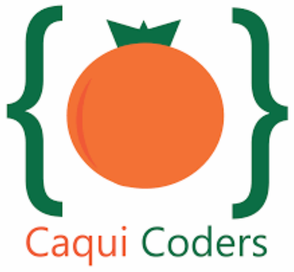

Introduction to Clean Architecture

Ivan Paulovich

Stockholm
Software Architecture Meetup
June 29th, 2020

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https://paulovich.net

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Paulovich.NET

Microsoft® Most Valuable Professional MVP Reconnect

#CleanArchitectureManga 🍄

Ivan Paulovich

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♡ Sponsor

Tech Lead, Software Engineer, 20+ GitHub projects about Clean Architecture, SOLID, DDD and TDD. Speaker/Streamer. Microsoft rMVP.

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- Stockholm, Sweden
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CleanArchitectureVSCodeSnippets

Clean Architecture C# Snippets for Visual Studio Code

TypeScript ☆ 6

FluentMediator

FluentMediator is an unobtrusive library that allows developers to build custom pipelines for Commands, Queries and Events.

C# ☆ 83 11

clean-architecture-manga

Template

🌀 Clean Architecture with .NET Core 3.1, C# 8 and React+Redux. Use cases as central organizing structure, completely testable, decoupled from frameworks

C# ☆ 1.6k 304

todo

✅ Commad-Line Task management with storage on your GitHub 🔥

C# ☆ 94 16

dotnet-new-caju

Template

Learn Clean Architecture with .NET Core 3.0 🔥

C# ☆ 202 30

event-sourcing-jambo

An Hexagonal Architecture with DDD + Aggregates + Event Sourcing using .NET Core, Kafka e MongoDB (Blog Engine)

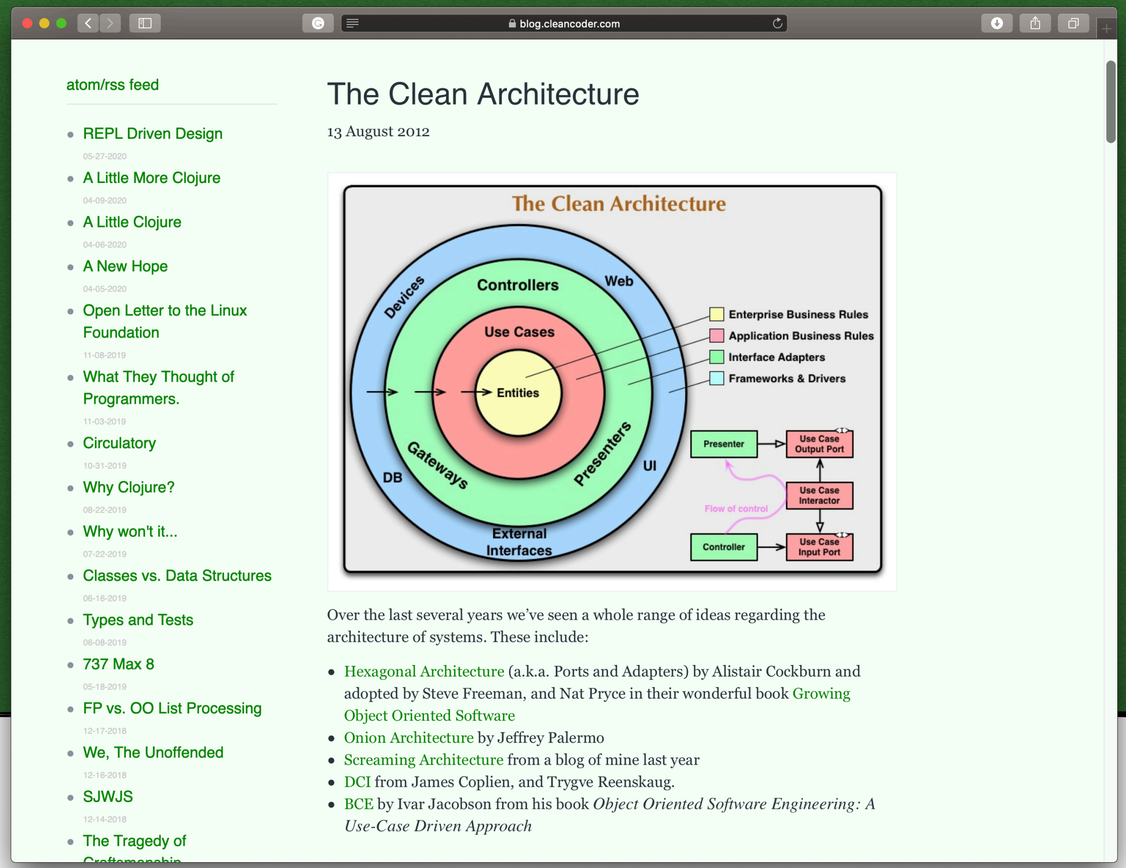
C# ☆ 146 62

What is the Clean Architecture Style?

https://blog.cleancoder.com/uncle-bob/2012/08/13/the-clean-architecture.html

> Each of these architectures produce systems that are:

- Independent of Frameworks.
- Testable.
- Independent of UI.
- Independent of Database.
- Independent of any external agency.



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style

/stʌɪl/

See definitions in:

All | Fashion | Hairdressing | Biology

noun

1. a particular procedure by which something is done; a manner or way.
   "different styles of management"

   Similar: manner | way | technique | method | methodology | approach

2. a distinctive appearance, typically determined by the principles according to which something is designed.
   "the pillars are no exception to the general style"

verb

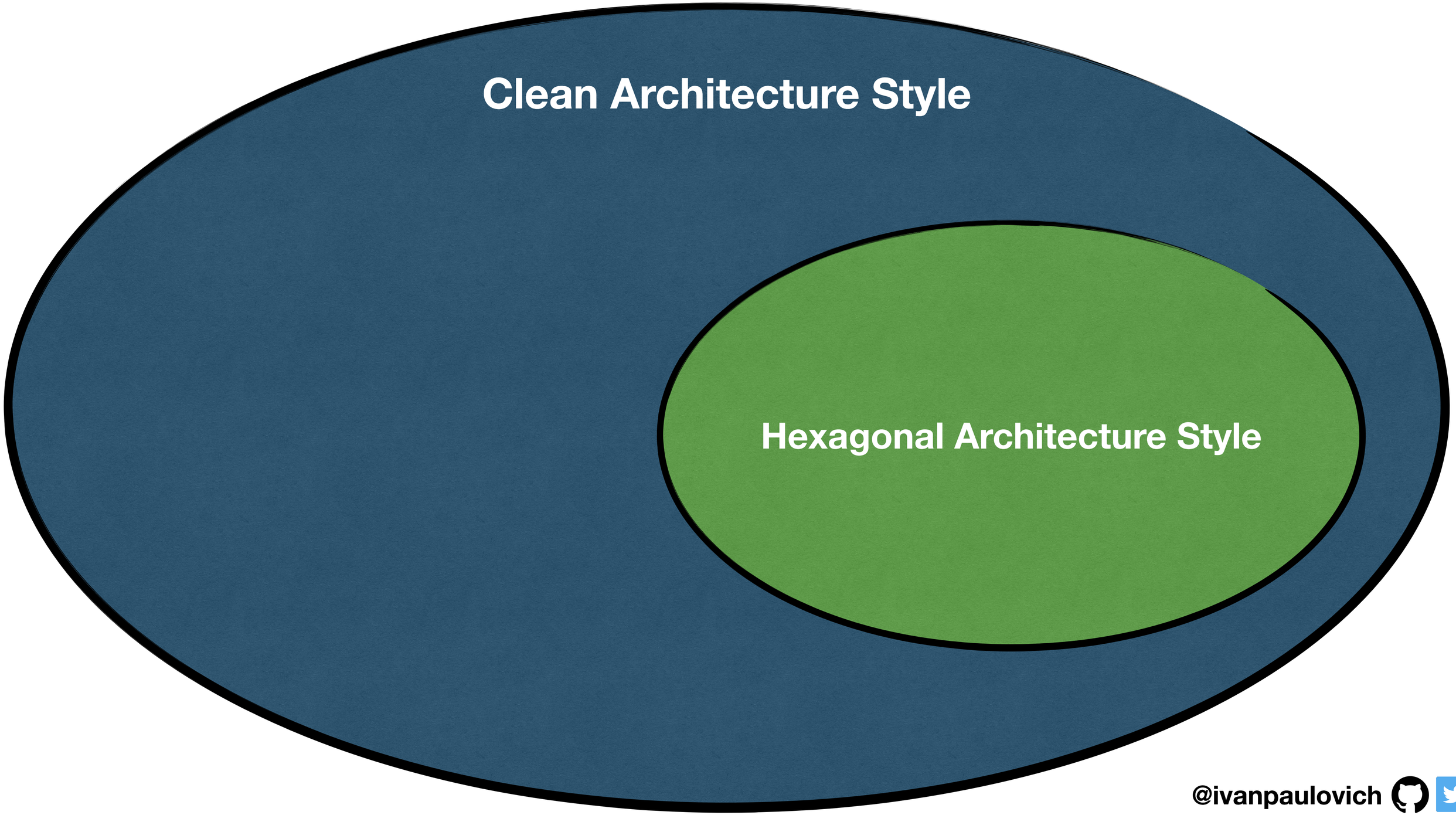
1. design or make in a particular form.
   "the yacht is well proportioned and conservatively styled"

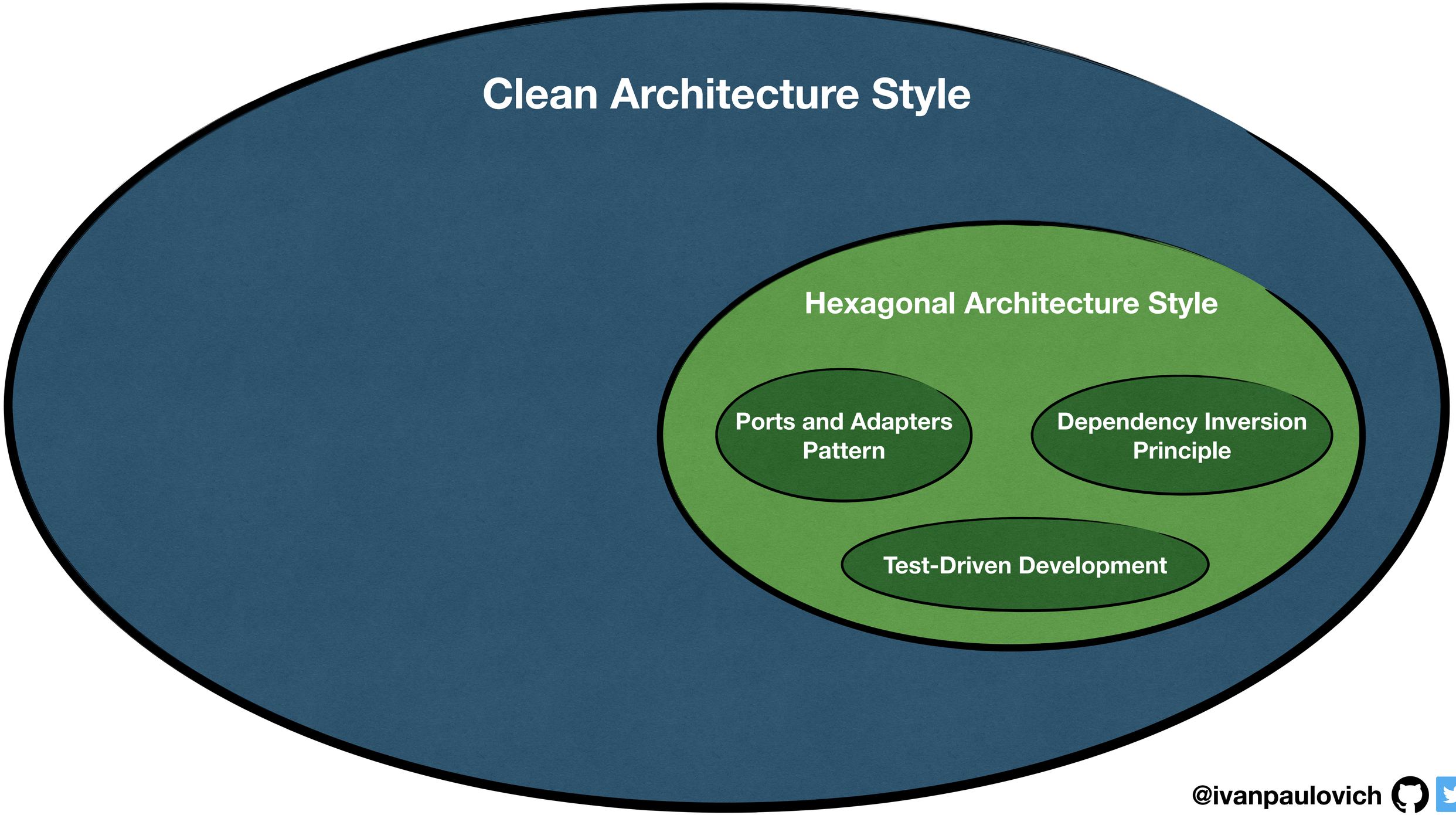
   Similar: design | fashion | tailor | make | produce

