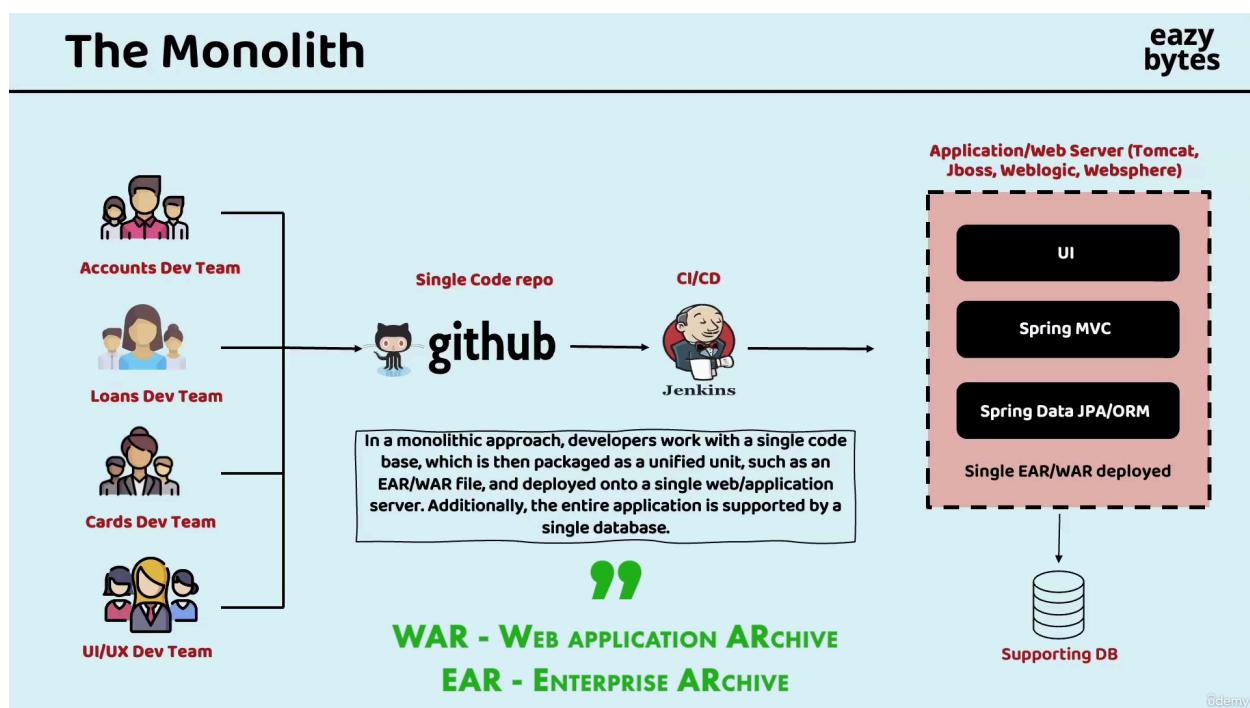


Develop Microservices with Java, Spring Boot, Spring Cloud, Docker, Kubernetes, Helm, Microservices Security



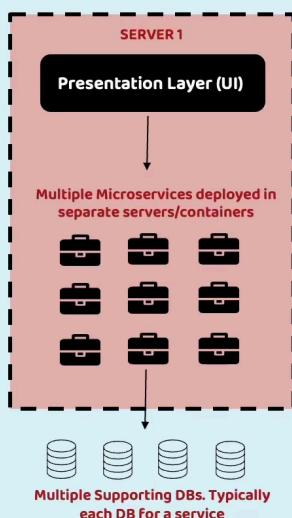
The Monolith

eazy
bytes



The GREAT MICROSERVICES

eazy
bytes



Microservices are independently releasable services that are modeled around a business domain. A service encapsulates functionality and makes it accessible to other services via networks—you construct a more complex system from these building blocks. One microservice might represent Accounts, another Cards, and yet another Loans, but together they might constitute an entire bank system.

Pros

- Easy to develop, test, and deploy
- Increased agility
- Ability to scale horizontally
- Parallel development
- Modeled Around a Business Domain

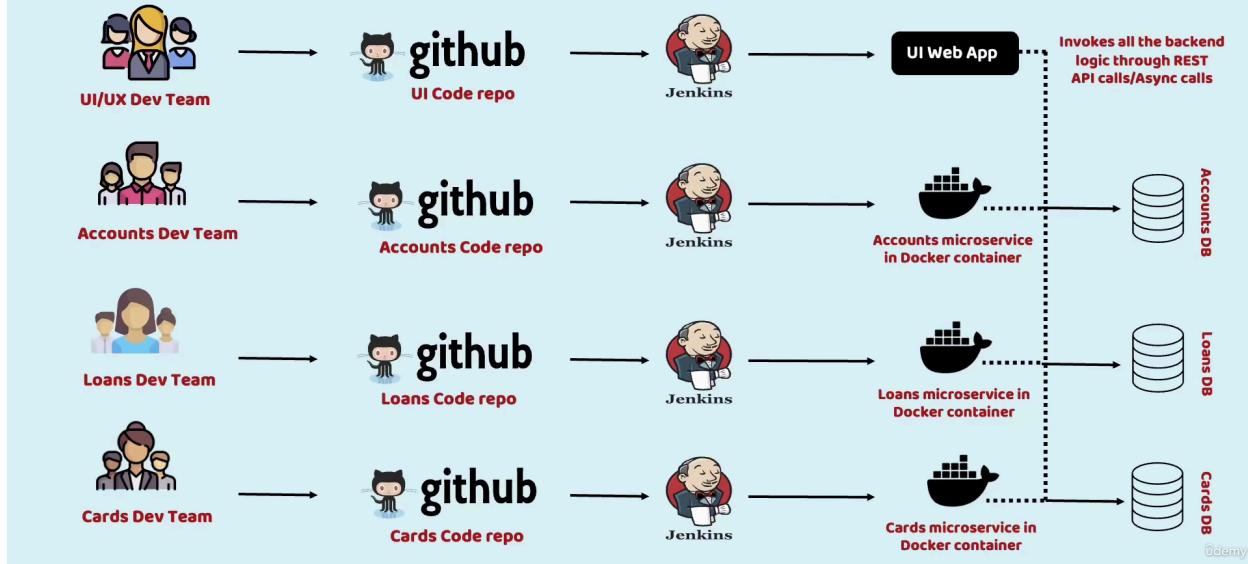
Cons

- Complexity
- Infrastructure overhead
- Security concerns

Odemy

The GREAT MICROSERVICES

eazy
bytes



Official spring website : <https://spring.io/>

Monolithic Application

Monolithic Application is a single-tier software application in which **all the components and features** of the system (such as user interface, business logic, and database access) are **developed, built, and deployed together as one single unit**.

All the modules of the application are **tightly coupled** (closely connected), meaning they depend on each other.

Usually, the entire application runs on **a single server** and uses **a single shared database**.

When you make any change or update in one module, you have to **rebuild and redeploy the entire application**, even if the change is small.

This architecture is simple to develop for small projects but becomes hard to manage and scale as the application grows larger.

🛒 Example: Online Shopping Application

Imagine you are creating an **Online Shopping App** (like Amazon).

This app has several features:

-  **User Login and Registration**
-  **Product Catalog**
-  **Shopping Cart**
-  **Payment Processing**
-  **Order Tracking**

In a **monolithic architecture**:

- All these features are **developed together** inside **one project**.
- They **share the same codebase** and **use one common database**.
- When you deploy the app, you **deploy it as one single application** (e.g., one `.war` or `.jar` file).

So, if you want to update the payment module, you must **rebuild and redeploy the entire application**, even if no other part has changed.

Microservices Application

Microservices Application is a type of software architecture where the **whole application is divided into many small, independent services (modules)**.

Each service is responsible for **a specific function or feature** (like login, payment, order, etc.), and each one can be **developed, deployed, and scaled separately**.

These services **communicate with each other** using APIs (usually REST APIs) or messaging systems.

Each service can also use **its own database** and **its own programming language or technology** if needed.

Because of this independence, if one service fails or needs an update, it **doesn't affect the other services** — making the system **more flexible, scalable, and reliable**.

Example: Online Shopping Application

Let's take the same **Online Shopping App** example.

In a **Microservices Architecture**, the app is broken down into separate services like:

Service Name	Responsibility	Own Database
 User Service	Handles user registration & login	Yes
 Product Service	Manages product details	Yes
 Cart Service	Manages shopping cart	Yes
 Payment Service	Handles payments	Yes
 Order Service	Manages orders & tracking	Yes

Each of these services is:

- Developed **independently** by separate teams.
- **Deployed separately** on different servers or containers.
- Can be **updated or scaled** without affecting others.

For example, if many users are shopping at once, you can scale only the **Cart Service** or **Order Service**, instead of scaling the entire application.

Sample Dependencies

Dependency	Description	Environment
Spring Web (WEB)	Build web, including RESTful, applications using Spring MVC. Uses Apache Tomcat as the default embedded container.	All (Dev, Prod)

H2 Database (SQL)	Provides a fast in-memory database that supports JDBC API and R2DBC access, with a small (2 MB) footprint. Supports embedded and server modes as well as a browser-based console application.	Dev / Test
Spring Data JPA (SQL)	Persist data in SQL stores with Java Persistence API using Spring Data and Hibernate.	All (Dev, Prod)
Spring Boot Actuator (OPS)	Supports built-in (or custom) endpoints that let you monitor and manage your application — such as application health, metrics, sessions, etc.	All (Dev, Prod)
Spring Boot DevTools (DEVELOPER TOOLS)	Provides fast application restarts, LiveReload, and configurations for enhanced development experience.	Dev only
Validation (I/O)	Bean Validation with Hibernate Validator.	All (Dev, Prod)
Lombok (DEVELOPER TOOLS)	Java annotation library which helps to reduce boilerplate code.	All

Spring Boot DevTools

Spring Boot DevTools is primarily designed for **local development only, not for production or staging environments**.

Here's a breakdown to make it clear 👇

⚙️ What Spring Boot DevTools Does

Spring DevTools helps **speed up local development** by:

- Automatically **restarting** the application when code changes are detected.
- Enabling **LiveReload**, so your browser refreshes automatically.
- Disabling caching for templates, static files, etc. (so you always see fresh changes).

- Improving developer experience for **rapid iteration**.

Why Not Use It in Production

- It **adds overhead** (monitors file changes, triggers restarts).
- It **disables caching** (hurts performance).
- It may **expose internal info** if accidentally left enabled.
- Spring Boot **automatically disables DevTools in a packaged (JAR/WAR) production build** — it only activates when running from your IDE or `spring-boot:run`.

Typical Usage

Environment	Use DevTools?	Notes
Local Development	 Yes	Fast reloads and testing changes quickly
Staging / QA	 No	Use normal builds for stability
Production	 No	Not recommended; automatically disabled

Spring Boot – `schema.sql` & `data.sql` Summary

- **Placement:**

Put the files in `src/main/resources/`

- `schema.sql` → for DDL (e.g., `CREATE TABLE`, `ALTER TABLE`)
- `data.sql` → for DML (e.g., `INSERT`, `UPDATE`)

- **Execution Order:**

- `schema.sql` → creates the schema
- `data.sql` → inserts initial data

- **Important Rule:**

If you use **schema.sql** / **data.sql**, disable Hibernate's auto schema generation:

`spring.jpa.hibernate.ddl-auto=none`

- Use **only one** approach to manage your schema.

If you prefer Hibernate to handle schema creation, skip **schema.sql** and set for example:

`spring.jpa.hibernate.ddl-auto=create`

- Hibernate will then generate tables automatically from your JPA entities.

- **Common `ddl-auto` Options:**

Option	Description
none	Manual schema via SQL files
validate	Only checks schema consistency
update	Updates schema to match entities
create	Recreates schema on startup
create-drop	Creates on startup, drops on shutdown

1. Development Environment

- **Goal:** Fast iteration, flexibility.

- **Approaches:**

- **Hibernate `ddl-auto`:**

- **create-drop**: Recreates schema on every app start/stop – ideal for testing new features.

- **update**: Incrementally updates schema; convenient for local single-developer setups but can cause schema drift.
- **schema.sql + data.sql**: Less common, ensures all developers work from the same baseline schema and test data.
- **Migration tools (Flyway/Liquibase)**: Used to catch migration issues early, even in dev.

2. Testing Environment

- **Goal**: Consistency, repeatability.
- **Approaches**:
 - **Hibernate ddl-auto (create-drop) with in-memory DBs**: Ensures a fresh database for each test suite; prevents test contamination.
 - **schema.sql + data.sql**: Loads a known schema and dataset before tests for predictable, reproducible results.
 - Spring Boot has built-in support for these in integration/unit tests.

3. Production Environment

- **Goal**: Stability, data integrity, controlled changes.
- **Recommended Approach**:
 - **Migration Tools (Flyway/Liquibase)**:
 - Versioned scripts (`V1__create_tables.sql`, etc.)
 - Track applied migrations and safely apply only new changes.
 - Ensures explicit, reviewable, and reversible schema changes.
- **Not Recommended**:

- **Hibernate ddl-auto**: Too risky – can cause accidental data loss or schema inconsistencies.
- **schema.sql**: All-or-nothing approach; doesn't support incremental updates or version tracking.

✓ Key Principle:

- **Dev/Test**: Convenience and speed (**ddl-auto**, in-memory DBs, SQL scripts).
- **Production**: Safety and predictability (migration tools, versioned scripts).

Springdoc OpenAPI

`springdoc-openapi` java library helps to automate the generation of API documentation using spring boot projects.

Automatically generates documentation in JSON/YAML and HTML format APIs. This documentation can be completed by comments using swagger-api annotations.

This library supports:

- OpenAPI 3
- Spring-boot v3 (Java 17 & Jakarta EE 9)
- JSR-303, specifically for `@NotNull`, `@Min`, `@Max`, and `@Size`.
- Swagger-ui
- Scalar
- OAuth 2
- GraalVM native images

Getting Started

For the integration between spring-boot and swagger-ui, add the library to the list of your project dependencies (No additional configuration is needed)

```
<dependency>
  <groupId>org.springdoc</groupId>
  <artifactId>springdoc-openapi-starter-webmvc-ui</artifactId>
  <version>2.8.14</version>
</dependency>
```

This will automatically deploy swagger-ui to a spring-boot application:

- Documentation will be available in HTML format, using the official [swagger-ui jars](#)
- The Swagger UI page will then be available at <http://server:port/context-path/swagger-ui.html> and the OpenAPI description will be available at the following url for json format: <http://server:port/context-path/v3/api-docs>

- server: The server name or IP
- port: The server port
- context-path: The context path of the application
- Documentation will be available in yaml format as well, on the following path :
`/v3/api-docs.yaml`

Run and Access the Docs

Once you start your Spring Boot app, open:

👉 **Swagger UI:**

`http://localhost:8080/swagger-ui.html`

👉 **OpenAPI JSON/YAML:**

`http://localhost:8080/v3/api-docs`

`http://localhost:8080/v3/api-docs.yaml`

Annotations

`@OpenAPIDefinition`

Where: In your `AccountsApplication.java` (main class)

Purpose:

Provides **global information** about your API — such as title, description, version, contact, license, and external documentation.

```

@SpringBootApplication
/*@ComponentScans({ @ComponentScan("com.eazybytes.accounts.controller") })
@EnableJpaRepositories("com.eazybytes.accounts.repository")
@EntityScan("com.eazybytes.accounts.model")*/
@EnableJpaAuditing(auditorAwareRef = "auditAwareImpl")
@OpenAPIDefinition()
info = @Info(
    title = "Accounts microservice REST API Documentation",
    description = "EazyBank Accounts microservice REST API Documentation",
    version = "v1",
    contact = @Contact(
        name = "Madan Reddy",
        email = "tutor@eazybytes.com",
        url = "https://www.eazybytes.com"
    ),
    license = @License(
        name = "Apache 2.0",
        url = "https://www.eazybytes.com"
    )
),
externalDocs = @ExternalDocumentation(
    description = "EazyBank Accounts microservice REST API Documentation",
    url = "https://www.eazybytes.com/swagger-ui.html"
)
)
public class AccountsApplication {

    public static void main(String[] args) {
        SpringApplication.run(AccountsApplication.class, args);
    }
}

```



Helps with:
Displays API title, author, contact info, license, etc. at the top of your Swagger UI page.

Accounts microservice REST API Documentation v1 OAS 3.1

/v3/api-docs

EazyBank Accounts microservice REST API Documentation

Madan Reddy - Website
Send email to Madan Reddy
Apache 2.0

EazyBank Accounts microservice REST API Documentation

@Schema

Where: On your `AccountsDto.java`

Purpose:

Describes the structure (model) of your DTO or entity class.
You can annotate both the **class** and **individual fields**.

package com.eazybytes.accounts.dto;

```
import io.swagger.v3.oas.annotations.media.Schema;
import jakarta.validation.constraints.NotEmpty;
import jakarta.validation.constraints.Pattern;
import lombok.Data;

@Data
@Schema(
    name = "Accounts",
    description = "Schema to hold Account information"
)
public class AccountsDto {

    @NotEmpty(message = "AccountNumber can not be a null or empty")
    @Pattern(regexp="(^$|[0-9]{10})",message = "AccountNumber must be 10 digits")
    @Schema(
        description = "Account Number of Eazy Bank account", example = "3454433243"
    )
    private Long accountNumber;

    @NotEmpty(message = "AccountType can not be a null or empty")
    @Schema(
        description = "Account type of Eazy Bank account", example = "Savings"
    )
    private String accountType;

    @NotEmpty(message = "BranchAddress can not be a null or empty")
    @Schema(
        description = "Eazy Bank branch address", example = "123 NewYork"
    )
    private String branchAddress;
}
```

Schemas

```
Accounts ^ Collapse all object
Schema to hold Account information

accountNumber* ^ Collapse all integer int64
Account Number of Eazy Bank account
Example 3454433243

accountType* ^ Collapse all string
Account type of Eazy Bank account
Example "Savings"

branchAddress* ^ Collapse all string
Eazy Bank branch address
Example 123
```

Helps with:

In Swagger UI → displays field descriptions and sample values when showing request/response schemas.

@Tag

Where: On top of your controller.

Purpose:

Groups related endpoints into sections for better readability.

```
@Tag(
    name = "CRUD REST APIs for Accounts in EazyBank",
    description = "CRUD REST APIs in EazyBank to CREATE, UPDATE, FETCH AND
DELETE account details"
)
@RestController
@RequestMapping(path="/api", produces = {MediaType.APPLICATION_JSON_VALUE})
@AllArgsConstructor
@Validated
public class AccountsController {
```

CRUD REST APIs for Accounts in EazyBank

CRUD REST APIs in EazyBank to CREATE, UPDATE, FETCH AND DELETE account details

PUT /api/update Update Account Details REST API

POST /api/create Create Account REST API

GET /api/fetch Fetch Account Details REST API

DELETE /api/delete Delete Account & Customer Details REST API



Helps with:

Creates a labeled section in Swagger UI like:

CRUD REST APIs for Accounts in EazyBank

and lists all related endpoints underneath.

@Operation

Where: Above each controller method.

Purpose:

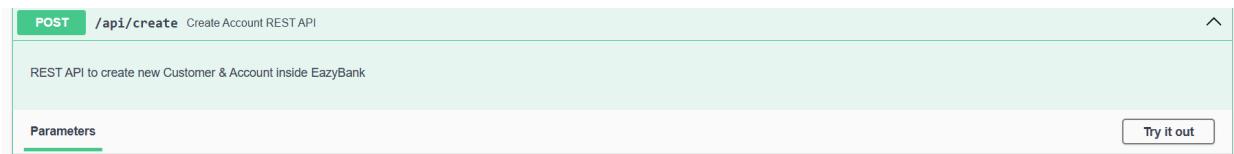
Describes what a specific endpoint does — its summary and details.

```
@Operation(  
    summary = "Create Account REST API",  
    description = "REST API to create new Customer & Account inside EazyBank"  
)  
@ApiResponses({  
    @ApiResponse(  
        responseCode = "201",  
        description = "HTTP Status CREATED"  
,  
    @ApiResponse(  
        responseCode = "500",  
        description = "HTTP Status Internal Server Error",  
        content = @Content(  
            schema = @Schema(implementation = ErrorResponseDto.class)  
        )  
    )  
})  
}@PostMapping("/create")
```

```

public ResponseEntity<ResponseDto> createAccount(@Valid @RequestBody CustomerDto
customerDto) {
    iAccountsService.createAccount(customerDto);
    return ResponseEntity
        .status(HttpStatus.CREATED)
        .body(new ResponseDto(AccountsConstants.STATUS_201,
AccountsConstants.MESSAGE_201));
}

```



Helps with:

In Swagger UI, this text appears next to the API endpoint so users immediately understand its purpose.

`@ApiResponse` and `@ApiResponses`

Where: Above each controller method.

Purpose:

Describes possible HTTP responses from the endpoint (e.g., 200, 201, 500).

`@Operation`

```

summary = "Create Account REST API",
description = "REST API to create new Customer & Account inside EazyBank"
)
```

```

@ApiResponses({

```

```

    @ApiResponse(
        responseCode = "201",
        description = "HTTP Status CREATED"
    ),

```

```

    @ApiResponse(
        responseCode = "500",
        description = "HTTP Status Internal Server Error",
        content = @Content(
            schema = @Schema(implementation = ErrorResponseDto.class)
        )
    )
}
```

```
}
```

```

    )
    @PostMapping("/create")
    public ResponseEntity<ResponseDto> createAccount(@Valid @RequestBody CustomerDto
customerDto) {
        iAccountsService.createAccount(customerDto);
        return ResponseEntity
            .status(HttpStatus.CREATED)
            .body(new ResponseDto(AccountsConstants.STATUS_201,
AccountsConstants.MESSAGE_201));
    }

```

Responses

Code	Description	Links
201	HTTP Status CREATED Media type <code>application/json</code> Controls Accept header. Example Value Schema <pre>{ "statusCode": "string", "statusMsg": "string" }</pre>	No links
500	HTTP Status Internal Server Error Media type <code>application/json</code> Example Value Schema <pre>{ "apiPath": "string", "errorCode": "100_CONTINUE", "errorMessage": "string", "errorTime": "2025-11-13T07:27:53.181Z" }</pre>	No links

💡 Helps with:

In Swagger UI → users can see:

- All possible HTTP status codes.
- Descriptions for success or error responses.
- Error model structure (like `ErrorResponseDto`).

@Parameter

Where: On method parameters (like `@RequestParam` or `@PathVariable`).

Purpose:

Describes query or path parameters, including validation rules and examples.

In your code:

```
@RequestParam  
@Pattern(regexp="^$|[0-9]{10}", message = "Mobile number must be 10 digits")  
String mobileNumber
```

You could optionally add:

```
@Parameter(description = "Customer's 10-digit mobile number", example = "9876543210")
```

 **Helps with:**

Shows parameter descriptions, data type, and example input.

more refer:

Spring Boot validation annotations

Add dependency

```
<dependency>  
  <groupId>org.springframework.boot</groupId>  
  <artifactId>spring-boot-starter-validation</artifactId>  
</dependency>
```

Step 2— Use @Valid in Controller

```
@PostMapping("/create")
```

```
public ResponseEntity<ResponseDto> createAccount(@Valid @RequestBody CustomerDto  
customerDto) {  
  
    ...  
}
```

 This tells Spring to validate the `CustomerDto` before using it.

