**Micro Services:**

1. **Monolith Architecture:**

=> Develop all functionalities in single app

=> Application will be packaged as one fat jar/fat war

=> App will be deployed in single sever.

**2. Drawbacks:**

=> Single point of failure

=>Re-Deploy entire of the app

=>Maintenance of the app

=>Burdon on server

**3. Micro Services**:

=>Micro Services is not Technologies

=>Micro Services is not Framework

=> Micro Services is not API

=>Micro Services is Architectural Design Pattern and it’s universal

=> Micro Services based application means collections of rest APIs.

=>Micro Services means independently and executed services.

**4. Benefits:**

=> Loosely Coupled

=> Easy Maintenance

=> Load will be Independency

=> Technology Independency

=> High Availability

**5. Challenges:**

=> Bounded Context (deciding no.of rest APIs to develop)

=> Duplicate Configuration

=> Visibility

**6. Micro Services Architecture:**

=> There is no standard architecture for Micro Service Development

=> People are customizing micro services project architecture according to their requirement.

1) Service Registry

2) Admin Server

3) Zipkin Server

4) Backend Services (Rest APIs)

5) API Gateway

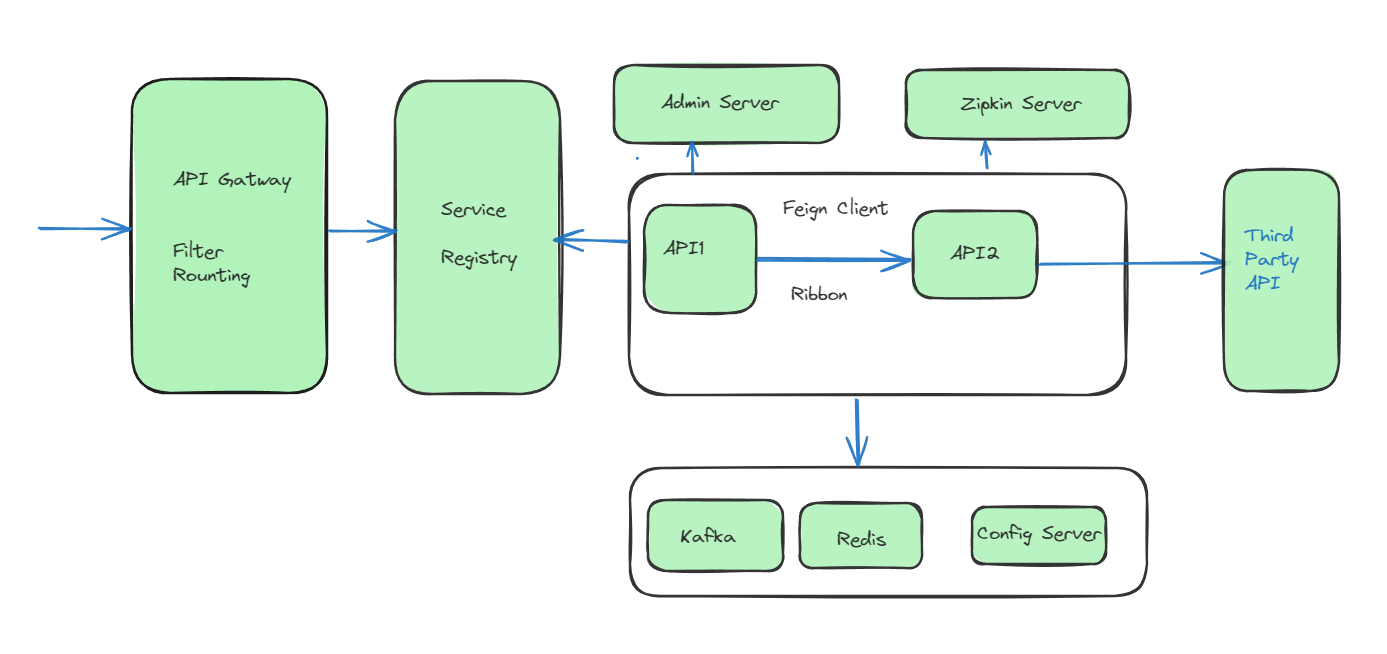
6) Feign Client

7) Config Server

8) Apache Kafka

9) Redis Cache

10) Docker



1. **Service Registry:**

=> Service Registry is used to maintain list of services available in the project.

