الجامعة السورية الخاصة
SYRIAN PRIVATE UNIVERSITY

Topic 5

Software Architecture

Clean Architecture

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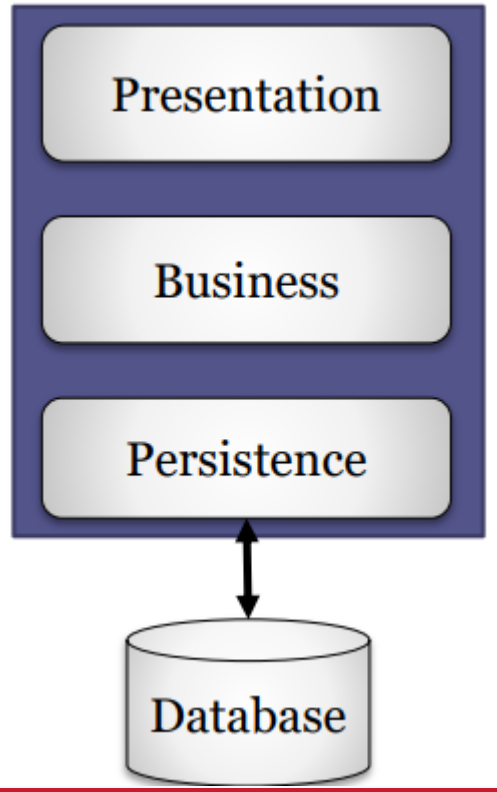
Course Roadmap

- General Principles in Software Design and Architecture: *The Context of Software Architecture, System Decomposition, What is Good Design?*
- Layered Architecture
- Practical Concerns 1: Communication between Layers, Façade Design Pattern, and Dependency Injection
- N-Tier, Client-server, Peer-to-Peer, MVC
- Microservices
- Practical Concerns 2: Message Broker, Related Design Patterns: CQRS, API Gateway, Strangler Pattern, Externalized Configuration, case study
- Clean Architecture: The Hexagonal Architecture, Ports and Adapters
- More Architectural Styles: Repository, Service-Oriented Architecture (SOA), Pipes and Filters

Technical vs domain partitioning

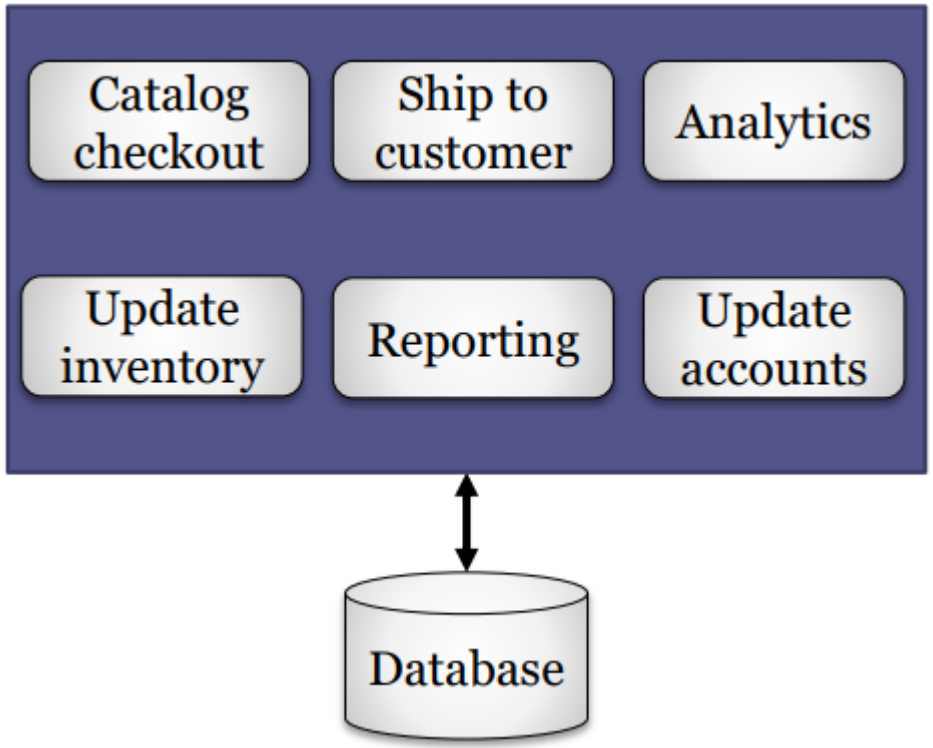
Technical partitioning

Organize system modules by technical capabilities



Domain partitioning

Organize modules by domain



Domain based

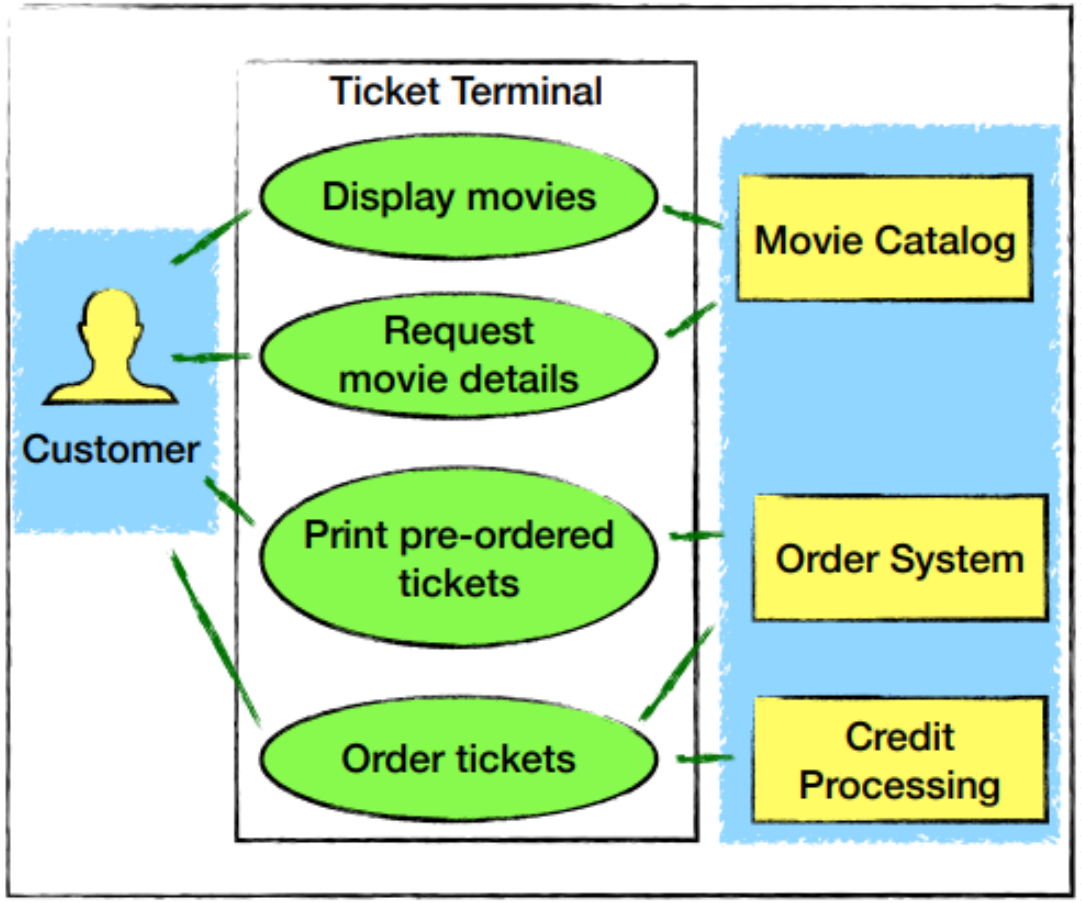
- Centered on the domain and the business logic
  - Goal: Anticipate and handle changes in domain
  - Collaboration between developers and domain experts
- Elements
  - Domain model: formed by: Context, Entities, Relationships
  - Application: Manipulates domain elements
- Variants
  - DDD - Domain driven design
  - Hexagonal style
  - Data centered
  - N-Layered Domain Driven Design
  - Naked Objects

Clean Architecture

- Use Cases as central organizing structure.
- Follows the Ports and Adapters pattern (Hexagonal Architecture).
  - Implementation is guided by tests.
  - Decoupled from technology details.
- Lots of Principles (SAP, SDP, SOLID..)
- Pluggable User Interface

