PUBLICIS SAPIENT

BOOKMYMOVIE

HIGH LEVEL DESIGN DOCUMENT

Version: 1.0

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Contents

About This Guide

This document is intended for understanding the details (Architectural/Technical Design, basic Features) of all the components of Bookmymovie Application. Purpose of this High Level Design (HLD) Document is to guide represent a suitable model for development. This document is also intended to help detect contradictions prior to coding and can be used as a reference manual for the preparing Low Level Design (LLD).

Audience

This guide is intended for the Bookmymovie Application Technical team.

Related Documents

Document title	Owner/Link	Version
Scope Of Work Document (SOW)	Front Runners	V2.0
Business Need Document (BND)	Product Owner	V1.0

Document History

Created on	Created by	Changed on	Changed by	Reviewed by	Version
24/07/2024	Palash Chanda	24/07/2024	Palash Chanda	TBD	V1.0
		26/09/2024	Palash Chanda	TBD	V2.0

Overview

The High Level Design (HLD) provides the detailed description of all the Components/Modules of this Bookmymovie Application/System. Technically this System can be considered as a collection of several Microservices/Infra on high level.

Clients

Client means who can use and utilize this Application/System. Here Client can be Public Users as well as Organizational Users.

Major Functionalities

B2B Features

Core Business-to-Business Features of Bookmymovie Application available in the System:

- Create: City (name/code) in the System.
- Fetch: All Cities from the System.
- Fetch: City (by id) from the System.
- Fetch: Cities (by name) from the System.
- Enable/Disable: City (by operational flag) in the System.
- Create: Theater (name/city/address-line/available facilities) in the System.
- Enable/Disable: Theater (by operational flag) in the System.
- Create: Screen (name/theater/show times/total rows/number of seats in each row/row type/row price) in the System.
- Enable/Disable: Screen (by operational flag) in the System.
- Create: Seats (seat number/price/type) in the System. Seats distribution (for a Theater) will be done automatically (based the defined Algorithm) when action is triggered.
- Create: Movie (name/category/description/trailer/certificate/duration/casts/crews) in the System.
- Fetch: Movie (by id) from the System.
- Enable/Disable: Movie (by operational flag) in the System.
- Create: Movie-Show (movie name/city/theater/screen/showtimes) in the System.
- Enable/Disable: Movie-Show (by operational flag) in the System.

B2C Features

Core Business-to-Consumer Features of Bookmymovie Application available in the System:

- Create: Viewer/User Profile in the System.
- Fetch: Viewer/User Profile (by mobile) from the System.
- Fetch: All Cities created/enabled in the System.
- Fetch: City (by id) created/enabled in the System.
- Fetch: Cities (by name) created/enabled in the System.
- Fetch: Movie (by id) created/enabled in the System.
- Fetch: Movie-Show (based on selected City and Movie) created/enabled in the System.
- Book Movie by selecting a Theater/Showtime/Seat for a day. Viewer can book maximum 10 Seats at a time. Offers can be applied as below:
  1. 10% discount on afternoon show booked ticket.
  2. 3% Convenience Fees will be applied on total amount after discount.

Future Scope

Features can be planned for the future implementations:

- B2B: Create/Update: Bulk Operations for City/Theater/Screen.
- B2C: Fetch: Theaters (by City name) created/enabled in the System.
- B2C: Fetch: Screens (by name) created/enabled in the System.
- B2C: Update: Movie-Show (seat/show-time) after successful Seat Booking.
- B2C: Notifications (Email/SMS/Push) should be sent to Viewer after successful Booking.
- B2C: Update: Viewer/User Profile (apart from mobile).
- B2C: Fetch: Booking/Payment (till 6monthos older) from the System.
- B2C: Viewers can provide Review/Ratings for the watched Movies.

Development Methodology

Here we are following Agile Methodology where Software is Developed and Delivered in multiple Phases (known as Milestone).

Works Estimation

Notes: Move this section to Client Proposal Document.

Estimate each Functional/Technical/NFR in terms of User Story Points which can be estimated based on the parameters: Works, Complexity, Dependency.

Estimation details:

- Infrastructure (Code Repo/Artifact Repo/Jenkins/SonarQube/Veracode) setup: 30 USP.
- Cloud Components/Services setup: 20 USP.
- Technical works (Architectural Design/Solution/Documents): 30 USP.
- B2B Functional Features: 70 USP.
- B2C Functional Features: 55 USP.
- Unplanned works: 20 USP.
- NFR: 30% of B2B + B2C Functional Features: 40USP.
- Total USP: 260 USP.