=>It provides information about registered services like Name of service, URL of service, status of service

=>It provides no.of instances available for each service.

=>We can use Eureka Server as a service registry.

=>Eureka server provided by Spring Cloud Netflix library

**2. Admin Server:**

=>Actuators are used to monitor and manage our applications

=>Monitoring and managing all the APIs separately is a challenging task

=>Admin Server Provides and user interface to monitor and manage all the APIs at one place using actuator endpoints.

**3. Zipkin Server:**

=> It is used for Distributed tracing

=>Using zipkin server, we can monitor which API is taking more time to process request.

=>Using Zipkin we can understand how many APIs involved in request processing.

**4. Backend APIs:**

=>Backend APIs contains business logic

=> Backend APIs are also called as REST APIs / services / micro services

Ex: payment-api, cart-api, flights-api, hotels-api

=> Note: Backend API can register as client for Service Registry, Admin server & Zipkin server (It is optional)

**5. Feign Client:**

=> It is provided by spring cloud libraries

=> It is used for Inter Service Communication

=> Inter service communication means one api is accessing another api using Service Registry.

Note: External communication means accessing third party APIs.

=>When we are using Feign Client we no need mention URL of the API to access. Using service name feign client will get service URL from service registry.

=> Feign Client uses Ribbon to perform Client side load balancing.

**6.** **API Gateway:**

=> API Gateway is used to manage our project backend APIs

=> API Gateway acts as mediator between user requests and backend APIs

=> API Gateway acts as entry point for all backend APIs

=>In API Gateway we will have 2 types of logics

1) Request Filter : To validate the request (go / no-go)

2) Request Router: forward request to particular backend-api based on URL Pattern

/hotels => hotels - API

/flights => flights - API

/trains => trains – API

**7.** **Config Server:**

=> Config Server is part of Spring Cloud Library

=> Config Server is used to externalize config properties of application

Note: In real-time we will keep app config properties outside of the project to simplify application maintenance.

**8.** **Apache Kafka:**

=> Kafka is a message broker

=> Kafka works based on Publisher - Subscriber model

=> To send msgs from one app to another app we will use Kafka as a mediator.

=> Using Kafka we can develop Event Driven Micro Services based applications.

**9. Redis Cache:**

=> In our application we will have 2 types of tables

1) Transaction tables (app will insert/update/delete records)

2) Non-Transactional tables (app will only retrieve records)

Note: It is not recommended to load non-transactional tables data from DB every time.

=> To reduce no.of round trips between Java app and Database we will use cache.

=> Redis is used for distributed cache implementation.

**Steps to develop WELCOME-API:**

1) Create Spring Boot application with below dependencies

- eureka-discovery-client

- starter-web

- devtools

- actuator

- zipkin

- admin-client

2) Configure @EnableDiscoveryClient annotation at boot start class

3) Create Rest Controller with required method

4) Configure below properties in application.yml file

**application.yml:**

|  |
| --- |
| server:  port: 1111  spring:  application:  name: WELCOME-API  boot:  admin:  client:  url: http://localhost:9090/  eureka:  client:  serviceUrl:  defaultZone: http://localhost:8761/eureka  management:  endpoints:  web:  exposure:  include: '\*' |

5) Run the application and check in Eureka Dashboard (It should display in eureka dashboard)

6) Check Admin Server Dashboard (It should display) (we can access application details from here)

Ex: Beans, loggers, heap dump, thread dump, metrics, mappings etc...

7) Send Request to REST API method

8) Check Zipkin Server UI and click on Run Query button

(it will display trace-id with details)

**Steps to develop GREET-API:**

1) Create Spring Boot application with below dependencies

- eureka-discovery-client

- starter-web

- devtools

- actuator

- zipkin

- admin-client

- openfeign

2) Configure @EnableDiscoveryClient annotation at boot start class

3) Create Rest Controller with required method

4) Configure below properties in application.yml file

**application.yml:**

|  |
| --- |
| server:  port: 2222  spring:  application:  name: GREET-API  boot:  admin:  client:  url: http://localhost:9090/  management:  endpoints:  web:  exposure:  include: '\*' |

5) Run the application and check in Eureka Dashboard (It should display in eureka dashboard)

6) Check Admin Server Dashboard (It should display) (we can access application details from here)

Ex: Beans, loggers, heap dump, thred dump, metrics, mappings etc...