And also

```

@Validated
public class AccountsController {

    private IAccountsService iAccountsService;

}

@PostMapping("/create")
public ResponseEntity<ResponseDto> createAccount(@Valid @RequestBody CustomerDto customerDto) {
    iAccountsService.createAccount(customerDto);
    return ResponseEntity
        .status(HttpStatus.CREATED)
        .body(new ResponseDto(AccountsConstants.STATUS_201, AccountsConstants.MESSAGE_201));
}

```

Step 3—Annotate DTO Fields

Inside DTOs, use annotations like `@NotNull`, `@Size`, `@Pattern`, etc.

A. Null and Empty Checks

Annotation	Purpose	Example
<code>@NotNull</code>	Field cannot be null	<code>@NotNull(message = "ID cannot be null")</code>
<code>@NotEmpty</code>	Field cannot be null or empty ("")	<code>@NotEmpty(message = "Name cannot be empty")</code>
<code>@NotBlank</code>	Field cannot be null, empty, or whitespace	<code>@NotBlank(message = "Username cannot be blank")</code>
<code>@Null</code>	Must be null (useful for auto-generated fields)	<code>@Null(message = "ID must be null during creation")</code>

B. Numeric Validations

Annotation	Purpose	Example
<code>@Min(value)</code>	Minimum value	<code>@Min(value = 18, message = "Age must be >= 18")</code>
<code>@Max(value)</code>	Maximum value	<code>@Max(value = 60, message = "Age must be <= 60")</code>
<code>@Positive</code>	Must be > 0	<code>@Positive(message = "Amount must be positive")</code>
<code>@PositiveOrZero</code>	Must be ≥ 0	<code>@PositiveOrZero(message = "Balance must be zero or positive")</code>
<code>@Negative</code>	Must be < 0	<code>@Negative(message = "Credit should be negative")</code>
<code>@Digits</code>	Restricts integer/fraction digits	<code>@Digits(integer = 5, fraction = 2)</code>

C. String & Pattern Validations

Annotation	Purpose	Example	🔗
<code>@Size(min, max)</code>	Validates string/collection length	<code>@Size(min = 3, max = 20, message = "Username must be 3-20 chars")</code>	
<code>@Pattern(regexp)</code>	Regex pattern validation	<code>'@Pattern(regexp="(^\$</code>	
<code>@Email</code>	Validates email format	<code>@Email(message = "Invalid email address")</code>	
<code>@URL</code>	Validates URL	<code>@URL(message = "Invalid website URL")</code>	

D. Date Validations

Annotation	Purpose	Example	🔗
<code>@Past</code>	Must be in the past	<code>@Past(message = "DOB must be in the past")</code>	
<code>@PastOrPresent</code>	Must be past or today	<code>@PastOrPresent(message = "Date cannot be future")</code>	
<code>@Future</code>	Must be in the future	<code>@Future(message = "Expiry date must be in the future")</code>	
<code>@FutureOrPresent</code>	Must be today or future	<code>@FutureOrPresent(message = "Booking date must be today or later")</code>	

Example DTO with Validations

```

@Data
@Schema(description = "Customer details schema")
public class CustomerDto {

    @NotNull(message = "Customer ID cannot be null")
    private Long customerId;

    @NotBlank(message = "Customer name is mandatory")
    @Size(min = 3, max = 50, message = "Name must be between 3–50 characters")
    private String name;

    @Email(message = "Email should be valid")
    private String email;

    @Pattern(regexp="(^$|[0-9]{10})", message = "Mobile number must be 10 digits")
    private String mobileNumber;

    @Valid
    private AccountsDto accounts; // Nested validation
}


```

Exception Handling

Global Exception Handling allows you to handle all exceptions in a **centralized place** rather than writing try-catch in every controller.

This improves **code reusability**, **readability**, and **Maintainability**.

extends ResponseEntityExceptionHandler

By extending this Spring class, you can **override built-in exception handlers**, such as:

- **MethodArgumentNotValidException** → for validation errors from **@Valid** or **@Validated** annotations

```

@ControllerAdvice
public class GlobalExceptionHandler extends ResponseEntityExceptionHandler {

    @Override
    protected ResponseEntity<Object> handleMethodArgumentNotValid(
        MethodArgumentNotValidException ex, HttpHeaders headers, HttpStatusCode status, WebRequest request) {
        Map<String, String> validationErrors = new HashMap<>();
        List<ObjectError> validationErrorList = ex.getBindingResult().getAllErrors();

        validationErrorList.forEach((error) -> {
            String fieldName = ((FieldError) error).getField();
            String validationMsg = error.getDefaultMessage();
            validationErrors.put(fieldName, validationMsg);
        });
        return new ResponseEntity<>(validationErrors, HttpStatus.BAD_REQUEST);
    }
}

```

Generic Exception — handleGlobalException

```

@ExceptionHandler(Exception.class)
public ResponseEntity<ErrorResponseDto> handleGlobalException(Exception exception,
                                                               WebRequest webRequest) {
    ErrorResponseDto errorResponseDTO = new ErrorResponseDto(
        webRequest.getDescription(false),
        HttpStatus.INTERNAL_SERVER_ERROR,
        exception.getMessage(),
        LocalDateTime.now()
    );
    return new ResponseEntity<>(errorResponseDTO, HttpStatus.INTERNAL_SERVER_ERROR);
}

```

Custom Exceptions — ResourceNotFoundException

```

@ExceptionHandler(CustomerAlreadyExistsException.class)
public ResponseEntity<ErrorResponseDto> handleCustomerAlreadyExistsException(CustomerAlreadyExistsException exception,
                                                                           WebRequest webRequest){
    ErrorResponseDto errorResponseDTO = new ErrorResponseDto(
        webRequest.getDescription(false),
        HttpStatus.BAD_REQUEST,
        exception.getMessage(),
        LocalDateTime.now()
    );
    return new ResponseEntity<>(errorResponseDTO, HttpStatus.BAD_REQUEST);
}

```

```

1 package com.eazybytes.accounts.exception;
2
3 import org.springframework.http.HttpStatus;[]
4
5
6 @ResponseStatus(value = HttpStatus.BAD_REQUEST)
7 public class CustomerAlreadyExistsException extends RuntimeException {
8
9     public CustomerAlreadyExistsException(String message) {
10         super(message);
11     }
12
13 }
14

```

Sample Project Structure

Recommended Spring Boot Project Structure

```
pgsql

com.example.projectname/
|
+-- constants/
|   └── AppConstants.java
|
+-- controller/
|   └── UserController.java
|
+-- dto/
|   └── UserDTO.java
|
+-- entity/
|   └── User.java
|
+-- exception/
|   ├── GlobalExceptionHandler.java
|   ├── ResourceNotFoundException.java
|   └── CustomException.java
|
+-- mapper/
|   └── UserMapper.java
|
+-- repo/
|   └── UserRepository.java
|
+-- service/
|   ├── UserService.java
|   └── impl/
|       └── UserServiceImpl.java
|
└── ProjectNameApplication.java
```

↓

@MappedSuperclass in Spring Boot / JPA

@MappedSuperclass is a **JPA annotation** used on a **base class** whose fields should be **inherited by entity classes**,
but the base class **itself is not an entity or table**.

Simple meaning:

It's like saying:

“This class has some common fields for other entities,
but don’t create a table for it in the database.”

Example

```
import jakarta.persistence.MappedSuperclass;  
  
import jakarta.persistence.Column;  
  
import java.time.LocalDateTime;  
  
@MappedSuperclass  
  
public abstract class BaseEntity {  
  
    @Column(name = "created_at")  
  
    private LocalDateTime createdAt;  
  
    @Column(name = "updated_at")  
  
    private LocalDateTime updatedAt;  
  
    // getters and setters  
  
}
```

Now, any entity that extends `BaseEntity` automatically inherits these columns.

Usage Example

```
import jakarta.persistence.Entity;  
  
import jakarta.persistence.Id;  
  
@Entity  
  
public class User extends BaseEntity {  
  
    @Id  
  
    private Long id;
```

```
    private String username;  
}  
}
```

✓ The **user** table will have:

id
username
created_at
updated_at

🚫 But there will be **no table for BaseEntity**.

💡 When to Use

Use **@MappedSuperclass** when you have:

- Common columns like `createdBy`, `createdAt`, `updatedAt`, `status`, etc.
 - You want to avoid repeating them in every entity.
 - You **don't need a separate table** for the base class.
-

when moving from older Spring style (**@Autowired**) to modern **Spring Boot best practices**.

The old way — using **@Autowired**

@RestController

```
public class CustomerController {
```

@Autowired

```
private CustomerService customerService;  
  
// endpoints  
  
}
```

✓ Works fine.

✗ But has **some drawbacks**:

- Makes the class **harder to test** (you can't easily pass a mock in constructor).
- Makes the dependency **hidden** — it's not obvious what this class needs.
- Causes problems if you use **final** fields (you can't make them final here).

The new & preferred way — Constructor Injection (with Lombok's `@AllArgsConstructor`)

```
@RestController
```

```
@RequiredArgsConstructor // or @AllArgsConstructor
```

```
@RequestMapping("/customers")
```

```
public class CustomerController {
```

```
    private CustomerService customerService;
```

```
    // endpoints
```

```
}
```

✓ Advantages:

1. **No need for `@Autowired`**
→ Spring automatically injects dependencies into the constructor.
2. **Fields can be `final`**
→ makes them immutable.

3. Easier to test

→ you can manually pass mock objects in unit tests.

4. Cleaner and safer

→ promotes dependency immutability and makes it clear what's required.

What happens behind the scenes

When you use `@AllArgsConstructor` (from Lombok):

`@AllArgsConstructor`

```
public class CustomerController {  
    private final CustomerService customerService;  
}
```

→ Lombok generates this constructor for you:

```
public CustomerController(CustomerService customerService) {  
    this.customerService = customerService;  
}
```

→ Then Spring automatically injects the bean using **constructor injection** — no need for `@Autowired`.

Package for constants/utility

The class is a **constants holder** — it's used to store **static final values** (fixed values that never change) used throughout your Spring Boot application.

It helps you **avoid hardcoding strings and numbers** in multiple places in your code.

Ex

```

1 package com.eazybytes.accounts.constants;
2
3 public final class AccountsConstants {
4
5     private AccountsConstants() {
6         // restrict instantiation
7     }
8
9     public static final String SAVINGS = "Savings";
10    public static final String ADDRESS = "123 Main Street, New York";
11    public static final String STATUS_201 = "201";
12    public static final String MESSAGE_201 = "Account created successfully";
13    public static final String STATUS_200 = "200";
14    public static final String MESSAGE_200 = "Request processed successfully";
15    public static final String STATUS_417 = "417";
16    public static final String MESSAGE_417_UPDATE= "Update operation failed. Please try again or contact Dev team";
17    public static final String MESSAGE_417_DELETE= "Delete operation failed. Please try again or contact Dev team";
18    // public static final String STATUS_500 = "500";
19    // public static final String MESSAGE_500 = "An error occurred. Please try again or contact Dev team";
20
21 }
22

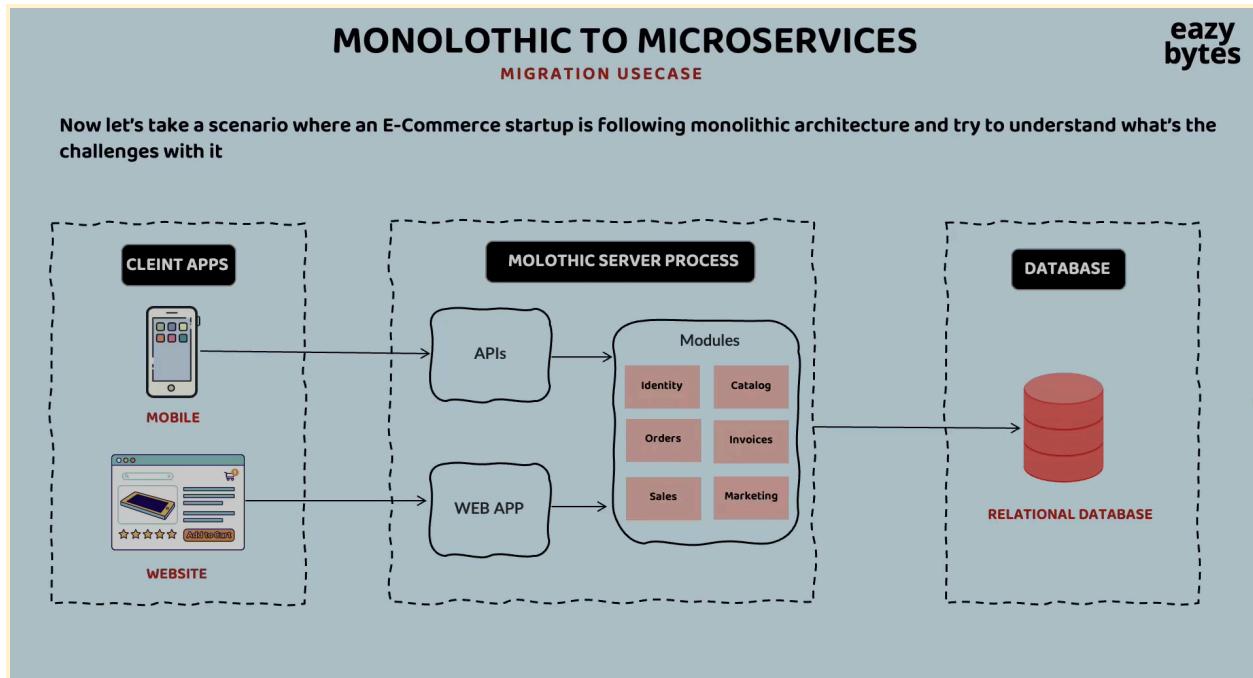
```

The **private constructor** prevents anyone from creating an object:

This is a **design pattern** known as a “*utility class*” pattern.

Monolith → Microservices (Migration)

Monolithic Architecture (Before Migration)



- All modules like:
 - Identity

- Catalog
- Orders
- Invoices
- Sales
- Marketing
- run inside **one big server/application.**
- **A single relational database** is used.
- Clients (mobile/web) call a single API layer which connects to this big system.

Advantages (initial days)

- ✓ Easy to develop
- ✓ Easy to test
- ✓ Easy to deploy
- ✓ Works well with small user load
- ✓ Good for small teams

Problems after the app grows (from the second diagram)

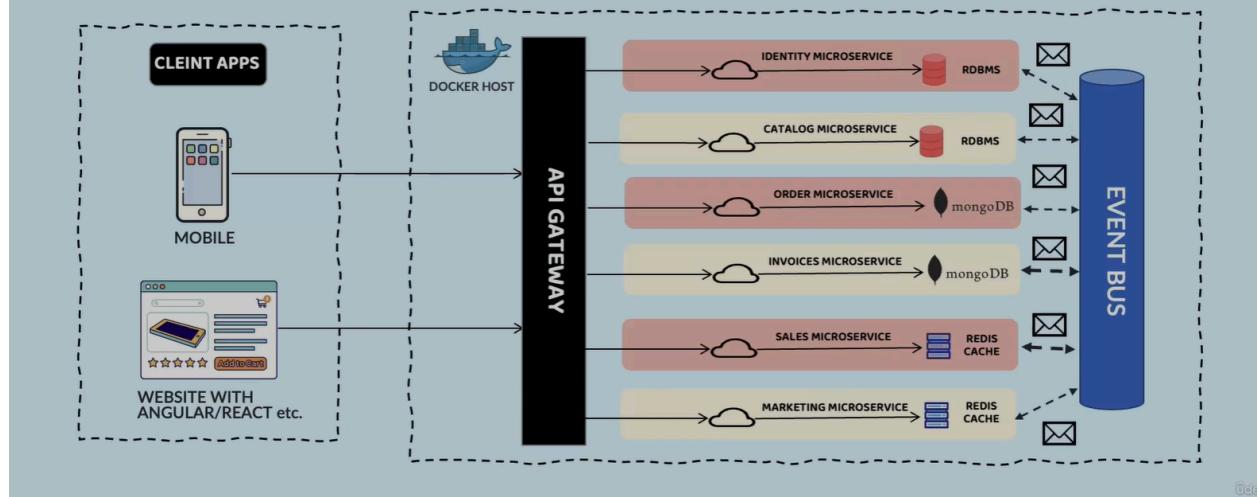
Once the system becomes large:

1. **Too much complexity** – one person cannot understand everything.
2. **Fear of changes** – one small change causes side effects.
3. **New feature development becomes slow & costly.**
4. **Deployment becomes risky** – even a small fix needs the whole app to redeploy.
5. **Single point of failure** – if one module breaks, the whole app crashes.
6. **Can't use new tech** – because everything is tightly coupled.
7. **Hard to scale teams** – small teams can't work independently.

This is the typical pain that forces companies to move to microservices.

Migration to Microservices (After Migration)

So the Ecommerce company decided and adopted the below cloud-native design by leveraging Microservices architecture to make their life easy and less risk with the continuous changes.



Key elements of the new design

- **API Gateway**
 - single entry point for all external users
 - routes calls to correct microservice
- **Multiple Microservices:**
 - Identity Service → RDBMS
 - Catalog Service → RDBMS
 - Order Service → MongoDB
 - Invoice Service → MongoDB
 - Sales Service → Redis Cache
 - Marketing Service → Redis Cache

Each microservice:

- ✓ Has its own database
- ✓ Runs independently (usually Docker containers)
- ✓ Can be deployed independently

Event Bus

- Used for **async communication**

- Microservices publish/subscribe events

Example:

- Order Service publishes "Order Created"
- Invoice Service listens and generates invoice

Strangler Fig Pattern

Strangler Fig pattern

eazy
bytes

The Strangler Fig Pattern is a software migration pattern used to gradually replace or refactor a legacy system with a new system, piece by piece, without disrupting the existing functionality. This pattern gets its name from the way a strangler fig plant grows around an existing tree, slowly replacing it until the original tree is no longer needed.

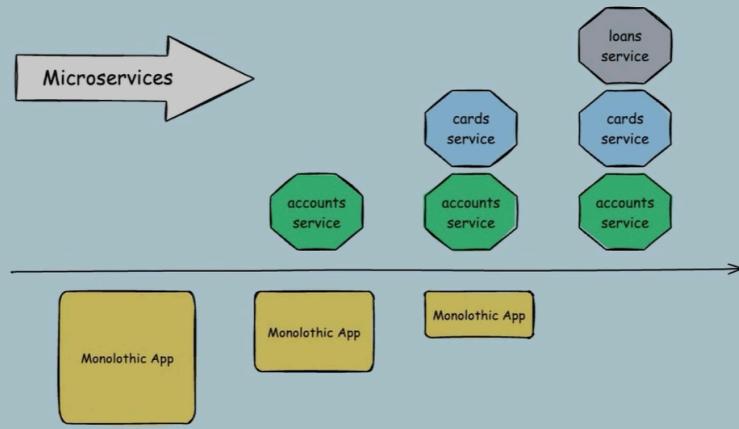
When to Use the Strangler Fig Pattern:

- When you need to modernize a large or complex legacy system.
- When you want to avoid the risk associated with a complete system rewrite or "big bang" migration.
- When the legacy system needs to remain operational during the transition to the new system.



The Strangler Fig Pattern facilitates the migration of a monolithic application to a modern microservices architecture by leveraging a Domain-Driven Design (DDD) approach.

The legacy monolith is carefully analyzed, broken down into distinct domains, and services are gradually rewritten using newer technologies. This incremental transformation ensures that each service is refactored independently, allowing for a smooth transition from the monolith to a fully microservices-based architecture while maintaining system functionality throughout the process.



Strangler Fig Pattern migration:

- ✓ Identification
- ✓ Transformation
- ✓ Co-existence
- ✓ Elimination

Stage	Description
Identification	Select the module to extract
Transformation	Build new microservice version
Co-existence	Old & new systems run together
Elimination	Remove monolith part

Deployment ,portability and scaling of microservices

DEPLOYMENT, PORTABILITY & SCALABILITY OF MICROSERVICES

eazy bytes

CHALLENGE 3

DEPLOYMENT

How do we deploy all the tiny 100s of microservices with less effort & cost?

PORTABILITY

How do we move our 100s of microservices across environments with less effort, configurations & cost?

SCALABILITY

How do we scale our applications based on the demand on the fly with minimum effort & cost?

To overcome the above challenges, we should **containerize** our microservices. Why? Containers offer a self-contained and isolated environment for applications, including all necessary dependencies. By containerizing an application, it becomes portable and can run seamlessly in any cloud environment. Containers enable unified management of applications regardless of the language or framework used.

Docker is an open source platform that "provides the ability to package and run an application in a loosely isolated environment called a container"

1. Deployment (Before vs After Containers)

Before Containers

- Each microservice had to be deployed on a **VM or physical server**.
- You needed to install:
 - Java/Node/Python runtime
 - Libraries
 - OS-level dependencies
- Every environment (dev/test/prod) behaved **differently**.
- Deployment was heavy, slow, and error-prone.
- “It works on my machine” issues were very common.

Example

To deploy a Payments service:

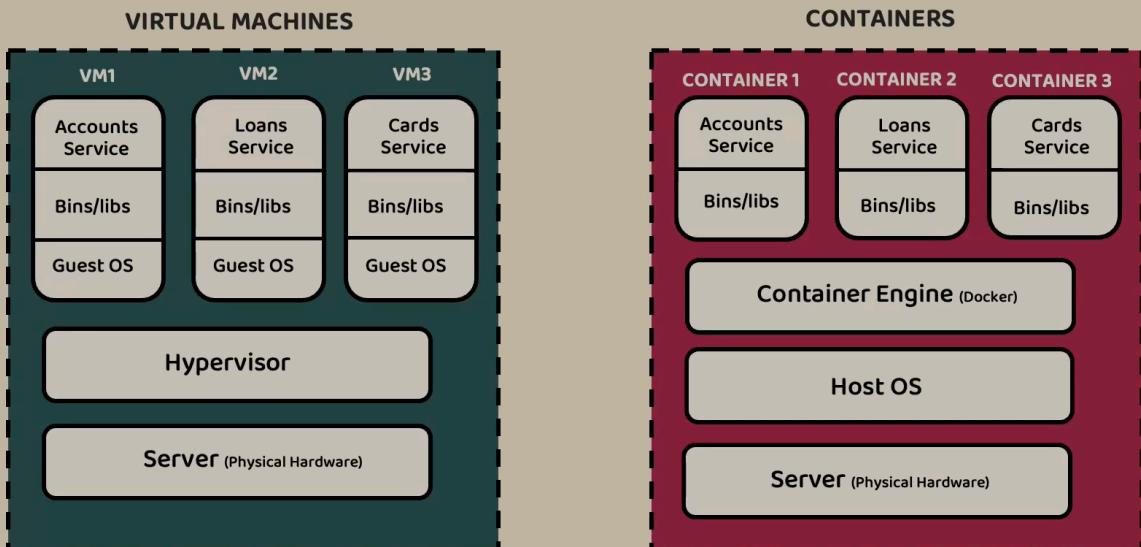
- Install JDK manually on the server
- Install Maven
- Install dependent libraries
- Configure environment variables
- Run JAR manually

After Containers

- Every microservice is packaged into a **Docker image**.
- Image contains:
 - Application code

- Runtime (JDK, Node, Python)
- Libraries
- OS dependencies
- Same image is used in **dev → test → prod.**
- Fast deployment through Kubernetes, ECS, Docker Swarm.

