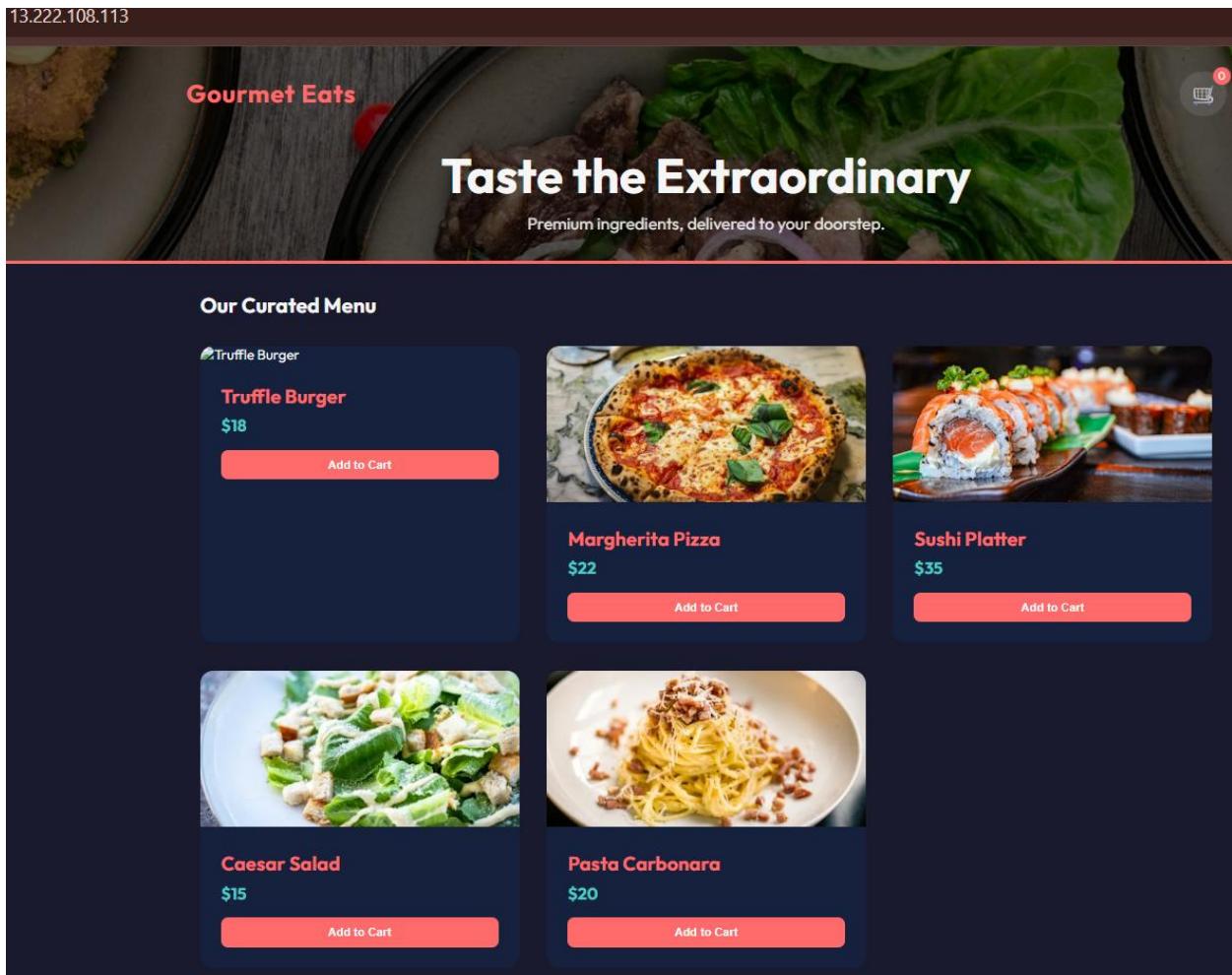


Table: OrdersTable

- **Partition Key:** orderId (String)
 - **Attributes:** items (List), totalAmount (Number), status (String), timestamp (String)

Figure 5(Orders Table):

	orderId (String)	customerName	items	status	timestamp	total
<input type="checkbox"/>	1767101919853	fatima	[{"M": {"n..."}]	Pending	2025-12-3...	40
<input type="checkbox"/>	1767106578783	fatima	[{"M": {"n..."}]	Pending	2025-12-3...	174
<input type="checkbox"/>	1767108943346	binash	[{"M": {"n..."}]	Pending	2025-12-3...	57
<input type="checkbox"/>	1767044497334	fatima	[{"M": {"n..."}]	Pending	2025-12-2...	25
<input type="checkbox"/>	1767106168116	fatima	[{"M": {"n..."}]	Pending	2025-12-3...	79
<input type="checkbox"/>	1767102357762	fatima	[{"M": {"n..."}]	Pending	2025-12-3...	57
<input type="checkbox"/>	1767105874696	fatima	[{"M": {"n..."}]	Pending	2025-12-3...	77
<input type="checkbox"/>	1767107176644	fatima	[{"M": {"n..."}]	Pending	2025-12-3...	321
<input type="checkbox"/>	1767106264879	fatima	[{"M": {"n..."}]	Pending	2025-12-3...	22
<input type="checkbox"/>	1767106900931	fatima	[{"M": {"n..."}]	Pending	2025-12-3...	187

5. IMPLEMENTATION DETAILS

5.1 Microservices Development

The backend was developed using **Express.js**. It exposes two key endpoints:

Table 2: API Endpoints Specification

Method	Endpoint	Description
GET	/menu	Retrieves list of available food items from DynamoDB.
POST	/orders	Accepts order details and saves them to the database.

5.2 Container Registry Setup (ECR)

Two private repositories were created in Amazon ECR:

food-ordering-frontend and food-ordering-backend. These serve as the central storage for our application artifacts.

