Integration Testing

Testing, Integration Testing

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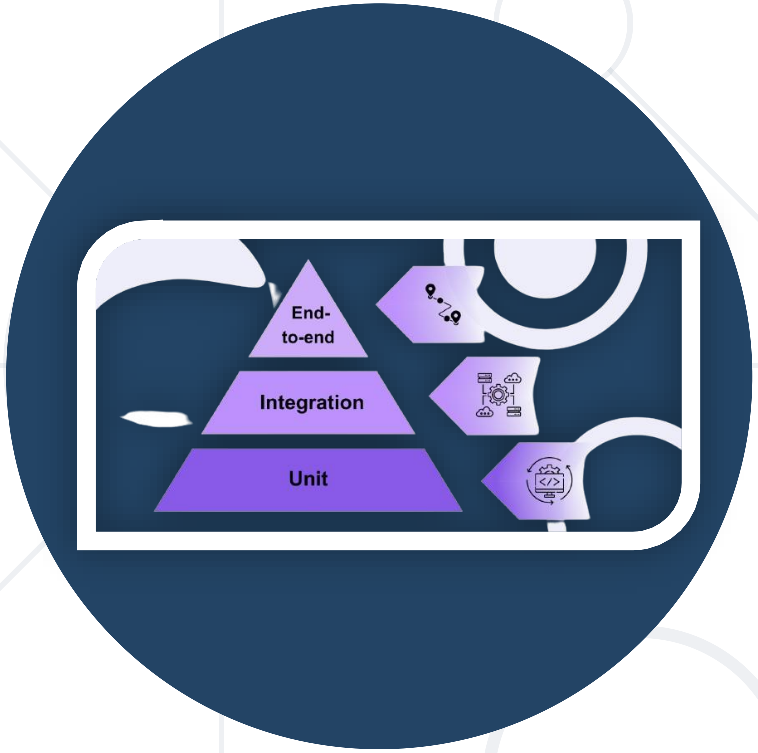
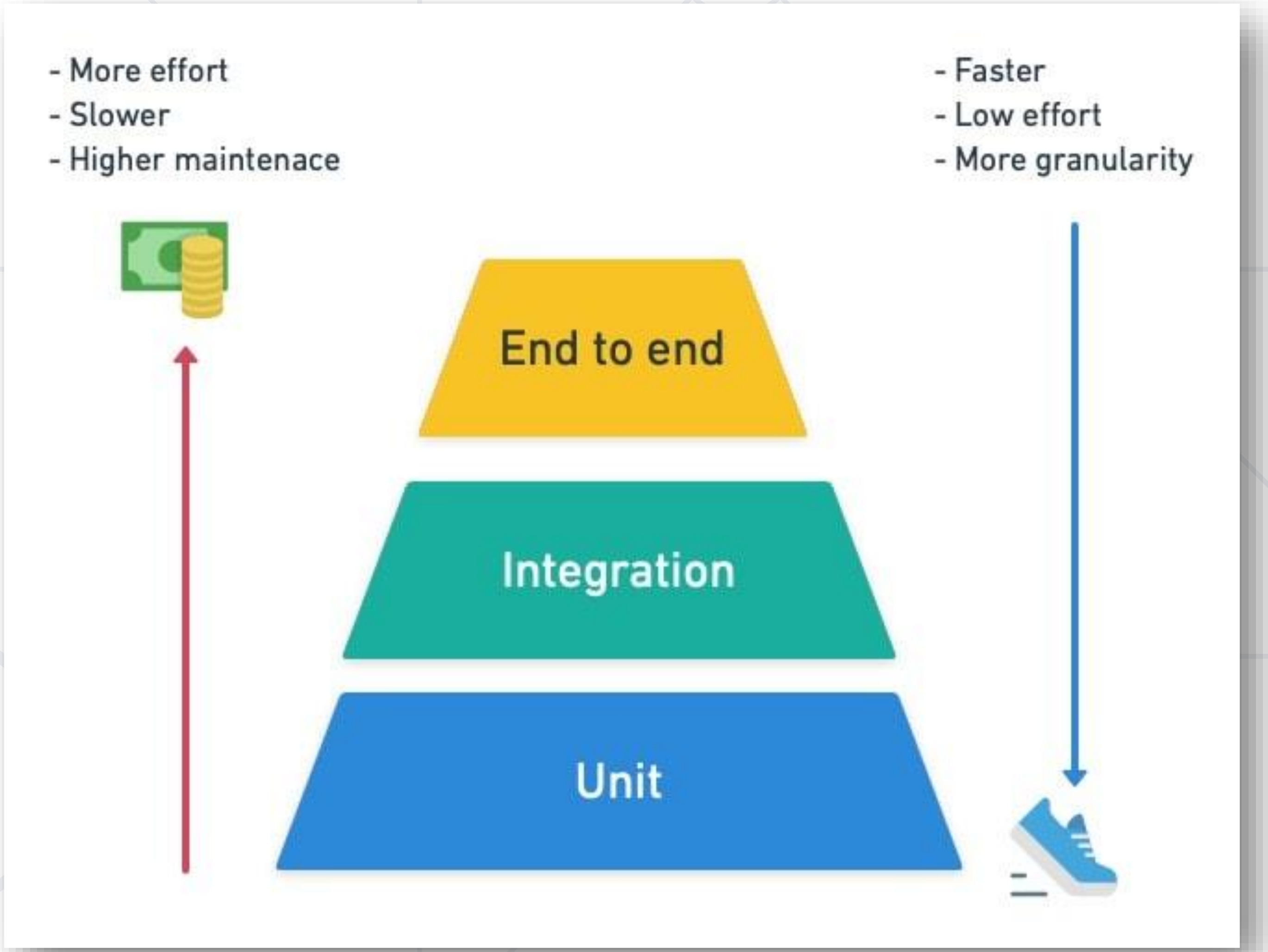