KPI Metrics

Notes: Move this section to Release Notes Document.

KPI Metrics has been considered to identify the Problem areas and improve to meet the set goals:

- Deployment Frequency: Codes will be released as per the Milestone plan in Production, that doesn't result in Failure/Downtime.
- Deployment Time/Speed: How long it takes to roll out Deployment once it is approved.
- Mean Time to Recovery (MTTR): Engineering Team's response time (from the issue trigger moment until Service is restored).
- Lead Time for Changes (LTFC): How long Team takes to deliver a new Feature.
- Time to Detection (TOD): How long Team takes to identify an issue.
- Defect Escape Rate (DER): How many Defects are detected during/after Deployment.

NFR Details

NFR Approaches considered:

- Security.
- Scaling/LB/GSLB.
- Reliability (Fault Tolerant/High Availability).
- Performance Testing (Load, Stress Testing).
- Monitoring (Logging, Metrics, Alerts, Trace, JVM Profiling).

NFR details:

- Search should be highly available.
- Booking should be highly consistent.
- Booking TPS calculation:
  1. Consider 1,00,000 Booking Requests/day.
  2. Booking Requests/second = 1,00,000/86,400 = 1.2
- Search TPS calculation:
  1. Consider 3,00,000 Search Requests/day,
  2. Search Requests/second = 3,00,000/86,400 = 3.5
- Concurrent seat Booking: Multiple Viewers are trying to book the Seat at same time.
- Global Enablement: User can be from different Geographic Locations (Future Scope).

Development Guidelines

Steps are being followed for Segment Sell Development:

- Developer creates a new branch from master branch.
- QA starts preparing Automation Scripts and push Scripts in acceptance-test folder.
- Developer clones Code from new branch.
- Developer writes Code.
- Developer confirms that local Code Build and Run is successful.
- Developer checks in Code in new branch.
- TL clones Code changes and review.
- TL checks in Code changes after review.
- Architect reviews Code changes.
- Developer creates PR.
- PR Build (all steps in CI) should besuccessful.
- PR is merged with master branch.
- Developer's Code changes are deployed in DEV using automated CI/CD Pipeline.

Dependencies & Risks

Concurrent seat Booking

Multiple Viewers are trying to book the Seat at same time:

- If Requests are coming to same Pod (Tomcat Server) it can be handled by the Java Synchronization.
- If Requests are coming to different Pods (Tomcat Servers) it can be handled as below ways:
  1. Optimistic Locking Mechanism: It is a Concurrency Control Mechanism which allows Users/Threads to modify a Resource/Record in order to create their own version/copy. But while committing one User/Thread will be allowed.
  2. Pessimistic Locking Mechanism [**recommended**]: It is a Concurrency Control Mechanism which doesn't allow Users/Threads to modify a Resource/Record as it is locked. It is way. Steps:
  2.1. DB/Cache has one Table/Kind which can store details:
  CityId/MovieId/TheaterId/ScreenId/ seatIds.
  2.2. While Booking, Viewer proceeds for the Payment selecting CityId/MovieId/TheaterId/ ScreenId/Seats(seatIds).
  2.3. Before it goes to the Payment Screen, it will check in that Table/Kind whether the above combination is available or not. If it is available, Viewer will not be allowed to proceed to the Payment Screen and gets Booking Errors and this Booking Transaction will be aborted by the System.

Architecture Details

This chapter describes the Application/System Architecture and communication among Components/ Microservices.

Architectural Style

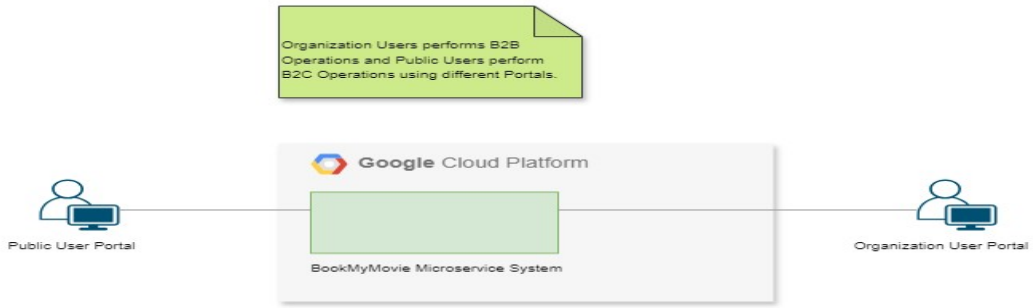
An Architecture can have multiple Architectural Styles. Here we have selected Microservice.