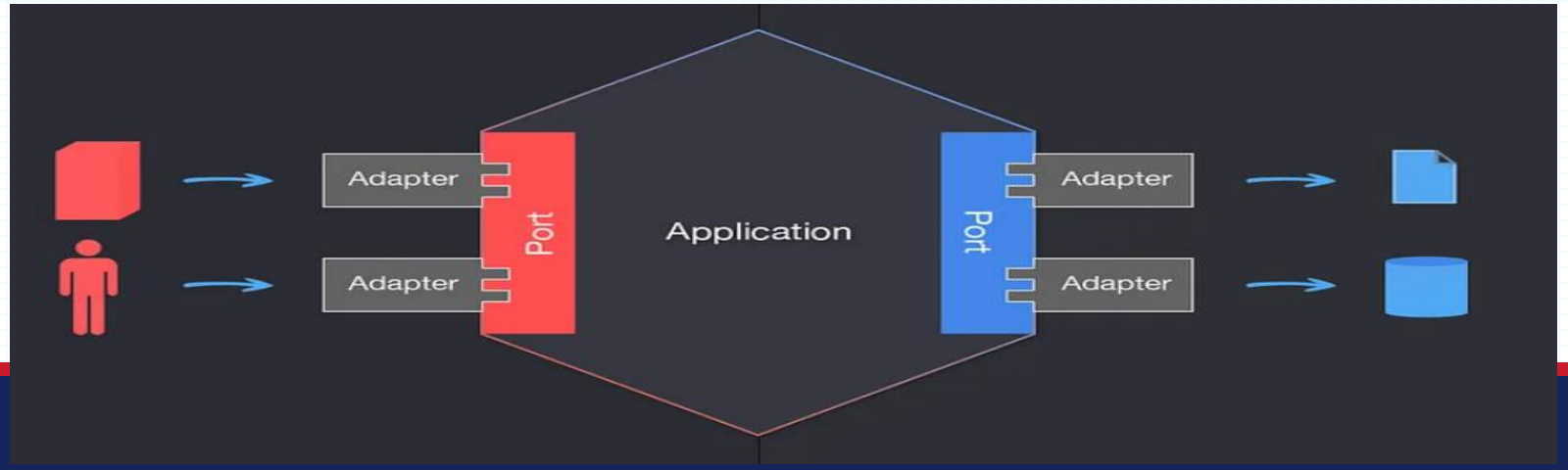
Use Cases

- Use Cases are **delivery independent**.
- Show the **intent** of a system.
- Use Cases are **algorithms** that interpret the input to generate the output data.
- **Primary** and **secondary** actors



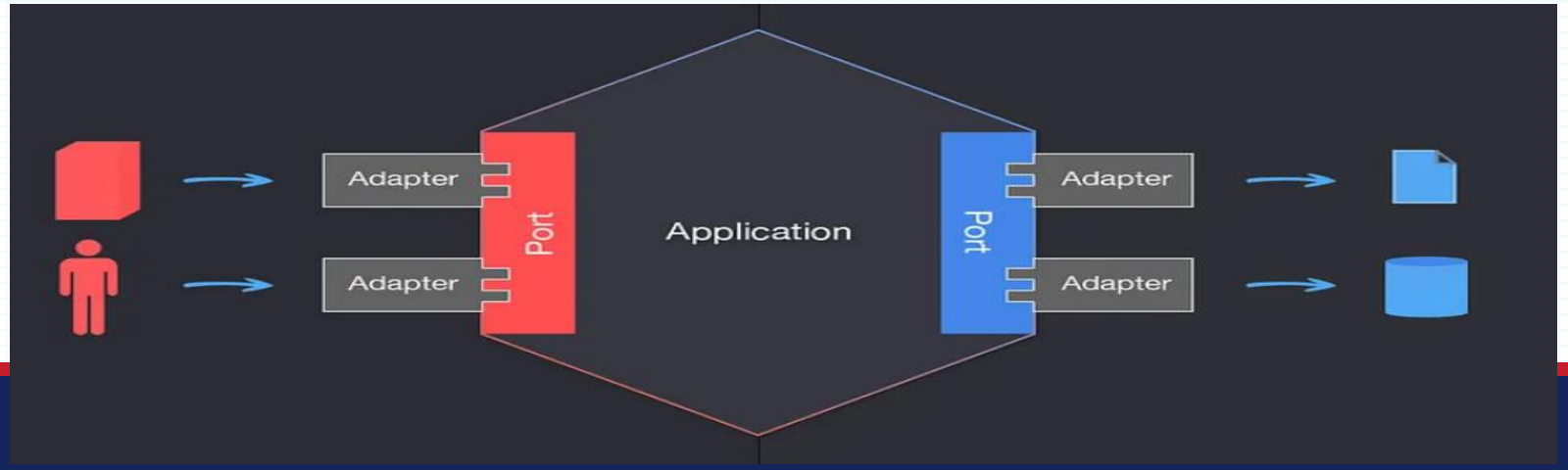
The Hexagonal Architecture

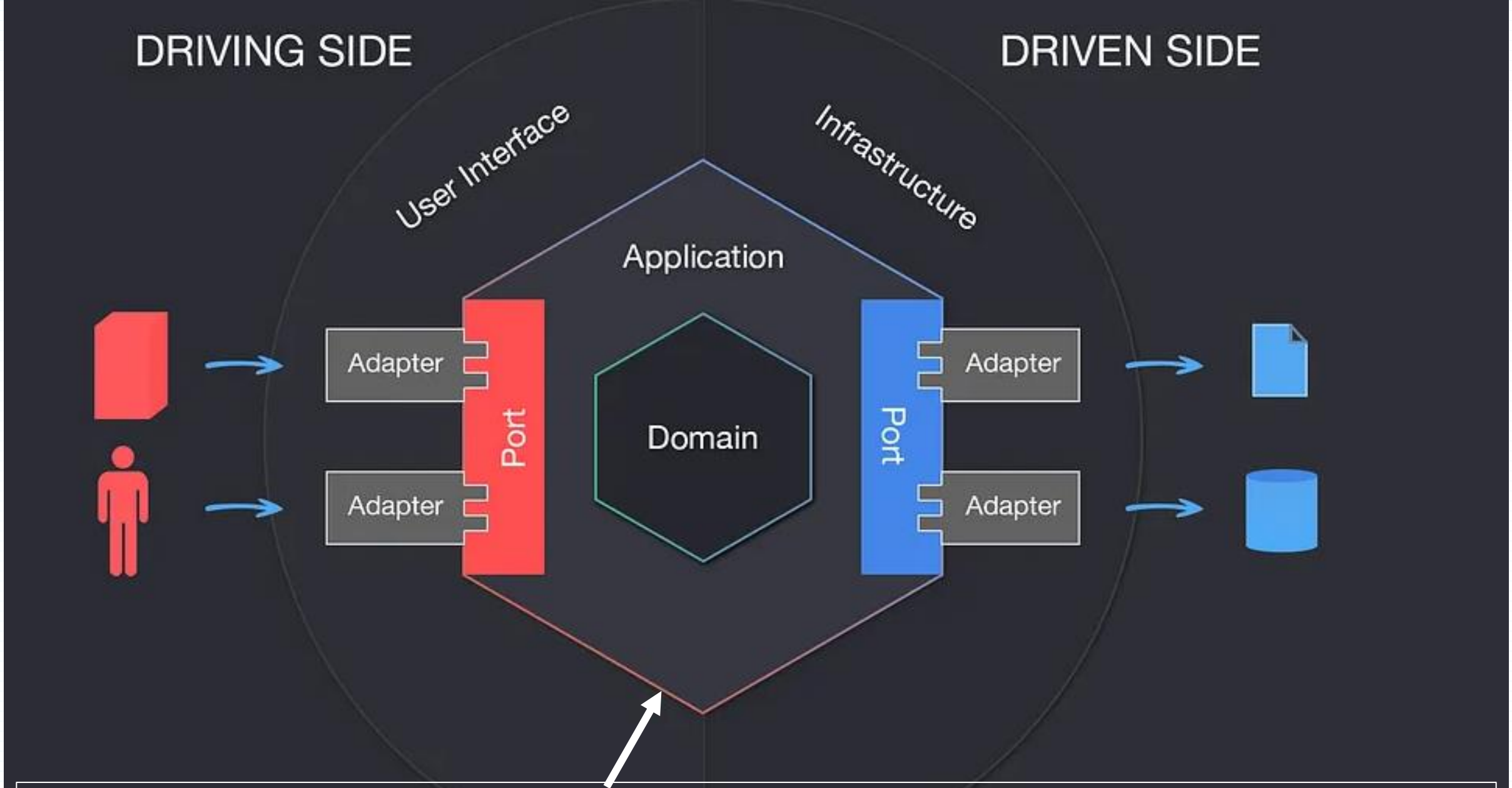
- The Hexagonal Architecture, also referred to as Ports and Adapters, is an architectural pattern that:
  - allows input by users or external systems to **arrive** into the Application at a Port via an Adapter, and allows output to be **sent** out from the Application through a Port to an Adapter.
- This creates an abstraction layer that protects the core of an application and isolates it from external — and somehow irrelevant — tools and technologies.