Testing

What Does "Testing Pyramid" Mean?

- The **Testing Pyramid** is a fundamental concept in software quality assurance
- It outlines a tripartite approach to testing: **unit tests** at the base, followed by foundational unit validation, followed by interconnected **integration** check-out, and culminating in all-encompassing **end-to-end** evaluations

The Testing Pyramid

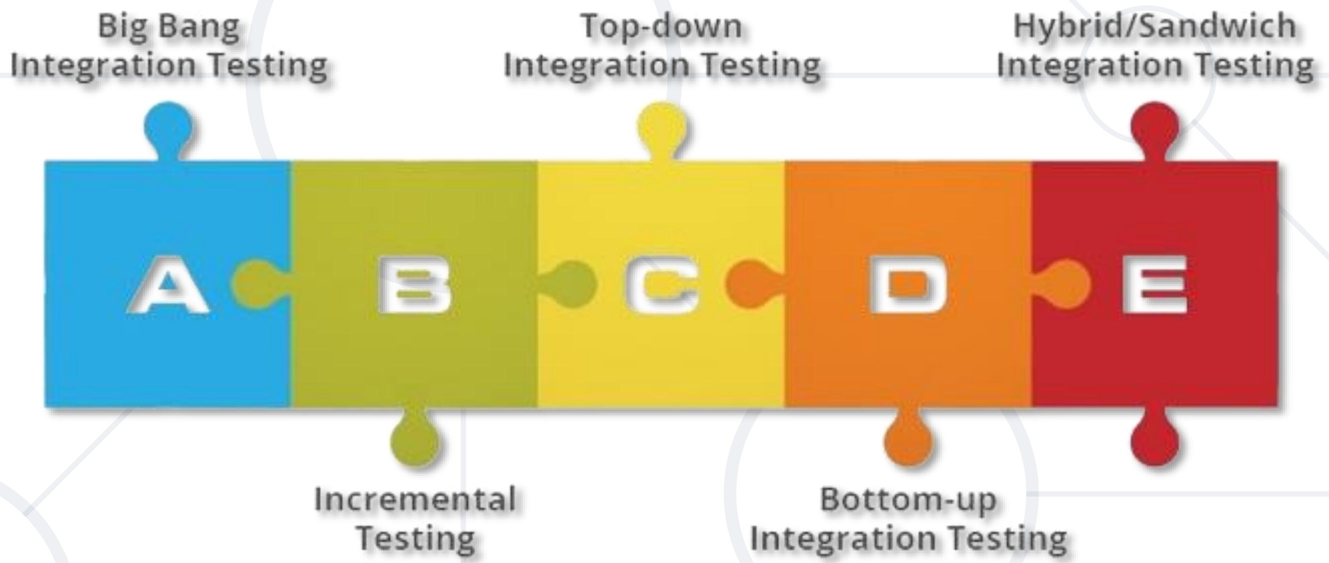


Integration Testing

Integration Testing

- **Integration testing** is a phase in software testing where **individual units** or **components** of the software are combined and tested as a **group**
- The **purpose** of integration testing is to **identify** issues that occur when these components interact with each other
- In Java, integration testing often involves testing interactions between different **classes**, **modules**, or **services**, including external systems like **databases**, **web services** or **third-party libraries**

Integration Testing



Importance of Integration Testing

- **Detects Interface Issues**: Ensures that different modules or services interact correctly with each other
- **Catches Integration Defects**: Identifies defects that might not be apparent in unit tests
- **Ensures End-to-End Functionality**: Verifies that the system works as a whole, ensuring end-to-end functionality
- **Validates Data Flow**: Confirms that data is correctly passed and processed across modules

Mocking

- Mocking in integration testing **involves simulating** the behavior of complex components or external systems that your system interacts with, to create a **controlled** and **predictable** environment
  - This allows you to test the **interactions** and **integration** of various components within your system without relying on actual external dependencies

Why Mocking in Integration Testing?