WHAT ARE CONTAINERS & HOW THEY ARE DIFFERENT FROM VMs ?



WHAT ARE CONTAINERS & Docker ?

What is software containerization ?

Software containerization is an OS virtualization method that is used to deploy and run containers without using a virtual machine (VM). Containers can run on physical hardware, in the cloud, VMs, and across multiple OSs.

What is a container ?

A container is a loosely isolated environment that allows us to build and run software packages. These software packages include the code and all dependencies to run applications quickly and reliably on any computing environment. We call these packages as container images.

What is Docker ?

Docker is an open-source platform that enables developers to automate the deployment, scaling, and management of applications using containerization. Containers are lightweight, isolated environments that encapsulate an application along with its dependencies, libraries, and runtime components.

Container : A container is a **lightweight, isolated runtime environment** that **packages an application together with its code, runtime, libraries, configuration, and dependencies**, while sharing the host operating system's kernel.

Isolated means the container runs separately with its own files, processes, and network, without affecting or interfering with other containers.

Lightweight means it uses very few resources because it shares the host OS kernel, so it starts fast and needs less memory/CPU.

Key Characteristics

- Does **not include a full OS**, unlike virtual machines
- **Fast** to start and stop
- **Portable**: runs the same on any system that supports containers
- **Isolated**: each container runs independently

✓ In Simple Terms

A container is a **small, isolated environment** that runs an application with all its dependencies bundled inside.

A container is a **small box** that has everything your application needs to run, anywhere.

Containerization : Containerization is the process of packaging an application and all its dependencies into a container image, and running it in isolated environments called containers.

📌 Key Points

- Ensures consistent behavior across dev → test → prod
- Avoids “works on my machine” problems
- Enables microservices architecture
- Used for fast deployment and scaling

✓ Simple Meaning

Containerization is the **method** of putting your app inside a container so it can run everywhere the same way.

Docker : Docker is a containerization platform designed to help developers build, share, and run container applications. It allows us to build, test, and deploy applications quickly.

Docker Engine → runs containers

Dockerfile → defines container blueprint

Docker Hub → stores and shares container images

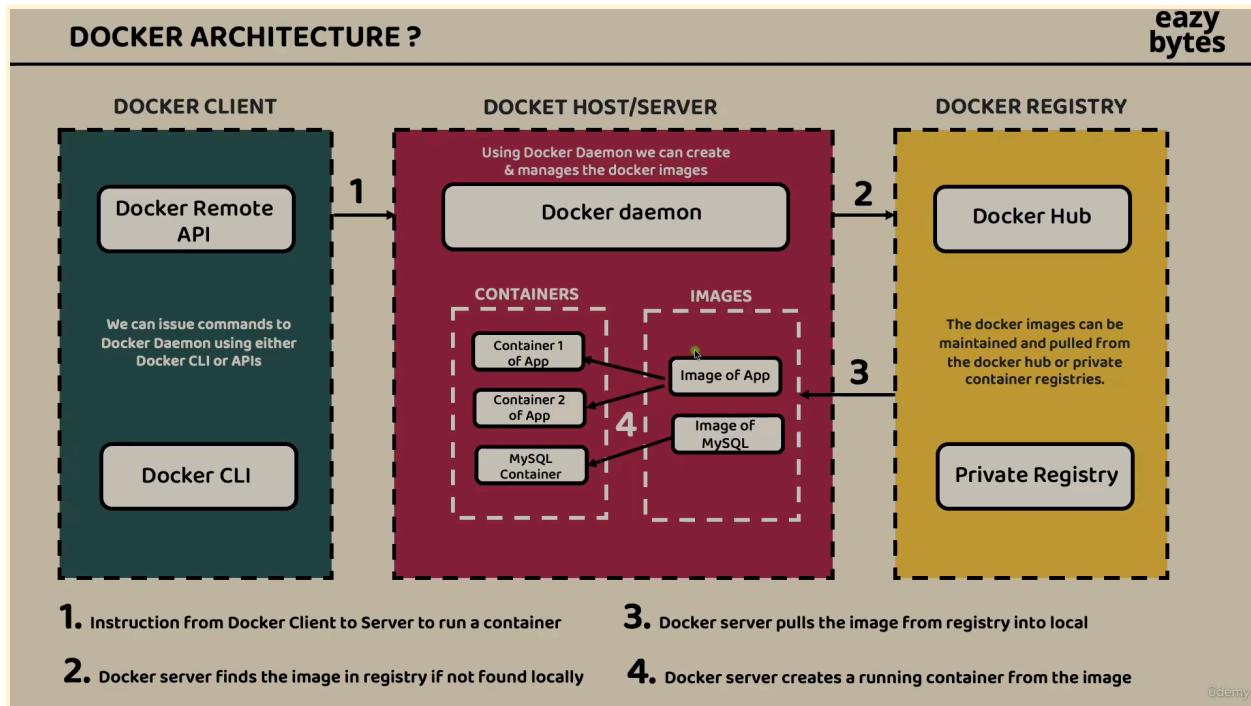
Works with Kubernetes for orchestration

Container: A lightweight, isolated environment that packages an **application** with required dependencies.

Containerization: The process of packaging and running applications inside containers.

Docker: A platform used to build, run, and manage containers.

Docker Architecture



1. Docker Client: This is the primary interface for users to interact with Docker. It provides a command-line interface (CLI)/API that sends commands to the Docker daemon.

When you run commands like:

`docker build`

`docker pull`

`docker run`

2. Docker Host:

This refers to the machine where the Docker daemon runs and where images and containers are stored and executed. It provides the environment for containerized applications.

Docker Daemon (dockerd): Running on the Docker host, the daemon is responsible for managing Docker objects such as images, containers, networks, and volumes. It listens for requests from the client and executes the necessary actions.

Docker Images: Images are read-only templates containing the application code, runtime, libraries, and dependencies needed to run a container. They are built from a **Dockerfile** and can be shared and versioned.

Docker Containers: A container is a runnable instance of a Docker image. It's an isolated environment where an application and its dependencies run, providing consistency across different environments. Containers can be created, started, stopped, moved, and deleted.

3.Docker Registry: A registry is a centralized repository for storing and distributing Docker images. Docker Hub is a public registry, while private registries can be set up for internal use. Images are pushed to and pulled from registries.

Docker Hub (default)

Amazon ECR

GitHub Container Registry

Azure Container Registry

Google Artifact Registry

Private registry

User → Docker Client → Docker Daemon → (Images/Containers) ↔ Docker Registry

Docker is open source platform

i) Go to <https://www.docker.com/> and install a desktop for docker (Installs Docker CLI (client) + Docker Engine (server/host) on your local machine).

Docker Desktop is an **application/GUI** for Windows or Mac.

ii) go to <https://hub.docker.com/> and create an account.

```
C:\Users\jakkula.ramesh\Desktop\Udemy Spring Boot\microservices\section2\accounts>docker version
Client:
 Version:          28.5.2
 API version:      1.51
 Go version:       go1.25.3
 Git commit:        ecc6942
 Built:            Wed Nov  5 14:45:58 2025
 OS/Arch:          windows/amd64
 Context:           desktop-linux

Server: Docker Desktop 4.51.0 (210443)
Engine:
 Version:          28.5.2
 API version:      1.51 (minimum version 1.24)
 Go version:       go1.25.3
 Git commit:        89c5e8f
 Built:            Wed Nov  5 14:43:25 2025
 OS/Arch:          linux/amd64
 Experimental:     false
containerd:
 Version:          v1.7.29
 GitCommit:        442cb34bda9a6a0fed82a2ca7cade05c5c749582
runc:
 Version:          1.3.3
 GitCommit:        v1.3.3-0-gd842d771
docker-init:
 Version:          0.19.0
 GitCommit:        de40ad0
```

Docker CLI (Client)

- The command-line tool you use to interact with Docker.
- Example: commands like `docker run`, `docker build`, `docker push`.
- Installed on your local machine (part of Docker Desktop).

Docker Host (Server / Engine / Daemon)

- The environment where **containers actually run**.
- Manages images, containers, volumes, and networks.
- On Windows/Mac, Docker Desktop internally runs a **Linux VM** as the Docker Host.
- When we run the `docker version`, the **Server** info we see corresponds to this Docker Host.

Docker Registry

- Central repository for Docker images.
- Example: **Docker Hub** (hub.docker.com).

Generate Docker images



GENERATE DOCKER IMAGES

To generate docker images from our existing microservices, we will explore the below three different commonly used approaches. We can choose one of them for the rest of the course

01 Dockerfile -> accounts
We need to write a dockerfile with the list of instructions which can be passed to Docker server to generate a docker image based on the given instructions

02 Buildpacks -> loans
Buildpacks (<https://buildpacks.io>), a project initiated by Heroku & Pivotal and now hosted by the CNCF. It simplifies containerization since with it, we don't need to write a low-level dockerfile.

03 Google Jib -> cards
Jib is an open-source Java tool maintained by Google for building Docker images of Java applications. It simplifies containerization since with it, we don't need to write a low-level dockerfile.

Spring Boot 2.x requires a minimum of Java 8

Spring Boot 3.x requires:

- ✓ Java 17 or higher
- ✓ Maven 3.6.3 or higher

Basic things before generating docker images

1. packaging jar/war

Check `pom.xml` — Packaging Type

Open your `pom.xml` and make sure the packaging is:

```
<packaging>jar</packaging>
```

- ✓ If `<packaging>` is missing → Maven will **not** generate a JAR.
- ✓ If packaging is set to `war`, Maven will build a **WAR file**, not JAR.

```
<?xml version="1.0" encoding="UTF-8"?>
<project xmlns="http://maven.apache.org/POM/4.0.0" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="http://maven.apache.org/POM/4.0.0 />
<modelVersion>4.0.0</modelVersion>
<parent>
  <groupId>org.springframework.boot</groupId>
  <artifactId>spring-boot-starter-parent</artifactId>
  <version>3.4.1</version>
  <relativePath/> <!-- lookup parent from repository -->
</parent>
<groupId>com.eazybytes</groupId>
<artifactId>accounts</artifactId>
<version>0.0.1-SNAPSHOT</version>
<name>accounts</name>
<packaging>jar</packaging>
<description>Microservice for Accounts</description>
<url/>
<licenses>
  ...
</license/>
...
```

2. Add Spring Boot Plugin (if missing)

Spring Boot requires this plugin to create a runnable JAR:

```
<build>
  <plugins>
    <plugin>
      <groupId>org.springframework.boot</groupId>
      <artifactId>spring-boot-maven-plugin</artifactId>
    </plugin>
  </plugins>
</build>
```

Without this, the JAR may not start properly.

3. Open cmd terminal **inside the folder where pom.xml exists**:

```
mvn clean install
```

```
C:\Users\jakkula.ramesh\Desktop\Udemy Spring Boot\microservices\section2\accounts>mvn clean install
[INFO] Scanning for projects...
[INFO]
[INFO] -----< com.eazybytes:accounts >-----
[INFO] Building accounts 0.0.1-SNAPSHOT
[INFO] ----- [ jar ] -----
[INFO]
[INFO] --- maven-clean-plugin:3.4.0:clean (default-clean) @ accounts ---
[INFO] Deleting C:\Users\jakkula.ramesh\Desktop\Udemy Spring Boot\microservices\section2\accounts\target
[INFO]
[INFO] --- maven-resources-plugin:3.3.1:resources (default-resources) @ accounts ---
[INFO] Copying 1 resource from src\main\resources to target\classes
[INFO] Copying 1 resource from src\main\resources to target\classes
[INFO]
[INFO] --- maven-compiler-plugin:3.13.0:compile (default-compile) @ accounts ---
[INFO] Recompiling the module because of changed source code.
[INFO] Compiling 20 source files with javac [debug parameters release 17] to target\classes
[INFO]
[INFO] --- maven-resources-plugin:3.3.1:testResources (default-testResources) @ accounts ---
[INFO] skip non existing resourceDirectory C:\Users\jakkula.ramesh\Desktop\Udemy Spring Boot\microservices\section2\accounts\src
[INFO]
[INFO] --- maven-compiler-plugin:3.13.0:testCompile (default-testCompile) @ accounts ---
[INFO] Recompiling the module because of changed dependency.
[INFO] Compiling 1 source file with javac [debug parameters release 17] to target\test-classes
[INFO]
[INFO] --- maven-surefire-plugin:3.5.2:test (default-test) @ accounts ---
[INFO] Downloading from central: https://repo.maven.apache.org/maven2/org/apache/maven/surefire/surefire-api/3.5.2/surefire-api-3.5.2.j
[INFO] Downloading from central: https://repo.maven.apache.org/maven2/org/apache/maven/surefire/surefire-common/3.5.2/maven-suref
[INFO] Downloading from central: https://repo.maven.apache.org/maven2/org/apache/maven/surefire/surefire-shared-utils/2.5.2/surefire-sha
```

```
[INFO] --- maven-jar-plugin:3.4.2:jar (default-jar) @ accounts ---
[INFO] Building jar: C:\Users\jakkula.ramesh\Desktop\Udemy Spring Boot\microservices\section2\accounts\target\accounts-0.0.1-SNAPSHOT.jar
[INFO]
[INFO] --- spring-boot-maven-plugin:3.4.1:repackage (repackage) @ accounts ---
[INFO] Downloading from central: https://repo.maven.apache.org/maven2/org/springframework/boot/spring-boot-buildpack-platform/3.4.1/spring-boot-buildpack-pl
```

The JAR name comes from Only **artifactId + version** are used in your pom.xml:

```
<groupId>com.eazybytes</groupId>
<artifactId>accounts</artifactId>
<version>0.0.1-SNAPSHOT</version>
<name>accounts</name>
<packaging>jar</packaging>
<description>Microservice for Accounts</description>
```

Name	Date modified	Type	Size
classes	11/15/2025 3:51 PM	File folder	
generated-sources	11/15/2025 3:51 PM	File folder	
generated-test-sources	11/15/2025 3:51 PM	File folder	
maven-archiver	11/15/2025 3:51 PM	File folder	
maven-status	11/15/2025 3:51 PM	File folder	
surefire-reports	11/15/2025 3:51 PM	File folder	
test-classes	11/15/2025 3:51 PM	File folder	
accounts-0.0.1-SNAPSHOT.jar	11/15/2025 3:51 PM	Executable Jar File	62,414 KB
accounts-0.0.1-SNAPSHOT.jar.original	11/15/2025 3:51 PM	ORIGINAL File	29 KB

4. We can run spring boot in two ways using maven command or using java command

i) Maven command to run Spring Boot

```
mvn spring-boot:run
```

This directly starts your application without creating or running the JAR manually.

```
C:\Users\jakkula.ramesh\Desktop\Udemy Spring Boot\microservices\section2\accounts>mvn spring-boot:run
[INFO] Scanning for projects...
[INFO]
[INFO] -----< com.eazybytes:accounts >-----
[INFO] Building accounts 0.0.1-SNAPSHOT
[INFO] -----[ jar ]-----
[INFO]
[INFO] >>> spring-boot-maven-plugin:3.4.1:run (default-cli) > test-compile @ accounts >>>
[INFO]
[INFO] --- maven-resources-plugin:3.3.1:resources (default-resources) @ accounts ---
[INFO] Copying 1 resource from src\main\resources to target\classes
[INFO] Copying 1 resource from src\main\resources to target\classes

2025-11-15T16:00:18.129+05:30  WARN 24252 --- [ restartedMain] JpaBaseConfiguration$JpaWebConfiguration : spring.jpa.open-in-view is enabled by default. Therefore, database queries may be performed during view rendering. Explicitly configure spring.jpa.open-in-view to disable this warning
2025-11-15T16:00:18.926+05:30  INFO 24252 --- [ restartedMain] o.s.b.a.h2.H2ConsoleAutoConfiguration : H2 console available at '/h2-console'. Database available at 'jdbc:h2:mem:testdb'
2025-11-15T16:00:19.009+05:30  INFO 24252 --- [ restartedMain] o.s.b.d.a.OptionalReloadServer          : LiveReload server is running on port 35729
2025-11-15T16:00:19.024+05:30  INFO 24252 --- [ restartedMain] o.s.b.a.e.web.EndpointLinksResolver   : Exposing 1 endpoint beneath base path '/actuator'
2025-11-15T16:00:19.160+05:30  INFO 24252 --- [ restartedMain] o.s.w.e.embedded.tomcat.TomcatWebServer : Tomcat started on port 8080 (http) with context path '/'
2025-11-15T16:00:19.179+05:30  INFO 24252 --- [ restartedMain] c.e.accounts.AccountsApplication        : Started AccountsApplication in 10.129 seconds (process running for 10.791)
```

to stop the application in cmd use “ctrl + c”

ii) using the “.jar” file

run:

```
java -jar target/yourappname-version.jar
```

Example:

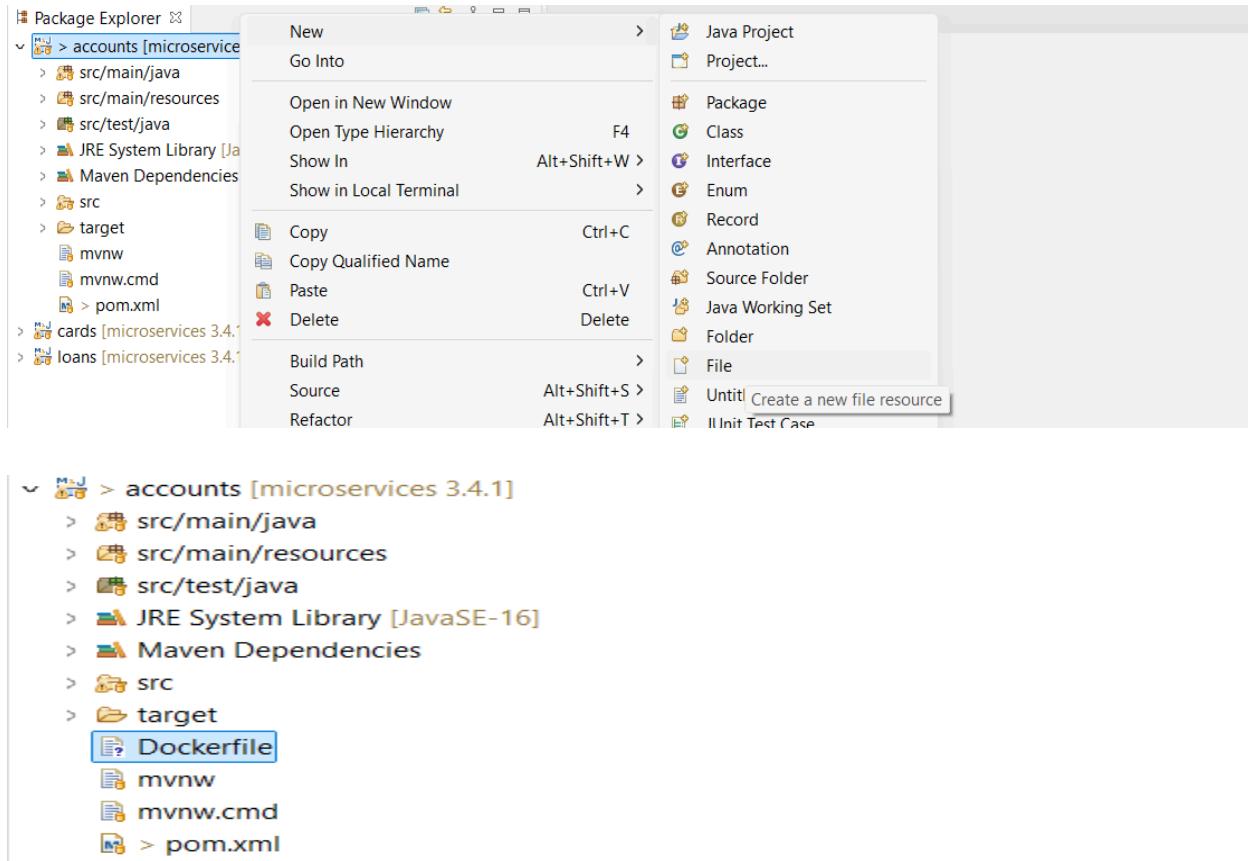
```
java -jar target/accounts-service-0.0.1-SNAPSHOT.jar
```

iii) In any IDE directly.

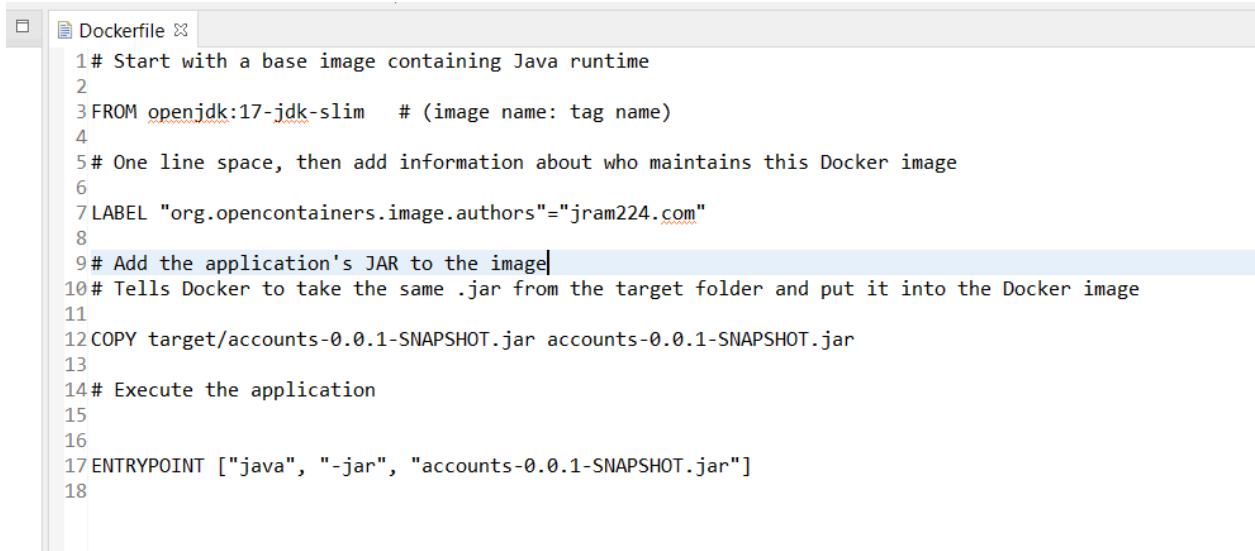
1) using Dockerfile

i) Create a file named **Dockerfile** (with no extension) in the project root by right-clicking on the project and selecting “New → File”.

The file name must be **Dockerfile** (exactly this name, with no extension), because Docker automatically looks for a file named **Dockerfile** while building the image



ii) Add the instructions in the Dockerfile, which are used to build your Docker image.



```
1# Start with a base image containing Java runtime
2
3FROM openjdk:17-jdk-slim    # (image name: tag name)
4
5# One line space, then add information about who maintains this Docker image
6
7LABEL "org.opencontainers.image.authors"="jram224.com"
8
9# Add the application's JAR to the image
10# Tells Docker to take the same .jar from the target folder and put it into the Docker image
11
12COPY target/accounts-0.0.1-SNAPSHOT.jar accounts-0.0.1-SNAPSHOT.jar
13
14# Execute the application
15
16
17ENTRYPOINT ["java", "-jar", "accounts-0.0.1-SNAPSHOT.jar"]
18
```

FROM openjdk:17-jdk-slim

- First requirement to run any Java application is a system with JRE/JDK.
- We instruct Docker to use an official Java 17 runtime as the base.