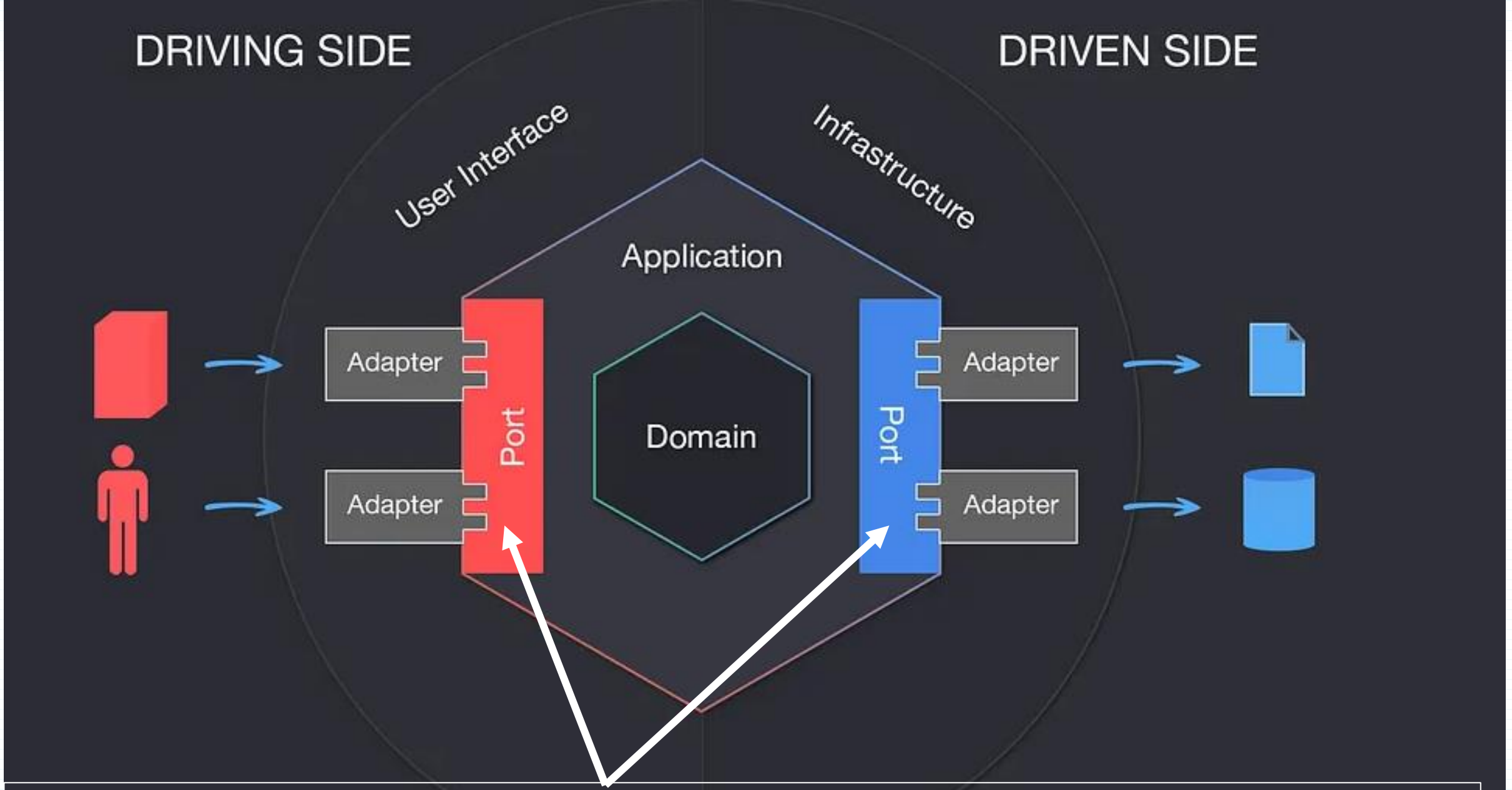
The Hexagonal Architecture

- **Ports**: We can see a Port as a technology-agnostic entry point, it determines the interface which will **allow foreign actors to communicate with the Application.**
- **Adapters:** An Adapter will **initiate the interaction** with the Application through a Port, using a specific technology,
  - for example, a REST controller would represent an adapter that allows a client to communicate with the Application.