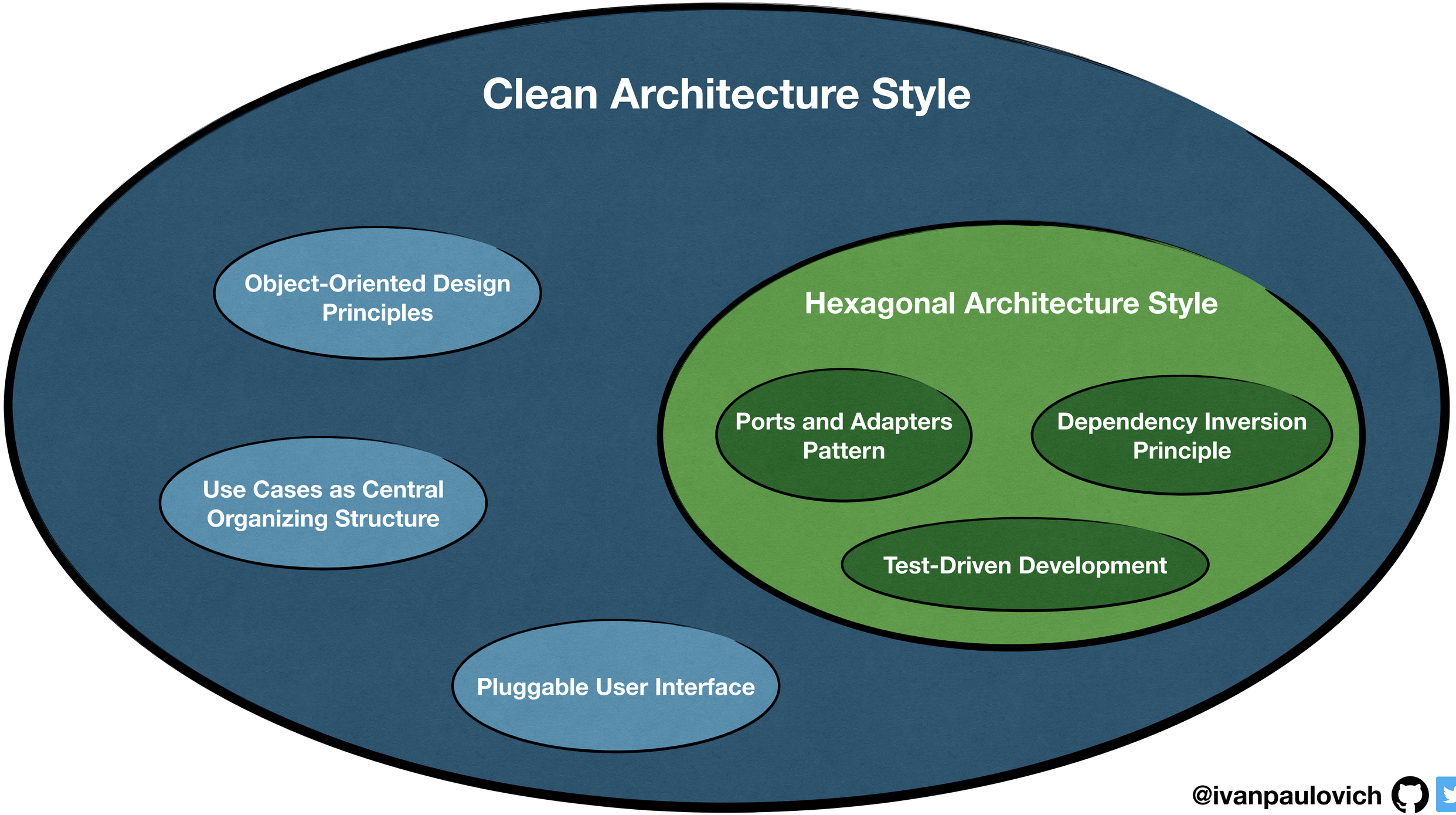
2. designate with a particular name, description, or title.
   "the official is styled principal and vice chancellor of the university"

   Similar: call | name | title | entitle | dub | designate | term | address

Clean Architecture Style


Clean Architecture Style
Hexagonal Architecture Style

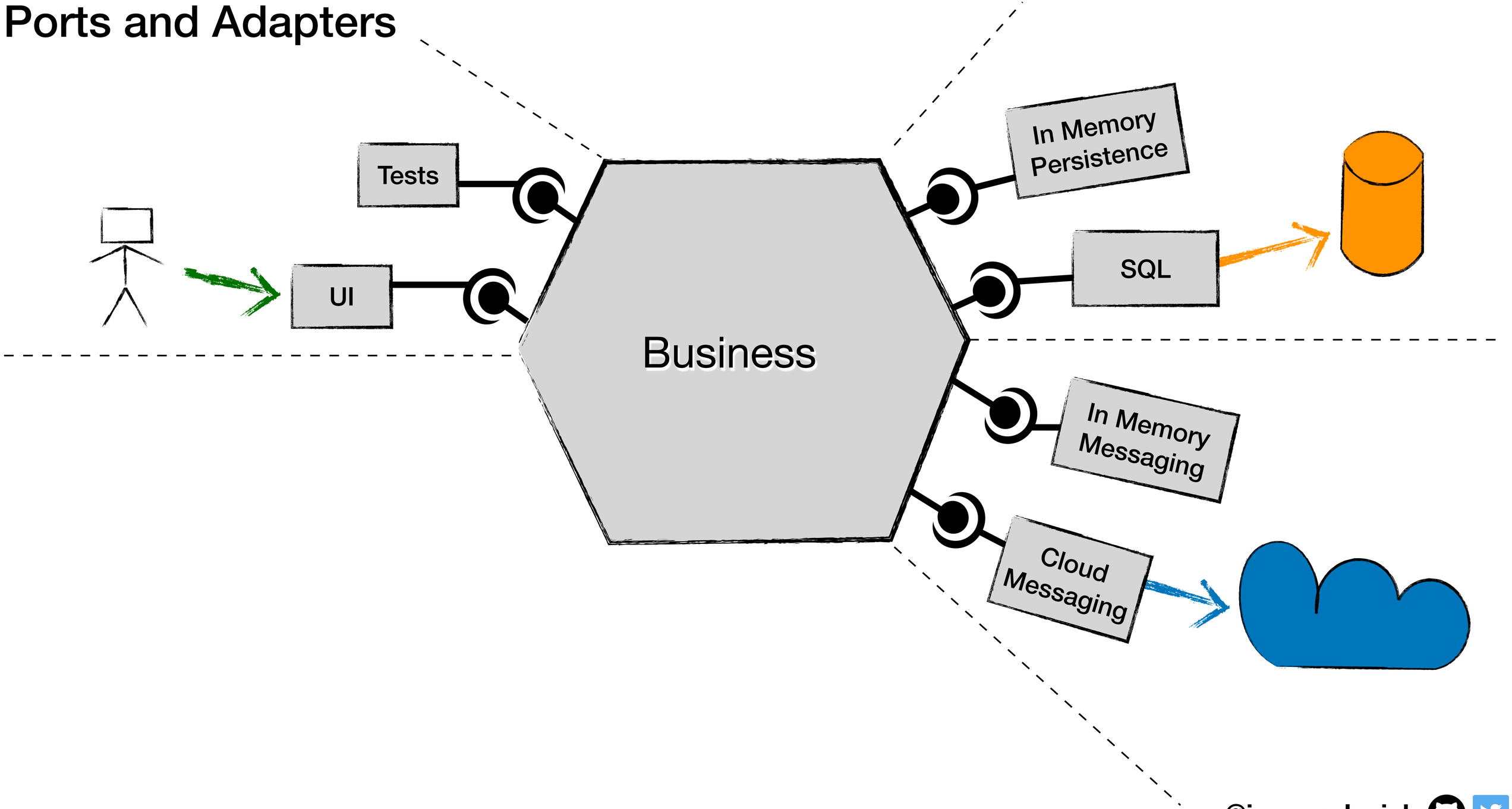

Clean Architecture Style
Hexagonal Architecture Style
Ports and Adapters Pattern
Dependency Inversion Principle
Test-Driven Development


Clean Architecture Style
Object-Oriented Design Principles
Use Cases as Central Organizing Structure
Pluggable User Interface
Hexagonal Architecture Style
Ports and Adapters Pattern
Dependency Inversion Principle
Test-Driven Development