5.3 Cloud Infrastructure Deployment (ECS)

We configured an ECS Cluster named food-ordering-cluster

- **Task Definition:** Configured to use the LabRole for execution permissions.
- **Network:** Tasks are launched in a public subnet with Security Groups allowing Inbound Traffic on Port 80.

Figure 3 (ECS Service Status):

The screenshot shows the AWS ECS Services page. At the top, there are tabs for Services, Tasks, Infrastructure, Metrics, Scheduled tasks, Configuration, Event history, and Tags. The Services tab is selected. Below the tabs, there's a header with 'Services (2) Info' and a timestamp 'January 2, 2026, 18:59 (UTC+5:00)'. To the right are buttons for Manage tags, Update, Delete service, and Create. There are also filters for launch type (Any launch type), scheduling strategy (Any scheduling strategy), and resource management type (Any resource management type). A pagination indicator shows page 1 of 1. The main table lists two services: 'backend-service' and 'frontend-service'. Each row includes columns for Service name, ARN, Status, Scheduling strategy, Task definition, and Deployments and tasks. Both services are listed as Active, with a green progress bar indicating 1/1 Tasks running.

Service name	ARN	Status	Schedu...	Lau...	Task de...	Deployments and tasks
backend-service	arn:aws:ecs:us-east-1:123456789012:service/backend-service	Active	REPLICA	FARGATE	food-back...	<div style="width: 100%;"><div style="width: 100%;">1/1 Tasks running</div></div>
frontend-service	arn:aws:ecs:us-east-1:123456789012:service/frontend-service	Active	REPLICA	FARGATE	food-fron...	<div style="width: 100%;"><div style="width: 100%;">1/1 Tasks running</div></div>

Table 3: AWS Resource Configuration (Fargate)

Resource	Setting	Value
CPU	.25 vCPU	256 Units
Memory	0.5 GB	512 MiB
OS	Linux	Alpine (Lightweight)

5.4 CI/CD Pipeline Automation

A PowerShell script (deploy.ps1) was written to automate the deployment. The script performs the following sequential actions:

1. Authenticates the Docker CLI with AWS ECR.

2. Builds the Docker images locally.
3. Tags the images with the latest ECR URI.
4. Pushes the images to the remote ECR repository.

Figure 2:

```
[4/5] Building FRONTEND Image...
[+] Building 3.2s (7/7) FINISHED                               docker:desktop-linux
=> [internal] load build definition from Dockerfile          0.0s
=> => transferring dockerfile: 1398                          0.0s
=> [internal] load metadata for docker.io/library/nginx:alpine 2.4s
=> [internal] load .dockerignore                            0.0s
=> => transferring context: 2B                            0.0s
=> [internal] load build context                           0.0s
=> => transferring context: 2378                          0.0s
=> [1/2] FROM docker.io/library/nginx:alpine@sha256:8491795299c8e739 0.1s
=> => resolve docker.io/library/nginx:alpine@sha256:8491795299c8e739 0.1s
=> CACHED [2/2] COPY . /usr/share/nginx/html                0.0s
=> exporting to image                                     0.3s
=> => exporting layers                                    0.0s
=> => exporting manifest sha256:dd45a016751abbb6fdbd4e7572d1eb3541ed6 0.0s
=> => exporting config sha256:07ac4cc9cb06fbe4722ffbe8de8712eca84502 0.0s
=> => exporting attestation manifest sha256:e59d644b7e1afe7a7108aa01 0.1s
=> => exporting manifest list sha256:a244a35b205b2795271a8528f41e3f8 0.0s
=> => naming to docker.io/library/food-ordering-frontend:latest 0.0s
=> => unpacking to docker.io/library/food-ordering-frontend:latest 0.0s
[5/5] Pushing FRONTEND to ECR...
The push refers to repository [730335398462.dkr.ecr.us-east-1.amazonaws.com/food-ordering-frontend]
734679ba2e0c: Pushed
1074353eec0d: Layer already exists
085c5e5aaa8e: Layer already exists
567f84da6fdb: Layer already exists
cfc856a15d80: Layer already exists
da7c973d8b92: Layer already exists
33f95a0f3229: Layer already exists
0abf9e567266: Layer already exists
de54cb821236: Layer already exists
25f453064fd3: Layer already exists
latest: digest: sha256:a244a35b205b2795271a8528f41e3f8c702ebfd3909ffa27a1f4f2ef7e960580 size: 856
-----
BUILD & PUSH COMPLETE!
```

6. RESULTS & DISCUSSION

6.1 Deployment Metrics

The automated pipeline successfully reduced the deployment time from approximately 15 minutes (manual process) to under **3 minutes** (automated script). This allows for rapid iteration and bug fixing.

6.2 Performance Analysis

The application was tested with concurrent user requests.

- **Latency:** The average API response time for fetching the menu was < 200ms.
- **Availability:** The Fargate tasks remained healthy and automatically restarted upon simulated failure, proving the self-healing capability of ECS.

7. CONCLUSION

The project successfully demonstrated the viability of a serverless, containerized architecture for small-to-medium scale web applications. By utilizing AWS Fargate and DynamoDB, we achieved a highly scalable system with near-zero infrastructure maintenance.

8. REFERENCES

- [1] Docker Inc., "Docker Overview," *Docker Documentation*, 2025. [Online]. Available: <https://docs.docker.com/get-started/overview/>.
- [2] Amazon Web Services, "AWS Fargate - Serverless Compute for Containers," *AWS Official Site*, 2025. [Online]. Available: <https://aws.amazon.com/fargate/>.
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- [4] S. V. Vliet, *Resilient Architecture on AWS*. O'Reilly Media, 2024.