- **Isolate Test Environment** - Prevent tests from being dependent on external systems or services
- **Control and Predictability** - Provide predictable responses and behaviors for external dependencies
- **Speed** - Speed up tests by avoiding actual network calls or resource-heavy operations
- **Consistency** - Ensure tests are consistent and not affected by changes in external systems

Setting Up Mocking in Integration Testing

- Define the Controller

```java
@RestController
public class CurrencyController {

  private final ExRateService exRateService;

  public CurrencyController(ExRateService exRateService) {
    this.exRateService = exRateService;
  }
. . .
```

Setting Up Mocking in Integration Testing

```
. . .
 @GetMapping("/api/convert")
  public ResponseEntity<ConversionResultDTO> convert(
      @RequestParam("from") String from,
      @RequestParam("to") String to,
      @RequestParam("amount") BigDecimal amount
  ) {
    BigDecimal result = exRateService.convert(from, to, amount);

    return ResponseEntity.ok(new ConversionResultDTO(
        from,
        to,
        amount,
        result
    ));
  }
```

Setting Up Mocking in Integration Testing

- Configure the Test Class
  - We will use **@MockBean** to mock the ExRateService

```
@SpringBootTest
@AutoConfigureMockMvc
@ExtendWith(SpringExtension.class)
public class CurrencyControllerIntegrationTest {

    @Autowired
    private MockMvc mockMvc;

    @MockBean
    private ExRateService exRateService;

...
```

Setting Up Mocking in Integration Testing

```
. . .
@Test
    public void testConvert() throws Exception {
        //Arrange
        BigDecimal mockResult = new BigDecimal("100.00");
        when(exRateService.convert(anyString(), anyString(),
any(BigDecimal.class))).thenReturn(mockResult);
//Act & Assert
        mockMvc.perform(get("/api/convert")
                .param("from", "USD")
                .param("to", "EUR")
                .param("amount", "50"))
                .andExpect(status().isOk())
                .andExpect(jsonPath("$.from").value("USD"))
                .andExpect(jsonPath("$.to").value("EUR"))
                .andExpect(jsonPath("$.amount").value(50))
                .andExpect(jsonPath("$.result").value(100.00));
    }
...
```

Setting Up Mocking in Integration Testing

```
. . .
@Test
    public void testConvert_notFound() throws Exception {
        //Arrange
        when(exRateService.convert(anyString(), anyString(),
any(BigDecimal.class))).thenThrow(new ApiObjectNotFoundException("Currency pair
not found", "USD-EUR"));
        //Act & Assert
        mockMvc.perform(get("/api/convert")
                .param("from", "USD")
                .param("to", "EUR")
                .param("amount", "50"))
                .andExpect(status().isNotFound())
                .andExpect(jsonPath("$.code").value("NOT FOUND"))
                .andExpect(jsonPath("$.id").value("USD-EUR"));
    }
}
```

Setting Up Mocking with @WithMockUser

- Create a Secure Controller

```java
@RestController
@RequestMapping("/api")
public class SecureController {

    @GetMapping("/secure")
    public ResponseEntity<String> getSecureData() {
        return ResponseEntity.ok("This is secured data");
    }
}
```

Setting Up Mocking with @WithMockUser

- Write the Integration Test

```
@WebMvcTest(SecureController.class)
public class SecureControllerTest {

    @Autowired
    private MockMvc mockMvc;

    @Test
    @WithMockUser(username = "user", roles = {"USER"})
    public void givenAuthRequestOnPrivateService_shouldSucceedWith200()
throws Exception {
        mockMvc.perform(get("/api/secure"))
                .andExpect(status().isOk())
                .andExpect(content().string("This is secured data"));
    }
. . .
```

Setting Up Mocking with @WithMockUser

```
. . .
@Test
    public void givenNoAuthRequestOnPrivateService_shouldFailWith401()
throws Exception {
        mockMvc.perform(get("/api/secure"))
                .andExpect(status().isUnauthorized());
    }
}
```