LABEL "org.opencontainers.image.authors"="jram224.com"

- Maintainer information: who is responsible for this Docker image.

COPY target/accounts-0.0.1-SNAPSHOT.jar accounts-0.0.1-SNAPSHOT.jar

- Add the compiled application JAR into the Docker image.
- Docker will copy the `.jar` from the `target` folder of your project.

ENTRYPOINT ["java", "-jar", "accounts-0.0.1-SNAPSHOT.jar"]

- Tells Docker how to run the application when the container starts.
- Executes the Spring Boot JAR inside the container automatically.

1. Open **Command Prompt** (cmd) **from your project folder** where `pom.xml` is located.

Make sure this is also the folder containing your `Dockerfile`.

- Run the following command to build your Docker image:

```
docker build . -t <dockerhub-username>/<image-name>:<tag>
```

- **<dockerhub-username>** → your Docker Hub username.
- **<image-name>** → the name you want to give the image.
- **<tag>** → version of the image (e.g., **1.0, latest**).
- **.** → indicates the current directory as the build context.

Example:

```
docker build -t jram224/accounts:1.0 .
```

- Docker will read the **Dockerfile** in the current folder and build the image.

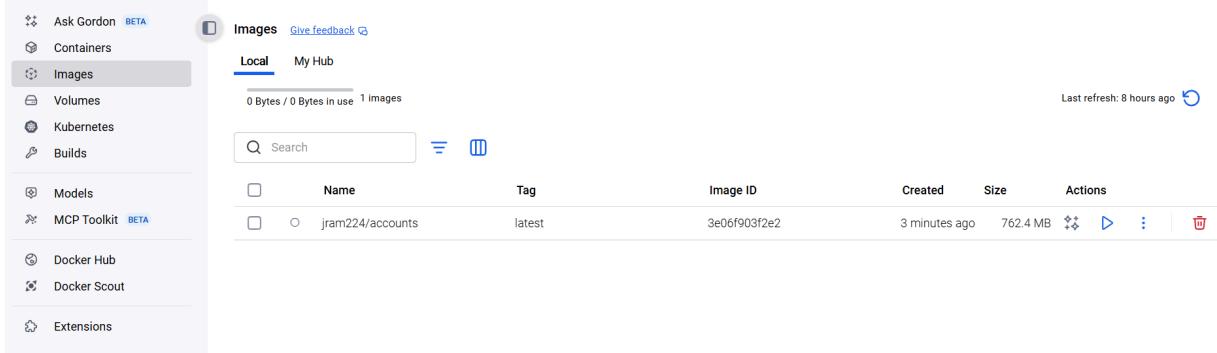
```
C:\Users\jakkula.ramesh\Desktop\Udemy Spring Boot\microservices\section2\accounts>docker build . -t jram224/accounts:latest
[+] Building 54.1s (7/7) FINISHED
--> [internal] load build definition from Dockerfile
--> => transferring dockerfile: 58B
--> [internal] load metadata for docker.io/library/openjdk:17.0.1-jdk-slim
--> [internal] load .dockerrcignore
--> => transferring context: 2B
--> [internal] load build context
--> => transferring context: 63.93MB
--> [1/2] FROM docker.io/library/openjdk:17.0.1-jdk-slim@sha256:fc5fa503124ba7021bbf8cb3718bf08791590d0aa2295c7cc551de65f9919290
--> => resolve docker.io/library/openjdk:17.0.1-jdk-slim@sha256:fc5fa503124ba7021bbf8cb3718bf08791590d0aa2295c7cc551de65f9919290
--> sha256:a2abf6c4d29d43a4bfb9f9fb769f524d0fb36a2edab49819c1bf3e76f40bf953ea 31.36MB / 31.36MB
--> sha256:2bbde5250315969db657b55bd8b2f5507fb659c0cf7f135edc84b684ffebab44a 1.58MB / 1.58MB
--> sha256:1343f138b677c0b1457cc7cb6310108df5388665281e0962273fb3492e52b86d 187.55MB / 187.55MB
--> => extracting sha256:a2abf6c4d29d43a4bfb9f9fb769f524d0fb36a2edab49819c1bf3e76f40bf953ea
--> => extracting sha256:2bbde5250315969db657b55bd8b2f5507fb659c0cf7f135edc84b684ffebab44a
--> => extracting sha256:1343f138b677c0b1457cc7cb6310108df5388665281e0962273fb3492e52b86d
--> [2/2] COPY target/accounts-0.0.1-SNAPSHOT.jar accounts-0.0.1-SNAPSHOT.jar
--> exporting to image
--> => exporting layers
--> => exporting manifest sha256:6e899f478c7381f3ca7ba73df37eac22f1476070db3c2f9738bb6b24c650e6ec
--> => exporting config sha256:b43fe172b9d3aad8104d642e2da94bc8787d310a17131541241eb8808+dfcb5d
--> => exporting attestation manifest sha256:53483db3ee3ff88510eb82eab124c7f9ab981e7b0475d4480a2aaaa9373af496
--> => exporting manifest list sha256:3e06f903f2e2681035ef1c3b308a779af2dee887ea5ab0902005dad0232b6b
--> => naming to docker.io/jram224/accounts:latest
--> => unpacking to docker.io/jram224/accounts:latest
```

- After the build completes, you can verify the image using:
You should also be able to list it using the command line:

docker images

```
C:\Users\jakkula.ramesh\Desktop\Udemy Spring Boot\microservices\section2\accounts>docker images
REPOSITORY      TAG      IMAGE ID      CREATED      SIZE
jram224/accounts  latest  3e06f903f2e2  About a minute ago  762MB
```

After building the image, you can see it in Docker Desktop under the **Images** tab.



The screenshot shows the Docker Desktop interface with the 'Images' tab selected. On the left, there's a sidebar with various options like Ask Gordon, Containers, Images (which is highlighted), Volumes, Kubernetes, Builds, Models, MCP Toolkit, Docker Hub, Docker Scout, and Extensions. The main area is titled 'Images' with a 'Local' tab selected and a 'My Hub' tab. It shows '0 Bytes / 0 Bytes in use' and '1 images'. A search bar is at the top, followed by a table with columns: Name, Tag, Image ID, Created, Size, and Actions. One row is visible: 'jram224/accounts' with 'latest' tag, Image ID '3e06f903f2e2', created '3 minutes ago', and size '762.4 MB'. Action icons are to the right of each row.

4. If you want to inspect Docker images

Inspect detailed image info

`docker image inspect <image-id>`

Shows JSON output with layers, environment variables, entrypoint, labels, and more.

```
C:\Users\jakkula.ramesh\Desktop\Udemy Spring Boot\microservices\section2\accounts>docker images
REPOSITORY      TAG      IMAGE ID      CREATED       SIZE
jram224/accounts   latest   3e06f903f2e2   About a minute ago   762MB

C:\Users\jakkula.ramesh\Desktop\Udemy Spring Boot\microservices\section2\accounts>docker inspect image 3e06f
[
    {
        "Id": "sha256:3e06f903f2e26811035ef1c2b308a779af2dee887ea5ab0902005dad0232b6b2",
        "RepoTags": [
            "jram224/accounts:latest"
        ],
        "RepoDigests": [
            "jram224/accounts@sha256:3e06f903f2e26811035ef1c2b308a779af2dee887ea5ab0902005dad0232b6b2"
        ],
        "Parent": "",
        "Comment": "buildkit.dockerfile.v0",
        "Created": "2025-11-15T16:06:01.901063866Z",
        "DockerVersion": "",
        "Author": "",
        "Architecture": "amd64",
        "Os": "linux",
        "Size": 277988098,
        "GraphDriver": {
            "Data": null,
            "Name": "overlayfs"
        },
        "RootFS": {
            "Type": "layers",
            "Layers": [
                "sha256:2edcec3590a4ec7f40cf0743c15d78fb39d8326bc029073b41ef9727da6c851f",
                "sha256:a7da989d53ee25f18b7810206b39580df30518043d1f34f1d514f665ba8026f4"
            ]
        }
    }
]
```

5. Run Docker Container Using the Image

`docker run -p <host-port>:<container-port> <image-name>:<tag>`

```
C:\Users\jakkula.ramesh\Desktop\Udemy Spring Boot\microservices\section2\accounts>docker run -p 8080:8080 jram224/accounts:latest
:: Spring Boot ::          (v3.4.1)

2025-11-15T16:33:13.255Z INFO 1 --- [           main] c.e.accounts.AccountsApplication      : Starting AccountsApplication v0.0.1-SNAPSHOT using Java 17
.0.1 with PID 1 (/accounts-0.0.1-SNAPSHOT.jar started by root in /)
2025-11-15T16:33:13.258Z INFO 1 --- [           main] c.e.accounts.AccountsApplication      : No active profile set, falling back to 1 default profile:
"default"
2025-11-15T16:33:14.565Z INFO 1 --- [           main] .s.d.r.c.RepositoryConfigurationDelegate : Bootstrapping Spring Data JPA repositories in DEFAULT mode
2025-11-15T16:33:14.613Z INFO 1 --- [           main] .s.d.r.c.RepositoryConfigurationDelegate : Finished Spring Data repository scanning in 39 ms. Found 2
JPA repository interfaces.
2025-11-15T16:33:15.435Z INFO 1 --- [           main] o.s.b.w.embedded.tomcat.TomcatWebServer : Tomcat initialized with port 8080 (http)
2025-11-15T16:33:15.456Z INFO 1 --- [           main] o.apache.catalina.core.StandardService : Starting service [Tomcat]
2025-11-15T16:33:15.457Z INFO 1 --- [           main] o.apache.catalina.core.StandardEngine : Starting Servlet engine: [Apache Tomcat/10.1.34]
2025-11-15T16:33:15.505Z INFO 1 --- [           main] o.a.c.c.C.[Tomcat].[localhost].[]   : Initializing Spring embedded WebApplicationContext
2025-11-15T16:33:15.506Z INFO 1 --- [           main] w.s.c.ServletWebServerApplicationContext : Root WebApplicationContext: initialization completed in 21
70 ms
2025-11-15T16:33:15.813Z INFO 1 --- [           main] com.zaxxer.hikari.HikariDataSource   : HikariPool-1 - Starting...
2025-11-15T16:33:16.070Z INFO 1 --- [           main] com.zaxxer.hikari.pool.HikariPool    : HikariPool-1 - Added connection conn0: url=jdbc:h2:mem:tes
tDB user:SA
2025-11-15T16:33:16.072Z INFO 1 --- [           main] com.zaxxer.hikari.HikariDataSource   : HikariPool-1 - Start completed.
2025-11-15T16:33:16.219Z INFO 1 --- [           main] o.hibernate.jpa.internal.util.LogHelper : HHH000294: Processing PersistenceUnitInfo [name: default]
2025-11-15T16:33:16.297Z INFO 1 --- [           main] org.hibernate.Version                : HHH000412: Hibernate ORM core version 6.6.4.Final
2025-11-15T16:33:16.345Z INFO 1 --- [           main] o.h.c.internal.RegionFactoryInitiator : HHH000026: Second-level cache disabled
2025-11-15T16:33:16.679Z INFO 1 --- [           main] o.s.o.j.p.SpringPersistenceUnitInfo  : No LoadTimeWeaver setup: ignoring JPA class transformer
2025-11-15T16:33:16.741Z WARN 1 --- [           main] org.hibernate.orm.deprecation       : HHH0000025: H2Dialect does not need to be specified explicitly using 'hibernate.dialect' (remove the property setting and it will be selected by default)
2025-11-15T16:33:16.769Z INFO 1 --- [           main] org.hibernate.orm.connections.Pooling : HHH10001005: Database info:
Database JDBC URL [Connecting through datasource 'HikariDataSource (HikariPool-1)']
Database driver: undefined/unknown
Remote Desktop Connection
```

Step-by-Step Explanation

1. **docker run** → tells Docker to start a new container from an image.
2. **-p <host-port>:<container-port>** → maps a port from your container to your local machine:
 - When you run a Docker container, it has its **own internal network** separate from your computer.
 - Your Spring Boot app inside the container usually runs on a port defined in the application, e.g., **8080**.
 - **<container-port>** → the port your application runs **inside the container** (Spring Boot app port).
 - **<host-port>** → the port on your **local machine** you want to use to access the app.
3. **<image-name>:<tag>** → specifies which image to use.
 - Must match the image name you built (or pulled).

Running Docker Container in Detached Mode

By default, **docker run** runs the container in the **foreground**, showing all logs in your terminal.

While it's running, you **cannot run any other command** in the same terminal.

To avoid this, we use **detached mode** so the container runs in the background.

just add -d to your normal docker run command

```
docker run -d -p <host-port>:<container-port> <image-name>:<tag>
```

```
C:\Users\jakkula.ramesh\Desktop\Udemy Spring Boot\microservices\section2\accounts>docker run -d -p 8080:8080 jram224/accounts:latest  
9a3c912e16928e8798d685152b78c4873dd777988a3d1159cb22a9e706a8cfec  
C:\Users\jakkula.ramesh\Desktop\Udemy Spring Boot\microservices\section2\accounts>
```

We can check running containers with:

`docker ps`

```
C:\Users\jakkula.ramesh\Desktop\Udemy Spring Boot\microservices\section2\accounts>docker ps
CONTAINER ID        IMAGE               COMMAND                  CREATED             STATUS              PORTS                               NAMES
9a3c912e1692        jram224/accounts:latest   "java -jar accounts..."   3 minutes ago      Up 3 minutes   0.0.0.0:8080->8080/tcp, [::]:8080->8080/tcp   affectionate_euler

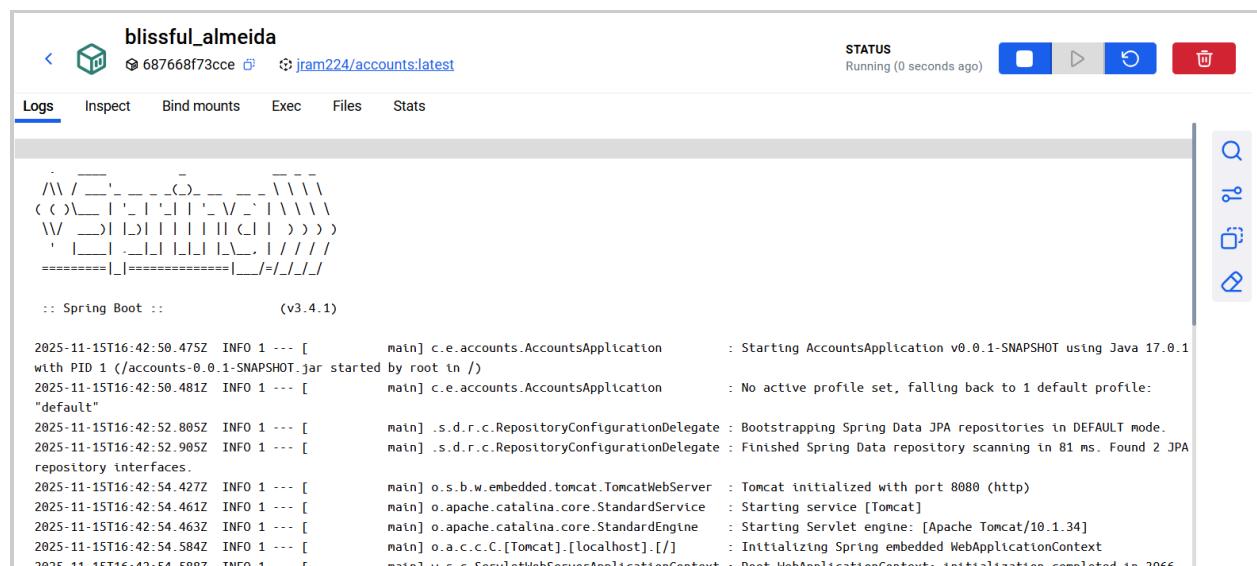
C:\Users\jakkula.ramesh\Desktop\Udemy Spring Boot\microservices\section2\accounts>
```

And stop them with:

```
docker stop <container id>
```

```
C:\Users\jakkula.ramesh\Desktop\Udemy Spring Boot\microservices\section2\accounts>docker stop 9a3c912e1692  
9a3c912e1692  
  
C:\Users\jakkula.ramesh\Desktop\Udemy Spring Boot\microservices\section2\accounts>docker ps  
CONTAINER ID        IMAGE               COMMAND             CREATED            STATUS              PORTS               NAMES  
  
C:\Users\jakkula.ramesh\Desktop\Udemy Spring Boot\microservices\section2\accounts>
```

We can also run Docker containers using **Docker Desktop**, without using the command line.



CRUD REST APIs for Cards in EazyBank CRUD REST APIs in EazyBank to CREATE, UPDATE, FETCH AND DELETE card details

PUT	/api/update	Update Card Details REST API
POST	/api/create	Create Card REST API
GET	/api/fetch	Fetch Card Details REST API
DELETE	/api/delete	Delete Card Details REST API

docker run → always creates a **new container** from the image.

docker ps -a → lists all containers (running or stopped).

docker start <container_id> → starts a **previously created container** without creating a new one.

```
C:\Users\jakkula.ramesh\Desktop\Udemy Spring Boot\microservices\section2\accounts>docker ps -a
CONTAINER ID        IMAGE               COMMAND             CREATED            STATUS              PORTS               NAMES
687668f73cce        jram224/accounts:latest   "java -jar accounts..."   5 minutes ago     Exited (143) 5 minutes ago
9a3c912e1692        jram224/accounts:latest   "java -jar accounts..."   10 minutes ago    Exited (143) 6 minutes ago
bdebfa29690f        jram224/accounts:latest   "java -jar accounts..."   15 minutes ago    Exited (130) 11 minutes ago

C:\Users\jakkula.ramesh\Desktop\Udemy Spring Boot\microservices\section2\accounts>docker start 687668f73cce
687668f73cce

C:\Users\jakkula.ramesh\Desktop\Udemy Spring Boot\microservices\section2\accounts>
```

Finally

PORT MAPPING IN DOCKER

eazy bytes

What is port mapping or port forwarding or port publishing ?

By default, containers are connected to an isolated network within the Docker host. To access a container from your local network, you need to configure port mapping explicitly. For instance, when running the accounts Service application, we can provide the port mapping as an argument in the docker run command: `-p 8081:8080` (where the first value represents the external port and the second value represents the container port). Below diagram demonstrates the functionality of this configuration.

The diagram shows a user on the Local Network (yellow box) invoking `http://localhost:8081` to access Accounts related APIs. This request is mapped via port 8081 to the Docker Network (dark green box), where an Accounts service container is running at port 8080.

STEPS TO BE FOLLOWED

1) Run the maven command, "mvn clean install" from the location where pom.xml is present to generate a fat jar inside target folder

2) Write instructions to Docker inside a file with the name Dockerfile to generate a Docker image. Sample instructions are mentioned on the left hand side

3) Execute the docker command "docker build . -t eazybytes/accounts:s4" from the location where Dockerfile is present. This will generate the docker image based on the tag name provided

4) Execute the docker command "docker run -p 8080:8080 eazybytes/accounts:s4". This will start the docker container based on the docker image name and port mapping provided

Sample Dockerfile

```
#Start with a base image containing Java runtime
FROM openjdk:17-jdk-slim

#Information around who maintains the image
MAINTAINER eazybytes.com

# Add the application's jar to the container
COPY target/accounts-0.0.1-SNAPSHOT.jar accounts-0.0.1-SNAPSHOT.jar

#execute the application
ENTRYPOINT ["java","-jar","/accounts-0.0.1-SNAPSHOT.jar"]
```

Odemy

Challenges with Dockerfile Approach

Steep Learning Curve

- Developers need to learn all Dockerfile instructions (FROM, COPY, RUN, ENTRYPOINT, etc.) to create optimized images.
- Also need to know Docker concepts like layers, caching, port mapping, volumes, and environment variables.

Maintenance & Updates

- Dockerfile may need frequent updates for:
 - Base image versions (openjdk:17-slim → newer version)
 - Application dependencies
 - Optimizations to reduce image size or improve build speed

Not Developer-Focused

- Developers often want to **focus on writing code**, not on DevOps tasks.
- Writing Dockerfiles requires effort outside their core skills.

Error-prone

- Small mistakes (like wrong **COPY** path, missing dependencies, incorrect **ENTRYPOINT**) can break builds.
- Need to test images repeatedly.

Alternatives

To reduce the burden on developers, we have **tools that automate image creation**:

Buildpacks or Google Jib(only for Java applications)

2) using Buildpacks

Official site : <https://buildpacks.io/> , <https://paketo.io/>

Buildpacks automatically **convert your application into a Docker image** without writing a Dockerfile. Spring Boot Maven Plugin (**spring-boot-maven-plugin**) has Buildpacks support built-in since Spring Boot 2.3+ so don't need to install any separate Buildpacks plugin.

i) Added the **image name** under the Spring Boot plugin configuration in pom.xml.

The **<image>** configuration should be **inside spring-boot-maven-plugin**

```

79<build>
80  <plugins>
81    <plugin>
82      <groupId>org.springframework.boot</groupId>
83      <artifactId>spring-boot-maven-plugin</artifactId>
84      <configuration>
85        <image>
86          <name>jram224/${project.artifactId}:latest</name>
87        </image>
88      </configuration>
89    </plugin>

```

ii) Open a cmd terminal **where your pom.xml file is located** as Maven needs to read the **pom.xml** from your application folder. Make sure this **pom.xml** has the **spring-boot-maven-plugin** configured with the **<image>** tag, like your latest version.