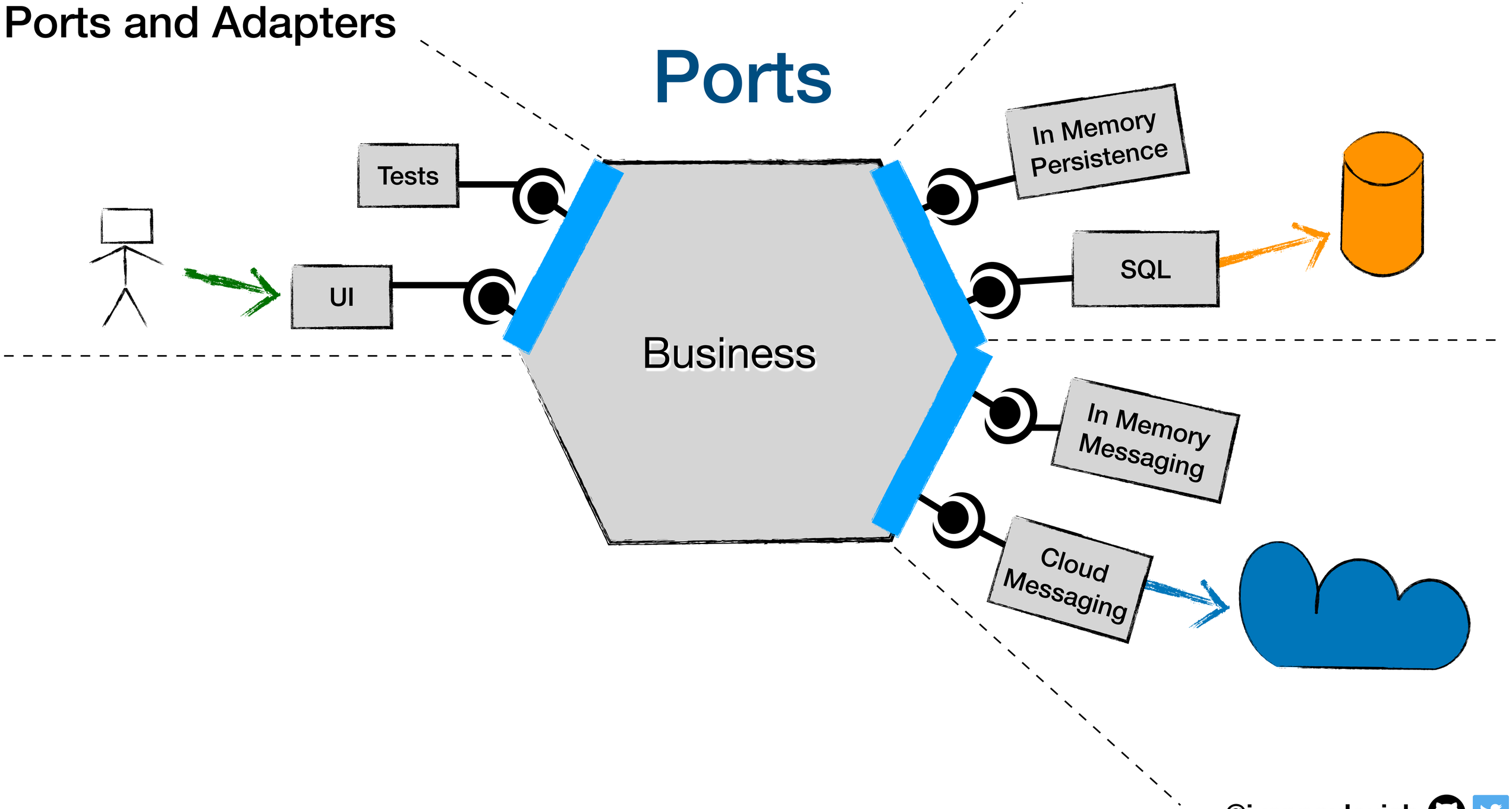
Hexagonal Architecture Style

- **Ports and Adapters** pattern.
- The implementation is **guided by tests**.
- It is **decoupled from technology** details.

Ports and Adapters



Ports and Adapters



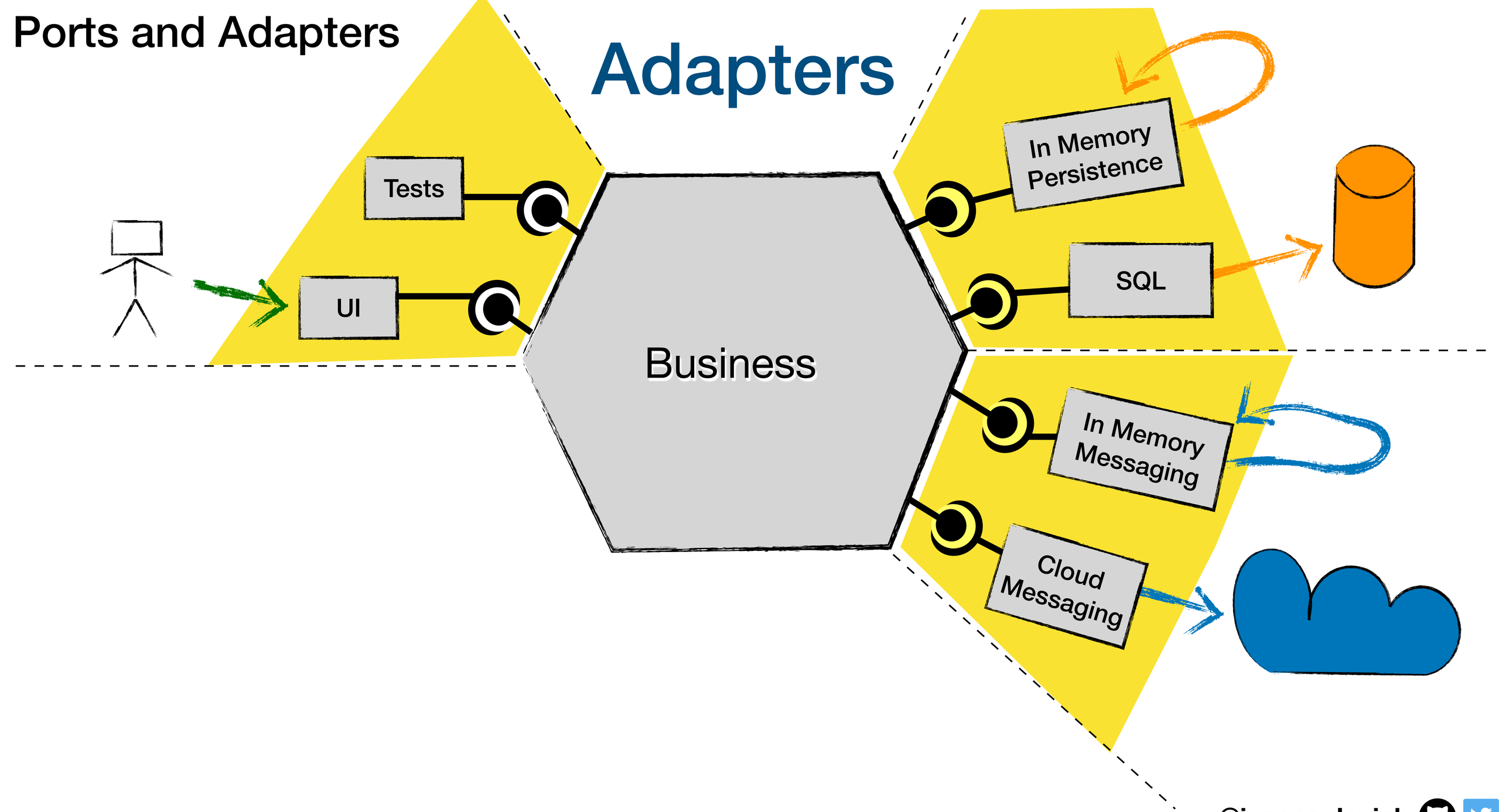
Ports

```
public interface IDepositUseCase
{
    Task Execute(DepositInput input);
}
```

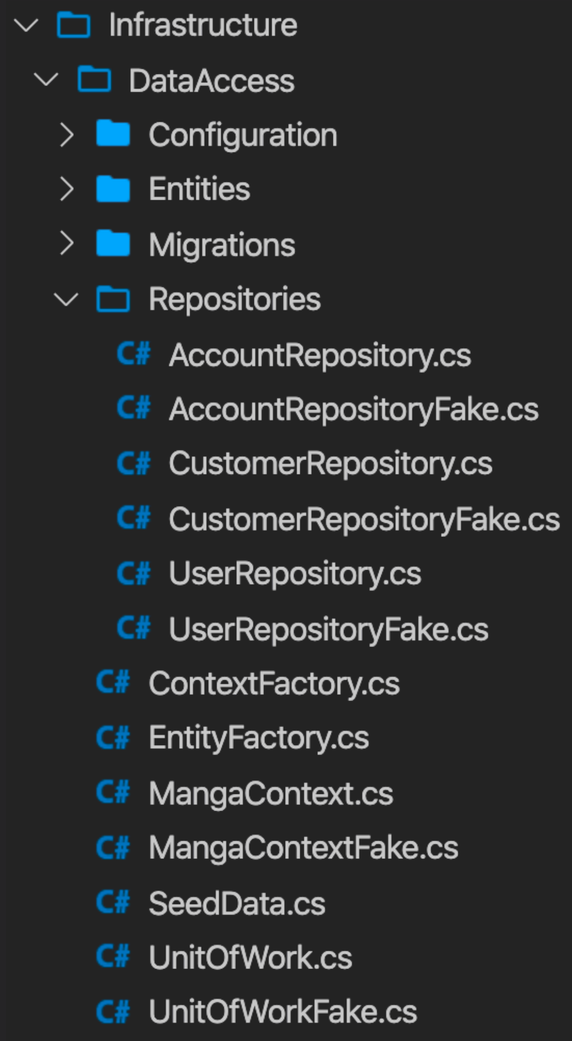
```
public interface IDepositOutputPort
{
    void Standard(DepositOutput output);
    void WriteError(string message);
    void NotFound(string message);
}
```

```
public interface IAccountRepository
{
    Task<IAccount> GetAccount(AccountId accountId);
    Task<IList<IAccount>> GetBy(CustomerId customerId);
    Task Add(IAccount account, ICredit credit);
    Task Update(IAccount account, ICredit credit);
    Task Update(IAccount account, IDebit debit);
    Task Delete(IAccount account);
}
```