Architectural Pattern

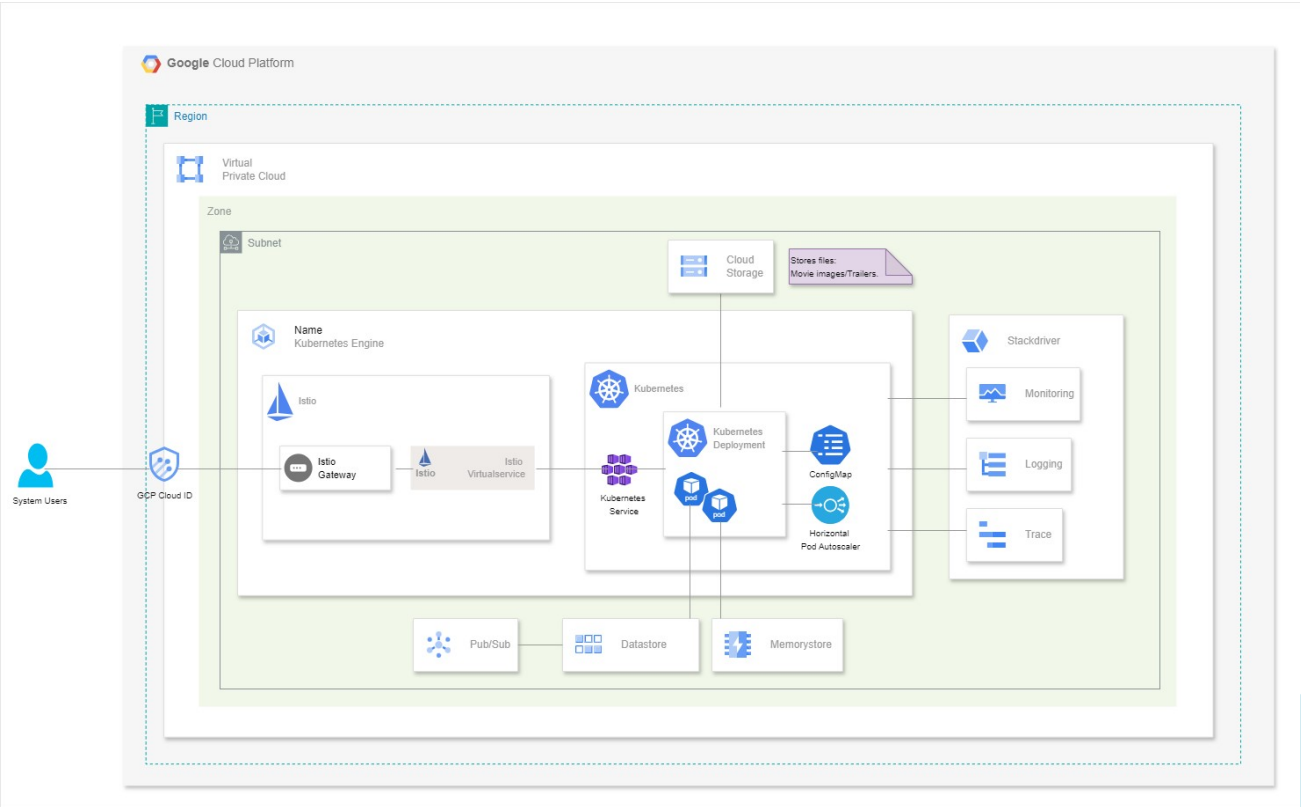
An Architectural Style can have multiple Architectural Patterns. Here we are focused on Backend API.

Technical Design

Technical Design Diagram (High Level: Users/System): It depicts which Components are used and how the Components/User are connected. It doesn't describe the flow between them.