Run the Buildpack Docker image command

`mvn spring-boot:build-image`

- Maven will automatically use **Paketo Buildpacks** to generate the Docker image.
- It will detect your **Java version** (from Maven compiler plugin / Spring Boot version) and build the image.

```
C:\Users\jakkula.ramesh\Desktop\Udemy Spring Boot\microservices\section2\loans>mvn spring-boot:build-image
[INFO] Scanning for projects...
[INFO]
[INFO] -----< com.eazybytes:loans >-----
[INFO] Building loans 0.0.1-SNAPSHOT
[INFO] -----[ jar ]-----
[INFO]
[INFO] >>> spring-boot-maven-plugin:3.4.1:build-image (default-cli) > package @ loans >>>
[INFO]
[INFO] --- maven-resources-plugin:3.3.1:resources (default-resources) @ loans ---
[INFO] Copying 1 resource from src\main\resources to target\classes
[INFO] Copying 1 resource from src\main\resources to target\classes
[INFO]
[INFO] --- maven-compiler-plugin:3.13.0:compile (default-compile) @ loans ---
[INFO] Recompiling the module because of added or removed source files.
```

```
[INFO] Successfully built image 'docker.io/jram224/loans:latest'
[INFO]
[INFO] -----
[INFO] BUILD SUCCESS
[INFO] -----
[INFO] Total time: 03:28 min
[INFO] Finished at: 2025-11-16T12:27:22+05:30
[INFO] -----
```

iii) Run Docker Container Using the Image

`docker run -d -p <host-port>:<container-port> <image-name>:<tag>`

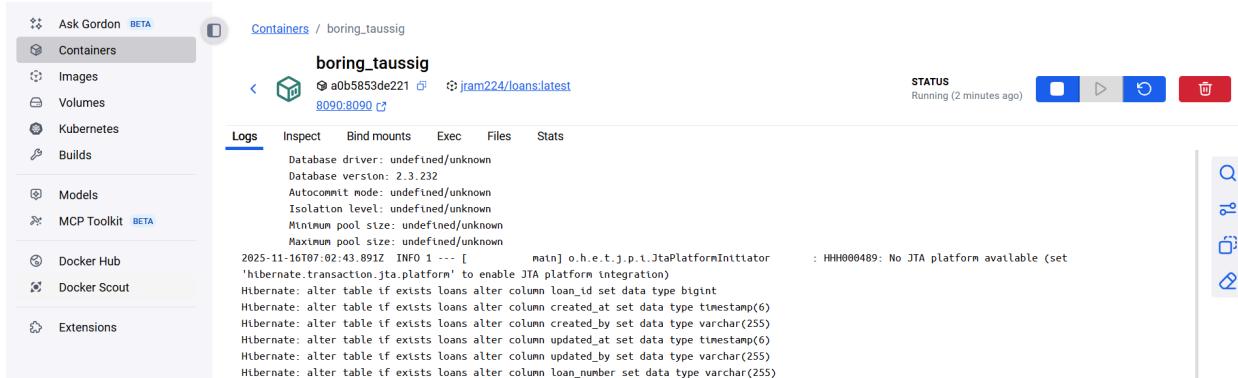
The “45 years ago” date shows up because the base image used by Buildpacks doesn’t have real timestamps, so Docker defaults to the Unix epoch (1970).

```
C:\Users\jakkula.ramesh\Desktop\Udemy Spring Boot\microservices\section2\loans>docker images
REPOSITORY          TAG      IMAGE ID   CREATED        SIZE
jram224/accounts    latest   3e06f903f2e2  15 hours ago  762MB
paketobuildpacks/run-jammy-tiny  latest   e108bbfe02f8  3 days ago   38.7MB
jram224/loans        latest   0fc4b2a76bd4  45 years ago  561MB
paketobuildpacks/builder-jammy-java-tiny  latest   4c0d99dc3034  45 years ago  1.13GB

C:\Users\jakkula.ramesh\Desktop\Udemy Spring Boot\microservices\section2\loans>docker run -d -p 8090:8090 jram224/loans:latest
a0b5853de22195bb05137764a6fbfb5009ad11d359c87446193380671f93626c1

C:\Users\jakkula.ramesh\Desktop\Udemy Spring Boot\microservices\section2\loans>
```

□	Name	Container ID	Image	Port(s)	CPU (%)	Last started	Actions
□	○ blissful_almeida	687668f73cce	jram224/accounts:latest		0%	14 hours ago	❖ ➤ ⚡ 🗑
□	● boring_taussig	a0b5853de221	jram224/loans:latest	8090:8090 ↕	0.13%	1 minute ago	❖ 🛡 ⚡ 🗑



CRUD REST APIs for Cards in EazyBank

CRUD REST APIs in EazyBank to CREATE, UPDATE, FETCH AND DELETE card details

PUT	/api/update	Update Card Details REST API
POST	/api/create	Create Card REST API
GET	/api/fetch	Fetch Card Details REST API
DELETE	/api/delete	Delete Card Details REST API

Running a Spring Boot app as a container using Buildpacks

eazy bytes

STEPS TO BE FOLLOWED

- 1) Add the configurations like mentioned on the right hand side inside the pom.xml. Make sure to pass the image name details
- 2) Run the maven command "mvn spring-boot:build-image" from the location where pom.xml is present to generate the docker image with out the need of Dockerfile
- 3) Execute the docker command "docker run -p 8090:8090 eazybytes/loans:s4". This will start the docker container based on the docker image name and port mapping provided

Sample pom.xml config

```

<build>
  <plugins>
    <plugin>
      <groupId>org.springframework.boot</groupId>
      <artifactId>spring-boot-maven-plugin</artifactId>
      <configuration>
        <image>
          <name>eazybytes/${project.artifactId}:s4</name>
        </image>
      </configuration>
    </plugin>
  </plugins>
</build>

```

Cloud Native Buildpacks offer an alternative approach to Dockerfiles, prioritizing consistency, security, performance, and governance. With Buildpacks, developers can automatically generate production-ready OCI images from their application source code without the need to write a Dockerfile.

2) using Google Jib

URL: <https://github.com/GoogleContainerTools/jib> ,
<https://github.com/GoogleContainerTools/jib/tree/master/jib-maven-plugin#quickstart>

- i) Make sure the `jib-maven-plugin` is inside your `<plugins>` section of `pom.xml`.

```

80    ...
81        <plugin>
82            <groupId>com.google.cloud.tools</groupId>
83            <artifactId>jib-maven-plugin</artifactId>
84            <version>3.4.6</version>
85            <configuration>
86                <to>
87                    <image>jram224/${project.artifactId}:latest</image>
88                </to>
89            </configuration>
90        </plugin>

```

- ii) Open a cmd terminal **where your pom.xml file is located** as Maven needs to read the **pom.xml** from your application folder.

Run the Buildpack Docker image command

```
mvn compile jib:dockerBuild
```

jib:dockerBuild builds the Docker image **directly into your local Docker environment**.

No Dockerfile is needed.

Jib automatically detects your Java version from the project.

The resulting image will have your configured **<image>** name and **<tag>**.

```
C:\Users\jakkula.ramesh\Desktop\Udemy Spring Boot\microservices\section2\cards>mvn compile jib:dockerBuild
[INFO] Scanning for projects...
[INFO]
[INFO] -----< com.eazybytes:cards >-----
[INFO] Building cards 0.0.1-SNAPSHOT
[INFO] -----[ jar ]-----
[INFO]
[INFO] --- maven-resources-plugin:3.3.1:resources (default-resources) @ cards ---
[INFO] Copying 1 resource from src\main\resources to target\classes
[INFO] Copying 1 resource from src\main\resources to target\classes
[INFO]
```

```
[INFO] Using credentials from Docker config (C:\Users\jakkula.ramesh\.docker\config.json) for eclipse-temurin:17-jre
[INFO] Using base image with digest: sha256:75ab7d1b4b18483e9245342cbee253b558952c1def5c1c18956196330a01683e
[INFO]
[INFO] Container entrypoint set to [java, -cp, @/app/jib-classpath-file, com.eazybytes.cards.CardsApplication]
[INFO]
[INFO] Built image to Docker daemon as jram224/cards
[INFO] Executing tasks:
[INFO] [=====] 100.0% complete
[INFO]
[INFO] -----
[INFO] BUILD SUCCESS
[INFO] -----
[INFO] Total time: 01:31 min
[INFO] Finished at: 2025-11-16T13:04:44+05:30
[INFO] -----
```

- iii) Run Docker Container Using the Image

```
docker run -d -p <host-port>:<container-port> <image-name>:<tag>
```

```
C:\Users\jakkula.ramesh\Desktop\Udemy Spring Boot\microservices\section2\cards>docker images
REPOSITORY          TAG      IMAGE ID   CREATED        SIZE
jram224/accounts    latest   3e06f903f2e2  16 hours ago  762MB
paketobuildpacks/run-jammy-tiny  latest   e108bbfe02f8  3 days ago   38.7MB
jram224/loans       latest   0fc4b2a76bd4  45 years ago  561MB
paketobuildpacks/builder-jammy-java-tiny  latest   4c0d99dc3034  45 years ago  1.13GB
jram224/cards       latest   c3bc1b14dfd1  55 years ago  493MB

C:\Users\jakkula.ramesh\Desktop\Udemy Spring Boot\microservices\section2\cards>docker run -d -p 9000:9000 jram224/cards:latest
9e41a4d8005b6baaafff8dd69cc59f0082717ff8d9a426d01a11d7d26a706152
```

The screenshot shows the Docker UI interface. On the left is a sidebar with various tabs: Ask Gordon (Beta), Containers (selected), Images, Volumes, Kubernetes, Builds, Models, MCP Toolkit (Beta), Docker Hub, Docker Scout, and Preferences. The main area shows a container named "admiring_maxwell" with the image ID "9e41a4d8005b6baaafff8dd69cc59f0082717ff8d9a426d01a11d7d26a706152" and port mapping "9000:9000". The "Logs" tab is selected, showing log output related to database initialization and Hibernate schema creation. To the right, there's a "STATUS" section indicating "Running (54 seconds ago)". Below the UI, a browser window shows the Swagger UI for the EazyBank API, with the URL "http://localhost:9000/swagger-ui/index.html#".

Running a Spring Boot app as a container using Google Jib

Sample pom.xml config

```
<build>
  <plugins>
    <plugin>
      <groupId>com.google.cloud.tools</groupId>
      <artifactId>jib-maven-plugin</artifactId>
      <version>3.3.2</version>
      <configuration>
        <to>
          <image>eazybytes/${project.artifactId}:s4</image>
        </to>
      </configuration>
    </plugin>
  </plugins>
</build>
```

STEPS TO BE FOLLOWED

- 1) Add the configurations like mentioned on the right hand side inside the pom.xml. Make sure to pass the image name details
- 2) Run the maven command "mvn compile jib:dockerBuild" from the location where pom.xml is present to generate the docker image with out the need of Dockerfile
- 3) Execute the docker command "docker run -p 9000:9000 eazybytes/cards:s4". This will start the docker container based on the docker image name and port mapping provided

Google Jib offer an alternative approach to Dockerfiles, prioritizing consistency, security, performance, and governance. With Jib, developers can automatically generate production-ready OCI images from their application source code without the need to write a Dockerfile and even local Docker setup.

Comparison of the Dockerfile, Buildpacks, and Jib:

<https://buildpacks.io/features/>

Comparison						
	 Cloud Native Buildpacks	 Dockerfile	 source-to-image (s2i)	 Jib	 ko	
Advanced Caching	Yes	No	Yes	No	Yes	
Auto-detection	Yes	No	Yes	Yes	Yes	
Bill-of-Materials	Yes	No	No	No	Yes	
Modular / Pluggable	Yes	No	No	N/A [†]	N/A [†]	
Multi-language	Yes	Yes	Yes	No	No	
Multi-process	Yes	No	No	No	No	
Minimal app image	Yes	Yes*	Yes‡	Yes	Yes	
Rebasing	Yes	No	No	No	No	
Reproducibility	Yes	No	No	Yes	Yes	
Reusability	Yes	No	Yes	N/A [†]	N/A [†]	
Integrations	○ Azure	○ Amazon ECS	○ OpenShift	○ Gradle	○ Terraform	
	○ CircleCI	○ CircleCI	○ Maven	○ GoReleaser	○ Skaffold	
	○ GitLab	○ GitLab	○ Google	○ Carvel kubectl	○ Tilt	
	○ Google	○ Google	○ Tekton	○ ...	○ ...	
	○ Heroku	○ Tekton	○ ...	○ ...	○ ...	
	○ Spring Boot	○ ...	○ ...	○ ...	○ ...	
	○ Tekton	○ ...	○ ...	○ ...	○ ...	
	○ ...	○ ...	○ ...	○ ...	○ ...	
	○ ...	○ ...	○ ...	○ ...	○ ...	
Governance	CNCF	Docker	Red Hat	Google	CNCF	
Best for Building...	○ Applications	○ Applications	○ Applications	○ Applications	○ Applications	
	○ Base Images	○ Base Images	○ Base Images	○ Base Images	○ Base Images	
	○ OS Images	○ OS Images	○ OS Images	○ OS Images	○ OS Images	

**So far, we have generated Docker images and stored them only in our local machine.
But storing images locally does not make sense for real projects — because applications must be deployed in multiple environments like Dev, QA, UAT, and Production.**

To make the image available to all environments, **we need to push our Docker images to a remote registry** (public or private).

Once the image is stored in a remote registry, **any environment can pull the same image whenever needed**, ensuring consistency.

Examples of remote image repositories:

- **Docker Hub (Public)**
- **GitHub Container Registry (GHCR)**
- **AWS ECR (Elastic Container Registry)**
- **Azure Container Registry (ACR)**
- **Google Container Registry / Artifact Registry**
- **Private/self-hosted registries** like Harbor, JFrog Artifactory, Nexus

How to Push Docker Images to Docker Hub

Since you are already **logged in to Docker Desktop** on your local machine, Because of this existing authentication, **you can push images to Docker Hub without entering your username and password again.**

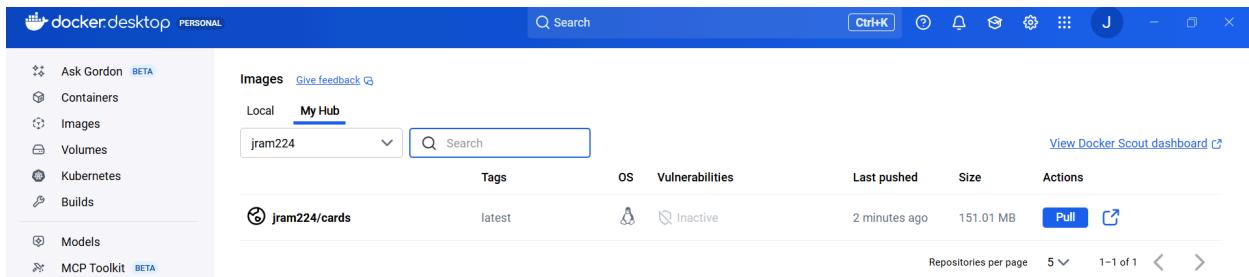
`docker image push docker.io/<imagename>:<tag>`

```
C:\Users\jakkula.ramesh\Desktop\Udemy Spring Boot\microservices\section2\accounts> docker ps -a
CONTAINER ID IMAGE COMMAND CREATED STATUS PORTS NAMES
9e41a4d8005b jram224/cards:latest "java -cp @/app/jib_..." 20 hours ago Exited (143) 20 hours ago admiring_maxwell
a0b5853de221 jram224/loans:latest "/cnb/process/web" 21 hours ago Exited (143) 20 hours ago boring_taussig
687668f73cce jram224/accounts:latest "java -jar accounts-..." 35 hours ago Exited (143) 35 hours ago blissful_almeida

C:\Users\jakkula.ramesh\Desktop\Udemy Spring Boot\microservices\section2\accounts> docker image push docker.io/jram224/cards:latest
The push refers to repository [docker.io/jram224/cards]
2581bc3ff3b6: Pushed
ec1e0321681c: Pushed
d9c6d7e52592: Pushed
b315b75540ca: Pushed
20043066d3d5: Pushed
469f7f46f06b: Pushed
a12c659f8ac1: Pushed
2abdf4167e30: Pushed
fd4969aa9957: Pushed
latest: digest: sha256:c3bc1b14dfd1324cbef6ca568e19ac9f5567b942b30485cb01c93cb41caf14f size: 1729

C:\Users\jakkula.ramesh\Desktop\Udemy Spring Boot\microservices\section2\accounts>
```

We can see either docker hub site or Hub option in docker desktop.



We can pull Docker images from a remote Docker registry (Docker Hub, ECR, ACR, etc.) also.

Let me test , i will delete cards docker images from local and will pull it from remote repo.

```
C:\Users\jakkula.ramesh\Desktop\Udemy Spring Boot\microservices\section2\accounts> docker ps -a
CONTAINER ID   IMAGE          COMMAND       CREATED      STATUS        PORTS     NAMES
a0b5853de221   jram224/loans:latest   "/cnb/process/web"   21 hours ago  Exited (143)  21 hours ago
687668f73cce   jram224/accounts:latest  "java -jar accounts-..."  35 hours ago  Exited (143)  35 hours ago
C:\Users\jakkula.ramesh\Desktop\Udemy Spring Boot\microservices\section2\accounts>
```

Pull

docker pull <imagename>:<tag>

```
C:\Users\jakkula.ramesh\Desktop\Udemy Spring Boot\microservices\section2\accounts>docker pull jram224/cards:latest
latest: Pulling from jram224/cards
Digest: sha256:c3bc1b14dfd1324cbbef6ca568e19ac9f5567b942b30485cb01c93cb41caf14f
Status: Image is up to date for jram224/cards:latest
docker.io/jram224/cards:latest
```

```
C:\Users\jakkula.ramesh\Desktop\Udemy Spring Boot\microservices\section2\accounts>docker images
REPOSITORY           TAG      IMAGE ID   CREATED    SIZE
jram224/accounts    latest   3e06f903f2e2  36 hours ago  762MB
paketobuildpacks/run-jammy-tiny  latest   e108bbfe02f8  4 days ago   38.7MB
jram224/loans        latest   0fc4b2a76bd4  45 years ago  561MB
paketobuildpacks/builder-jammy-java-tiny  latest   4cd99dc3034  45 years ago  1.13GB
jram224/cards        latest   c3bc1b14dfd1  55 years ago  493MB
```

After we build Docker images (either locally or by pulling them from a remote registry like Docker Hub), we normally run the container using:

```
docker run <options> <image-name>
```

But this approach has **major disadvantages**:

✗ 1. Running multiple applications becomes painful

If you want to run many services (e.g., accounts, loans, cards microservices), you must run:

```
docker run ...
```

```
docker run ...
```

```
docker run ...
```

for each application manually.

✗ 2. Running multiple instances is even more time-consuming

If you want **multiple instances** of the same application for load balancing (e.g., 3 replicas):

```
docker run ...
```

```
docker run ...
```

```
docker run ...
```

You must repeat it manually → very slow and error-prone.

✗ 3. Managing networks, volumes, and environment variables is difficult

You must manually provide:

- ports
- volumes
- networks
- env variables (`--env`)
- dependencies (`--link`)

This becomes messy.

Solution: Use Docker Compose

To overcome all these limitations, Docker provides **Docker Compose**.

Docker Compose

site:<https://docs.docker.com/compose/>

Docker Compose is a tool for defining and running multi-container applications.

Compose simplifies the control of your entire application stack, making it easy to manage services, networks, and volumes in a single YAML configuration file. Then, with a single command, you create and start all the services from your configuration file.

Compose works in all environments - production, staging, development, testing, as well as CI workflows. It also has commands for managing the whole lifecycle of your application:

- Start, stop, and rebuild services
- View the status of running services
- Stream the log output of running services
- Run a one-off command on a service

Without Compose

Run 6 commands manually:

`docker run service1`

```
docker run service2
```

```
docker run service3
```

```
docker run instance1
```

```
docker run instance2
```

With Compose

Run **one** command:

```
docker compose up
```

If you want, I can also show:

Complete **docker-compose.yml** for your Spring Boot microservices.

① Start all services

```
docker compose up
```

Runs all containers defined in **docker-compose.yml**.

To run in the background:

```
docker compose up -d
```

② Stop and remove containers, networks, volumes created by compose

```
docker compose down
```

Equivalent to:

- stop containers
- remove containers
- remove networks

③ Start existing containers (without recreating)

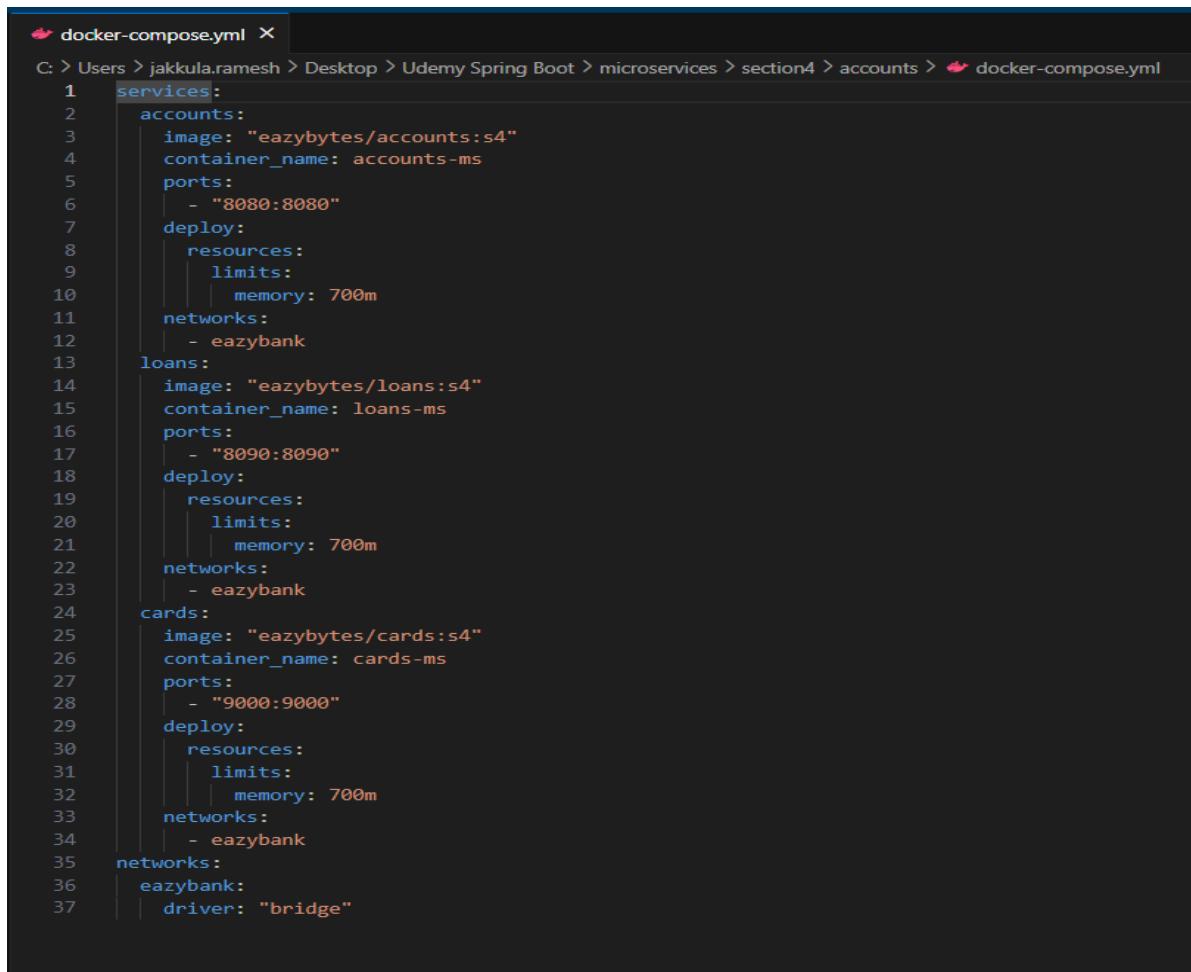
docker compose start

Start containers that are already created but stopped.

④ Stop running containers (but do not remove them)

docker compose stop

Stops services but does *not* remove containers.