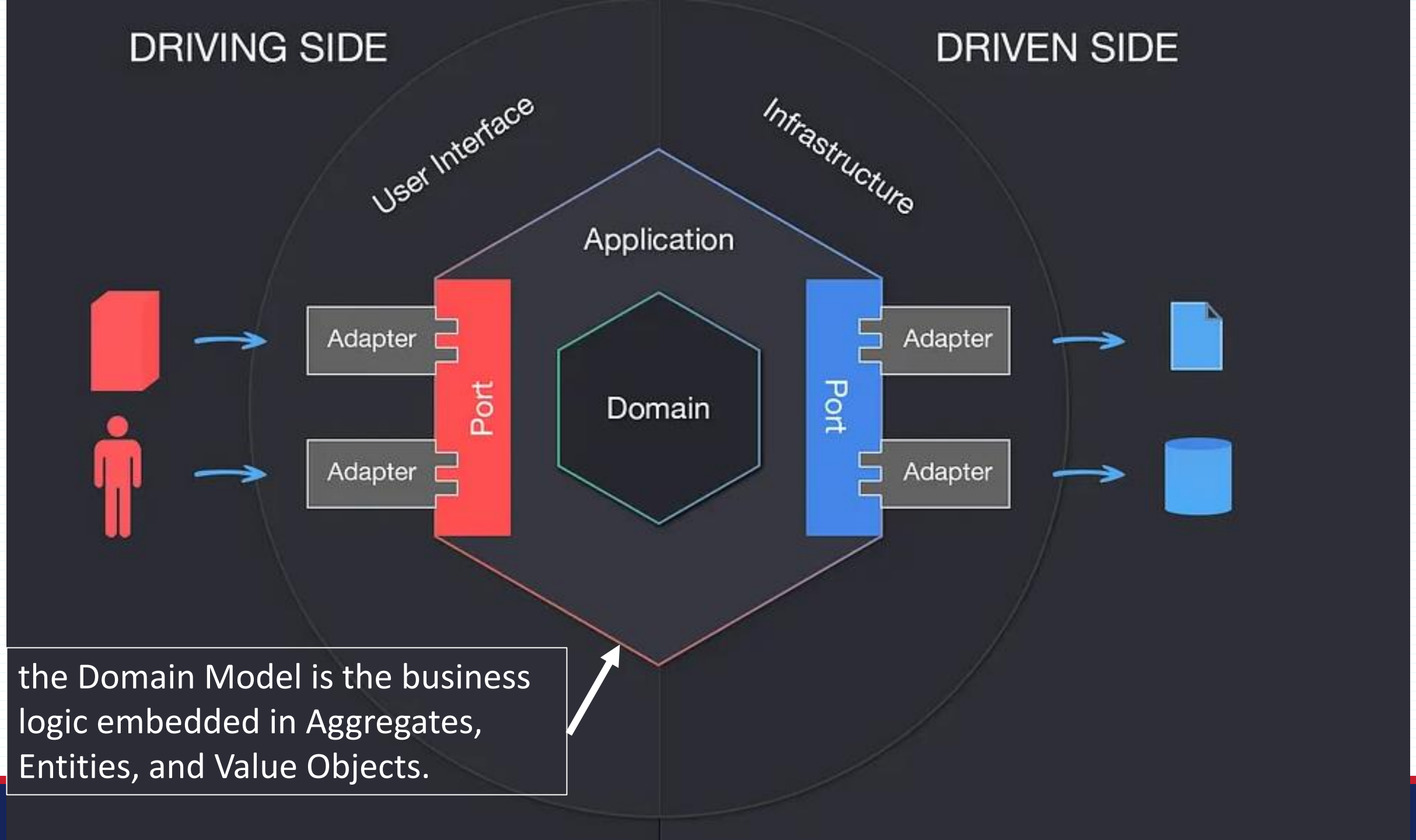


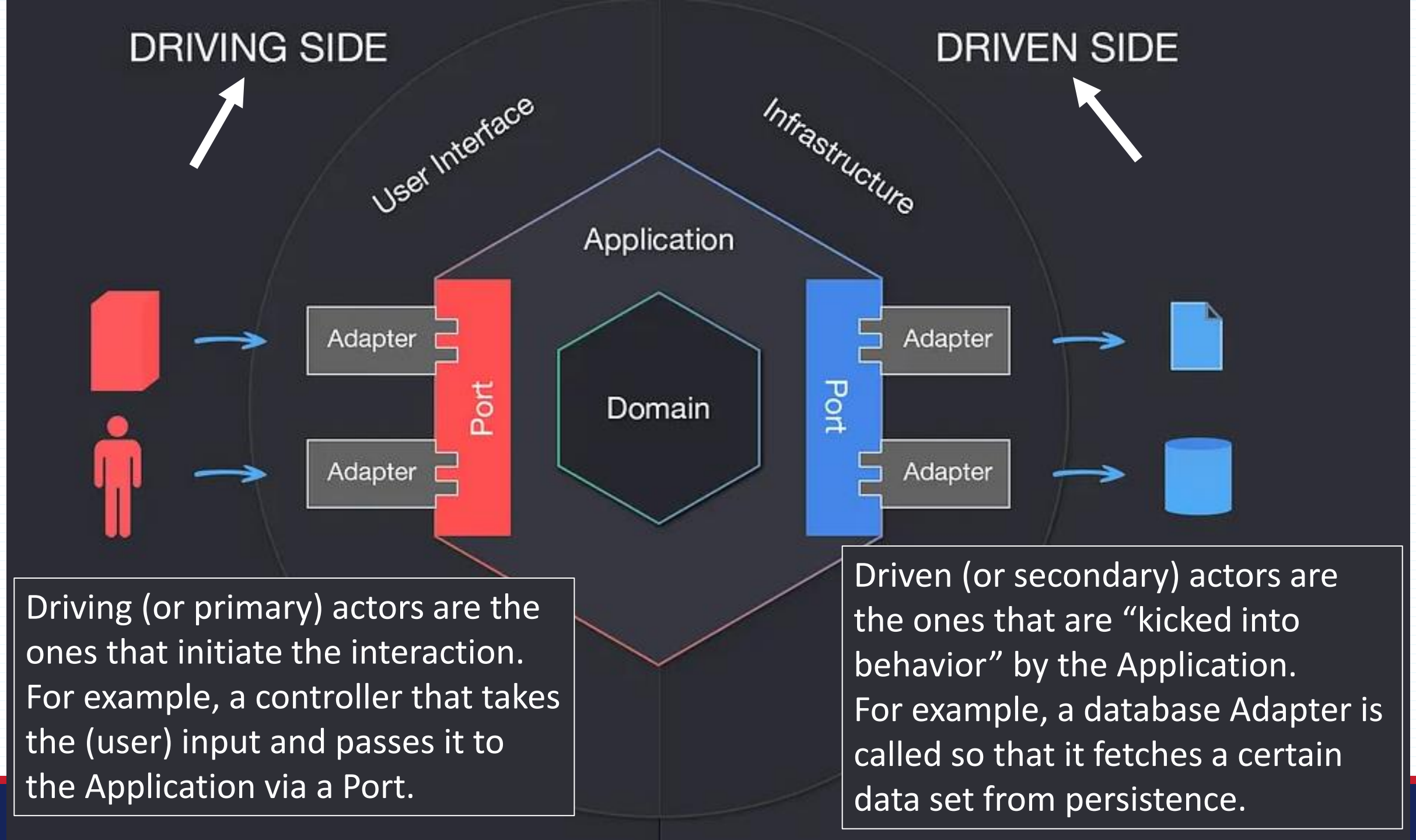


The Application is the core of the system, it contains the Application Services which orchestrate the functionality or the use cases.



The Application receives commands or queries from the Ports, and sends requests out to other external actors, like databases, via Ports as well.

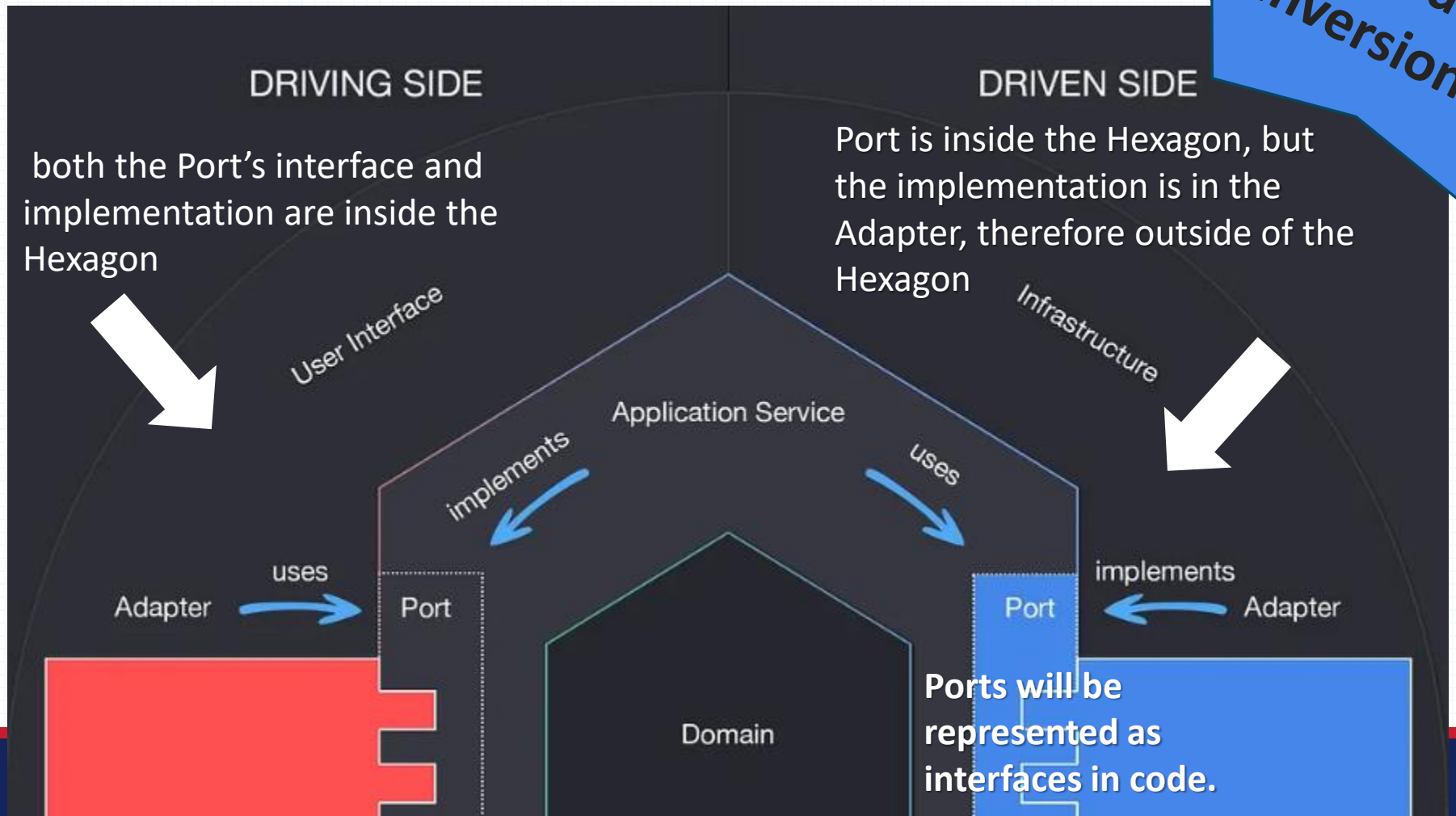

DRIVING SIDE
DRIVEN SIDE
User Interface
Infrastructure
Application
Adapter
Adapter
Port
Domain
Port
Adapter
Adapter
the Domain Model is the business logic embedded in Aggregates, Entities, and Value Objects.