7) Send Request to REST API method

8) Check Zipkin Server UI and click on Run Query button

(it will display trace-id with details)

**Interservice communication:**

|  |
| --- |
| => Add @EnableFeignClients dependency in GREET-API boot start class  => Create FeignClient interface like below  @FeignClient(name = "WELCOME-API")  public interface WelcomeApiClient {    @GetMapping("/welcome")  public String invokeWelcomeMsg();  }  => Inject feign client into GreetRestController like below  @RestController  public class GreetRestController {    @Autowired  private WelcomeApiClient welcomeClient;    @GetMapping("/greet")  public String getGreetMsg() {    String welcomeMsg = welcomeClient.invokeWelcomeMsg();    String greetMsg = "Good Morning, ";    return greetMsg.concat(welcomeMsg);  }  }  => Run the applications and access greet-api method  **(It should give combined response)** |

**Load Balancing:**

=> Distribute requests to multiple servers

=> Run welcome-api in multiple instances.

1) Remove port number configuration welcome api yml file

2) Make changes in rest controller to display port number in response.

3) Right click => Run as => run configuration => select welcome-api => VM Arguments => -Dserver.port=8081 and apply and run it.

4) Right click => Run as => run configuration => select welcome-api => VM Arguments => -Dserver.port=8082 and apply and run it.

**What is Auto Scaling? :**

=> It is used to scale up or scale down servers to run our application based on incoming traffic.

1) Fault Tolerance

2) High Availability

3) Cost Management

**Working with Spring Cloud API Gateway:**

1) Create Spring boot application with below dependencies

-> eureka-client

-> cloud-gateway

-> devtools

2) Configure @EnableDiscoveryClient annotation at boot start class

3) Configure API Gateway Routings in application.yml file like below

**application.yml file:**

|  |
| --- |
| server:  port: 3333  spring:  cloud:  gateway:  routes:  - id: welcome-api  uri: lb://WELCOME-API  predicates:  - Path=/welcome  - id: greet-api  uri: lb://GREET-API  predicates:  - Path=/greet    application:  name: CLOUD-API-GATEWAY |

welcome-api ==> 2 instances ==> 8081 & 8082 ==> /welcome

greet-api==> 1 instance ==> 2222 => /greet

api-gateway==> 1 instance ==> 3333

http://localhost:3333/welcome

<http://localhost:3333/greet>

In API gateway we will have 3 types of logics

1) Routes

2) Predicates

3) Filters

-> Routing is used to define which request should be processed by which REST API in backend. Routes will be configured using Predicate.

-> Predicate: This is a Java 8 Function Predicate. The input type is a Spring Framework ServerWebExchange. This lets you match on anything from the HTTP request, such as headers or parameters or url-patterns.

-> Filters are used to manipulate incoming request and outgoing response of our application.

Note: Using Filters we can implement security also for our application.

|  |
| --- |
| @Component  public class MyPreFilter implements GlobalFilter {  private Logger logger = LoggerFactory.getLogger(MyPreFilter.class);  @Override  public Mono<Void> filter(ServerWebExchange exchange, GatewayFilterChain chain) {  logger.info("MyPreFilter :: filter () method executed...");  // Accessing HTTP Request information  ServerHttpRequest request = exchange.getRequest();  HttpHeaders headers = request.getHeaders();  Set<String> keySet = headers.keySet();    keySet.forEach(key -> {  List<String> values = headers.get(key);  System.out.println(key +" :: "+values);  });  return chain.filter(exchange);  }  } |

-> We can validate client given token in the request using Filter for security purpose

-> We can write request and response tracking logic in Filter

-> Filters are used to manipulate request & response of our application

-> Any cross-cutting logics like security, logging, and moniroing can be implemented using Filters

**What is Cloud Config Server? :**

=> We are configuring our application config properties in application.properties or application.yml file

Ex: DB Props, SMTP props, Kafka Props, App Messages etc...

=> application.properties or application.yml file will be packaged along with our application (it will be part of our app jar file)

=> If we want to make any changes to properties then we have to re-package our application and we have to re-deploy our application.

Note: If any changes required in config properties then we have to repeat the complete project build & deployment which is time consuming process.