The screenshot shows a terminal window with the file path: C: > Users > jakkula.ramesh > Desktop > Udemy Spring Boot > microservices > section4 > accounts > docker-compose.yml. The file content is as follows:

```
1 services:
2   accounts:
3     image: "eazybytes/accounts:s4"
4     container_name: accounts-ms
5     ports:
6       - "8080:8080"
7     deploy:
8       resources:
9         limits:
10          memory: 700m
11     networks:
12       - eazybank
13   loans:
14     image: "eazybytes/loans:s4"
15     container_name: loans-ms
16     ports:
17       - "8090:8090"
18     deploy:
19       resources:
20         limits:
21           memory: 700m
22     networks:
23       - eazybank
24   cards:
25     image: "eazybytes/cards:s4"
26     container_name: cards-ms
27     ports:
28       - "9000:9000"
29     deploy:
30       resources:
31         limits:
32           memory: 700m
33     networks:
34       - eazybank
35   networks:
36     eazybank:
37       driver: "bridge"
```

IMPORTANT DOCKER COMMANDS

eazy
bytes

01	docker images To list all the docker images present in the Docker server	06	docker ps To show all running containers	11	docker container stop [container-id] To stop one or more running containers
02	docker image inspect [image-id] To display detailed image information for a given image id	07	docker ps -a To show all containers including running and stopped	12	docker container kill [container-id] To kill one or more running containers instantly
03	docker image rm [image-id] To remove one or more images for a given image ids	08	docker container start [container-id] To start one or more stopped containers	13	docker container restart [container-id] To restart one or more containers
04	docker build . -t [image-name] To generate a docker image based on a Dockerfile	09	docker container pause [container-id] To pause all processes within one or more containers	14	docker container inspect [container-id] To inspect all the details for a given container id
05	docker run -p [hostport]:[containerport] [image_name] To start a docker container based on a given image	10	docker container unpause [container-id] To resume/unpause all processes within one or more containers	15	docker container logs [container-id] To fetch the logs of a given container id

Üder

16	docker container logs -f [container-id] To follow log output of a given container id	21	docker image prune To remove all unused images	26	docker logout To login out from docker hub container registry
17	docker rm [container-id] To remove one or more containers based on container ids	22	docker container stats To show all containers statistics like CPU, memory, I/O usage	27	docker history [image-name] Displays the intermediate layers and commands that were executed when building the image
18	docker container prune To remove all stopped containers	23	Docker system prune Remove stopped containers, dangling images, and unused networks, volumes, and cache	28	docker exec -it [container-id] sh To open a shell inside a running container and execute commands
19	docker image push [container_registry/username:tag] To push an image from a container registry	24	docker rmi [image-id] To remove one or more images based on image ids	29	docker compose up To create and start containers based on given docker compose file
20	docker image pull [container_registry/username:tag] To pull an image from a container registry	25	docker login -u [username] To login in to docker hub container registry	30	docker compose down To stop and remove containers for services defined in the Compose File

Cloud-Native Application

Cloud-native applications are **modern software applications designed and built specifically to run in cloud environments**.

A **cloud-native application** is an application built to **run, scale, and recover automatically in the cloud**, using technologies like **containers, microservices, DevOps, and Kubernetes** to achieve high scalability, resilience, and agility (Speed + Flexibility).

They are broken down into small, independent services that can be developed, deployed, and scaled individually without impacting other parts of the application, leading to faster updates and greater flexibility.

What are cloud native applications ?

eazy bytes



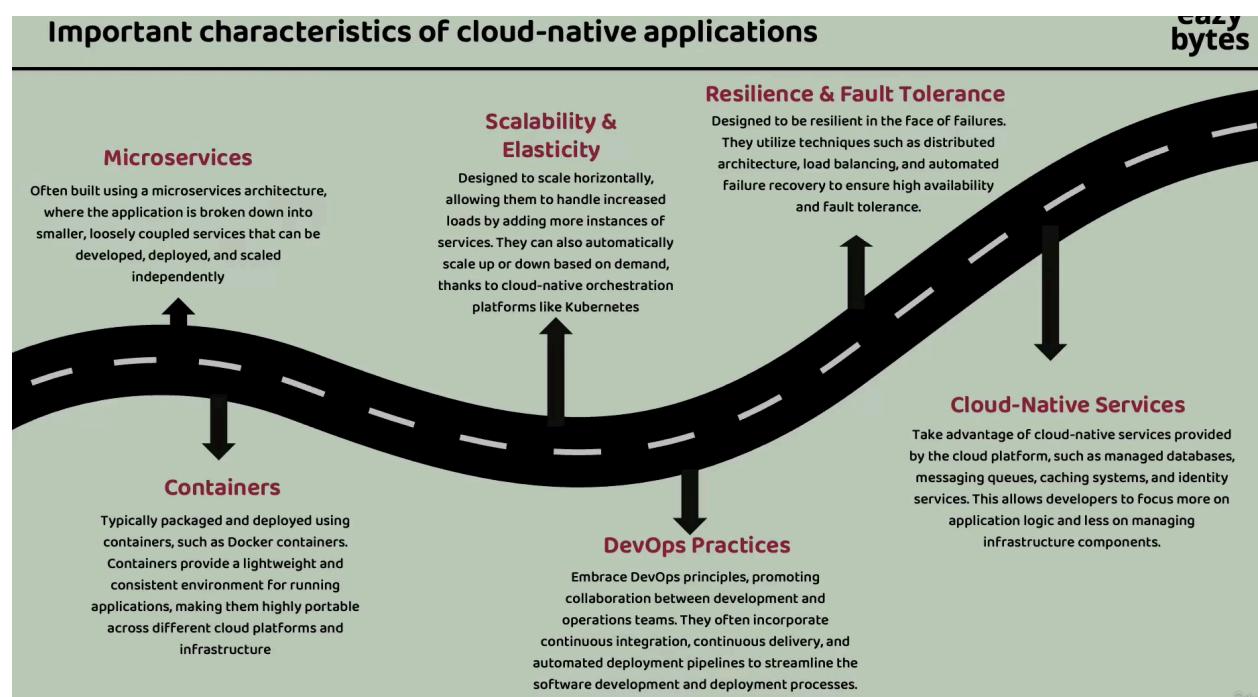
The layman definition

Cloud-native applications are software applications designed specifically to leverage cloud computing principles and take full advantage of cloud-native technologies and services. These applications are built and optimized to run in cloud environments, utilizing the scalability, elasticity, and flexibility offered by the cloud.

The Cloud Native Computing Foundation (CNCF) definition

Cloud native technologies empower organizations to build and run scalable applications in modern, dynamic environments such as public, private, and hybrid clouds. Containers, service meshes, microservices, immutable infrastructure, and declarative APIs exemplify this approach.

These techniques enable loosely coupled systems that are resilient, manageable, and observable. Combined with robust automation, they allow engineers to make high-impact changes frequently and predictably with minimal toil.



Key Characteristics of Cloud-Native Applications

1 Microservices Architecture

- Application is broken into small, independent services.
- Each service can be developed, deployed, and scaled separately.

2 Containers (Docker)

- Each microservice runs inside a lightweight container.
- Ensures consistency across environments (dev → test → prod).

3 Orchestration (Kubernetes)

- Manages container deployment, scaling, and recovery automatically.

4 DevOps + CI/CD

- Automated build, testing, deployment pipelines.
- Enables frequent and reliable releases.

5 Scalability & Elasticity

- Applications automatically scale up during high load and scale down during low load.

6 Resilience & Fault Tolerance

- If one microservice fails, the system continues running.
- Self-healing, rollback, and auto-recovery.

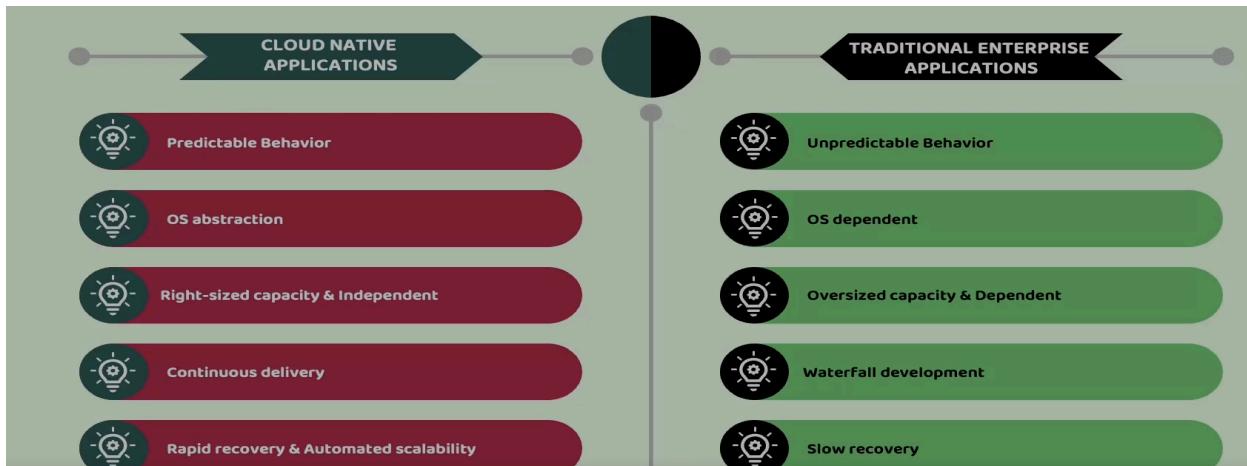
7 API-Driven

- Services communicate using APIs (REST, gRPC, GraphQL).

8 Cloud Managed Services

- Uses cloud-native databases, caches, queues (e.g., AWS DynamoDB, Azure Cosmos DB, GCP Pub/Sub).

Cloud-Native vs Traditional Applications

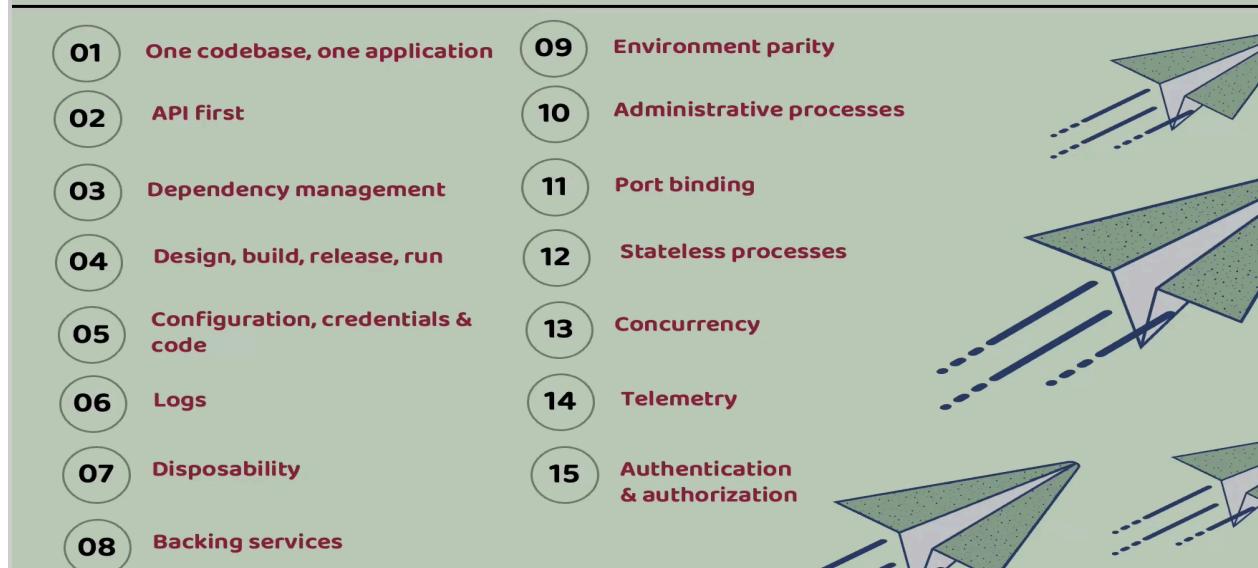


Cloud-Native vs Traditional Applications

Feature	Cloud-Native	Traditional (Monolithic)
Architecture	Microservices	One big application
Deployment	Containers (Docker)	VMs or servers
Scaling	Automatic, per service	Manual, whole app
Resilience	Self-healing	Single point of failure
Release Cycle	Fast, frequent	Slow, risky
Cloud Compatibility	Built for cloud	Adapted to cloud

Core Development Principles of Cloud-Native Applications

15-Factor methodology

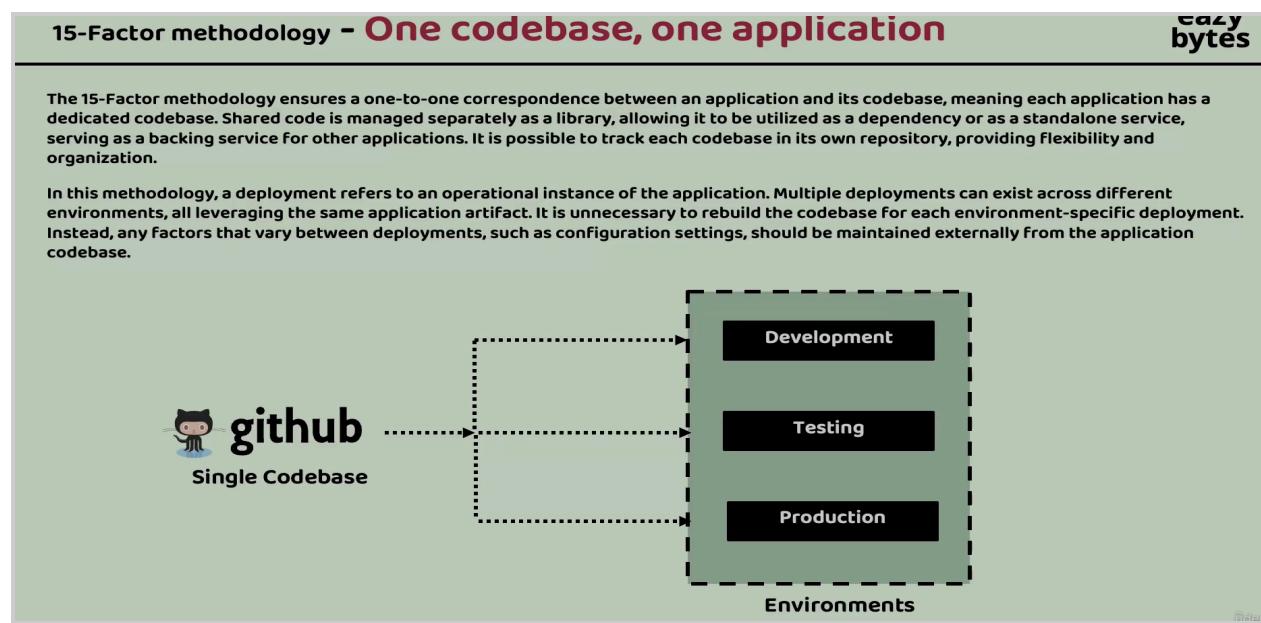


① One Codebase, One Application

Each application must have **one single codebase**, tracked in version control (like GitHub). Multiple deployments (Dev, Test, Prod) must all come from the **same codebase**.

Key Points:

- One codebase → many deployments
- No separate repos for each environment
- Config changes should be externalized, not kept in code
- Shared code should be packaged as libraries or services, not duplicated



② API First

APIs are designed **before** writing the actual implementation. This ensures clear contracts between services.

Key Points:

- Follows distributed system design
- Teams work independently using API contracts
- Prevents integration issues
- API changes won't break other services if the contract remains stable
- Helps in building reusable and testable services

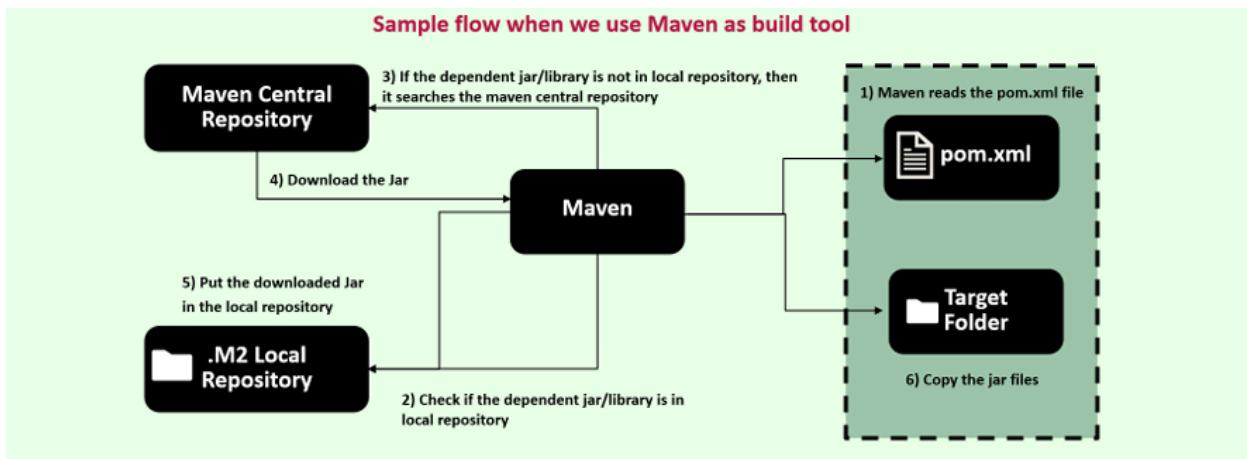
③ Dependency Management

All dependencies must be **declared explicitly** in a manifest (like `pom.xml`).

Key Points:

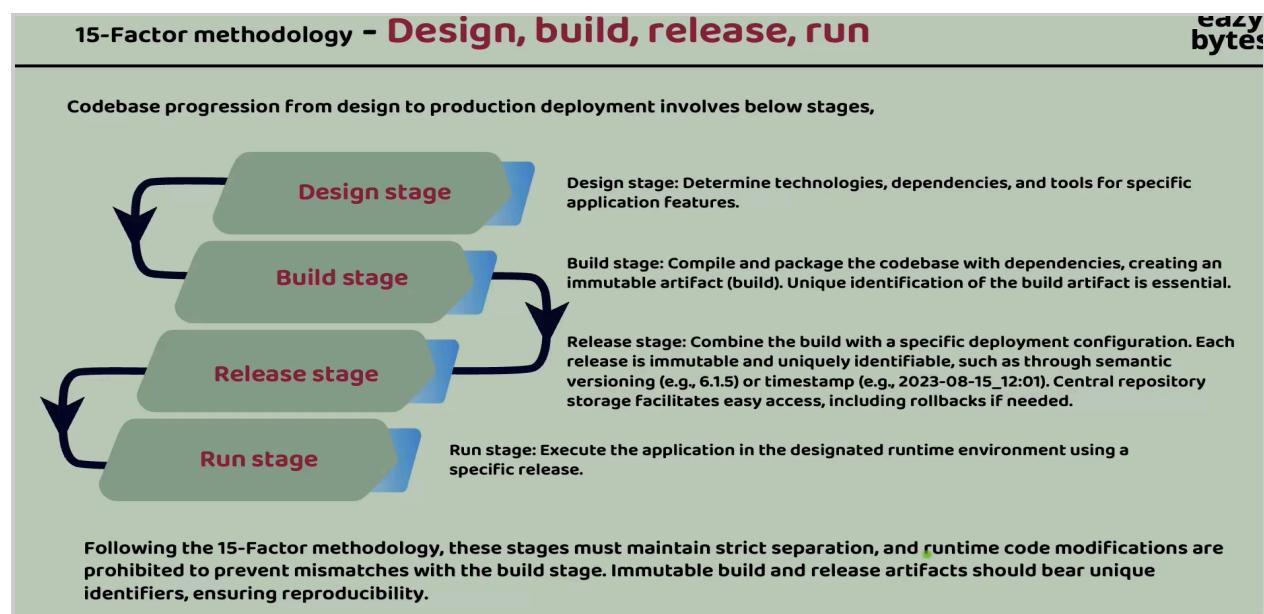
- No implicit/hidden dependencies
- Use dependency managers (Maven, Gradle, npm, etc.)
- Dependency manager will:
 - Check local repo
 - If missing → download from central repo
 - Store in cache
- Ensures consistency and reproducibility

Java Example Flow (Maven):



④ Design, Build, Release, Run

Application lifecycle is split into **four strict stages**, and they should not mix.



Key Points:

- No code changes allowed at runtime
- Build & Release must be immutable
- Release must be uniquely identifiable (version or timestamp)
- Ensures reproducibility and easier rollbacks

5 Configuration, Credentials & Code (Separation of Concerns)

Configuration must be **externalized**, not hardcoded inside the application.

Examples of configs to externalize:

- Database URLs
- Credentials / API keys
- Environment variables
- Feature flags

Why?

- Same code runs in Dev/Test/Prod
- No rebuild needed for different environments
- More secure (no passwords inside code)

15-Factor methodology - Configuration, credentials & code

eazy bytes

According to the 15-Factor methodology, configuration encompasses all elements prone to change between deployments. It emphasizes the ability to modify application configuration independently, without code changes or the need to rebuild the application.

Configuration may include resource handles for backing services (e.g., databases, messaging systems), credentials for accessing third-party APIs, and feature flags. It is essential to evaluate whether any confidential or environment-specific information would be at risk if the codebase were exposed publicly. This assessment ensures proper externalization of configuration.

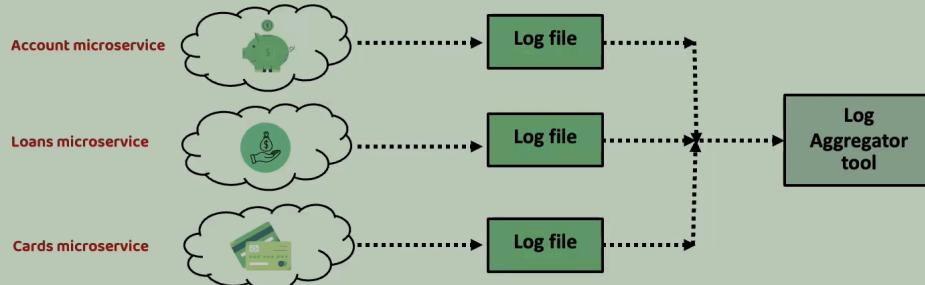
To comply with this principle, configuration should not be embedded within the code or tracked in the same codebase, except for default configuration, which can be bundled with the application. Other configurations can still be managed using separate files, but they should be stored in a distinct repository.

The methodology recommends utilizing environment variables to store configuration. This enables deploying the same application in different environments while adapting its behavior based on the specific environment's configuration.

The diagram illustrates the 15-Factor methodology. On the left, there is a GitHub logo with the text "Single Codebase". A dashed arrow points from this to a central box labeled "Configurations", which contains three sub-boxes: "Dev Config", "Testing Config", and "Prod Config". Another dashed arrow points from the "Single Codebase" to a second box labeled "Environments", which contains three sub-boxes: "Development", "Testing", and "Production". A green dot is located at the bottom right of the "Environments" box.

6 Logs – Treat Logs as Event Streams

In a cloud-native application, log routing and storage are not the application's concern. Instead, applications should direct their logs to the standard output, treating them as sequentially ordered events based on time. The responsibility of log storage and rotation is now shifted to an external tool, known as a log aggregator. This tool retrieves, gathers, and provides access to the logs for inspection purposes.



7 Disposability – Fast Startup & Graceful Shutdown

Applications must be:

- Quick to start
- Safe to stop at any time
- Able to handle unexpected restarts

Why?

Cloud-native environments like Kubernetes constantly start/stop containers.

Practices:

- Use graceful shutdown hooks
- Keep startup lightweight
- Don't store state inside app
- Ensure long-running operations can restart safely

8 Backing Services – Treat Services as Attached Resources

Resources like:

- DB
- Cache
- Message queue
- Storage
- Third-party APIs

must be considered **external services** that can be attached/detached without code changes.