Ports and Adapters

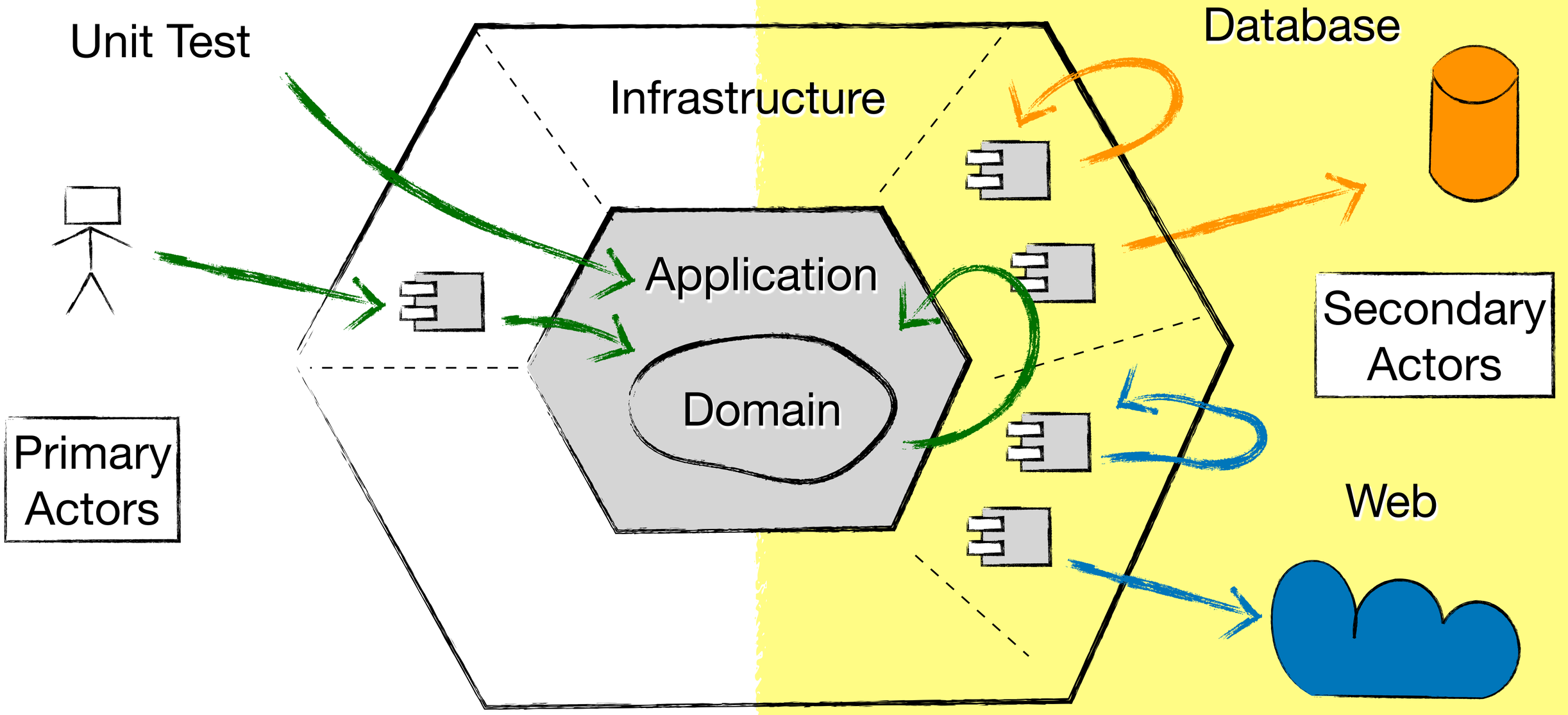


Adapters

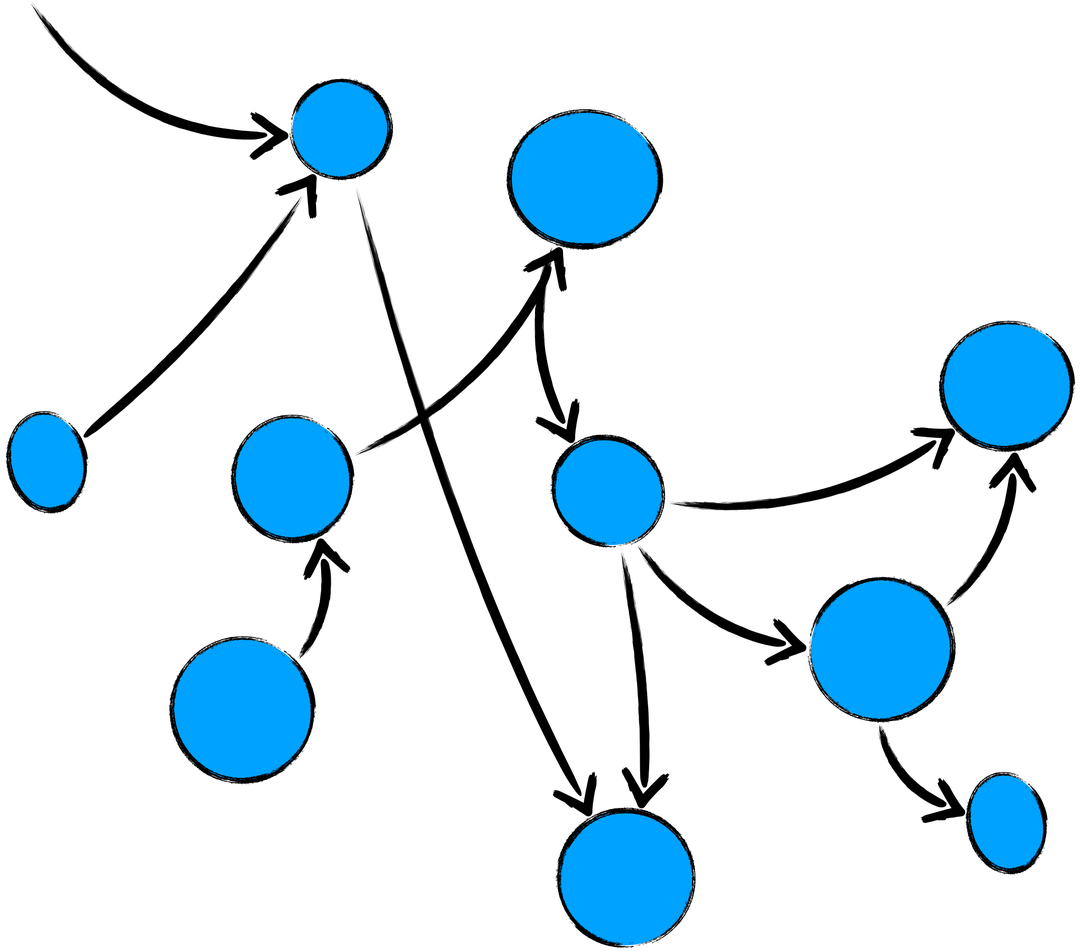



```
public sealed class AccountRepository : IAccountRepository
{
    10 references
    private readonly MangaContext _context;

    /// <summary>
    /// </summary>
    /// <param name="context"></param>
    0 references
    public AccountRepository(MangaContext context) => this._context = context ??
                                                          throw new ArgumentNullException(
                                                              nameof(context));


    /// <inheritdoc />
    2 references
    public async Task<IList<IAccount>> GetBy(CustomerId customerId)      You, 2 months ago • Design Chan
    {
        var accounts = this._context
            .Accounts
            .Where(e => e.CustomerId.Equals(customerId))
            .Select(e => (IAccount)e)
            .ToList();

        return await Task.FromResult(accounts)
            .ConfigureAwait(false);
    }

    /// <inheritdoc />
    1 reference
    public async Task Add(IAccount account, ICredit credit)
    {
        await this._context
            .Accounts
            .AddAsync((Account)account)
            .ConfigureAwait(false);

        await this._context
            .Credits
            .AddAsync((Credit)credit)
            .ConfigureAwait(false);
    }
```