=> To avoid this problem, we have to separate our project code and project config properties files.

=> To externalize config properties from the application we can use Cloud Config Server.

=> Cloud Config Server is part of Spring Cloud Library.

Note: Application config properties files we will maintain in git hub repo and config server will load them and will give to our application based on our application-name.

=> Our micro services will get config properties from Config server and config server will load them from GIT hub repo.

**Developing Config Server App:**

|  |
| --- |
| 1) Create Git Repository and keep ymls files required for projects  Note: We should keep file name as application name  app name : greet then file name : greet.yml  app name : welcome then file name : welcome.yml  ### Git Repo : https://github.com/ashokitschool/configuration\_properties  2) Create Spring Starter application with below dependency  <dependency>  <groupId>org.springframework.cloud</groupId>  <artifactId>spring-cloud-config-server</artifactId>  </dependency>  3) Write @EnableConfigServer annotation at boot start class  @SpringBootApplication  @EnableConfigServer  public class Application {  public static void main(String[] args) {  SpringApplication.run(Application.class, args);  }  }  4) Configure below properties in application.yml file  server:  port: 9090  spring:  cloud:  config:  server:  git:  uri: https://github.com/ashokitschool/configuration\_properties  clone-on-start: true  management:  security:  enabled: false  5) Run Config Server application |

**Config Server Client Development:**

|  |
| --- |
| 1) Create Spring Boot application with below dependencies  a) web-starter  b) config-client  c) dev-tools  <dependency>  <groupId>org.springframework.cloud</groupId>  <artifactId>spring-cloud-starter-config</artifactId>  </dependency>  2) Create Rest Controller with Required methods  @RestController  @RefreshScope  public class WelcomeRestController {  @Value("${msg}")  private String msg;  @GetMapping("/")  public String getWelcomeMsg() {  return msg;  }  }  3) Configure ConfigServer url in application.yml file like below  server:  port: 9091  spring:  config:  import: optional:configserver:http://localhost:9090  application:  name: welcome  4) Run the application and test it.  5) Change app-name to 'welcome' and test it. |

**Redis Cache:**

1) Transactional Tables (app will perform DML operations)

2) Non-Transactional tables (app will perform DQL operations)

=> When table is static there is no use of retrieving data from that table again and again.

=> For static tables data we should use Cache.

What is Cache: temporary storage?

=> Get static table data only once and store it in a variable and re-use that variable for future requests.

**EX: countries data example**

|  |
| --- |
| @Controller  public class UserController {  private List<String> countries = null;  @GetMapping("/register")  public String loadRegisterPage(Model model){  if(countries == null)  countries = service.getCountries();  }  model.addAttribute("countries", countries);  return "regiterPage";  }  } |

=> The advantage with above logic is countries we will fetch only once from database.

**Redis Cache:**

=> It is an open source data store

=> We can use Redis as

a) Database

b) Cache

c) Message broker

=> Redis supporting for 50+ programming languages

=> We can setup Redis in 2 ways

1) On prim Setup (Windows / Linux)

2) Redis Cloud

**Spring Boot with Redis Cloud DB:**

It Repo URL: https://github.com/ashokitschool/SpringBoot\_Redis\_Cloud\_DB\_App.git

1) Setup Redis Cloud Database

2) Create Spring boot app with below dependencies

a) web-starter

b) Devtools

c) data-redis

d) redis.client

3) Configure redis DB server details in application.properties file

4) Create Redis Config class to build JedisConnectionFactory

5) Create Binding class for data representation

6) Create Repository for crud operations (Crud Repository)

7) Create Rest Controller with required methods

8) Run the app and test it using postman.

**Circuit Breaker Design Pattern:**

=> Circuit Breaker => It is an elected concept

=> It is used to protect us from high voltage or low voltage power

=> It is used to divert traffic when some problem detected in normal execution flow.

=> We can use Circuit Break concept in our micro services to implement fault tolerance systems / Resilience systems.

Note: When main logic is failing continuously then we have to execute fallback logic for some time.