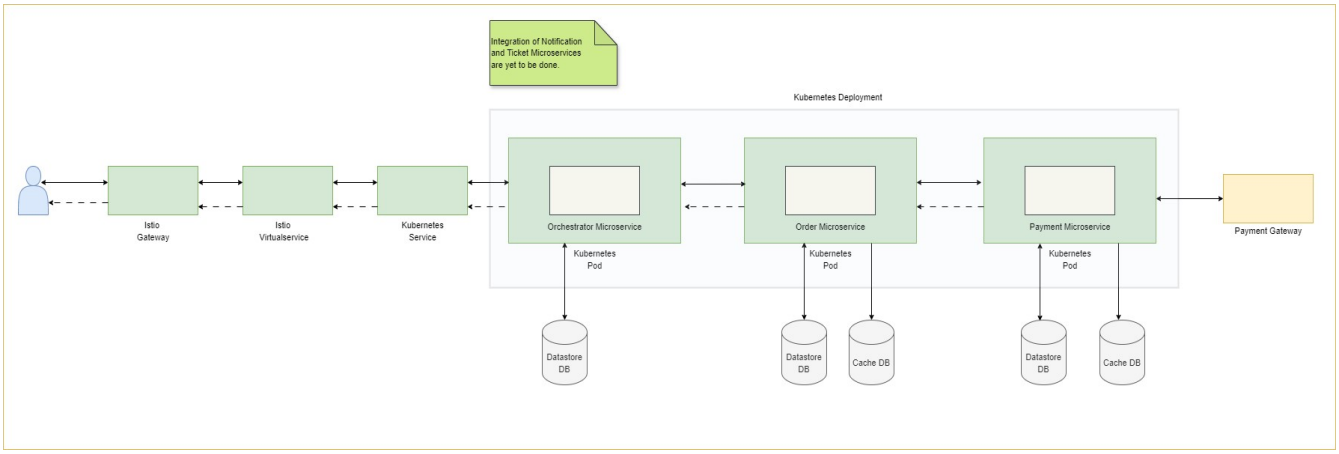
Technical Design Diagram (Details: Users/System/Resources/Components): It depicts which Components are used and how the Components/User are connected. It doesn't describe the flow between them



Technical Design Diagram details:

- User connects with Istio Gateway.
- Istio Gateway connects with Istio Virtual Service.
- Virtual Service connects with Kubernetes Service.
- Kubernetes Service connects with Kubernetes Pod (in Kubernetes Deployment).
- Kubernetes Pod connects with GCP Datastore.
- Kubernetes Pod also connects with GCP Memorystore.
- GCP Pubsub connects with GCP datastore.
- GKE connects with GCP Stackdriver Trace.
- GKE connects with GCP Stackdriver Logging.
- GKE connects with GCP Stackdriver Monitoring.

Technical Flow



Technical Flow Diagram depicts how User communicates with several Components and Microservices:

- User sends Request.
- Istio Gateway receives the Request and sends it to Istio Virtualservice.
- Istio Virtualservice receives the Request and sends it to Kubernetes Service.
- Kubernetes Service receives the Request and sends it to Orchestrator Microservice.
- Orchestrator Microservice sends the interim/acknowledgement Response to User and Asynchronously sends Request to Order Microservice.
- Order Microservice sends the interim/acknowledgement Response to Orchestrator Microservice and Asynchronously sends Request to Payment Microservice.
- Payment Microservice completes Payment process, generates the Final/Asynchronous Response and sends it to Order Microservice.
- Order Microservice completes Order process and sends Final/Asynchronous Response to Orchestrator Microservice.
- Orchestrator Microservice sends Final/Asynchronous Response to User.

Module Details

Module/Component represents (Technically) each Microservice in this System:

- Orchestrator Microservice: Role: System Entrypoint.
- Viewer Microservice: Role: Load/Display Viewer's Profile.
- Theater Microservice: Role: Load/Display City/Theater/Screen/Seats.
- Movie Microservice: Role: Movie and running Show details.
- Order Microservice: Role: Order processing for booking a Movie.
- Payment Microservice: Roles: Payment processing for booking a Movie.
- Notification Microservice: Role: Sending notifications (email/sms) for booking a Movie.
- Utility Microservice: Roles: Offer details, Ratings (User/Critics), Generate offers automatically based on the DOB, Marriage Anniversary.

Design Principles and Patterns

Design Principles/Patterns should be used:

- 12 Factor App Principles.
- Microservice Design Patterns:
  1. Decomposition Pattern.
  2. API Gateway Pattern.
  3. Integration Pattern: Agreegrator Pattern, Choreography Pattern.
  4. Centralized/Externalized configuration.
  5. Service Registration & Discovery.
  6. Database Pattern.
  7. Deployment Pattern.
  8. Error Approach.
  9. Transaction Approach.
  10. Testing Approach.
  11. Security Approach.
  12. Scaling Approach.
  13. Reliability Approach.
  14. Monitoring Approach.
- OOPs Features and OOPs Design Patterns (like SOLID, DRY Principles etc.).
- Java Design Patterns: Front Controller Design Pattern, Singleton Pattern (Configuration Classes), Builder Pattern.
- Dependency Injection Pattern so that Object Relationships become Loosely Coupled.