Your app only changes **config**, never **code**, when switching between:

- Local DB → Cloud DB
- Test Redis → Production Redis

15-Factor methodology - Backing services **bytes**

Backing services refer to external resources that an application relies on to provide its functionality. These resources can include databases, message brokers, caching systems, SMTP servers, FTP servers, or RESTful web services. By treating these services as attached resources, you can modify or replace them without needing to make changes to the application code.

Consider the usage of databases throughout the software development life cycle. Typically, different databases are used in different stages such as development, testing, and production. By treating the database as an attached resource, you can easily switch to a different service depending on the environment. This attachment is achieved through resource binding, which involves providing necessary information like a URL, username, and password for connecting to the database.

In the below example, we can see that a local DB can be swapped easily to a third-party DB like AWS DB with out any code changes,

9 Environment Parity

Keep Dev, Test, QA, and Prod environments as **similar as possible**.

Why?

- Fewer bugs caused by environment differences
- Easier debugging
- Predictable deployments

Achieved by:

- Containers
- IaC (Terraform)
- Same build artifacts used everywhere

Environment parity aims to minimize differences between various environments & avoiding costly shortcuts. Here, the adoption of containers can greatly contribute by promoting the same execution environment.

There are three gaps that this factor addresses:



Time gap: The time it takes for a code change to be deployed can be significant. The methodology encourages automation and continuous deployment to reduce the time between code development and production deployment.



People gap: Developers create applications, while operators handle their deployment in production. To bridge this gap, a DevOps culture promotes collaboration between developers and operators, fostering the "you build it, you run it" philosophy.



Tools gap: Handling of backing services differs across environments. For instance, developers might use the H2 database locally but PostgreSQL in production. To achieve environment parity, it is recommended to use the same type and version of backing services across all environments.

10 Admin Processes

Administrative tasks must run as **one-off processes**, not part of the app.

Examples:

- Database migration scripts
- Cron jobs
- Data cleanup
- Debug commands

These should run:

- As standalone jobs
- Separate from the main app container

11 Port Binding

Apps should **self-contain** their web server.

Instead of relying on external servers like:

- Apache
- Nginx
- Tomcat (traditional WAR)

Cloud-native apps:

- Bind to a port internally
- Expose it to the platform

Example:

Spring Boot app runs via embedded Tomcat on port 8080.

12 Stateless Processes

Do not store session or state inside the application instance. State must be stored in:

- Database
- Redis
- Message queues
- Object storage

Reason:

Cloud-native platforms frequently kill and recreate containers. If your state is inside the container → it's lost.

13 Concurrency – Scale Out via Processes

Scale by running many small instances, not by making one big server.

Cloud-native apps scale horizontally.

Example: 5 containers → 10 containers → 20 containers depending on load.

15-Factor methodology - Concurrency

Scalability is not solely achieved by creating stateless applications. While statelessness is important, scalability also requires the ability to serve a larger number of users. This means that applications should support concurrent processing to handle multiple users simultaneously.

According to the 15-Factor methodology, processes play a crucial role in application design. These processes should be horizontally scalable, distributing the workload across multiple processes on different machines. This concurrency is only feasible when applications are stateless. In Java Virtual Machine (JVM) applications, concurrency is typically managed through the use of multiple threads, which are available from thread pools.

Vertical Scalability	
 Virtual Machine 2 GB RAM 2 CPU Before	 Virtual Machine 4 GB RAM 4 CPU After

Horizontal Scalability		
 Virtual Machine 2 GB RAM 2 CPU Before	 Virtual Machine 2 GB RAM 2 CPU After	 Virtual Machine 2 GB RAM 2 CPU After

14 Telemetry

Applications must expose:

- Metrics

- Traces
- Health checks

Why?

To allow monitoring tools like:

- Prometheus
- Grafana
- ELK
- Jaeger

to give system visibility.

Telemetry enables:

- Auto-scaling
- Alerting
- Diagnosis
- Performance insights

15 Authentication & Authorization (Secure by Default)

Every cloud-native app must:

- Authenticate users
- Authorize access
- Secure data in transit and at rest

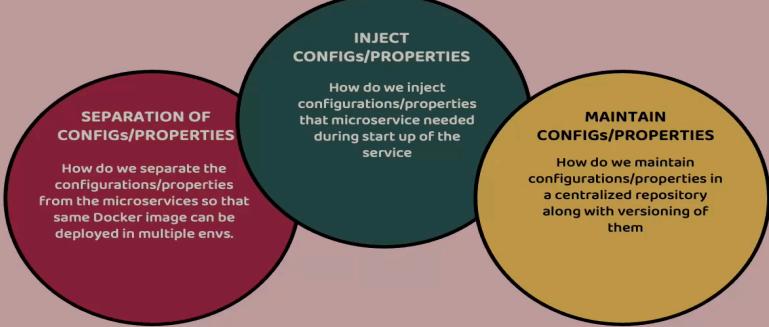
Common methods:

- OAuth2
 - JWT
 - OpenID
-

Configuration Management in Microservices

CONFIGURATION MANAGEMENT IN MICROSERVICES

eazy bytes



There are multiple solutions available in Spring Boot ecosystem to handle this challenge. Below are the solutions. Let's try to identify which one suites for microservices

- 1) Configuring Spring Boot with properties and profiles
- 2) Applying external configuration with Spring Boot
- 3) Implementing a configuration server with Spring Cloud Config Server

GeekyML

Microservices need **flexible, environment-specific configurations** so that the **same code** can run in multiple environments (dev, QA, stage, prod).

Spring Boot provides many ways to **externalize configuration**, from simple property files to advanced centralized configuration systems. Ex : **application.properties / application.yml, Spring Profiles ,Command-Line Arguments, Environment Variables,External Java Properties File and Spring Cloud Config Server.**

Read properties in spring boot:

HOW TO READ PROPERTIES IN SPRINGBOOT APPS

eazy bytes

In Spring Boot, there are multiple approaches to reading properties. Below are the most commonly used approaches,

Using @Value Annotation

(1)

You can use the `@Value` annotation to directly inject property values into your beans. This approach is suitable for injecting individual properties into specific fields. For example:

```
@Value("${property.name}")
private String propertyName;
```

Using Environment

(2)

The `Environment` interface provides methods to access properties from the application's environment. You can autowire the `Environment` bean and use its methods to retrieve property values. This approach is more flexible and allows accessing properties programmatically. For example:

```
@Autowired
private Environment environment;

public void getProperty() {
    String propertyName =
        environment.getProperty("property.name");
}
```

Using @ConfigurationProperties

(3)

Recommended approach as it avoids hard coding the property keys

The `@ConfigurationProperties` annotation enables binding of entire groups of properties to a bean. You define a configuration class with annotated fields matching the properties, and Spring Boot automatically maps the properties to the corresponding fields.

```
@ConfigurationProperties("prefix")
public class MyConfig {
    private String property;
}

// getters and setters
```

In this case, properties with the prefix "prefix" will be mapped to the fields of the `MyConfig` class.

Basic ways:

Using @value : which @Value → reads single values

Values which we need inject from application.properties or yml

```
build:  
    version: "1.0"
```

```
@Validated  
public class AccountsController {  
  
    private final IAccountsService iAccountsService;  5 usages  
    public AccountsController(IAccountsService iAccountsService){  no usages  
        this.iAccountsService =iAccountsService ;  
    }  
    @Value("${build.version}")  no usages  
    private String buildVersion;
```

```
@GetMapping("/build-version")  no usages  
public ResponseEntity<String> getBuildVersion(){  
    return ResponseEntity.status(HttpStatus.OK).body(buildVersion);  
}
```

Code	Details
200	<p>Response body</p> <pre>1</pre>

Not Suitable for Multiple or Grouped Properties

@Value is good for **one or two properties**, but when you have 5, 10, or many properties, you get:

```
@Value("${app.name}") String name;
```

```
@Value("${app.version}") String version;  
@Value("${app.build}") String build;  
@Value("${app.author}") String author;
```

Your class becomes messy and unmaintainable.

Using Environment Interface:

We use this instead of directly accessing values from `application.properties` or `application.yml` when needed. Also, some sensitive information like passwords should not be stored in these files because they can be exposed. In such cases, we can inject values through **environment variables** and read them using the `Environment` interface. It also reads single values.

```
@Autowired no usages  
private Environment environment;  
|
```

I want to get the java/maven version from environment from local pc

```
@GetMapping("Environment_Interface") no usages  
public ResponseEntity<String> environmentInterface(){  
    return ResponseEntity.status(HttpStatus.OK).body(environment.getProperty("MAVEN_HOME"));  
}
```

We can see we got the location

```
C:\Program Files\Maven\apache-maven-3.6.3
```

Ex 2: for know java version

```
C:\Program Files\Java\jdk-17
```

Using `@ConfigurationProperties` Annotation:

We use this approach when we want to **cleanly manage multiple or grouped configuration values inside a single POJO class**, instead of using many `@Value` annotations. It is type-safe, structured, and ideal for microservices.

Step 1. Add Properties in application.yml

We should organize properties using a **prefix**, so Spring can map them to a Java class.

```
accounts:
  message: "Welcome to EazyBank accounts related local APIs "
  contactDetails:
    name: "John Doe - Developer"
    email: "john@eazibank.com"
  onCallSupport:
    - (555) 555-1234
    - (555) 523-1345
```

Step 2. Create POJO Using property values

When using `@ConfigurationProperties`, we always define a **prefix** in the annotation, and the **same prefix must exist in application.yml**.

This tells Spring Boot *where exactly to read the values from*.

```
import java.util.List;
import java.util.Map;

@ConfigurationProperties(prefix = "accounts") no usages
public record AccountsContactInfoDto(String message, Map<String, String> contactDetails, List<String> onCallSupport) {
```

Note: If all values are set in `application.yml` and you don't plan to modify them programmatically, **setters are optional**. Only **getters** are sufficient for reading the values.

Here we used **Java record** class , instead of usual way of approach like creating getter and other

A **record** is a special kind of class in Java (introduced in Java 16) designed to be **immutable data carriers**.

Key Points

1. **Immutable** by default → fields are `final`

2. **No setters** → you cannot change values after creation
3. **Automatic getters** → called **accessor methods**, with the **same name as the field**
4. **Auto-generated**: `equals()`, `hashCode()`, `toString()`
5. Perfect for **DTOs or POJOs** that just carry data

Step 3: Enable the properties using `@EnableConfigurationProperties` in the main class.

You must tell Spring to load this class. we must enable it in the main class using `@EnableConfigurationProperties(pojo/dto.class)` so that Spring can load and bind the properties from `application.yml`.

```
@EnableConfigurationProperties(AccountsContactInfoDto.class)
public class AccountsApplication {

    public static void main(String[] args) { SpringApplication.run(AccountsApplication.class, args); }

}
```

Step 4. Use It in Controller or Service

```
💡 @Autowired no usages
private AccountsContactInfoDto accountsContactInfoDto;
```

```
@GetMapping("account_details") no usages
public ResponseEntity<AccountsContactInfoDto> getAccountDetails() {
    return ResponseEntity.status(HttpStatus.OK).body(accountsContactInfoDto);
}
```

200

Response body

```
{
    "message": "Welcome to EazyBank accounts related local APIs",
    "contactDetails": {
        "name": "John Doe - Developer",
        "email": "john@eazybank.com"
    },
    "onCallSupport": [
        "(555) 555-1234",
        "(555) 523-1345"
    ]
}
```

Ex2:

```
19    app:  
20        name: Accounts Service  
21        version: 1.0.0  
22        build: 2025  
23        author: Ram
```

```
6     @ConfigurationProperties(prefix = "app")  no usages  
7     @Data  
8     public class AppConfigProperties {  
9         private String name;  no usages  
10        private String version;  no usages  
11        private String build;  no usages  
12        private String author;  no usages  
13    }  
14 }
```

```
@EnableConfigurationProperties(AppConfigProperties.class)  
> public class AccountsApplication {  
  
>>     public static void main(String[] args) { SpringApplication.run(AccountsApplication.class, args); }  
}
```

```
189     @GetMapping("account_details")  no usages  
190     public ResponseEntity<AppConfigProperties> getAppDetails() {  
191         return ResponseEntity.status(HttpStatus.OK).body(appConfigProperties);  
192     }  
193 }
```

```
200 Response body  
{  
  "name": "Accounts Service",  
  "version": "1.0.0",  
  "build": "2025",  
  "author": "Ram"  
}
```

When you have different environments (e.g., **dev**, **test**, **prod**) and want different configuration values for each, you **cannot rely on a single application.yml**.

this is where **Spring Profiles** come into play

Spring Profiles

"A Spring Profile is a **way to define and configure different configuration values for different environments, such as dev, test, staging, and prod.**

Only the configuration for the active **profile is loaded at runtime.**"

Each environment can have its own `application.properties` or `application.yml` file (e.g., `application-dev.yml`, `application-prod.yml`) containing environment-specific values."

Profiles

Spring provides a great tool for grouping configuration properties into so-called profiles(dev, qa, prod) allowing us to activate a bunch of configurations based on the active profile.

Profiles are perfect for setting up our application for different environments, but they're also being used in another use cases like Bean creation based on a profile etc.

So basically a profile can influence the application properties loaded and beans which are loaded into the Spring context.

The default profile is always active. Spring Boot loads all properties in `application.properties` into the default profile.

We can create another profiles by creating property files like below,

`application_prod.properties` -----> for prod profile
`application_qa.properties` -----> for QA profile

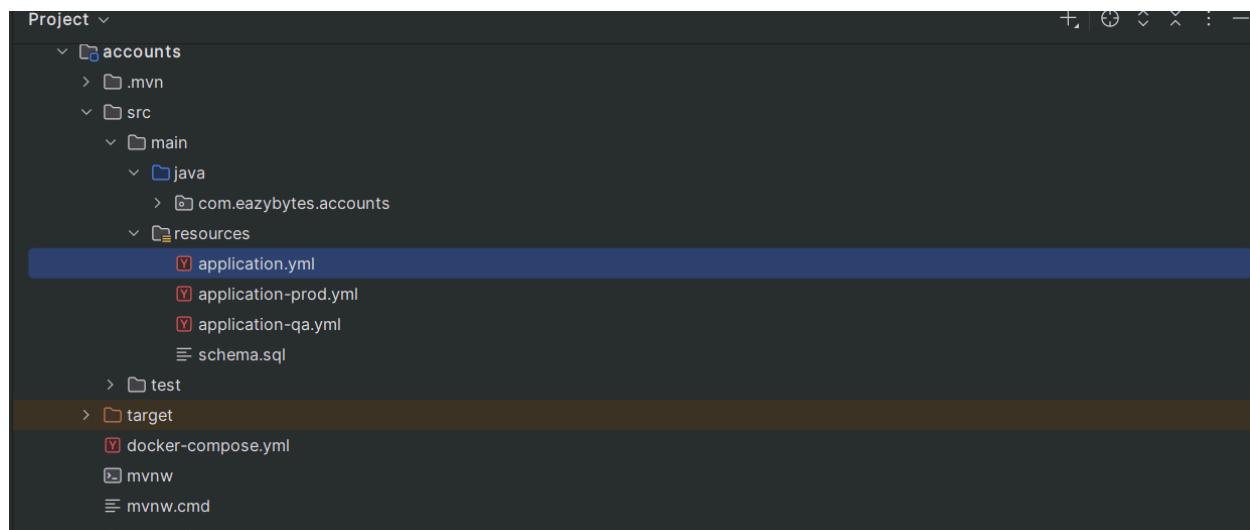
We can activate a specific profile using `spring.profiles.active` property like below,

`spring.profiles.active=prod`

An important point to consider is that once an application is built and packaged, it should not be modified. If any configuration changes are required, such as updating credentials or database handles, they should be made externally.

Example

We have microservice with different configurations for different environments.



In a microservice, each environment (dev, qa, prod) can have its own configuration. Spring Boot automatically loads profile-specific configuration files **only when they follow the correct naming pattern**, such as `application-qa.yml`, `application-prod.yml`, or `application-dev.yml`.

It **does not** load files that use underscores, such as `application_qa.yml`.

`application.yml`

`application_qa`

<pre>build: version: "3.0" app: name: Accounts Dev Service version: 1.0.0 build: 2025 author: RamDev</pre>	<pre>build: version: "2.0" app: name: Accounts QA Service version: 1.0.0 build: 2025 author: RamQA</pre>
---	---

`Application_prod`

<pre>build: version: "1.0" app: name: Accounts Prod Service version: 1.0.0 build: 2025 author: RamProd</pre>

Inside each profile-specific file, you use:

`spring.config.activate.on-profile: qa/prod/stg`

This tells Spring Boot: **“Load this file only when the QA profile is active.”**

`spring.config.activate.on-profile`

<pre>17 config: 18 activate: 19 on-profile: "prod"</pre>	<pre>17 config: 18 activate: 19 on-profile: "qa"</pre>
--	--

Then we should activate the environment (`spring.profiles.active=dev/prod/qa`) in the default file `application.properties/application.yml` file.

Spring always loads the default file `application.properties/application.yml` FIRST, then profile-specific file. The profile file overrides matching values from the default file.

Because of this built-in mechanism, **you do NOT need to manually import or load profile files**

Then it loads the file that matches the active profile:

The screenshot shows a terminal window with two parts. On the left, lines 17 and 18 of a configuration file are shown. Line 17 contains the word "profiles:" and line 18 contains "active: "qa"". On the right, the terminal output shows a 200 status code and a "Response body" containing a JSON object with fields "name", "version", "build", and "author", all set to values specific to the QA environment.

```
200
Response body
{
  "name": "Accounts QA Service",
  "version": "1.0.0",
  "build": "2025",
  "author": "RamQA"
}
```

Or

The screenshot shows a terminal window with two parts. On the left, lines 17 and 18 of a configuration file are shown. Line 17 contains the word "profiles:" and line 18 contains "active: "prod"". On the right, the terminal output shows a 200 status code and a "Response body" containing a JSON object with fields "name", "version", "build", and "author", all set to values specific to the Production environment.

```
200
Response body
{
  "name": "Accounts Prod Service",
  "version": "1.0.0",
  "build": "2025",
  "author": "RamProd"
}
```

However, this approach is **not immutable**, because every time we need to run the application in a specific environment, we must manually change `spring.profiles.active` in the default file (`application.yml`) and then rebuild or regenerate Docker images.

To avoid this problem, we use dynamic configuration methods that allow us to set the environment **at startup**, without modifying the code or rebuilding the Docker image.

Spring Boot allows overriding properties at startup using:

1. **Command-line arguments**

2. JVM system properties
3. Environment variables

These methods give you **immutable infrastructure** — the same JAR or Docker image runs in all environments, and only configuration changes.

Externalize the configuration using Command-line arguments

Command-line arguments (highest precedence)

```
java -jar app.jar --key=value
```

Notes

- Use the same property name as in Spring configuration.
- CLI arguments (`--key=value`) override:
 - profile-specific files
 - JVM system properties
 - application.yml

Note: Each property starts with `--`, Arguments are separated by spaces

```
java -jar app.jar --spring.profiles.active=qa --server.port=8085
```

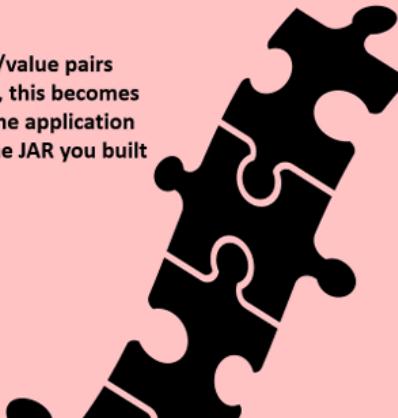
How to externalize configurations using command-line arguments ?

eazy
bytes

Spring Boot automatically converts command-line arguments into key/value pairs and adds them to the Environment object. In a production application, this becomes the property source with the highest precedence. You can customize the application configuration by specifying command-line arguments when running the JAR you built earlier.

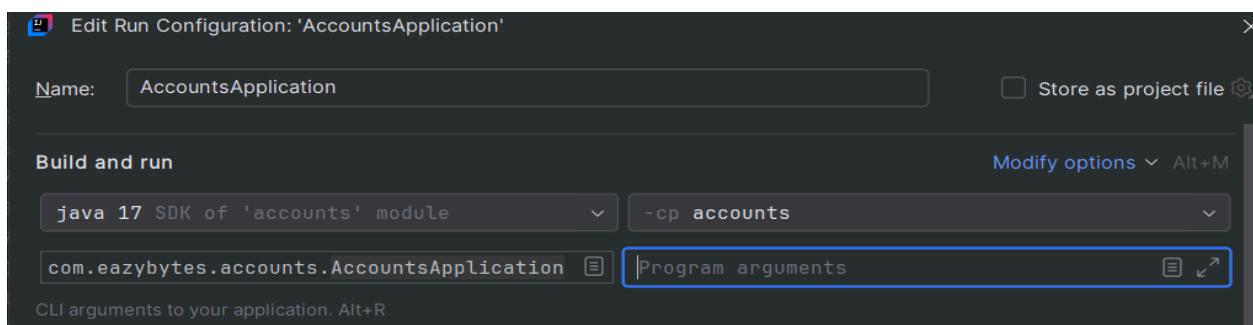
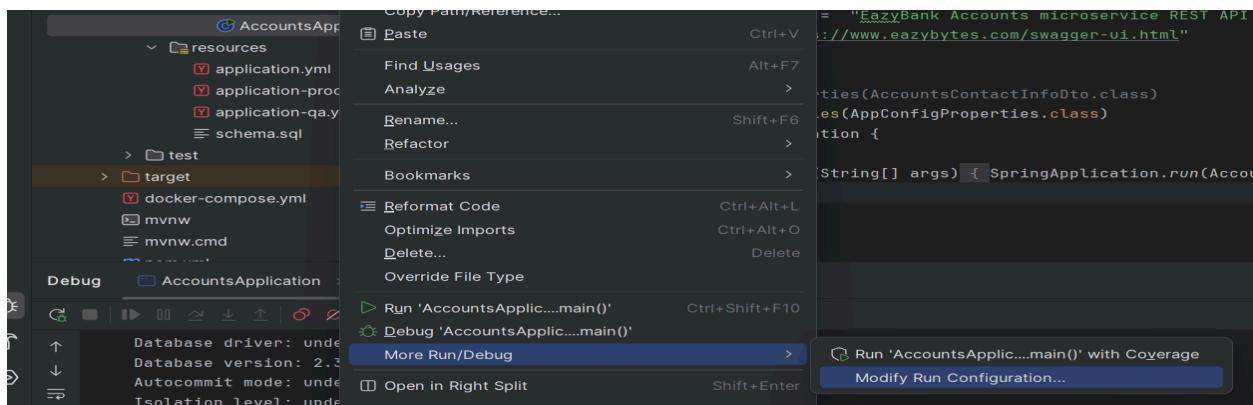
```
java -jar accounts-service-0.0.1-SNAPSHOT.jar --build.version="1.1"
```

The command-line argument follows the same naming convention as the corresponding Spring property, with the familiar `--` prefix for CLI arguments.

