1. Architecture Overview

The solution will be divided into three main components:

1. **Java Spring Backend Service**: A Spring Boot application that provides APIs.
2. **React Frontend Service**: A frontend application built with React.js.
3. **Infrastructure Deployment**: Using Azure to deploy and manage resources required for the application.

Azure Resources Involved

1. **Azure Kubernetes Service (AKS)**: To host the Java Backend and React Frontend containers.
2. **Azure Container Registry (ACR)**: To store the built Docker images for the backend and frontend.
3. **Azure App Gateway or Load Balancer**: To route traffic to the appropriate services.
4. **Azure PostgreSQL Database**: Replacing the in-memory database with a managed database.
5. **Azure Monitor**: To enable logging, monitoring, and alerts.
6. **Azure Key Vault**: To securely store and access secrets, connection strings, and sensitive information.

2. CI/CD Pipelines

Pipeline 1: Backend Service CI/CD

- **CI**:
    1. Trigger on code commit or pull request.
    2. Checkout the code and run tests (`mvn test`).
    3. Build the Docker image (`docker build -t <backend_image> .`).
    4. Push the Docker image to **Azure Container Registry** (`docker push <backend_image>`).
- **CD**:
    1. Deploy to AKS using `kubectl` or `helm`.
    2. Manage different environments (Dev, QA, Prod) by applying different configurations.

Pipeline 2: Frontend Service CI/CD

- **CI**:
    1. Trigger on code commit or pull request.
    2. Build the React project using `npm install` and `npm run build`.
    3. Build the Docker image for the frontend (`docker build -t <frontend_image> .`).
    4. Push the Docker image to **Azure Container Registry** (`docker push <frontend_image>`).
- **CD**:
    1. Deploy the built frontend image to AKS.
    2. Ensure proper routing via Ingress or Load Balancer.

Pipeline 3: Infrastructure Deployment

- **IaC (Infrastructure as Code)**:
    1. Use **Azure Resource Manager (ARM) templates** or **Terraform** scripts to define the infrastructure.

2. Deploy the following components:
    - AKS Cluster
    - ACR
    - PostgreSQL Database
    - App Gateway or Load Balancer
    - Azure Monitor setup
    - Azure Key Vault
- **CD**:
    1. Use a pipeline to apply the ARM/Terraform configurations.
    2. Implement `terraform destroy` or `az group delete` commands for cleanup.

3. Step-by-Step Implementation

Step 1: Infrastructure as Code (IaC)

Azure Resource Manager (ARM) templates provide a declarative way to define infrastructure, making it easier to manage and deploy Azure resources consistently. For this assignment, we'll create ARM templates for the following components:

1. **Resource Group**: A container to hold all the Azure resources.
2. **Azure Container Registry (ACR)**: To store Docker images for the frontend and backend applications.
3. **Azure Kubernetes Service (AKS)**: To host the containers and deploy the application.
4. **Azure PostgreSQL Database**: As a managed database service to replace the in-memory database.
5. **Azure Key Vault**: To store secrets and sensitive configuration.
6. **Azure Monitor**: To enable logging, monitoring, and alerts.

1. Create the ARM Templates

The solution will include multiple ARM templates to set up the infrastructure, and a master `azuredeploy.json` template to link them together.

2. Master Template: `azuredeploy.json`

The `azuredeploy.json` template will link the individual ARM templates using the **`linkedTemplates`** approach, making it easier to manage and reference dependencies between different resources.

3. ARM Template for Each Resource

3.1 Azure Container Registry Template: `acr-template.json`

This template creates an Azure Container Registry to store Docker images.

3.2 Azure Kubernetes Service Template: `aks-template.json`

This template creates an AKS cluster and connects it to ACR for image pulling.

3.3 Azure PostgreSQL Template: `postgresql-template.json`

Deploys a managed PostgreSQL database instance.

4. Key Vault Template

This Key Vault will be used to securely store and access sensitive information such as database credentials, client secrets for the AKS service principal, and other application secrets.

Key Vault Template Details

1. **`keyVaultName`**: Name of the Key Vault instance.
2. **`location`**: Azure region where the Key Vault will be created.
3. **`objectId`**: Azure Active Directory object ID (service principal or managed identity) that will be granted access to the Key Vault. For AKS, this can be the service principal's Object ID.
4. **`dbAdminUsername`** and **`dbAdminPassword`**: Credentials for the PostgreSQL database that will be stored in the Key Vault.
5. **`clientSecret`**: The client secret for the AKS service principal.

5. Monitor Template

`monitor-template.json` file that sets up **Azure Monitor** resources for logging, monitoring, and alerting. It includes a **Log Analytics workspace** and **Application Insights** to monitor the deployed infrastructure and application components, providing detailed insights into performance, availability, and overall health.