**Circuit Breaker Implementation:**

|  |
| --- |
| #### 1) Create Spring Boot project with below dependencies  a) web-starter  b) actuator  c) aop  d) resillence4J  <dependency>  <groupId>io.github.resilience4j</groupId>  <artifactId>resilience4j-spring-boot3</artifactId>  <version>2.0.2</version>  </dependency>  #### 2) Create Rest Controller  @RestController  public class DataRestController {  @GetMapping("/data")  @CircuitBreaker(fallbackMethod = "getDataFromDB", name = "ashokit")  public String getData() {  System.out.println("redis method called..");  int i = 10 / 0;  return "Redis Data sent to u r email";  }  public String getDataFromDB(Throwable t) {  System.out.println("db method called..");  return "DB Data sent to u r email";  }  }  #### 3) Configure Circuit Breaker Properties  spring:  application.name: resilience4j-demo  management:  endpoints.web.exposure.include:  - '\*'  endpoint.health.show-details: always  health.circuitbreakers.enabled: true  resilience4j.circuitbreaker:  configs:  default:  registerHealthIndicator: true  slidingWindowSize: 10  minimumNumberOfCalls: 5  permittedNumberOfCallsInHalfOpenState: 3  automaticTransitionFromOpenToHalfOpenEnabled: true  waitDurationInOpenState: 5s  failureRateThreshold: 50  eventConsumerBufferSize: 10  #### 4) Test The application and monitor actuator health endpoint |

**Apache Kafka:**

=> Kafka is a Message broker

=> Kafka is used as Streaming platform

=> Kafka is used for real-time data processing

=> Kafka works based on pub & sub model

Publisher: App which is producing msgs

Subscriber: App which is consuming msgs

**Kafka Architecture:**

1) Zookeeper

2) Kafka Server

3) Kafka Topic

4) Publisher App

5) Subscriber (Consumer/Listener)

**Apache Kafka Setup in Windows:**

Step-1: Download Zookeeper from below URL

URL: http://mirrors.estointernet.in/apache/zookeeper/

Step-2: Download Apache Kafka from below URL

URL: http://mirrors.estointernet.in/apache/kafka/

Step-3: Set Path to ZOOKEEPER in Environment variables up to bin folder

### Note: Copy zookeeper. Properties and server. Properties files from Kafka/config folder to Kafka/bin/windows folder. ###

Step-4: Start Zookeeper server using below command from Kafka/bin/windows folder

Command: zookeeper-server-start.bat zookeeper. Properties

Step-5: Start Kafka Server using below command from Kafka/bin/windows folder

Command: kafka-server-start.bat server. Properties

Note: If Kafka server is getting stopped, delete Kafka logs from c:/tmp/ folder.

Step-6: Create Kafka Topic using below command from Kafka/bin/windows folder

Command: kafka-topics.bat --create --bootstrap-server localhost: 9092 --replication-factor 1 --partitions 1 --topic ashokit\_topic

Step-7: View created Topics using below command

Command: kafka-topics.bat --list --bootstrap-server localhost: 9092

**Kafka Producer App Development:**

**1) Create Spring Boot application with below dependencies**

|  |
| --- |
| <dependencies>  <dependency>  <groupId>org.springframework.boot</groupId>  <artifactId>spring-boot-starter-web</artifactId>  </dependency>  <dependency>  <groupId>org.apache.kafka</groupId>  <artifactId>kafka-streams</artifactId>  </dependency>  <dependency>  <groupId>org.springframework.kafka</groupId>  <artifactId>spring-kafka</artifactId>  </dependency>  <dependency>  <groupId>com.fasterxml.jackson.core</groupId>  <artifactId>jackson-databind</artifactId>  </dependency>  <dependency>  <groupId>org.springframework.boot</groupId>  <artifactId>spring-boot-starter-test</artifactId>  <scope>test</scope>  </dependency>  <dependency>  <groupId>org.springframework.kafka</groupId>  <artifactId>spring-kafka-test</artifactId>  <scope>test</scope>  </dependency>  </dependencies> |

**2) Create Kafka Constants class:**

|  |
| --- |
| public class AppConstants {  public static final String TOPIC = "ashokit\_order\_topic";  public static final String HOST = "localhost:9092";  } |

**3) Create Model class to represent data:**

|  |
| --- |
| @Data  public class Order {  private String id;  private Double price;  private String email;    } |