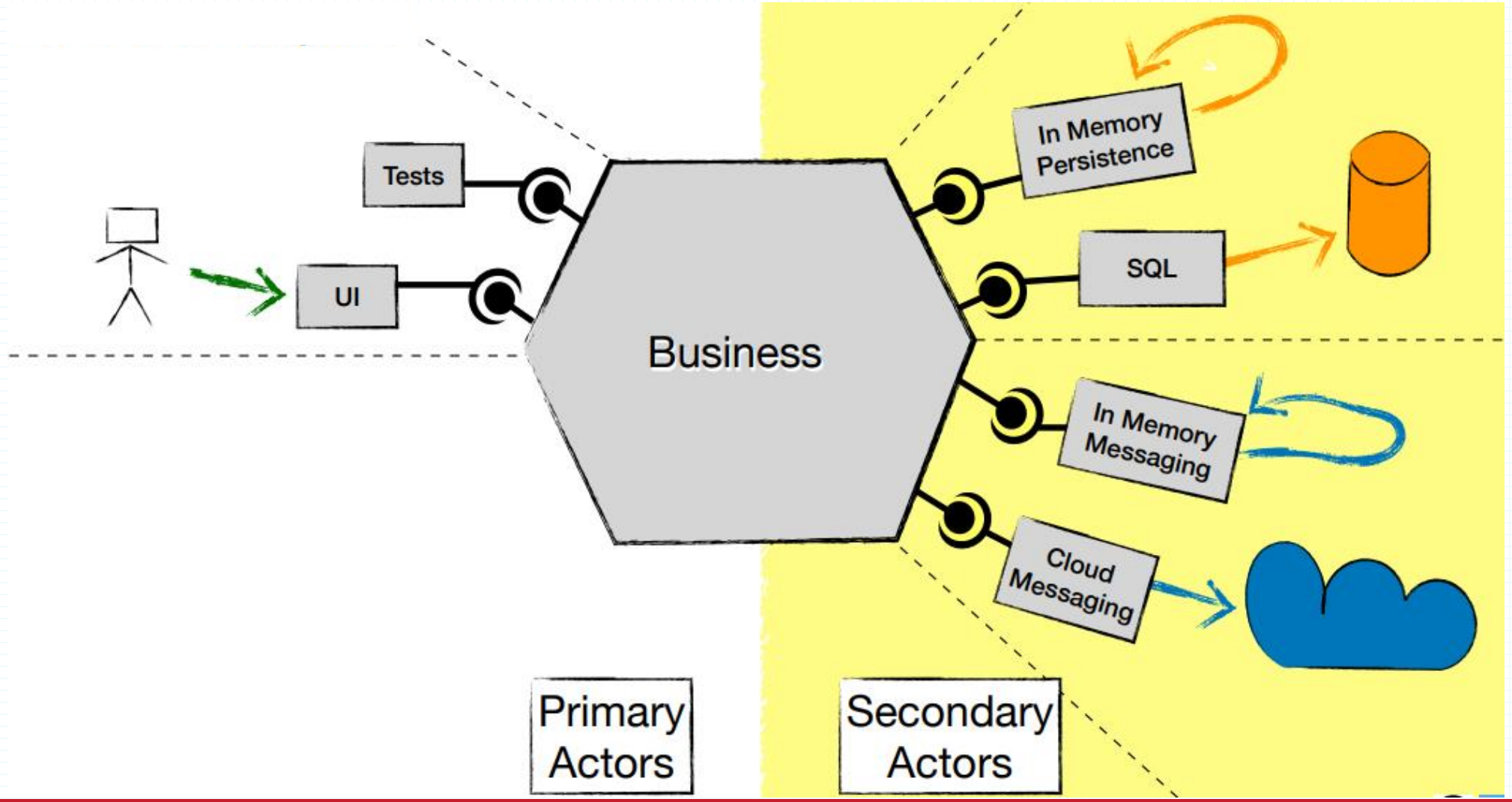
Driving (or primary) actors are the ones that initiate the interaction. For example, a controller that takes the (user) input and passes it to the Application via a Port.

Driven (or secondary) actors are the ones that are “kicked into behavior” by the Application. For example, a database Adapter is called so that it fetches a certain data set from persistence.

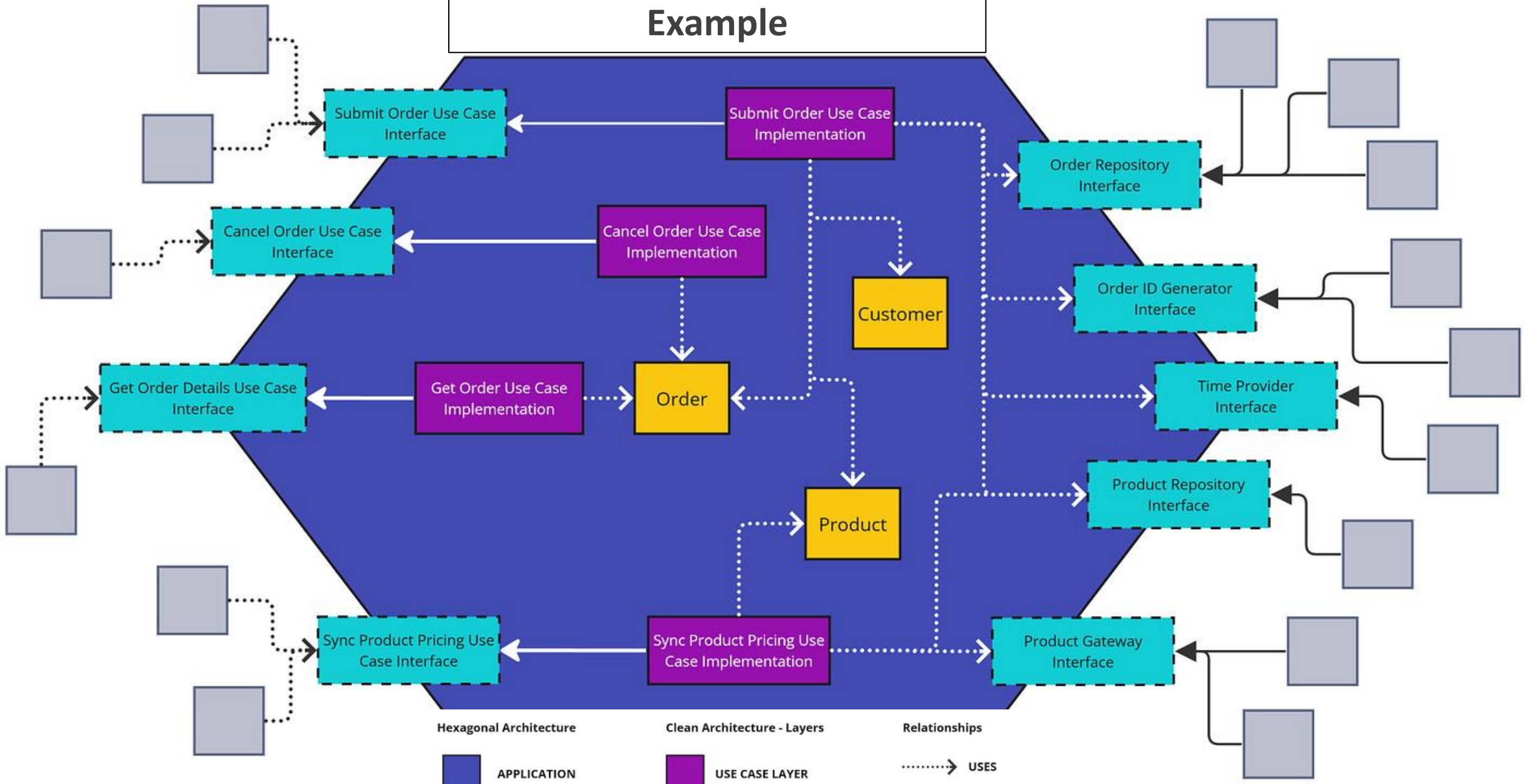
The Flow


DRIVING SIDE
both the Port's interface and implementation are inside the Hexagon
User Interface
Application Service
implements
uses
Adapter
uses
Port
Domain
DRIVEN SIDE
Port is inside the Hexagon, but the implementation is in the Adapter, therefore outside of the Hexagon
Infrastructure
implements
Port
Adapter
Dependency Inversion ☺
Ports will be represented as interfaces in code.