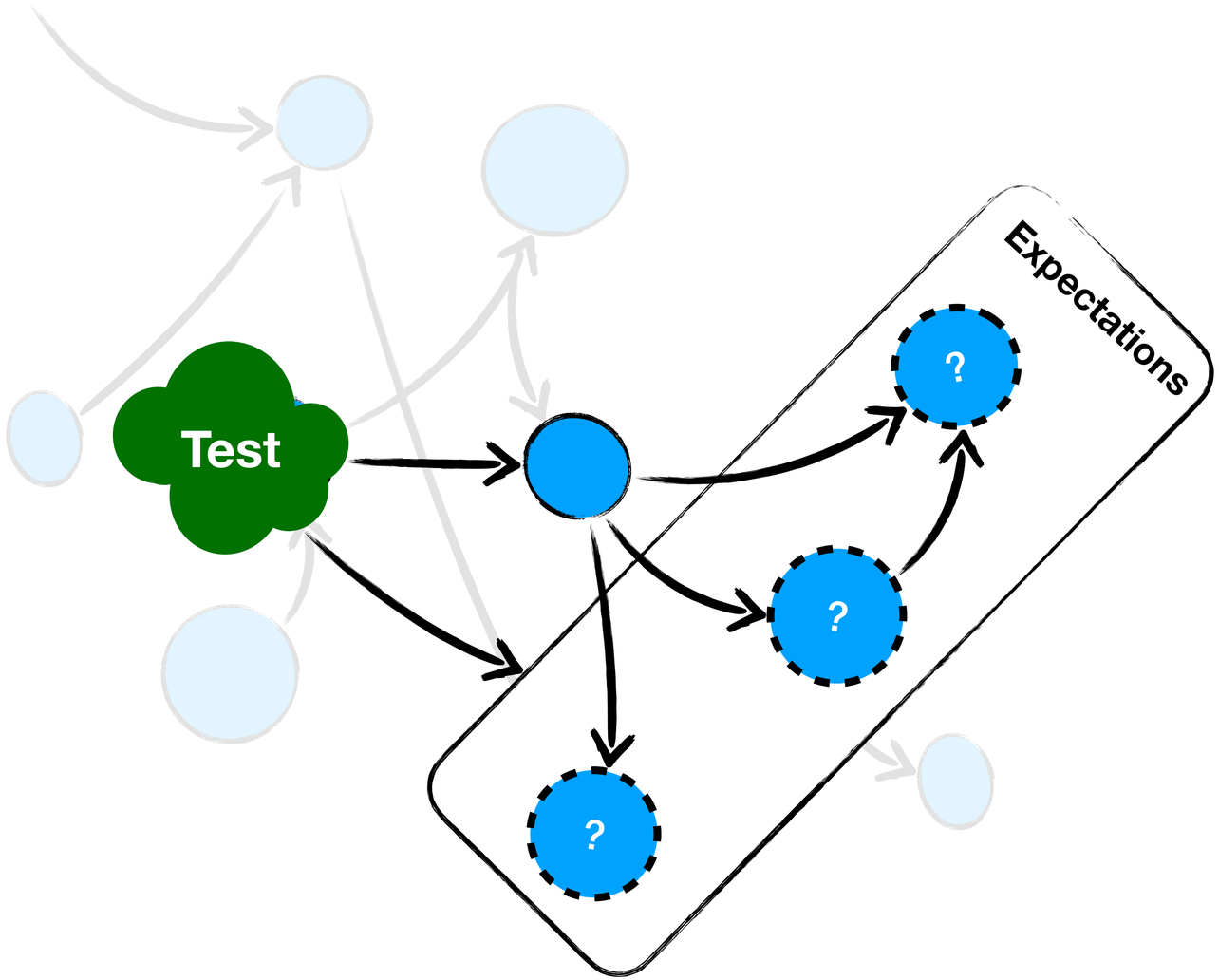
Ports and Adapters



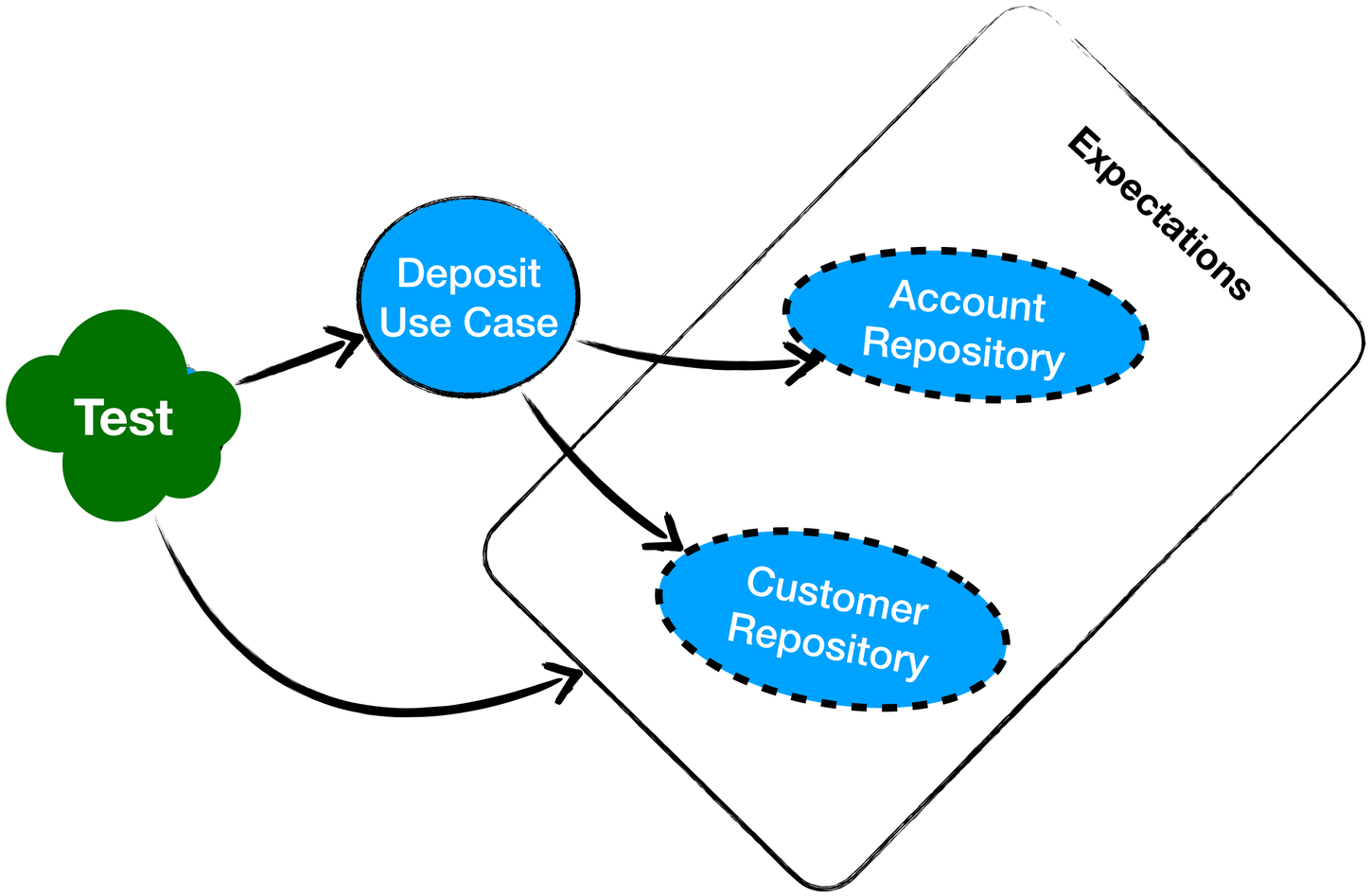
A Web of Objects



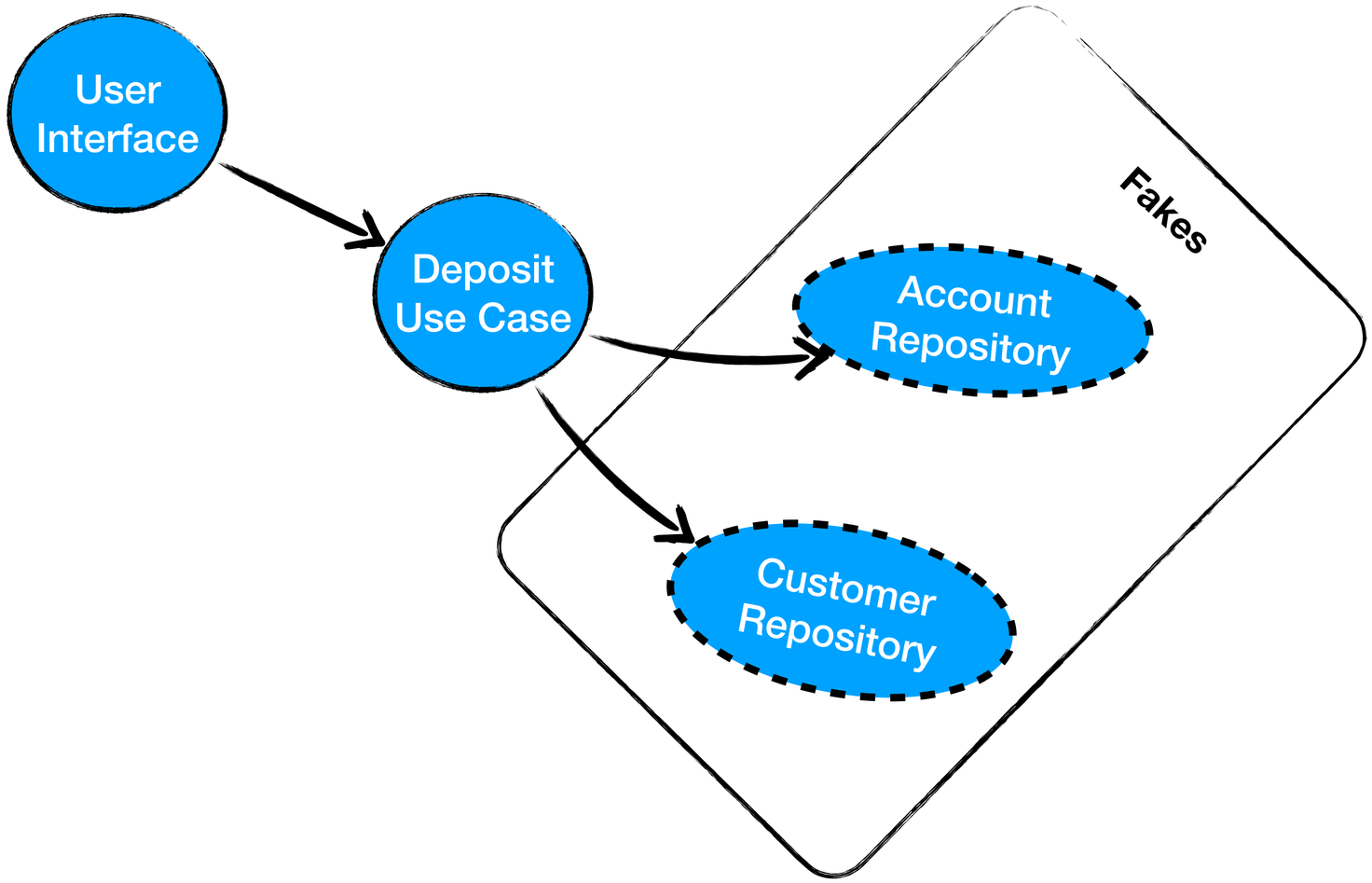
Testing



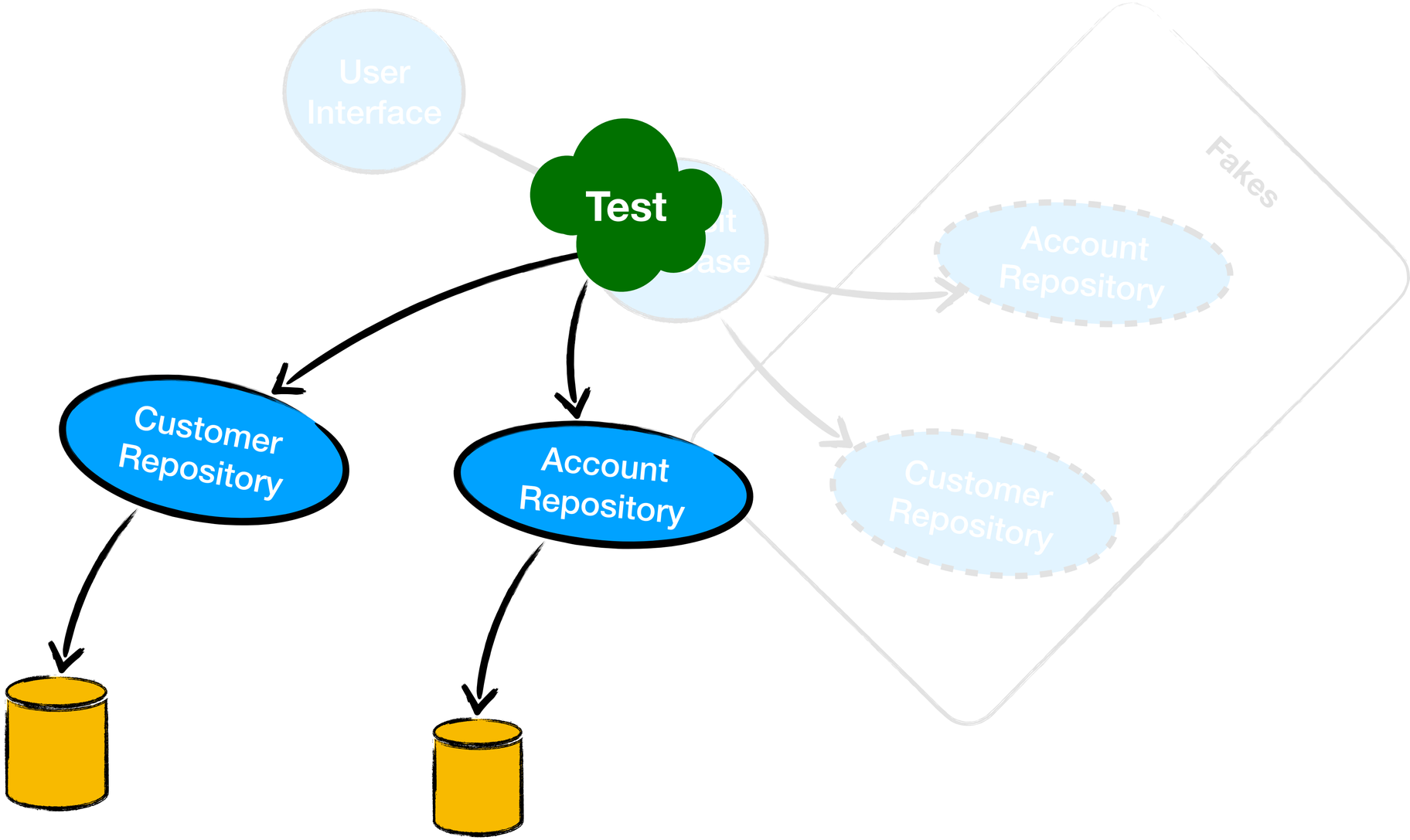
The First Test



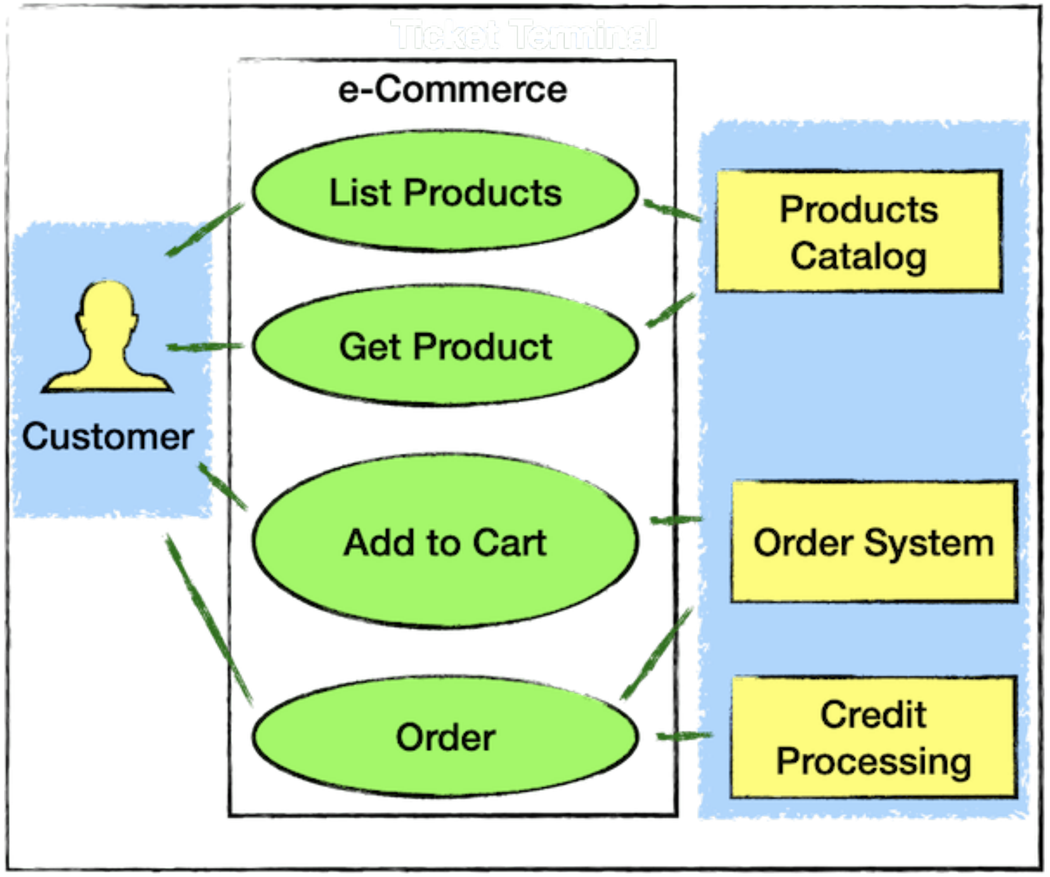
The Walking Skeleton



Integration Tests

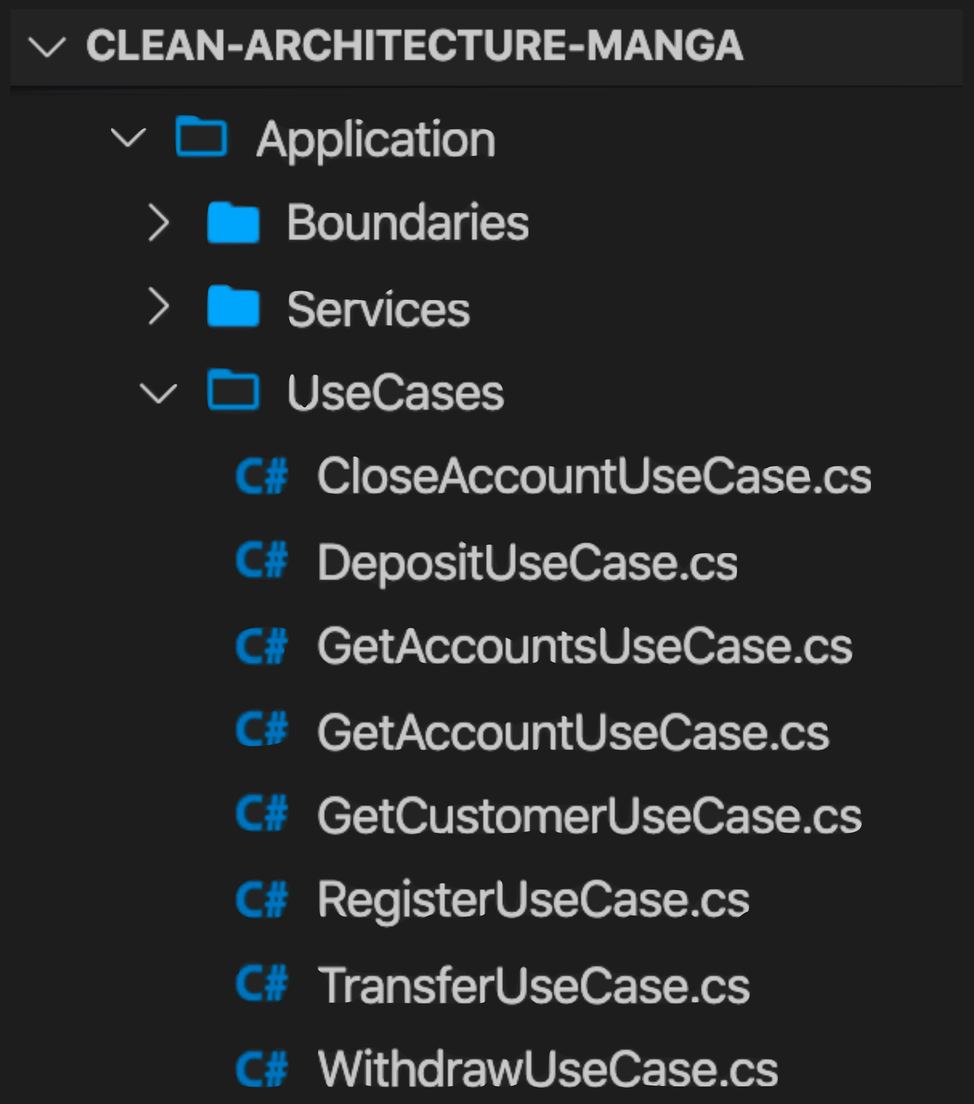


Use Cases



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

Deposit Use Case




```
public async Task Execute(DepositInput input)
{
    if (input is null)
    {
        this._depositGetAccountsOutputPort
            .WriteError(Messages.InputIsNull);
        return;
    }

    IAccount account = await this._accountRepository
        .GetAccount(input.AccountId)
        .ConfigureAwait(false);

    if (account is null)
    {
        this._depositGetAccountsOutputPort
            .NotFound(Messages.AccountDoesNotExist);
        return;
    }

    ICredit credit = await this._accountService
        .Deposit(account, input.Amount)
        .ConfigureAwait(false);

    await this._unitOfWork
        .Save()
        .ConfigureAwait(false);

    this.BuildOutput(credit, account);
}
```

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Deposit Use Case Input and Output Messages

```
public sealed class DepositInput
{
    /// <summary>
    ///     Initializes a new instance of the <see cref="DepositInput" /> class.
    /// </summary>
    /// <param name="accountId">AccountId.</param>
    /// <param name="amount">Positive amount to deposit.</param>
    5 references
    public DepositInput(
        Guid accountId,
        decimal amount)
    {
        this.AccountId = new AccountId(accountId);
        this.Amount = new PositiveMoney(amount);
    }

    /// <summary>
    ///     Gets AccountId.
    /// </summary>
    3 references
    public AccountId AccountId { get; }

    /// <summary>
    ///     Gets the Amount.
    /// </summary>
    2 references
    public PositiveMoney Amount { get; }
}
```

```
public sealed class DepositOutput
{
    /// <summary>
    ///     Initializes a new instance of the <see cref="DepositOutput" /> class.
    /// </summary>
    /// <param name="credit">Credit object.</param>
    /// <param name="updatedBalance">The updated balance.</param>