Monitor Template: `monitor-template.json`

This template creates the following resources:

1. **Log Analytics Workspace**: A workspace for storing logs and metrics for various Azure services.
2. **Application Insights**: An application monitoring resource to track the performance and health of your Java backend and React frontend.
3. **Diagnostic Settings**: Configured on the AKS cluster to send logs and metrics to the Log Analytics workspace.

Monitor Template Details

1. **`location`**: Specifies the Azure region where the monitoring resources will be deployed.
2. **`logAnalyticsWorkspaceName`**: Name of the **Log Analytics Workspace**.
3. **`applicationInsightsName`**: Name of the **Application Insights** instance.
4. **`aksResourceId`**: Resource ID of the Azure Kubernetes Service (AKS) cluster. This is required to set up diagnostic settings to send AKS logs and metrics to the Log Analytics workspace.

Step 2: CI/CD Pipelines with Azure DevOps

1. Create Pipelines using Azure DevOps YAML templates.

Step 3: Configure AKS with Azure DevOps

- Create a **Service Connection** in Azure DevOps to connect to AKS.
- Use `kubectl` commands or **Helm Charts** for deploying the application.

Step 4: Implement Logging and Monitoring

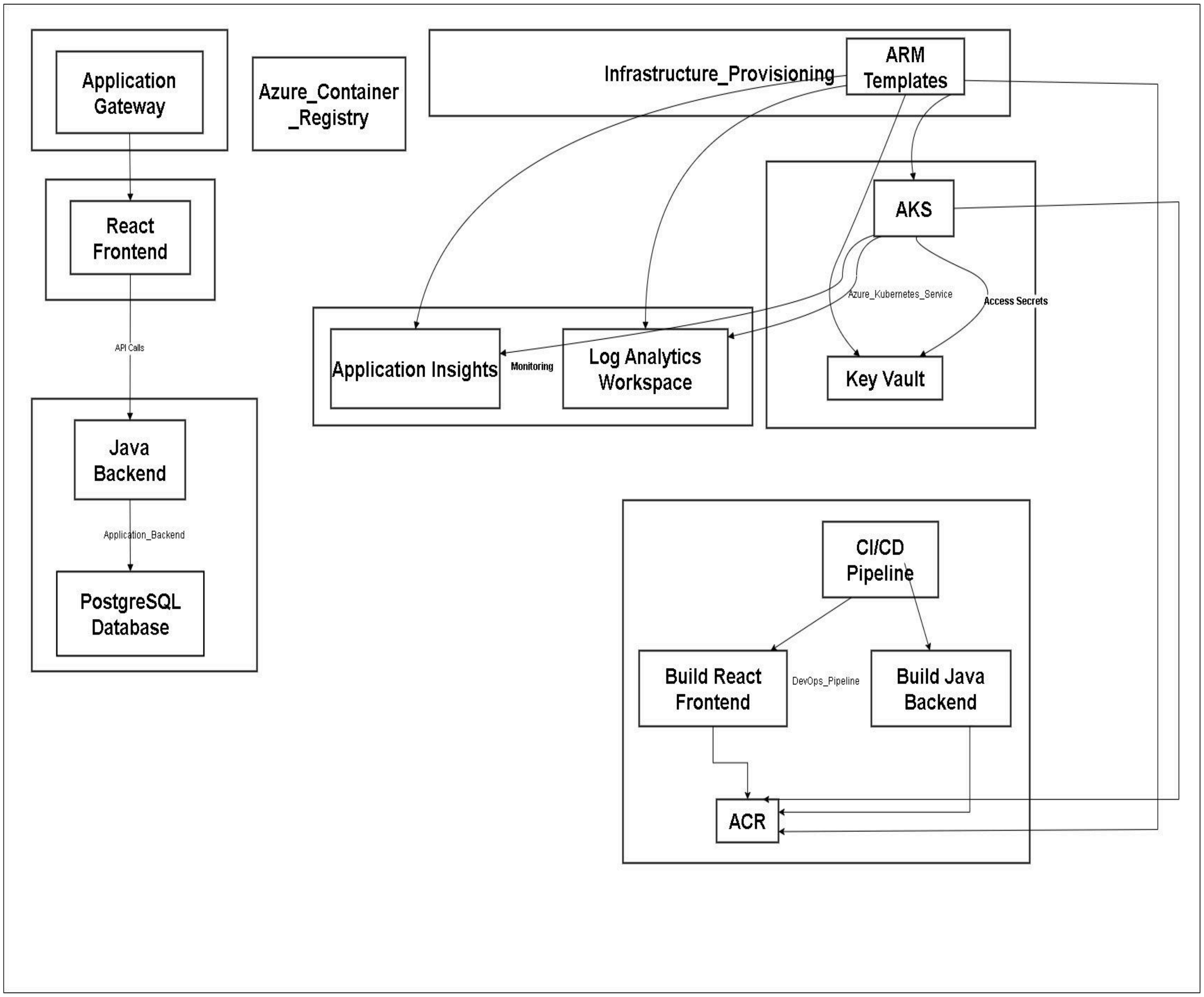
- Set up **Azure Monitor** with Log Analytics for container insights.
- Use `kubectl logs` and `kubectl describe` for troubleshooting.