Decomposition Pattern

Microservices can be identified and decomposed as:

- Decomposed by Functionality: Theater, Movie, Vierer, Order, Payment etc.
- Decomposed by Roles/responsibilities: Auth, Gateway/Orchestrator, Utility etc.

API Gateway Pattern

API Gateway Patten can be implemented as:

- Istio Service Mesh will be acting as an API Gateway for the Entire System.
- Gateway Microservice will be acting as an API Gateway for the Microservice Ecosystem.

Choreography Pattern

Choreography Pattern implements Microservice-to- Microservice communication. Here Microservices can talk to each other directly (Asynchronous mode) without any centralized Orchestrator.

Centralized/Externalized Configurations

Configurations can be Centralized and Externalized as:

- Business Configurations (Rules/Validations) should reside in DB.
- Technical Configurations in GKE ConfigMap

Service Registration & Discovery

Service Registration/Discovery is required for the Microservices communication. Prerequisite is Istio Daemon should be installed on the Kubernetes Cluster. Approach:

- Microservice should be registered in Istio Data Plane/Layer (Service Entry).
- Microservice should be discovered by Istio Control Plane/Layer (Sidecar Envoy Proxy).

Database Pattern

Database Pattern should be Single DB per Microservice. Details:

- GCP Firestore (Datastore mode) Service will be used. Reasons behind selecting NoSQL DB:
  1. Required Document-Data-Model not Relational-Data-Model.
  2. Scalibility of NoSQL DB is better than Relational DB in high traffic environment.
  3. GCP Datastore is a Multi Regional Service. Disaster Recovery & backup not required.
  4. ACID property support not required.
- GCP Datastore Database Document-Data-Model:

KIND: City		
Key Name	Key Value Type	Id
CityId	Long	K
CityName	String	
CityCode	String	
Operational	Boolean	

KIND: Theater		
Key Name	Key Value Type	Id
TheaterId	Long	K
CityId	Long	
TheaterName	String	
AddressLine	String	
AvailableFacilities	List	
Operational	Boolean	

KIND: Screen		
Key Name	Key Value Type	Id
ScreenId	Long	K
TheaterId	Long	
ScreenName	String	
ShowTimes	List	
TotalRows	Integer	
NumberOfSeatsInEachRow	Integer	
RowNames	List	
RowNameTypeMap	Map	
RowTypePriceMap	Map	
Operational	Boolean	

KIND: Seat		
Key Name	Key Value Type	Id
SeatId	Long	K
ScreenId	Long	
SeatNumber	String	
SeatType	String	
SeatPrice	String	
Operational	Boolean	

KIND: Movie		
Key Name	Key Value Type	Id
MovieId	Long	K
MovieName	String	
MovieCategory	String	
MovieDescription	String	
MovieTrailerPath	String	
MovieCertificate	String	
MovieDuration	String	
MovieCasts	List	
MovieCrews	List	
Operational	Boolean	

KIND: MovieShow		
Key Name	Key Value Type	Id
MovieShowId	Long	K
MovieId	Long	
CityId	Long	
TheaterId	Long	
TheaterName	String	
ScreenId	Long	
ScreenName	String	
ShowTimes	List	
Operational	Boolean	

KIND: Order		
Key Name	Key Value Type	Id
Id	Long	K
OrderId	String	
TransactionId	String	
PaymentId	Long	
PaymentCategory	String	
FinalAmount	String	
OrderTimeStamp	LocalDateTime	

KIND: Payment		
Key Name	Key Value Type	Id
PaymentId	Long	K
TransactionId	String	
PaymentCategory	String	
FinalAmount	BigDecimal	
PaymentTimeStamp	LocalDateTime	

- GCP Datastore Database Kind/Collection Logical Relationships:
  1. One City can have multiple Theaters.
  2. One Theater can have multiple Screens.
  3. One Screen can have multiple Seats.
  4. One Screen can have multiple Movie-Show.

Deplоment Pattern

Deployment Pattern can be:

- Single Container per Pod for each Microservice.
- Blue-Green Rollling Upgrade Strategy where exitsting Workload will not be touched.