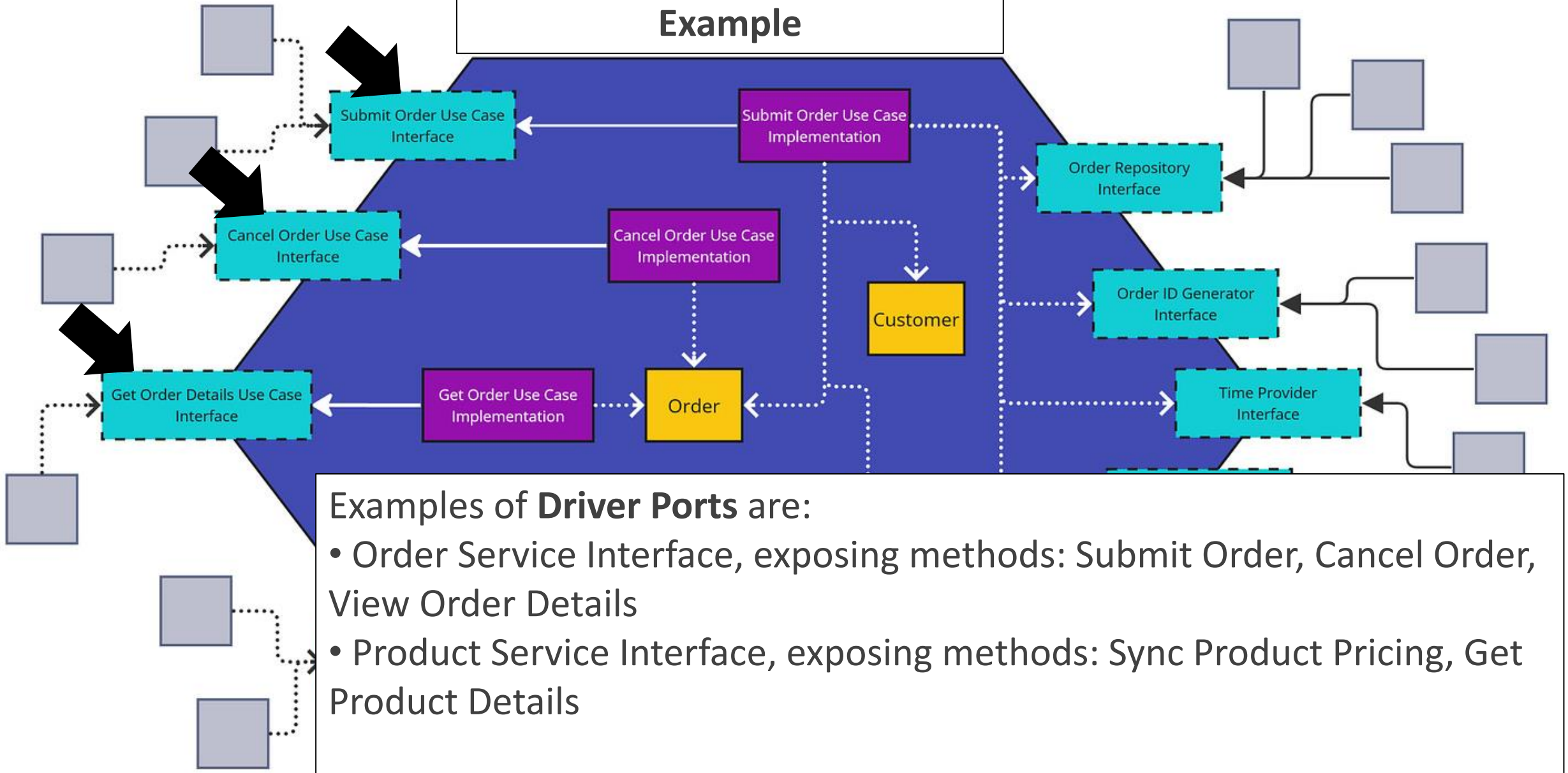
Ports and Adapters



Example


Submit Order Use Case Interface
Submit Order Use Case Implementation
Order Repository Interface
Cancel Order Use Case Interface
Cancel Order Use Case Implementation
Customer
Order ID Generator Interface
Get Order Details Use Case Interface
Get Order Use Case Implementation
Order
Time Provider Interface
Product
Product Repository Interface
Sync Product Pricing Use Case Interface
Sync Product Pricing Use Case Implementation
Product Gateway Interface
Hexagonal Architecture
APPLICATION
PORTS
ADAPTERS
Clean Architecture - Layers
USE CASE LAYER
DOMAIN LAYER
Relationships
USES
IMPLEMENTS

Example

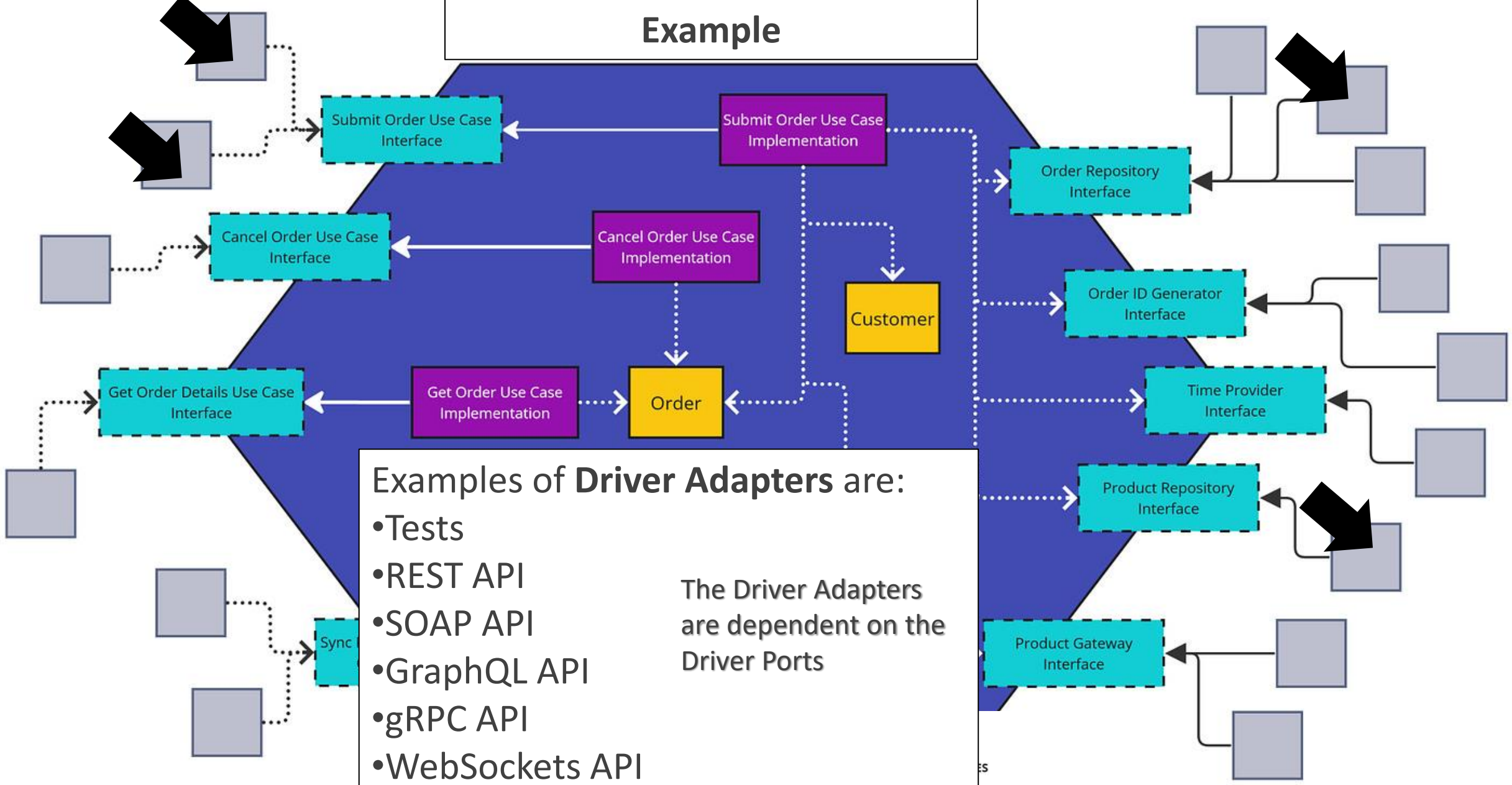


Examples of **Driver Ports** are:

- Order Service Interface, exposing methods: Submit Order, Cancel Order, View Order Details
- Product Service Interface, exposing methods: Sync Product Pricing, Get Product Details

We can write **Unit Tests** targeting **Driver Ports** to test use case / business logic.