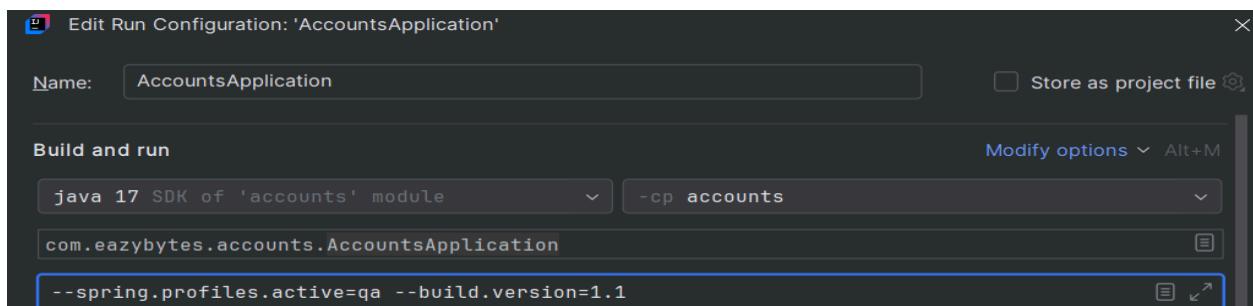


We can also provide command-line arguments directly in the IDE's run configuration, apart from just from the command line.”

Go to the main class, right-click on it, and select *Modify Run Configuration*.



Provide in program arguments , I just providing two Arguments are separated by spaces



The screenshot shows the Swagger UI for the 'Accounts' microservice. At the top, it says '200 Response body'. Below that, the JSON response body is displayed, which includes the service's name, version, build number, and author. The JSON content is as follows:

```
{
  "name": "Accounts QA Service",
  "version": "1.0.0",
  "build": "2025",
  "author": "RamQA"
}
```

Externalize the configuration using JVM System properties

JVM system properties

```
java -Dkey=value -jar app.jar
```

Notes

- System properties use the **-D** prefix.
- Follow the same naming as Spring keys.
- If both a system property **and** a command-line argument are provided, the command-line argument wins.

Note: Each property starts with **-D**, and they are separated by **spaces**

```
java -Dspring.profiles.active=prod -Dserver.port=9090 -jar app.jar
```

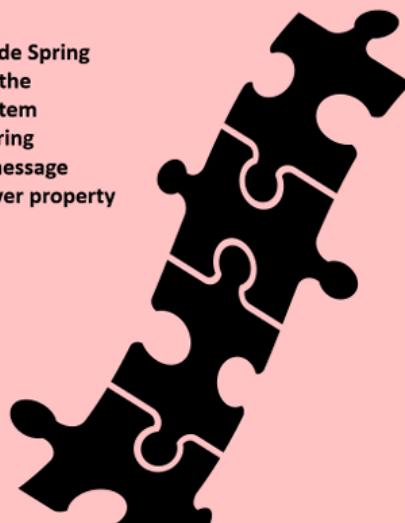
How to externalized configurations using JVM system properties ?

eazy
bytes

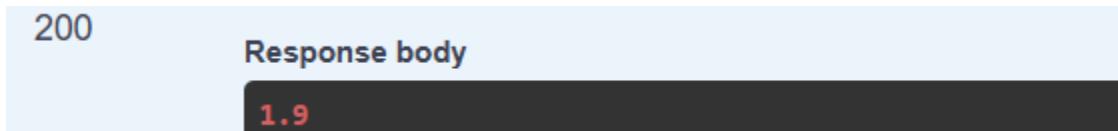
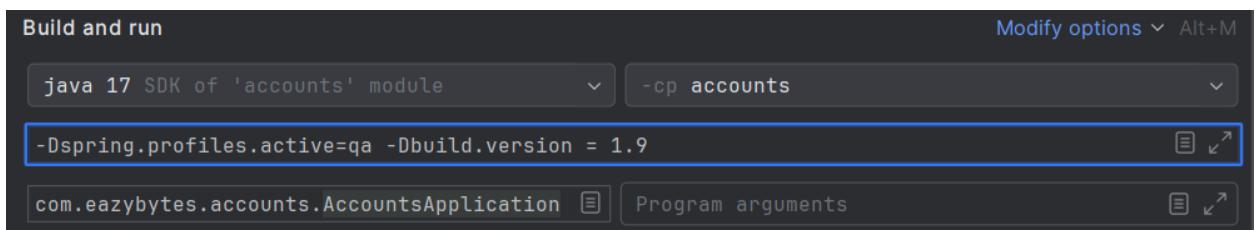
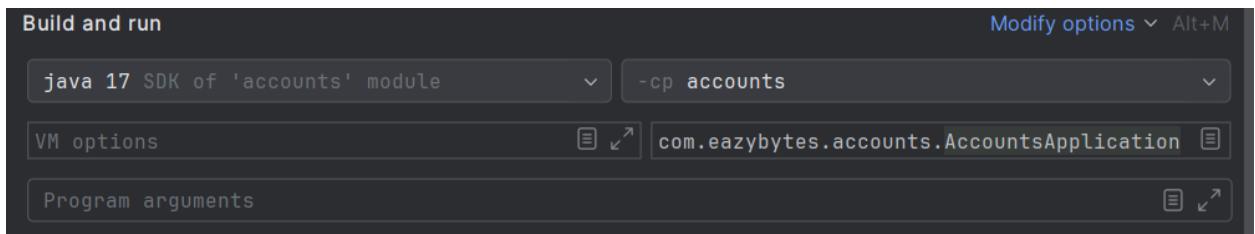
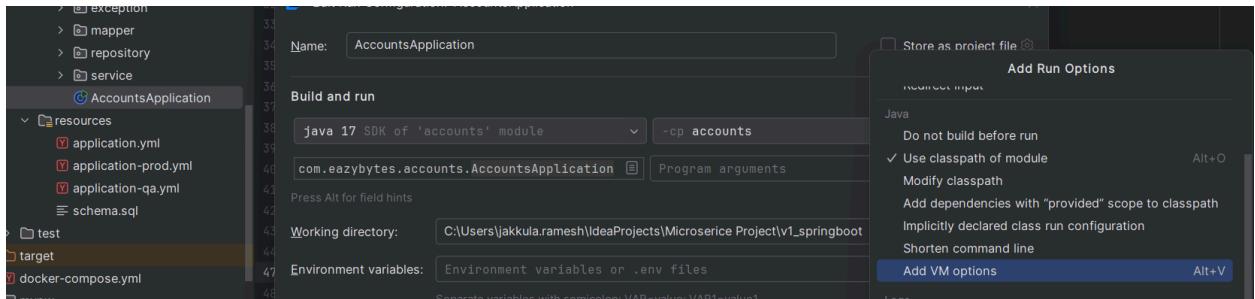
JVM system properties, similar to command-line arguments, can override Spring properties with a lower priority. This approach allows for externalizing the configuration without the need to rebuild the JAR artifact. The JVM system property follows the same naming convention as the corresponding Spring property, prefixed with **-D** for JVM arguments. In the application, the message defined as a JVM system property will be utilized, taking precedence over property files.

```
java -Dbuild.version="1.2" -jar accounts-service-0.0.1-SNAPSHOT.jar
```

In the scenario where both a JVM system property and a command-line argument are specified, the precedence rules dictate that Spring will prioritize the value provided as a command-line argument. This means that the value specified through the CLI will be utilized by the application, taking precedence over the JVM properties.



We can **also provide JVM System variables directly in the IDE's run configuration**. Click on modify option , will get VM option.



Externalize the configuration using environment variables

Environment variables

`KEY=value java -jar app.jar`

- Example (Windows CMD):

```
cmd

set SERVER_PORT=7070
set SPRING_PROFILES_ACTIVE=dev
java -jar app.jar
```

- ✓ They work **only for that CMD window.**
- ✓ No need to add them in Windows System Environment Variables.

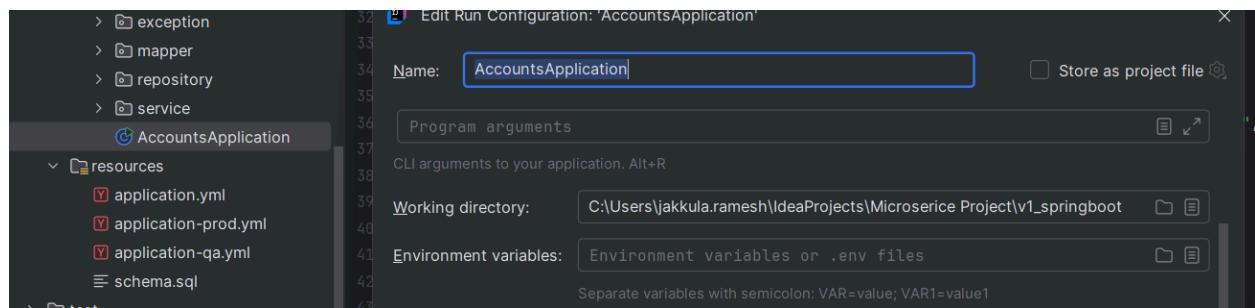
✗ Once you close CMD, those values disappear.

To map an environment variable to a Spring property:

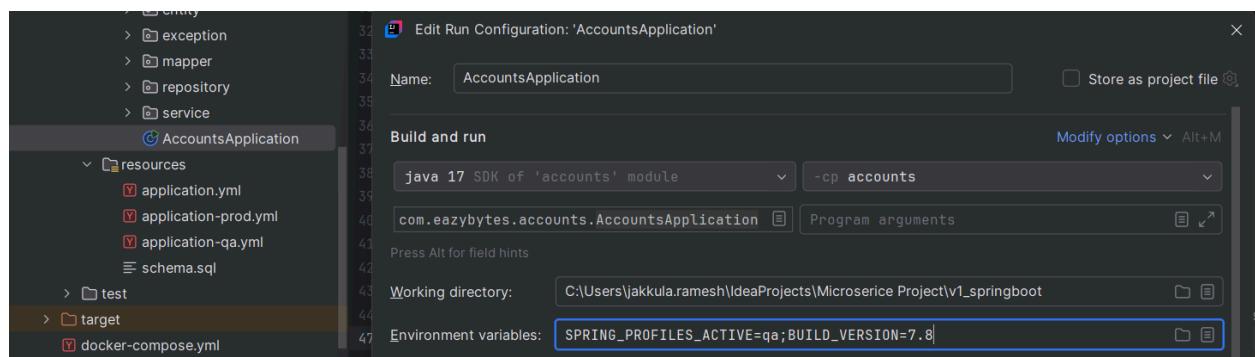
- Convert all letters to **uppercase**
- Replace dots (.) or dashes (-) with **underscores** (_)

Example: **BUILD_VERSION** → recognized as **build.version**

We can **also provide environment variables directly in the IDE's run configuration, apart from just from the environment variables.**"



They are not separated by ; .



200

Response body

7.8

This screenshot shows a successful API response with a status code of 200. The response body contains the value '7.8', which corresponds to the 'BUILD_VERSION' environment variable set in the run configuration.

200

Response body

```
{
  "name": "Accounts QA Service",
  "version": "1.0.0",
  "build": "2025",
  "author": "RamQA"
}
```

This screenshot shows a successful API response with a status code of 200. The response body is a JSON object containing details about the service, including its name, version, build date, and author. These values correspond to the 'SPRING_PROFILES_ACTIVE' and 'BUILD_VERSION' environment variables defined in the run configuration.

How to externalized configurations using environment variables ?

eazy
bytes

Environment variables are widely used for externalized configuration as they offer portability across different operating systems, as they are universally supported. Most programming languages, including Java, provide mechanisms to access environment variables, such as the `System.getenv()` method.

To map a Spring property key to an environment variable, you need to convert all letters to uppercase and replace any dots or dashes with underscores. Spring Boot will handle this mapping correctly internally. For example, an environment variable named `BUILD_VERSION` will be recognized as the property `build.version`. This feature is known as relaxed binding.

Windows

```
env:BUILD_VERSION="1.3"; java -jar accounts-service-0.0.1-SNAPSHOT.jar
```

Linux based OS

```
BUILD_VERSION="1.3" java -jar accounts-service-0.0.1-SNAPSHOT.jar
```



Most-Useful Priority

Priority	Source	Example	Notes
1 (Highest)	Command-line arguments	<code>--server.port=9090</code>	Overrides everything
2	System Properties	<code>-Dserver.port=9090</code>	Next highest
3	Environment Variables	<code>SERVER_PORT=9090</code>	Works for OS-level
4	Profile-specific files	<code>application-dev.properties</code>	Only when profile is active

While Spring Boot lets us override configuration at startup using command-line arguments, JVM properties, or environment variables, it still falls short for real microservice environments.

There is **no centralized configuration, no version control, no secret encryption, and no runtime refresh**. Managing configs across many microservices becomes difficult.

This is why **Spring Cloud Config** is used—it provides **centralized, versioned, secure, and refreshable configuration** for all environments, enabling truly immutable deployments.

1 CLI arguments, JVM properties, and environment variables are effective ways to externalize configuration and maintain the immutability of the application build. However, using these approaches often involves executing separate commands and manually setting up the application, which can introduce potential errors during deployment.

2 Given that configuration data evolves and requires changes, similar to application code, what strategies should be employed to store, track revisions and audit the configuration used in a release?

3 In scenarios where environment variables lack granular access control features, how can you effectively control access to configuration data?

4 When the number of application instances grows, handling configuration in a distributed manner for each instance becomes challenging. How can such challenges be overcome?

5 Considering that neither Spring Boot properties nor environment variables support configuration encryption, how should secrets be managed securely?

6 After modifying configuration data, how can you ensure that the application can read it at runtime without necessitating a complete restart?



Spring Cloud Config

Spring Cloud Config is a **centralized configuration** management solution for applications, especially **designed for microservices architectures**. It allows you to **store, manage, and provide configuration properties for multiple applications and environments(dev/prod/stg/qa)** from a central place.

<https://spring.io/projects/spring-cloud-config>

Key Points:

- **Centralized storage** – all configs are in one place (Git repository ,Filesystem,Database,Classpath,Cloud storage or other).
- **Environment-specific** – supports different settings for **dev, staging, qa, prod**, etc.
- **Version-controlled** – you can track changes and roll back if needed.
- **Secure and refreshable** – secrets can be encrypted, and services can refresh configs at runtime without restarting.
- **Works for many microservices** – multiple microservices can fetch their configuration from the same central Config Server, ensuring consistency and ease of management.

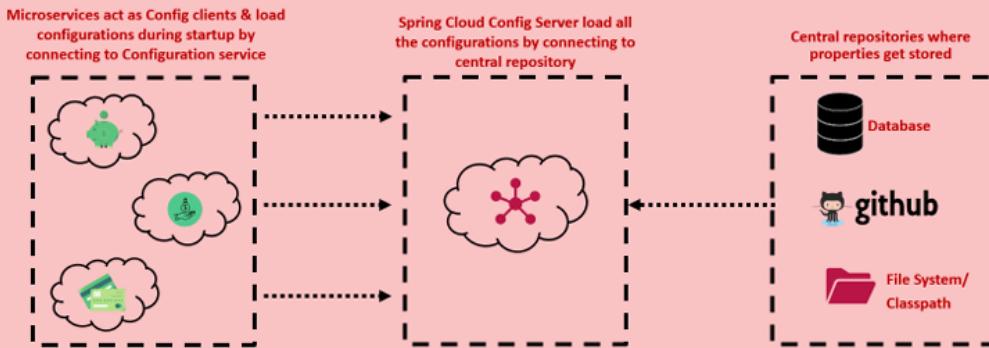
Spring Cloud Config

eazy bytes

A centralized configuration server with Spring Cloud Config can overcome all the drawbacks that we discussed in the previous slide. Spring Cloud Config provides server and client-side support for externalized configuration in a distributed system. With the Config Server you have a central place to manage external properties for applications across all environments.

Centralized configuration revolves around two core elements:

- A data store designed to handle configuration data, ensuring durability, version management, and potentially access control.
- A server that oversees the configuration data within the data store, facilitating its management and distribution to multiple applications.

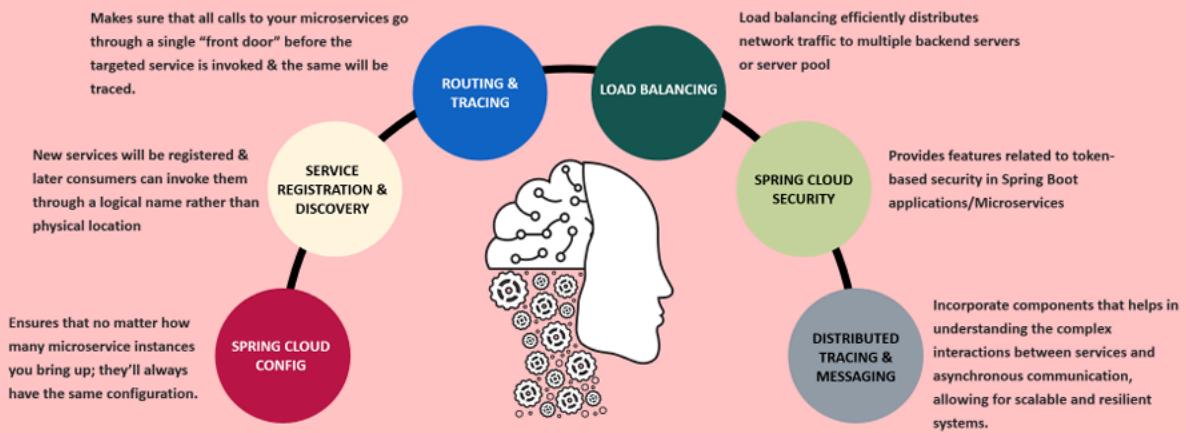


WHAT IS SPRING CLOUD?

USING SPRING CLOUD FOR MICROSERVICES DEVELOPMENT

eazy bytes

Spring Cloud provides frameworks for developers to quickly build some of the common patterns of Microservices



Spring Boot and Spring Cloud follow different release cycles, so their versions do **not** match automatically. Always use a **compatible combination** based on the official compatibility matrix, otherwise the application will show errors like:

Spring Boot [3.x.x] is not compatible with this Spring Cloud release train

More info : <https://spring.io/projects/spring-cloud-config#support>

Spring Cloud Config Server Setup

1. Create a Spring Boot Project

- Use Spring Initializr or your IDE.
- Add dependencies:
 - spring-cloud-config-server
 - spring-boot-starter-actuator

Config Server SPRING CLOUD CONFIG

Central management for configuration via Git, SVN, or HashiCorp Vault.



Spring Boot Actuator OPS

Supports built in (or custom) endpoints that let you monitor and manage your application - such as application health, metrics, sessions, etc.



2. Enable Config Server

- Annotate the main class with `@EnableConfigServer`.

```
@SpringBootApplication
@EnableConfigServer
public class SpringcloudconfigserverApplication {

    public static void main(String[] args) { SpringApplication.run(SpringcloudconfigserverApplication.class, a
```

3. Configure Server Properties in config server

- In `application.yml` or `application.properties`:
 - Set the server port (e.g., 8888).

```
1   server:
2     port: "8071"
3   spring:
4     application:
5       name: "springcloudconfigserver"
```

Depending on the requirement we can add more actuator things and others.

Point to your configuration repository (Git, filesystem, etc.):

Ex 1: Reading Configurations from the Classpath location of spring cloud config

- Create folder (ex: config) a inside Config Server project → `src/main/resources`



- Add all **.yml / .properties files of your microservices** (e.g., accounts, orders, payment, etc.) inside the **config** folder of the Spring Cloud Config Server.

The name of the **.yml / .properties** files in the Config Server's classpath must match the **spring.application.name** of the microservice.

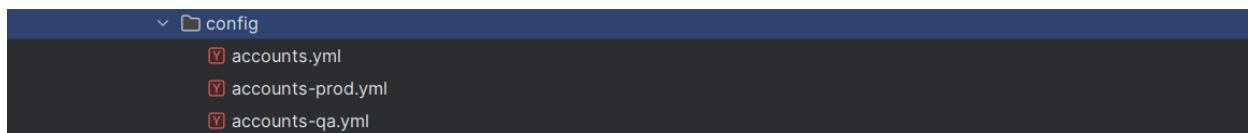
So, if your microservice has:

`spring.application.name: accounts`

Ex: `accounts-qa.yml`

`accounts-prod.yml`

Only keep the configuration details that you want to externalize (i.e., values that will change across environments like **dev, test, prod**).



- Enable native profile in **Config Server**

`spring.profiles.active=native`

This tells the Config Server to read configuration **from the local file system or classpath** instead of Git.

Tell Config Server to read from classpath

`spring.cloud.config.server.native.searchLocations=classpath:/config`

This specifies the **exact folder inside the classpath** (`src/main/resources/config`) where all configuration files are stored.

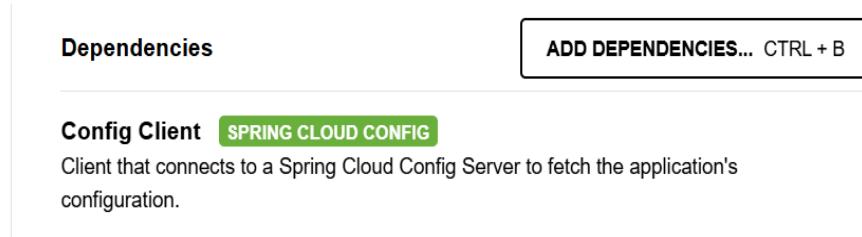
```
1  server:
2    port: "8071"
3  spring:
4    application:
5      name: "springcloudconfigserver"
6    profiles:
7      active: native
8    cloud:
9      config:
10     server:
11       native:
12         search_LOCATIONS: "classpath:/config"
13
```

- **Start Config Server**

When the Config Server starts, it **automatically reads all configuration files from the classpath /config folder** and makes them available to client microservices.

- **Client microservice setup**

Add Config Client dependency + set Config Server URL inside microservices.



```
3  spring:
4    application:
5      name: "accounts"
6    profiles:
7      active: "prod"
8    config:
9      import: "optional:configserver:http://localhost:8071/"
```

`spring.config.import=optional:configserver:http://localhost:8071`

This tells the microservice to **fetch its configuration from the Config Server** running at port **8071** during application startup.

optional: means do not fail the application startup if the Config Server is not reachable or not running.

`spring.profiles.active=prod`

Your microservice will **activate only the prod profile** and therefore it will **fetch only the configuration files related to the prod environment** from the Config Server.

- **Start microservices and test**

```
restartedMain] c.e.accounts.AccountsApplication      : The following 1 profile is active: "prod"
restartedMain] o.s.c.c.c.ConfigServerConfigDataLoader : Fetching config from server at : http://localhost:8071/
restartedMain] o.s.c.c.c.ConfigServerConfigDataLoader : Located environment: name=accounts, profiles=[default], label=null, version=null, state=null
restartedMain] o.s.c.c.c.ConfigServerConfigDataLoader : Fetching config from server at : http://localhost:8071/
restartedMain] o.s.c.c.c.ConfigServerConfigDataLoader : Located environment: name=accounts, profiles=[prod], label=null, version=null, state=null
```

We can see output which uses configuration details of the selected environment (ex: prod).



The **classpath approach**, where config files are kept inside `src/main/resources/config`, is suitable only for small or demo projects because **it is not secure—anyone who has access to the Config Server's codebase can view all configuration details**. It also **requires rebuilding and redeploying the Config Server whenever configuration changes are needed**.

To overcome these limitations, we use a file system location, which keeps configuration external, more secure, and fully separated from the Config Server application.

Ex 2: Reading Configurations from the System location