Error Approach

Error management approaches are:

- Transient Errors: Retry immediately. Details:
  1. Exception/Errorcode/Errormessage mappings should be configured.
  2. Exceptions should be cought only in the Service Layers and thrown from the other layers.
  3. Metrics will be executed. Alerts got triggered and Email notification will be sent.
  4. Populate Error block (error code/message) in Response based on the Exception occurs.
- Non-Transient Errors: Replicate, Analyze, Find root cause and provide the fix.

Transaction Management Approach

SAGA Coreography for distributed Transaction:

- There is no SEC (SAGA execution Coordinator) to handle the Transaction.
- Compensate/Rollback Method for each API's Service Method.
- Transaction can be monitored using TxnId in Tracker Table/Kind.

Testing Approach

Testing Approaches are:

- Unit Testing using JUnit/Mockito/SquareTest.
- E2E/Integration Testing using Web/Mobile Applications.
- Automation Testing: BDD approach (using Cucumber, Gherkin language).
- Performance Testing using JMeter: Load, Stress Testing.
- Smoke Testing: Validate that new Build is ready for the Testing.
- Sanity Testing: Validate that Bugs are fixed or not.
- Regression Testing: Validate existing functionalities working or not after the Bug fixed.
- Notes: For the Defects/Bugs (Severity: Fatal/Major/Minor) management JIRA will be used.

Security Approach

As per the existing implementations, following Security mechanisms are available in the System:

- Authentication/Authorization: Determines Who/What can be accessed. Approaches:
  1. For the API used by Public Users in B2C:
  1.1. API Gateway Server will be used: Orchestrator.
  1.2. Authentication is enabled using Mobile/OTP.
  1.3. OAuth2.0 External Authorization (Google/Apple/Facebook etc).
  2. For the API used by Public Users and Organization Users in B2B/B2C:
  2.1. API Gateway Server will be used: Orchestrator-Admin.
  2.2. Authentication (Mobile/OTP) and Authorization (Role based - Admin/BA/Analytics).
- Cloud shared Security model:
  1. Cloud will secure: Runtime, OS, Server, Networking.
  2. Customer will secure: Data, Application, IAM, Configurations.
- Future Scope/Enhancement: Encryption can be enabled when System Users (Public Users and Organization Users) are consuming API from the external Client (like app, web). Here encrypted Data can be decrypted at Server end.

Reliability Pattern

Reliability Approaches ensures Fault Tolerant/High Availability:

- Create multiple Regions.
- Create multiple AZ in a Region.
- Create multiple Clusters in an AZ.
- Create multiple Servers in a Cluster.
- Create multiple Application instances in a Server.
- Scaling: Kubernetes HPA (CPU based Autoscaling).
- Kubernetes DR/Issues:
  1. ETCD Backup.
  2. Multiple Cluster set up: Multiple Kubernetes Clusters should be there in different Regions and can be accessed using LB/GSLB (in Acrive-Acrive or Acrive-Passive mode).
  3. Enable Graceful shutdown.
- Implement using Resiliense4J/Hystrix: Circuit Breaker, Rate Limiter, Retry, Bulkhead.
- Cache:
  1. Server/Client side Caching: NA.
  2. CDN: Frontend (static components) caching is not enabled as this Application is not global.

Observability Pattern

Observability/Monitoring Approaches can be:

- Logging/Log-Agreegation: GCP Log.
- Kubernetes Metrics creation using Micrometer API.
- Kubernetes Alerts creation and configure Email/SNOW.
- Distributed Request tracing: GCP Trace.
- Kubernetes Health check: Liveness Probe, Readiness Probe.
- JVM Performance Tuning: Heap/Stack memory set, GC set, GC Logging set.
- JVM Performance Profiling/Monitoring:
  1. Download/Analysis Heap Dump from Kubernetes Container into a local machine.
  2. Download/Analysis Thread Dump from Kubernetes Container into a local machine.
  3. Analysis GC: GC Log, GC is running frequently.

Technology and Tool Details

Cloud Provider

GCP Cloud Provider is selected and Resources Selection is done based on the Requirements/Budget:

- GKE: Kubernetes Cluster for Microservices Containerized Deployment.
- GCR: Docker Images storage.
- GCP Memorystore (Redis).
- Firestore DB (Datastore mode): NoSQL Database and supports write operations with no limit.
- GCP Operations/Stackdriver: Logging, Monitoring (Metrics/Alerts), Trace.
- GCP PubSub: TBD.