MockMvcRequestBuilders Methods

- **perform()**
  - This method is used to perform an HTTP request
  - It takes a **RequestBuilder** as an argument, which can be created using static methods from **MockMvcRequestBuilders**

```
mockMvc.perform(MockMvcRequestBuilders.get("/endpoint"));
```

MockMvcRequestBuilders Methods

- **andExpect()**
  - This method is used to **define expectations** on the result of the HTTP request
  - It is used to check the **status**, **headers**, and **content** of the response

```
mockMvc.perform(MockMvcRequestBuilders.get("/endpoint"))
        .andExpect(status().isOk())
        .andExpect(content().string("Expected response"));
```

MockMvcRequestBuilders Methods

- andDo()
  - This method allows you to perform **additional** actions with the result, such as logging or printing the response
  - It's often used with **print()** to output the response details

```
mockMvc.perform(MockMvcRequestBuilders.get("/endpoint"))
       .andDo(print());
```

MockMvcRequestBuilders Methods

- **andReturn()**
  - This method returns the **MvcResult** object, which can be used to inspect the result further
  - It's useful for more complex **verifications** or for extracting information from the response

```
MvcResult result =
mockMvc.perform(MockMvcRequestBuilders.get("/endpoint"))
                                      .andReturn();
```

Mocking in Integration Testing Summary

- **Mocking in Integration Testing** - Helps isolate the test environment, control responses, and improve test speed and consistency
- **RestTemplate with @MockBean** - Simple way to mock dependencies within Spring Boot applications

Basic Integration Test with @SpringBootTest

- Controller

```
@RestController
@RequestMapping("/api")
public class UserController {

    @Autowired
    private UserService userService;

    @GetMapping("/users/{id}")
    public ResponseEntity<User> getUserById(@PathVariable Long id) {
        User user = userService.findById(id);
        return ResponseEntity.ok(user);
    }
}
```

Basic Integration Test with @SpringBootTest

- **Service**

```java
@Service
public class UserService {
    @Autowired
    private UserRepository userRepository;

    public User findById(Long id) {
        return userRepository.findById(id).orElseThrow(() -> new
ResourceNotFoundException("User not found"));
    }
}
```

- **Repository**

```java
public interface UserRepository extends JpaRepository<User, Long> {
}
```

Basic Integration Test with @SpringBootTest

- **Integration Test**

```
@SpringBootTest
@AutoConfigureMockMvc
public class UserControllerIntegrationTest {

    @Autowired
    private MockMvc mockMvc;

    @Autowired
    private UserRepository userRepository;

    @BeforeEach
    public void setUp() {
        userRepository.save(new User(1L, "John Doe"));
    }
. . .
```

Basic Integration Test with @SpringBootTest

```
. . .
    @AfterEach
    public void tearDown() {
        userRepository.deleteAll();
    }

    @Test
    public void testGetUserById() throws Exception {
        mockMvc.perform(get("/api/users/1"))
                .andExpect(status().isOk())
                .andExpect(content().contentType(MediaType.APPLICATION_JSON))
                .andExpect(jsonPath("$.name").value("John Doe"));
    }
}
```

Using @DataJpaTest for Repository Testing

- Repository Test

```
@DataJpaTest
public class UserRepositoryIntegrationTest {
    @Autowired
    private TestEntityManager entityManager;
    @Autowired
    private UserRepository userRepository;
    @Test
    public void testFindById() {
        User user = new User(1L, "John Doe");
        entityManager.persist(user);
        entityManager.flush();

        User found = userRepository.findById(user.getId()).orElse(null);
        assertThat(found.getName()).isEqualTo(user.getName());
    }
}
```

Integration Testing with @Testcontainers

- **Integration Test**

```
@SpringBootTest
@AutoConfigureMockMvc
@Testcontainers
public class UserControllerIntegrationTest {

    @Container
    public static MySQLContainer<?> mysql = new MySQLContainer<>("mysql:8.0.23")
        .withDatabaseName("testdb")
        .withUsername("test")
        .withPassword("test");

    @DynamicPropertySource
    public static void dynamicProperties(DynamicPropertyRegistry registry) {
        registry.add("spring.datasource.url", mysql::getJdbcUrl);
        registry.add("spring.datasource.username", mysql::getUsername);
        registry.add("spring.datasource.password", mysql::getPassword);
    }
. . .
```

Integration Testing with @Testcontainers

```java
. . .
@Autowired
    private MockMvc mockMvc;
    @Autowired
    private UserRepository userRepository;
    @BeforeEach
    public void setUp() {
        userRepository.save(new User(1L, "John Doe"));
    }
    @AfterEach
    public void tearDown() {
        userRepository.deleteAll();
    }
    @Test
    public void testGetUserById() throws Exception {
        mockMvc.perform(get("/api/users/1"))
                .andExpect(status().isOk())
                .andExpect(content().contentType(MediaType.APPLICATION_JSON))
                .andExpect(jsonPath("$.name").value("John Doe"));
    }
}
```