**4) Create Kafka Producer Config class:**

|  |
| --- |
| @Configuration  public class KafkaProduceConfig {  @Bean  public ProducerFactory<String, Order> producerFactory() {  Map<String, Object> configProps = new HashMap<>();  configProps.put(ProducerConfig.BOOTSTRAP\_SERVERS\_CONFIG, AppConstants.HOST);  configProps.put(ProducerConfig.KEY\_SERIALIZER\_CLASS\_CONFIG, StringSerializer.class);  configProps.put(ProducerConfig.VALUE\_SERIALIZER\_CLASS\_CONFIG, JsonSerializer.class);  return new DefaultKafkaProducerFactory<>(configProps);  }  @Bean  public KafkaTemplate<String, Order> kafkaTemplate() {  return new KafkaTemplate<>(producerFactory());  }  } |

**4) Create Service Class:**

|  |
| --- |
| @Service  public class OrderService {  @Autowired  private KafkaTemplate<String, Order> kafkaTemplate;  public String addMsg(Order order) {  // publish msg to kafka topic  kafkaTemplate.send(AppConstants.TOPIC, order);  return "Msg Published To Kafka Topic";  }  } |

**5) Create Rest Controller classes:**

|  |
| --- |
| @RestController  public class OrderRestController {  @Autowired  private OrderService service;  @PostMapping("/order")  public String createOrder(@RequestBody Order order) {  String msg = service.addMsg(order);  return msg;  }  } |

**Kafka Subscriber App Development:**

1. **Develop spring boot app with below dependencies:**

|  |
| --- |
| <dependencies>  <dependency>  <groupId>org.springframework.boot</groupId>  <artifactId>spring-boot-starter-web</artifactId>  </dependency>  <dependency>  <groupId>org.apache.kafka</groupId>  <artifactId>kafka-streams</artifactId>  </dependency>  <dependency>  <groupId>org.springframework.kafka</groupId>  <artifactId>spring-kafka</artifactId>  </dependency>  <dependency>  <groupId>com.fasterxml.jackson.core</groupId>  <artifactId>jackson-databind</artifactId>  </dependency>  <dependency>  <groupId>org.springframework.boot</groupId>  <artifactId>spring-boot-starter-test</artifactId>  <scope>test</scope>  </dependency>  <dependency>  <groupId>org.springframework.kafka</groupId>  <artifactId>spring-kafka-test</artifactId>  <scope>test</scope>  </dependency>  </dependencies> |

**2) Create Constants class:**

|  |
| --- |
| public class KafkaConstants {  public static final String TOPIC = "ashokit\_order\_topic";  public static final String HOST = "localhost:9092";  } |

**3) Create Model class:**

|  |
| --- |
| @Data  public class Order {  private String id;  private Double price;  private String email;  } |

**4) Create Consumer Config:**

|  |
| --- |
| @Configuration  public class KafkaConsumerConfig {  @Bean  public ConsumerFactory<String, Order> consumerFactory() {  Map<String, Object> configProps = new HashMap<String, Object>();  configProps.put(ConsumerConfig.BOOTSTRAP\_SERVERS\_CONFIG, AppConstants.HOST);  configProps.put(ConsumerConfig.KEY\_DESERIALIZER\_CLASS\_CONFIG, StringDeserializer.class);  configProps.put(ConsumerConfig.VALUE\_DESERIALIZER\_CLASS\_CONFIG, JsonDeserializer.class);  return new DefaultKafkaConsumerFactory<>(configProps, new StringDeserializer(), new JsonDeserializer<>());  }  @Bean  public ConcurrentKafkaListenerContainerFactory<String, Order> kafkaListnerFactory() {  ConcurrentKafkaListenerContainerFactory<String, Order> factory =  new ConcurrentKafkaListenerContainerFactory<>();  factory.setConsumerFactory(consumerFactory());  return factory;  }  } |

**5) Add below method in boot app start class:**

|  |
| --- |
| @KafkaListener(topics = AppConstants.TOPIC, groupId="group\_ashokit\_order")  public void subscribeMsg(String order) {  System.out.print("\*\*\* Msg Recieved From Kafka \*\*\* :: ");  System.out.println(order);  //logic  } |

**6) Run the producer application & Consumer application:**

|  |
| --- |
| ####### Send Request to Producer app and observe Subscriber app console ############  {  "id" : "OD101",  "price" : 200.00,  "email" : "smith@gmail.com"  } |

**Git Hub Repo:**

Producer App: https://github.com/ashokitschool/spring\_boot\_kafka\_producer.git