Example

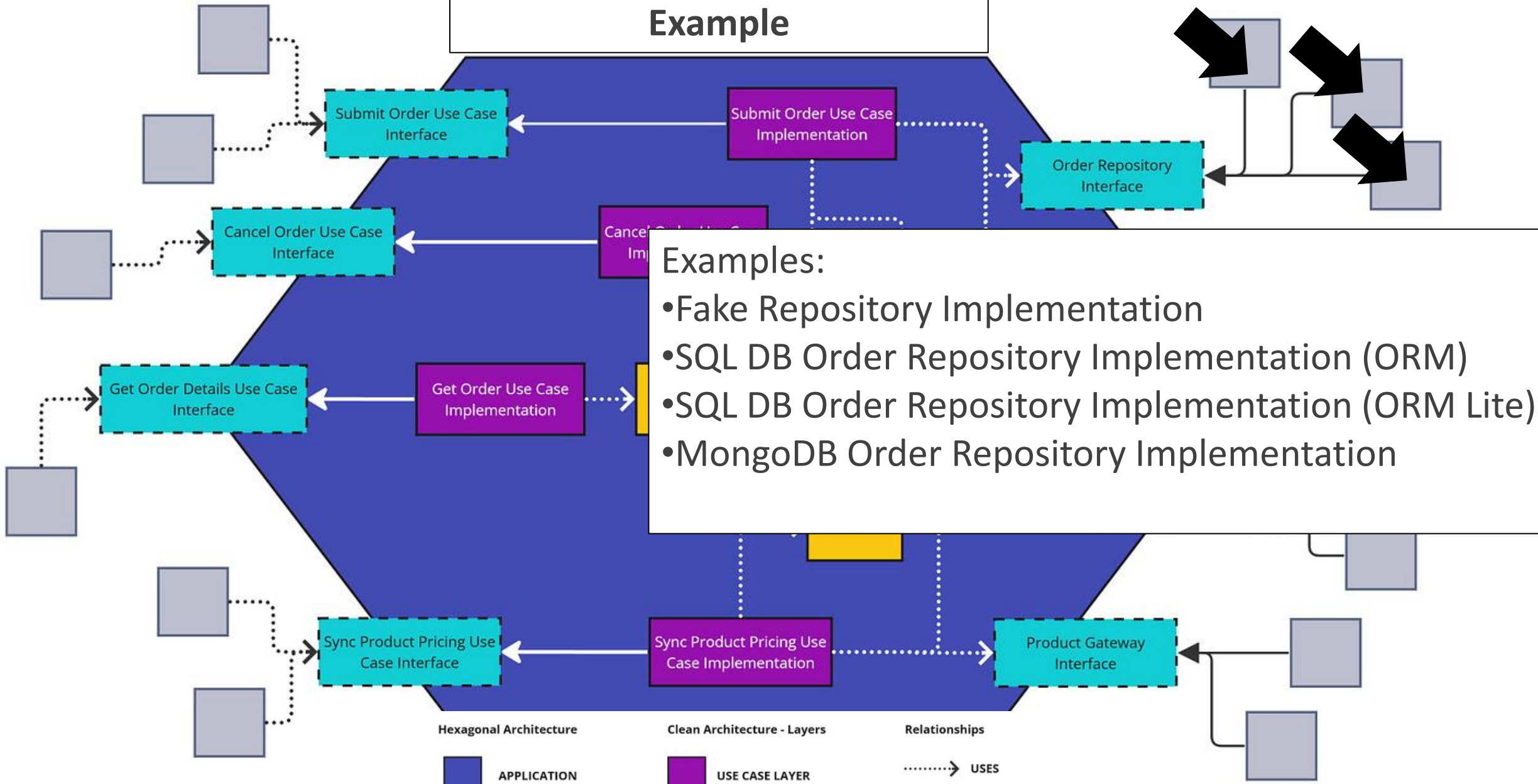


Examples of **Driver Adapters** are:

- Tests
- REST API
- SOAP API
- GraphQL API
- gRPC API
- WebSockets API
- RabbitMQ Consumer
- Kafka Consumer

The Driver Adapters are dependent on the Driver Ports

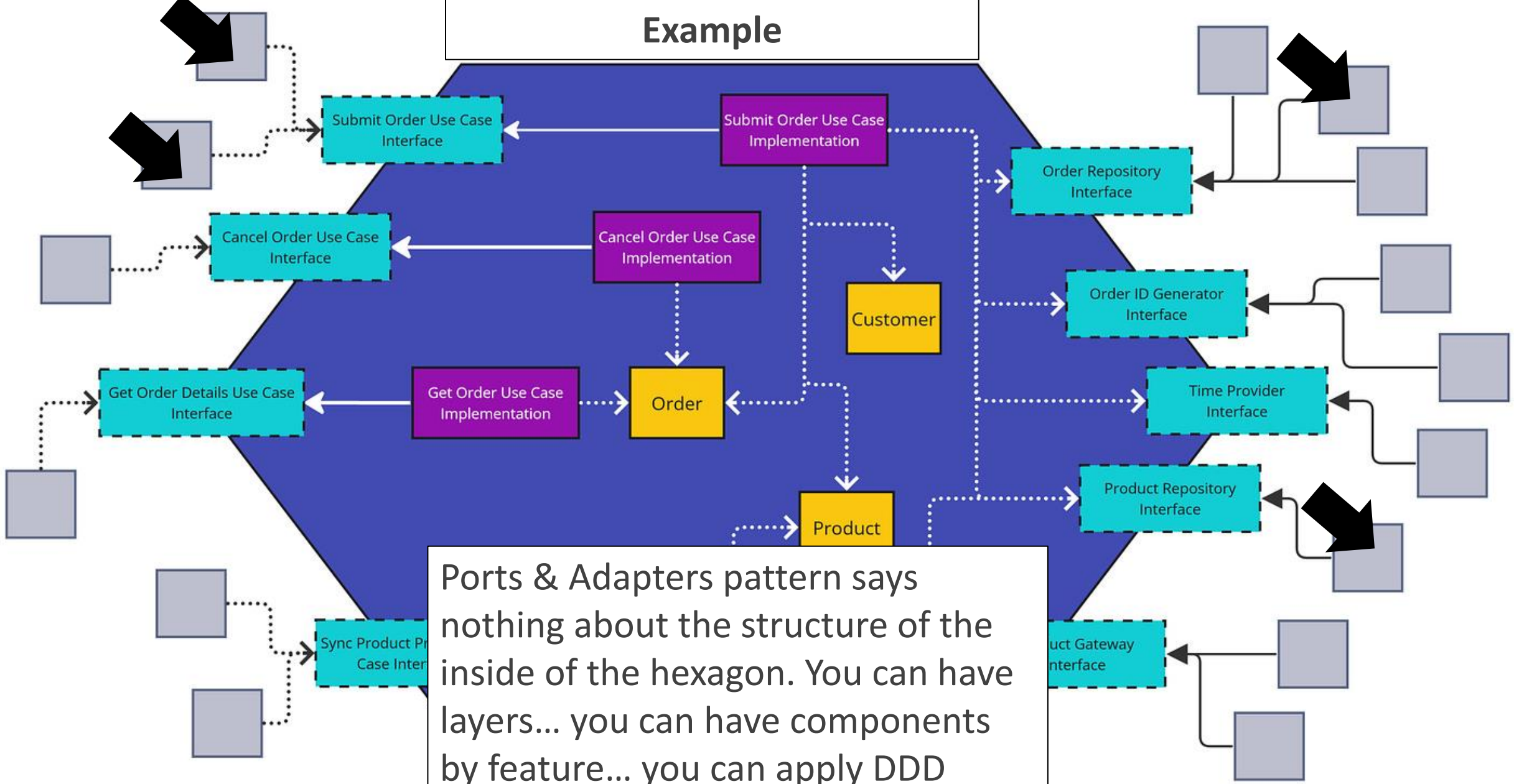
Example



Examples:

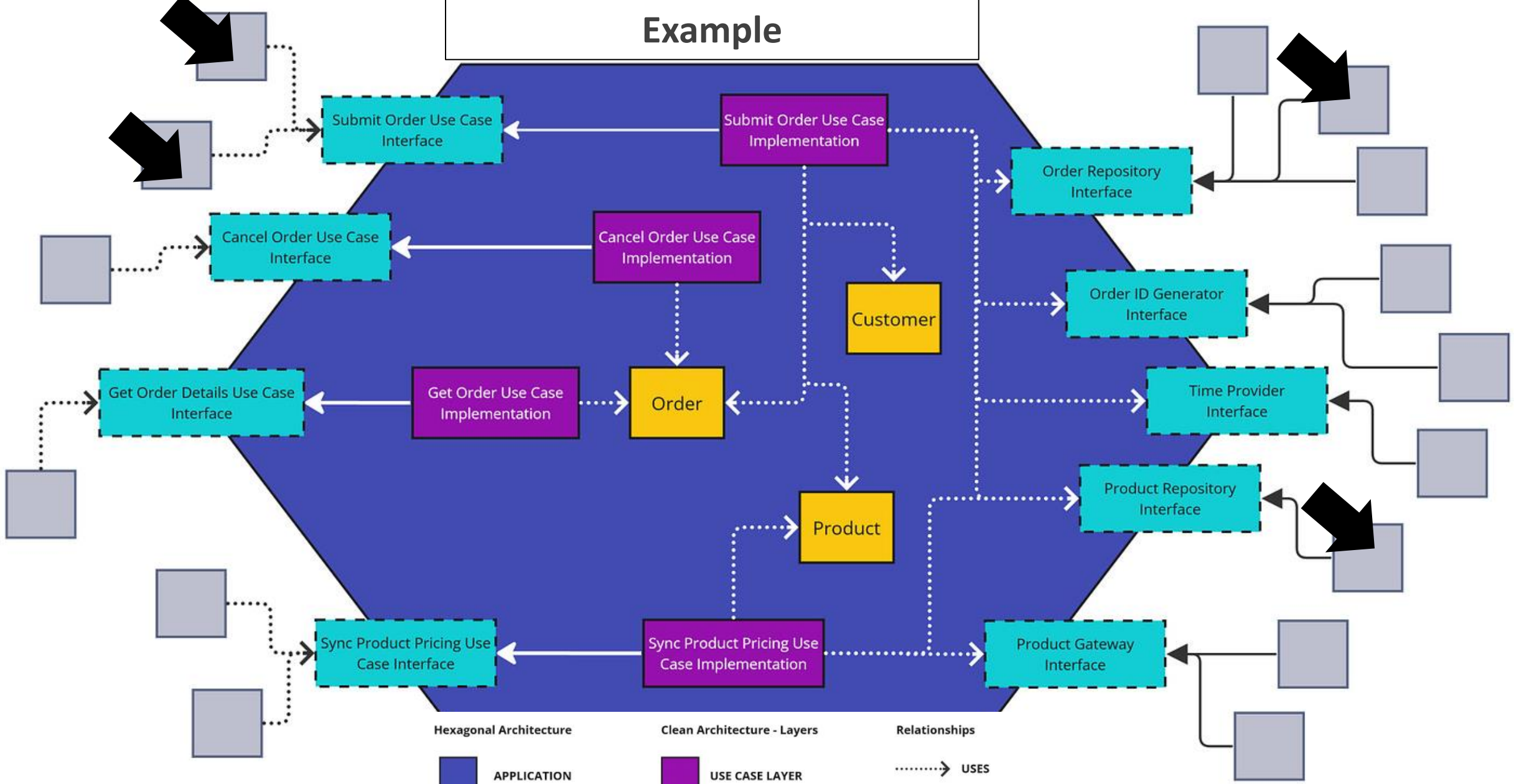
- Fake Repository Implementation
- SQL DB Order Repository Implementation (ORM)
- SQL DB Order Repository Implementation (ORM Lite)
- MongoDB Order Repository Implementation

Example



Ports & Adapters pattern says nothing about the structure of the inside of the hexagon. You can have layers… you can have components by feature… you can apply DDD tactical patterns… you can have a single CRUD… it's up to you.

Example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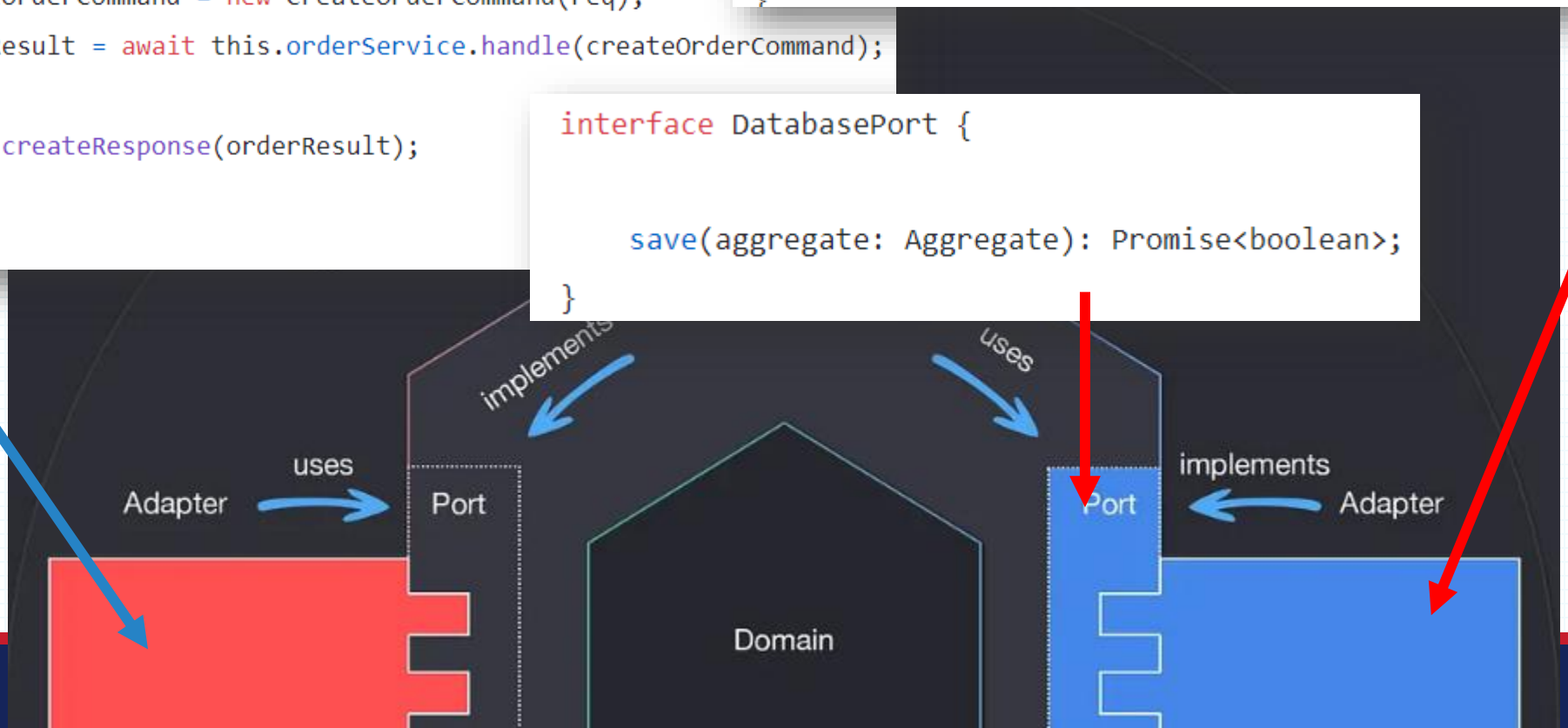
Hexagonal Architecture
APPLICATION
PORTS
ADAPTERS
Clean Architecture - Layers
USE CASE LAYER
DOMAIN LAYER
Relationships
USES
IMPLEMENTS

```
class OrderAdapter extends HttpRequestHandler {

    private orderService: DrivingPort;

    constructor(orderService: DrivingPort) {
        super();
        this.orderService = orderService;
    }

    public async createOrder(req: Request): Promise<Response> {
        const createOrderCommand = new CreateOrderCommand(req);
        const orderResult = await this.orderService.handle(createOrderCommand);

        return this.createResponse(orderResult);
    }
}
```

```
class OrderRepositoryAdapter extends Repository implements DatabasePort {

    public async save(order: Aggregate): Promise<boolean> {
        return await this.insert(order)
    }
}
```

```
interface DatabasePort {

    save(aggregate: Aggregate): Promise<boolean>;
}
```



حسن التصميم السابق باستخدام ما تعرفنا عليه في محاضرة اليوم!

حالة عملية للنقاش

شركة تطوير تعمل على بناء نظام برمجي لإدارة خدمات الرعاية الصحية عن بُعد، ويتميز النظام المراد بالخصائص التالية:

- يتكامل النظام مع أجهزة قياس العلامات الحيوية للمرضى لتحصيل البيانات والقياسات الحيوية مباشرة لتحليلها.
- يوفر واجهة مستخدم تفاعلية للأطباء والممرضين تتيح لهم مراقبة الحالة الصحية للمرضى بشكل لحظي عند الحاجة وتقديم الاستشارات عبر الإنترنت.
- يتيح النظام للمرضى حجز المواعيد والتواصل مع الأطباء عبر المحادثات النصية أو مكالمات الفيديو.
- يقدم النظام توصيات طبية مخصصة بناءً على بيانات المرضى وسجلهم الصحي باستخدام تقنيات الذكاء الصنعي.
- يوفر النظام خدمة إدارة الوصفات الطبية الإلكترونية، حيث يمكن للأطباء إصدار الوصفات وتحويلها مباشرة إلى الصيدليات.
- يدعم النظام تخزين الملفات الطبية بشكل آمن مع إمكانية مشاركتها مع مقدمي الرعاية الصحية بناءً على موافقة المريض.