Best Practices

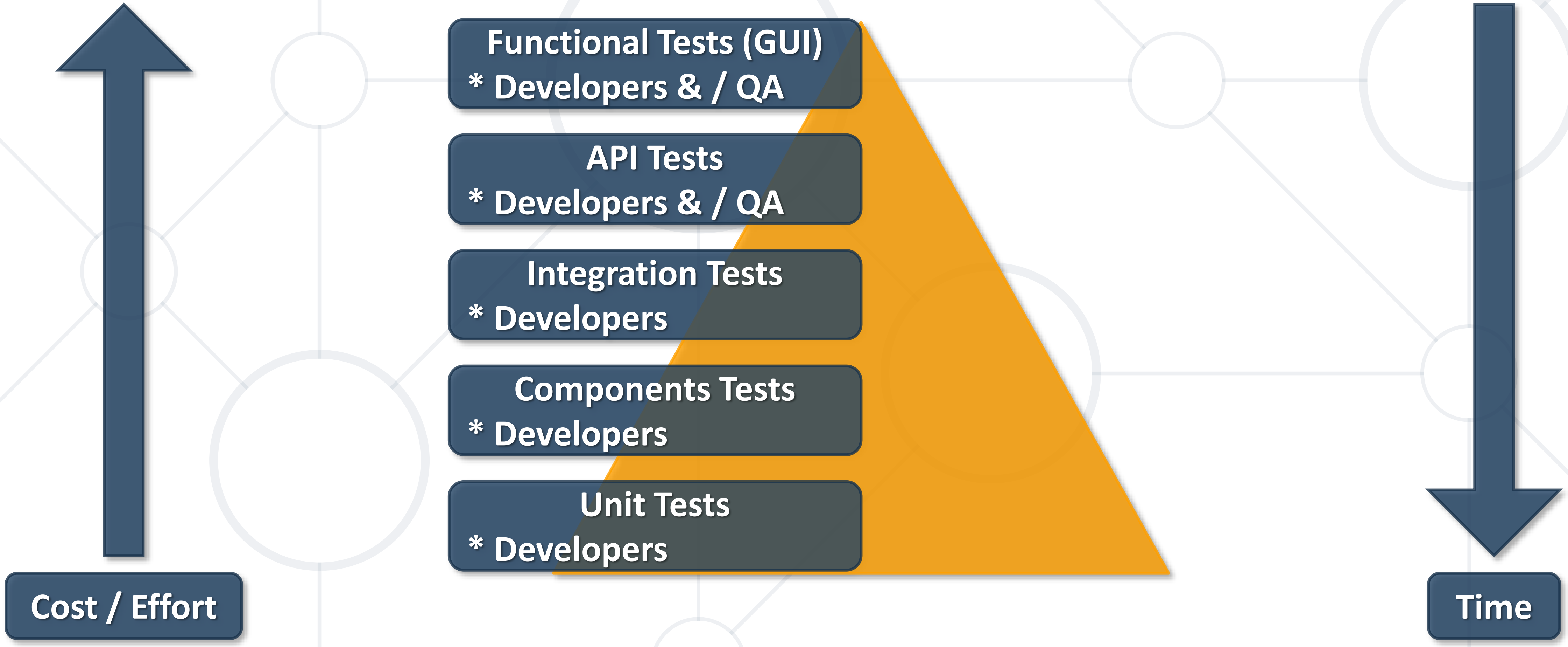
- **Isolation** - Ensure tests are independent and isolated to avoid interference
- **Setup and Teardown** - Use **@BeforeEach** and **@AfterEach** to set up and clean up the test environment
- **Data Management** - Use **in-memory** databases or reset the database state between tests to maintain consistency
- **Realistic Scenarios** - Use **Testcontainers** for more realistic integration testing, particularly for database-dependent tests

Conclusion

- Integration testing in Spring Boot is **essential** for verifying the correct interaction between **different** parts of an application
- By using annotations like **@SpringBootTest**, **@DataJpaTest**, and tools like **MockMVC** and **Testcontainers**, developers can ensure their applications are robust and function correctly in a **production-like** environment

Different Testing levels

- Different Testing levels **require different** time and resources



Summary

- **Testing** is an important part of the application lifecycle
  - New features need to be verified, before delivered to the clients
- **Integration Testing**
  - Testing the interactions between multiple layers of an application
  - The purpose is is to verify that different components of an application work together correctly

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