    1 reference
    public DepositOutput(
        ICredit credit,
        Money updatedBalance)
    {
        this.Transaction = credit ?? throw new ArgumentNullException(nameof(credit));
        this.UpdatedBalance = updatedBalance;
    }

    /// <summary>
    ///     Gets the Transaction object.
    /// </summary>
    3 references
    public ICredit Transaction { get; }

    /// <summary>
    ///     Gets the updated balance.
    /// </summary>
    2 references
    public Money UpdatedBalance { get; }
}
```

Deposit Use Case Request/Response

```
/// <summary>
///     The request to Deposit.
/// </summary>
1 reference | You, 3 months ago | 1 author (You)
public sealed class DepositRequest
{
    /// <summary>
    ///     Gets or sets the Account ID.
    /// </summary>
    [Required]
    1 reference
    public Guid AccourtId { get; set; } = Guid.Empty;

    /// <summary>
    ///     Gets or sets the amount to Deposit.
    /// </summary>
    [Required]
    1 reference
    public decimal Amount { get; set; } = .0M;
}
```

```
public sealed class DepositResponse
{
    /// <summary>
    ///     The Deposit response constructor.
    /// </summary>
    1 reference
    public DepositResponse(
        decimal amount,
        string description,
        DateTime transactionDate,
        decimal updatedBalance)
    {
        this.Amount = amount;
        this.Description = description;
        this.TransactionDate = transactionDate;
        this.UpdateBalance = updatedBalance;
    }

    /// <summary>
    ///     Gets amount Deposited.
    /// </summary>
    [Required]
    1 reference
    public decimal Amount { get; }

    /// <summary>
    ///     Gets description.
    /// </summary>
    [Required]
    1 reference
    public string Description { get; }

    /// <summary>
    ///     Gets transaction Date.
    /// </summary>
    [Required]
    1 reference
    public DateTime TransactionDate { get; }

    /// <summary>
    ///     Gets updated Balance.
    /// </summary>
    [Required]
    1 reference
    public decimal UpdateBalance { get; }
}
```

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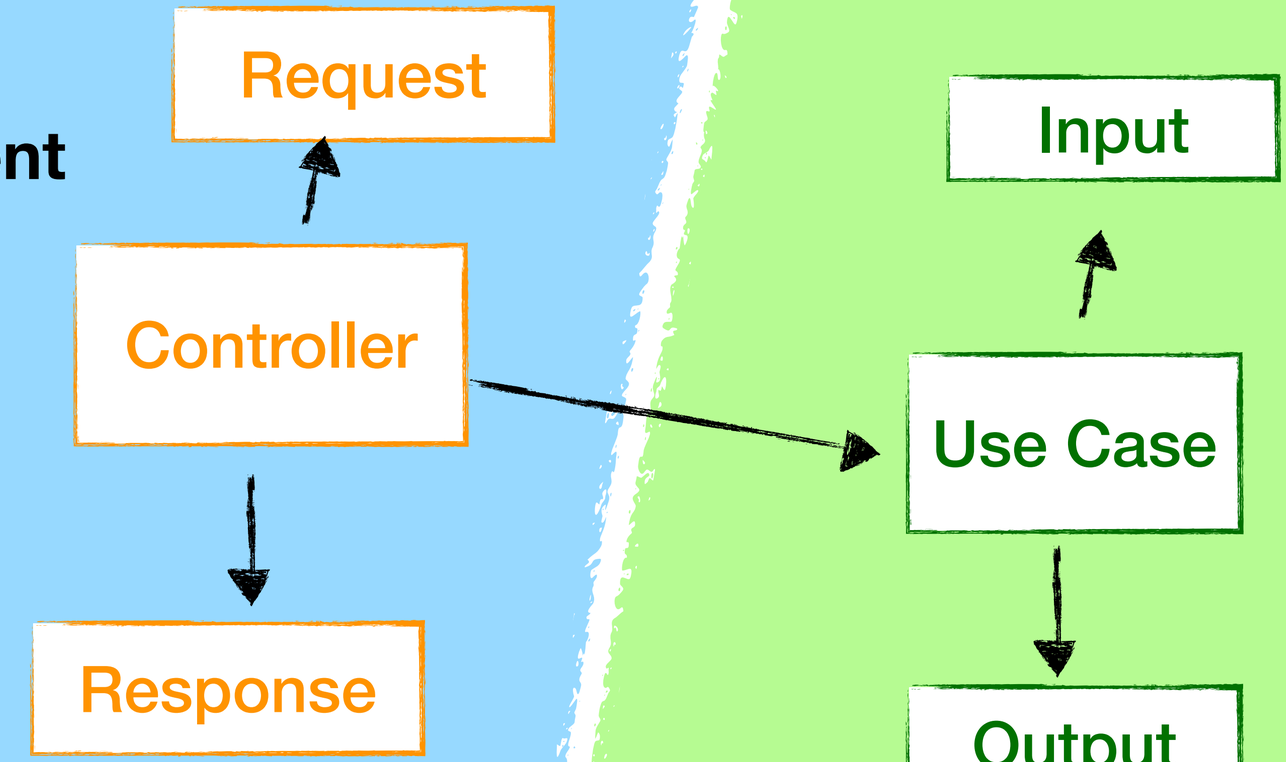
- Concrete
- Specific
- Unstable
- Inconsistent