Step 5: Database Integration

- Replace the in-memory database with **Azure PostgreSQL**.
- Update the `application.properties` in the Java backend to use the Azure PostgreSQL connection string from **Azure Key Vault**.

Step 6: Automatic Scaling and Clean Up

- Enable **Horizontal Pod Autoscaler** in AKS for auto-scaling.
- Create a `terraform destroy` or `az group delete` pipeline for resource cleanup.


Application Gateway
Azure_Container_Registry
Infrastructure_Provisioning
ARM Templates
React Frontend
API Calls
AKS
Azure_Kubernetes_Service
Access Secrets
Application Insights
Monitoring
Log Analytics Workspace
Key Vault
Java Backend
Application_Backend
PostgreSQL Database
CI/CD Pipeline
Build React Frontend
DevOps_Pipeline
Build Java Backend
ACR

Solution Directory Structure

```
react-and-spring-data-rest/
├── .mvn
│   └── wrapper/
├── src/
│   ├── main/
│   │   ├── java/
│   │   │   └── com/
│   │   │       └── contoso/
│   │   │           └── payroll/
│   │   │               ├── Application.java
│   │   │               └── [Other Java files]
│   │   ├── js/
│   │   │   ├── api/
│   │   │   │   ├── uriListConverter.js
│   │   │   │   └── uriTemplateInterceptor.js
│   │   │   ├── app.js
│   │   │   ├── client.js
│   │   │   ├── follow.js
│   │   │   └── websocket-listener.js
│   │   ├── resources/
│   │   │   ├── static/
│   │   │   │   └── built/
│   │   │   │       └── main.css
│   │   │   ├── templates/
│   │   │   │   └── index.html
│   │   │   └── application.properties
│   ├── test/
│   │   └── java/
│   │       └── com/
│   │           └── contoso/
│   │               └── payroll/
│   │                   └── [Test files]
├── .dockerignore
├── .gitignore
├── azure-pipelines/
│   ├── backend-pipeline.yml
│   ├── frontend-pipeline.yml
│   └── infrastructure-pipeline.yml
├── arm-templates/
│   ├── azuredeploy.json
│   ├── parameters.json
│   ├── keyvault-template.json
│   └── monitor-template.json
├── docker/
│   ├── backend/
│   │   ├── Dockerfile
│   │   └── [Other Docker files]
│   └── frontend/
│       ├── Dockerfile
│       └── [Other Docker files]
├── scripts/
```

```
│   └── deployment-scripts/
│       ├── deploy.sh
│       └── cleanup.sh
├── README.md
└── LICENSE
```

Explanation of Each Directory

1. `.mvn/wrapper`: Maven wrapper files for building the Java application.
2. `src/main/java/com/contoso/payroll`: Java source code for the backend application.
3. `src/main/js`: JavaScript files for the React frontend application.
4. `src/main/resources`: Resource files, including static assets and configuration files for the backend.
5. `src/test`: Contains unit and integration tests for the Java backend.
6. `.dockerignore`: Specifies files to ignore when building Docker images.
7. `.gitignore`: Specifies files and directories to ignore in Git.
8. `azure-pipelines`: Contains YAML files for Azure DevOps pipelines:
    - `backend-pipeline.yml`: CI/CD pipeline for the Java backend.
    - `frontend-pipeline.yml`: CI/CD pipeline for the React frontend.
    - `infrastructure-pipeline.yml`: Pipeline for deploying the infrastructure using ARM templates.
9. `arm-templates`: Contains ARM templates for deploying Azure resources:
    - `azuredeploy.json`: Main deployment template.
    - `parameters.json`: Parameters file for the ARM templates.
    - `keyvault-template.json`: Template for deploying Azure Key Vault.
    - `monitor-template.json`: Template for setting up monitoring resources.
10. `docker`: Contains Docker-related files:
    - `backend`: Contains Dockerfile and related files for the Java backend.
    - `frontend`: Contains Dockerfile and related files for the React frontend.
11. `scripts`: Contains scripts for deployment and cleanup tasks:
    - `deployment-scripts`: Shell scripts for automating deployments and cleanups.
12. `README.md`: Documentation file explaining how to set up and use the project.
13. `LICENSE`: License information for the project.