Code Repository

Code Repository will be used:

- Distributed VCS: Bitbucket Repository Monorepo.
- Single Code Repository for all the Environments (DEV/INT/CERT/PROD).

CI/CD

CI/CD purpose Jenkins Pipeline Job (Declarative Pipeline) will be used to integrate following phases/stages:

- Set up Environment.
- Source Code Checkout.
- Unit Testing.
- Build Artifact.
- Automation Testing.
- SonarQube Rules Validations.
- Veracode Code Scanning.
- Publish Artifact to Nexus repository Manager.
- Generate Image.
- Publish Image to GCR.
- Trigger Deployment for the Microservice Deployment in GKE.

Tools/Frameworks Used

Languages/Frameworks/Tools selected:

- Languages/Frameworks: Java17.0 (OpenJDK), Spring (Core/Web/Data/Boot), REST.
- Container Technologies: Docker, Kubernetes, Helm, Minikube.
- Code-analysis/Code-security: SonarQube/Veracode.
- Build/Deployment: Maven/Jenkins.
- Web Servers/IDE/Tools: Apache Tomcat7/IntelliJ/GCloud-CLI/Postman/JMeter.
- Databases: GCP Firestore (Datastore mode).
- Infrastructure as Code Tool: TerraForm.
- Diagram as Code Tool: PlantUML (C4-Diagrams).
- Generative AI: Spring-AI/OpenAI (AI Service provider).

Coding Standards

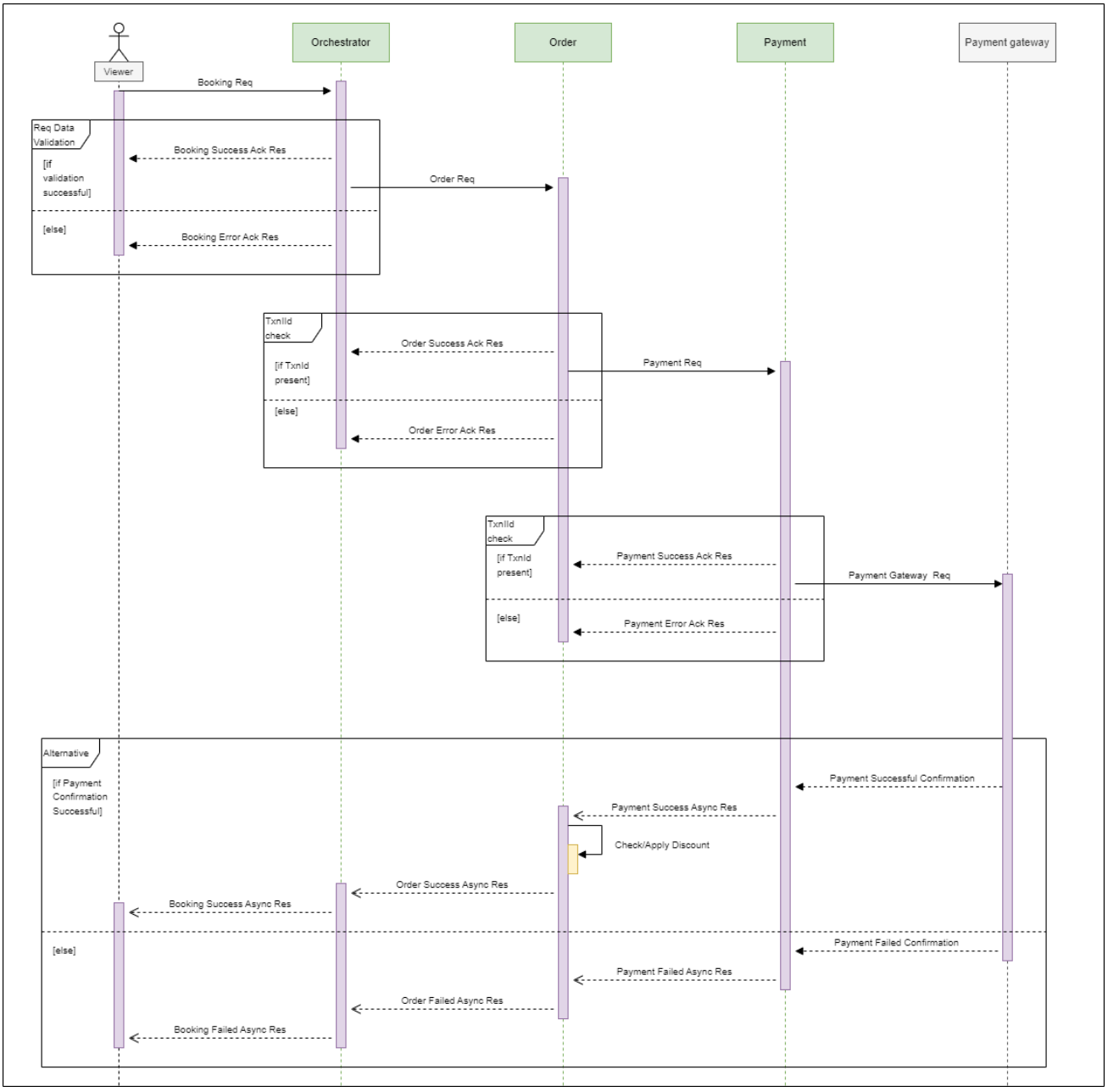
Industry standard best practices will be used during the Development:

- OOP/Java Design Patterns.
- Code Design approach.
- Code Review Process:
  1. Manual Code review: Application Development Guidelines are followed properly.
  2. Tool-based Code review: SonarQube - Code Conventions, Bad practices, Bugs, Code Coverage, Cognitive and Cyclomatic Complexity etc.
- Notes: For more details refer to the Coding_Guideline_V1.0 specification.

Functionalities Overview

Booking Process

Functional Flow Sequence diagram:



Flow details: Prerequisites: Viewer will be loaded in the System after providing the required details.

- Viewer/User will login in the System.
- Viewer/User will search and select the City.
- Movies will be displayed. Viewers can search Movie by name/category.
- Select Movie and get details (category, description, trailer, certificate, duration, casts, crews).
- Proceed for the Booking.
- Get Movie-Show details (theater available for the city, screens available for the theater, seats available for the screen, showtimes).

- Select Theater/Screen/Seats/Showtime. Viewer can select maximum 10 Seats at a time.
  1. 10% discount on afternoon show booked ticket.
  2. 3% Convenience Fees will be applied on total amount after discount.
- Proceed for the Payment.
- Provides the Payment details.
- Finally receive the Booking details (movie name, theater, screen, seats, showtimes, total amount paid, booking id) on successful Payment.
- Notes: For more details refer to the BND_V1.0 (Business Need Document) specification.

Compliance & Security

As a Compliance Certificate, Veracode Code Scanning Report will be provided at the end of Milestone.
No Compliance will not be provided for the Infrastructure, Cloud Services.

Future Scopes

Following Features and Enhancements can be considered for the Future Scopes:

- Functional Scopes: Follow Future Scopes in Major Functionalities Section.
- Authentication/Authorization: Determines Who/What can be accessed. Approaches:
  1. For the API used by Public Users in B2C:
  1.1. API Gateway Server will be used: Orchestrator.
  1.2. Authentication is enabled using Mobile/OTP.
  1.3. OAuth2.0 External Authorization (Google/Apple/Facebook etc).
  2. For the API used by Organization Users in B2B:
  2.1. API Gateway Server will be used: Orchestrator-Admin.
  2.2. Authentication (Mobile/OTP) and Authorization (Role based - Admin/BA/Analytics).
- OWASP approaches for Web Application Security:
  1. SQL Injection Attack.
  2. Cross-site scripting Attack.
  3. Sensitive Data Exposure.
  4. Security Misconfiguration.
  5. Insecure Deserialization.
  6. Insufficient Logging and Monitoring.
- Payment Gateway integration for Payment processing.
- Neo4J Graph Database integration for Rating/Review/Notifications etc.
- Ticket Microservice integration.
- Notification Microservice integration.
- Schedular Microservice integration: Based on the DOB/Anniversary offers will be sent to User.
- GCP Alerts and Email notification creation for Monitoring.
- Cache: Cache the Records (City/Theater/Movies) which are not frequently changed.
- Implement Fault Tolerant/High Availability using Resiliense4J/Hystrix: Circuit Breaker, Retry.
- Global Enablement:
  1. CDN (Edge Locations) should be enabled at User's Region.
  2. Multiple Kubernetes Clusters should be available in different Regions and Configure GSLB (Active-Active/Active-Passive mode) to distribute Loads in multiple Regions.
  3. Currency/Language configurations for the Users from different Regions.
- AI based Chatbot integration to enable Automation: check City/Theater/Movies/shows etc.

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