- Abstract
- General
- Stable
- Consistent

User Interface

Core

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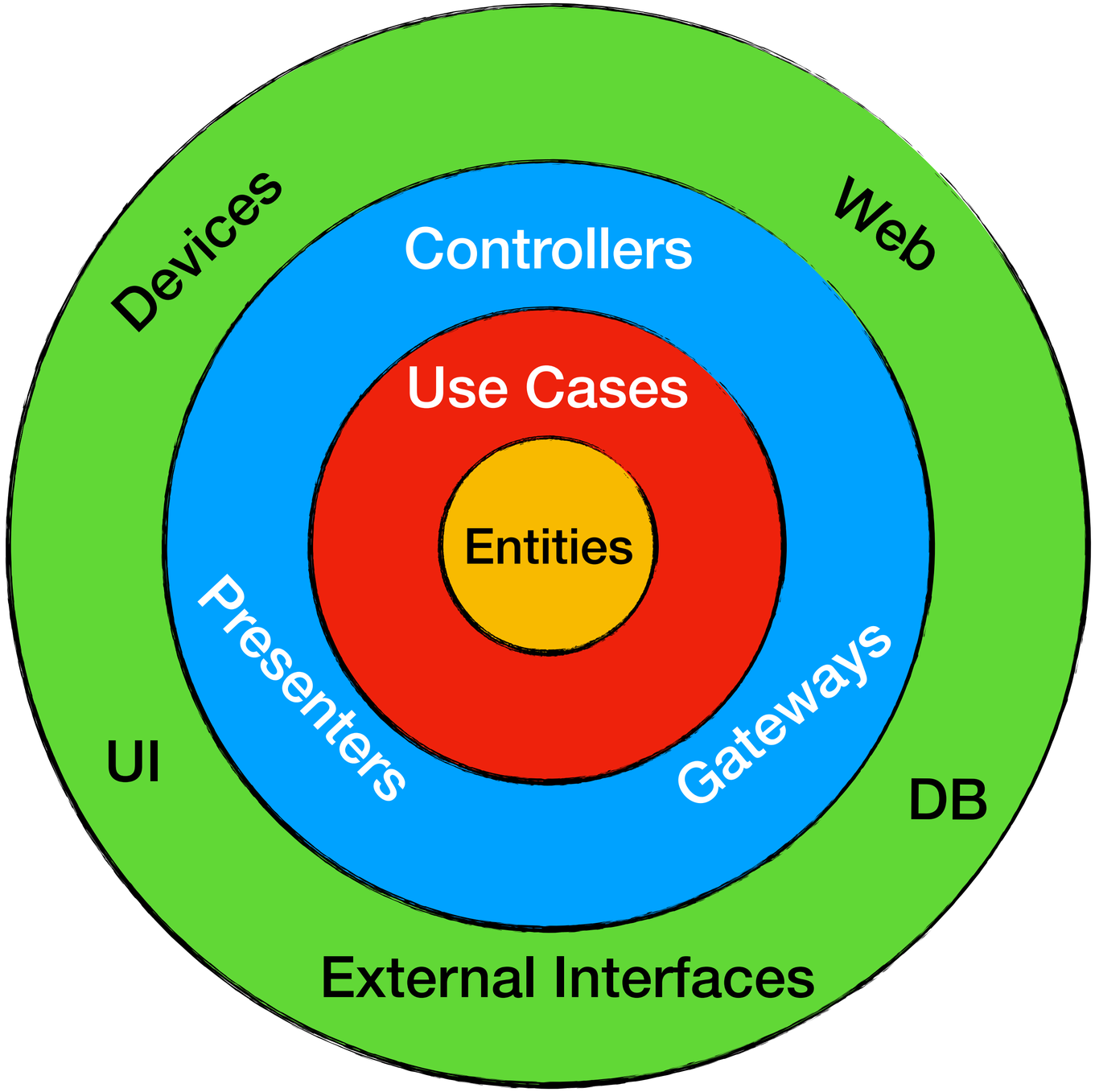
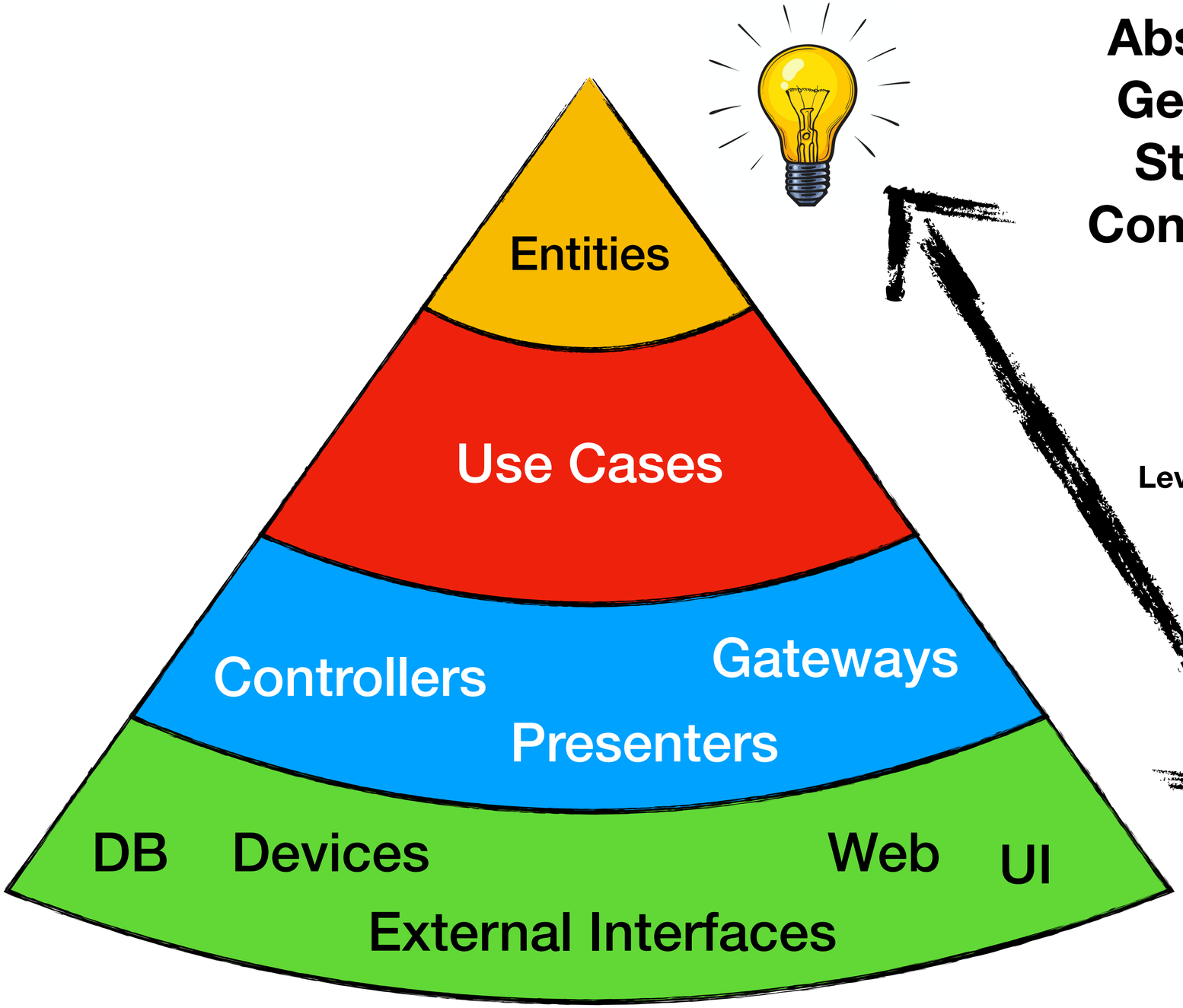
Object-Oriented Design Principles

Clean Architecture



- Abstractness increases with stability.
- Modules depend in the direction of stability.
- Classes that change together are packaged together.

Clean Architecture

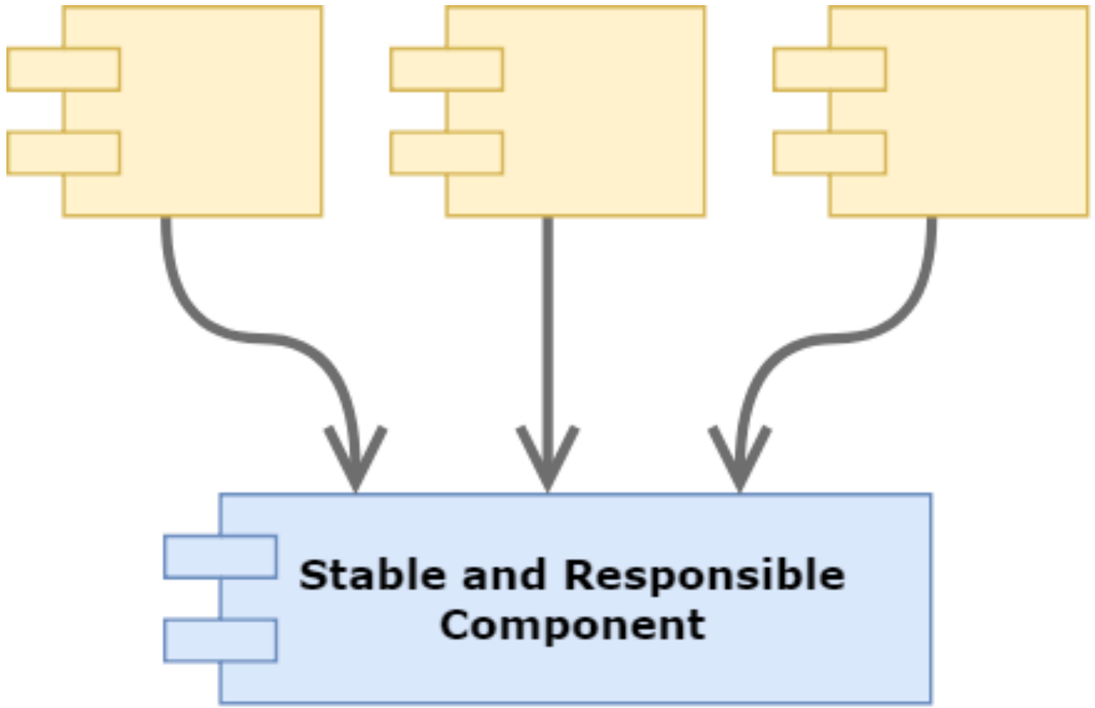


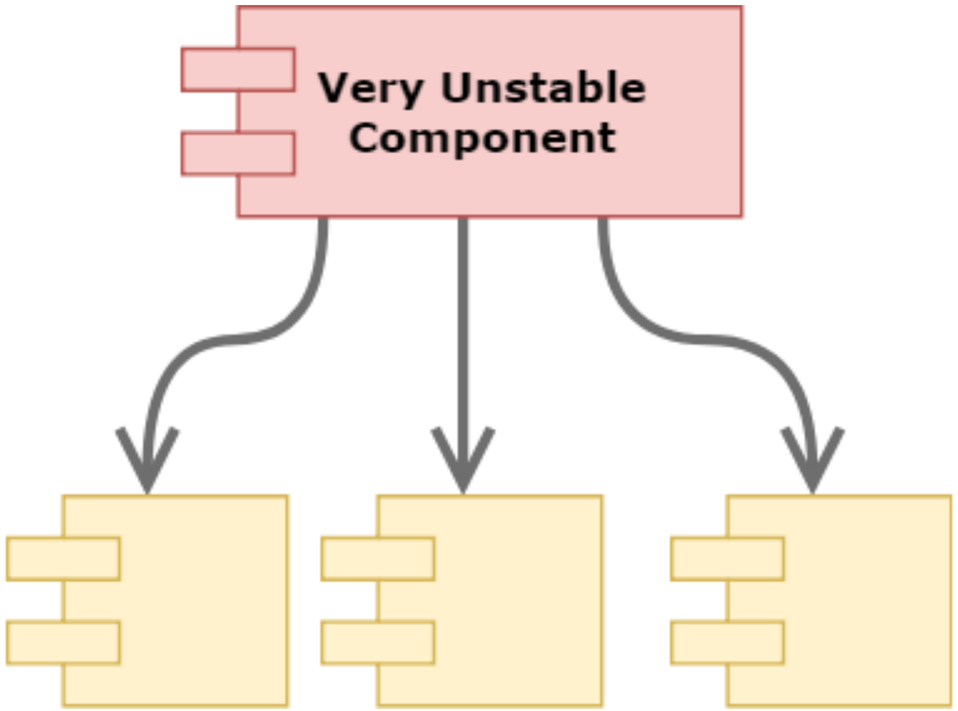
**Abstract,
General,
Stable,
Consistent**

Level

**Concrete,
Specific,
Unstable,
Inconsistent**

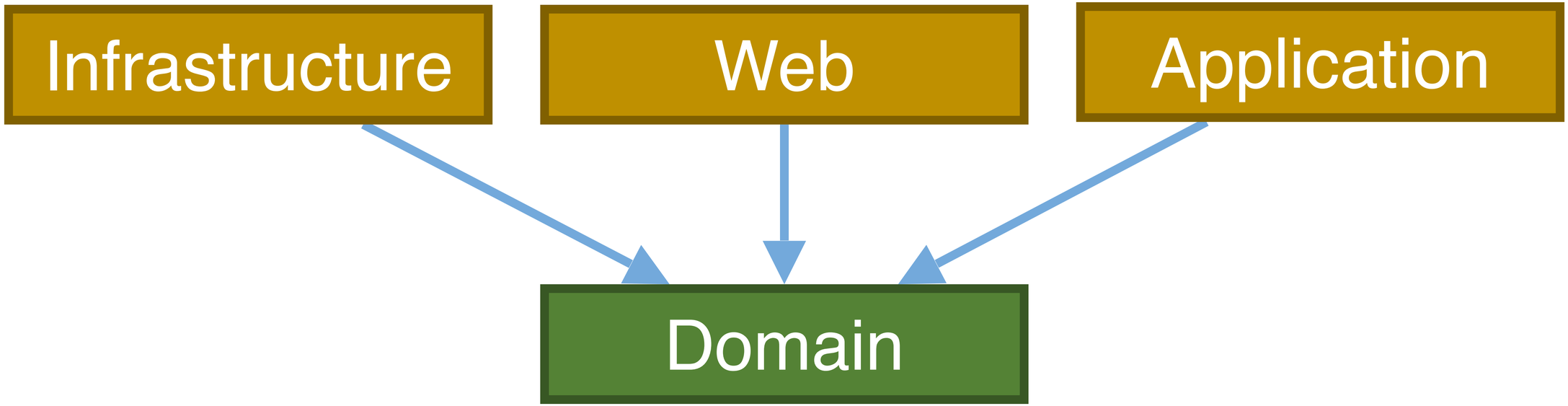
The Stable Dependencies Principle[1]



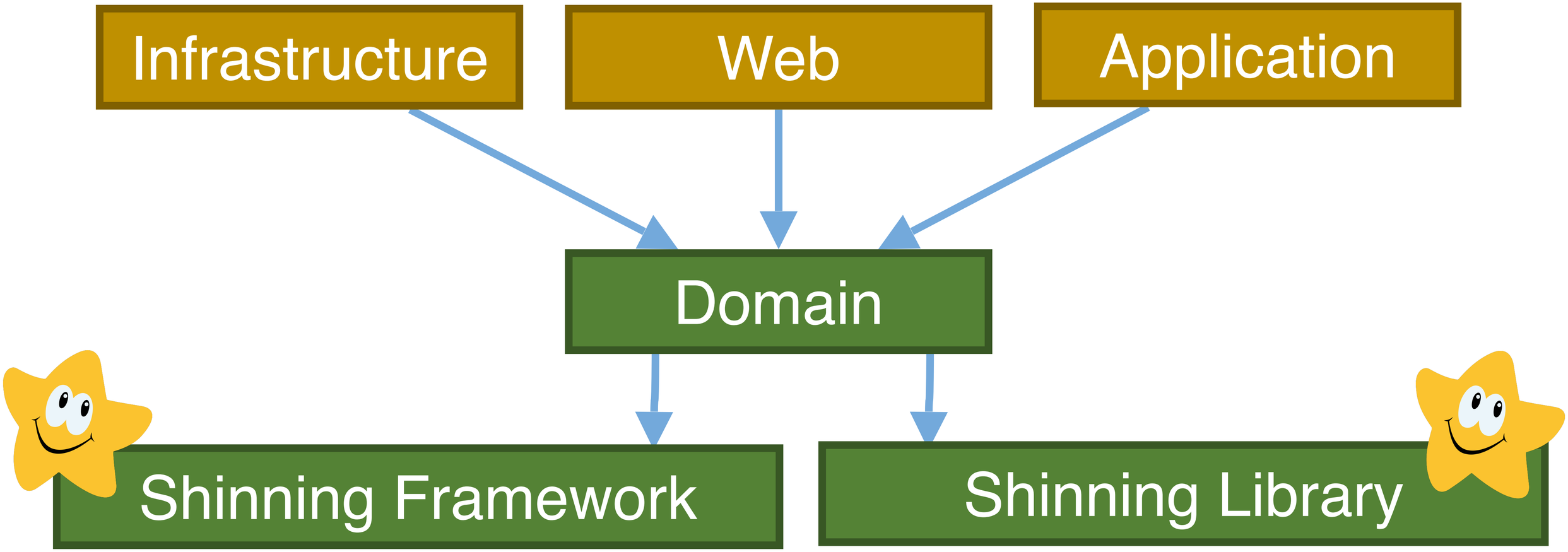


[1]Clean Architecture, Robert C. Martin, 2017

The Stable Dependencies Principle



The Stable Dependencies Principle



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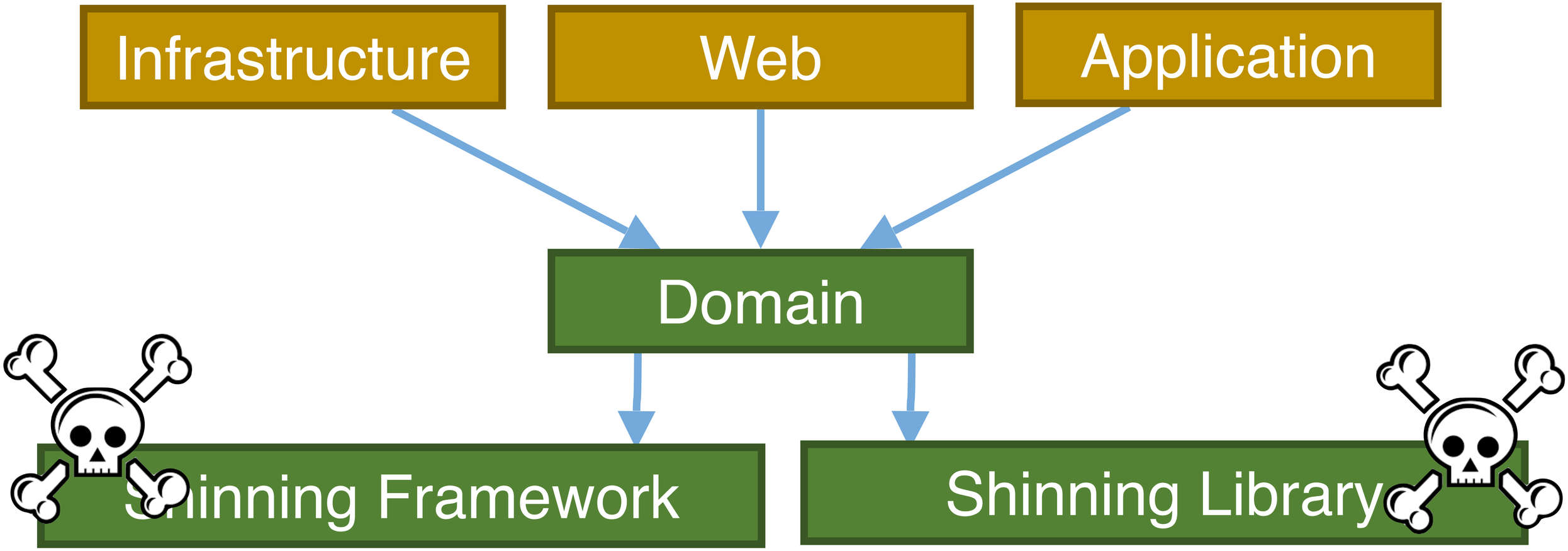
The Stable Dependencies Principle



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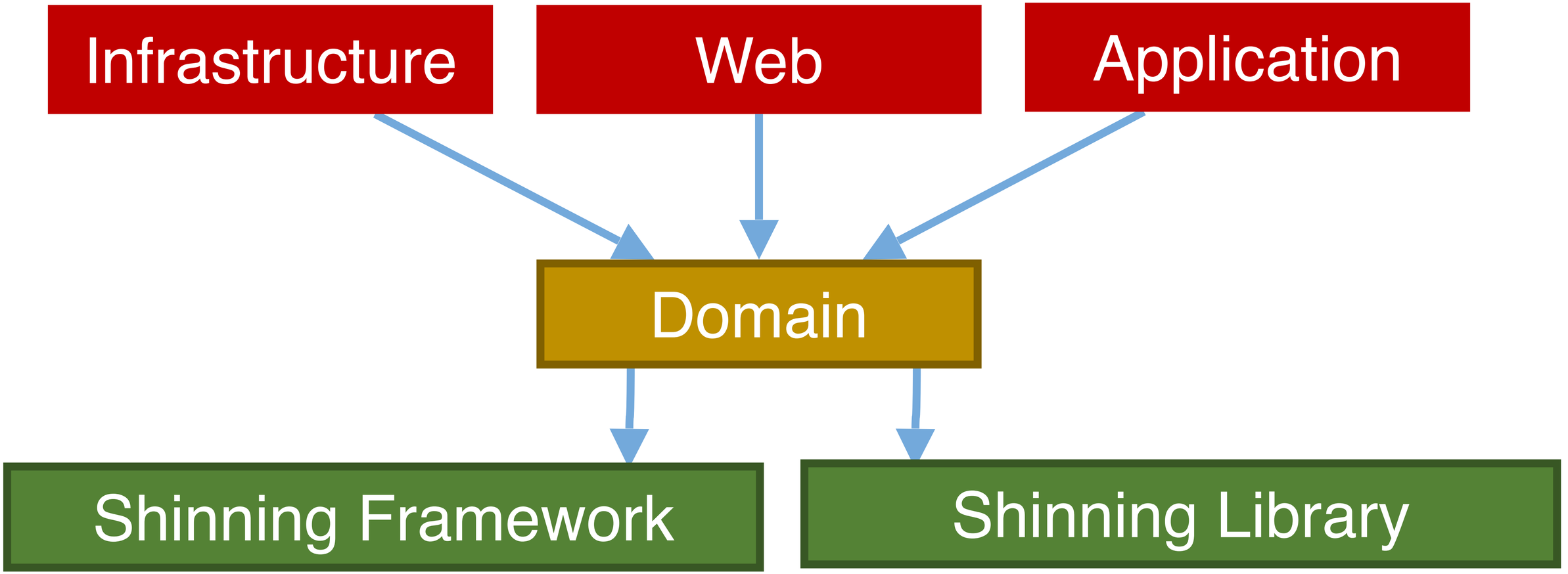
The Stable Dependencies Principle



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Walkthrough an Use Case

```
public sealed class AccountsController : ControllerBase
{
    /// <summary>
    ///     Deposit on an account.
    /// </summary>
    /// <response code="200">The updated balance.</response>
    /// <response code="400">Bad request.</response>
    /// <response code="500">Error.</response>
    /// <param name="mediator"></param>
    /// <param name="presenter"></param>
    /// <param name="request">The request to deposit.</param>
    /// <returns>The updated balance.</returns>
    [Authorize]
    [HttpPatch("Deposit")]
    [ProducesResponseType(StatusCodes.Status200OK, Type = typeof(DepositResponse))]
    [ProducesResponseType(StatusCodes.Status400BadRequest)]
    [ProducesResponseType(StatusCodes.Status500InternalServerError)]
    0 references
    public async Task<IActionResult> Deposit(
        [FromServices] IMediator mediator, [FromServices] DepositPresenter presenter,
        [FromForm][Required] DepositRequest request)
    {
        var input = new DepositInput(request.AccountId, request.Amount);
        await mediator.PublishAsync(input)
            .ConfigureAwait(false);
        return presenter.ViewModel;
    }
}
```

Controller

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Walkthrough an Use Case

```
public async Task Execute(DepositInput input)
{
    if (input is null)
    {
        this._depositOutputPort
            .WriteError(Messages.InputIsNull);
        return;
    }

    IAccount account = await this._accountRepository
        .GetAccount(input.AccountId)
        .ConfigureAwait(false);

    if (account is null)
    {
        this._depositOutputPort
            .NotFound(Messages.AccountDoesNotExist);
        return;
    }

    ICredit credit = await this._accountService
        .Deposit(account, input.Amount)
        .ConfigureAwait(false);

    await this._unitOfWork
        .Save()
        .ConfigureAwait(false);

    this.BuildOutput(credit, account);
}

1 reference
private void BuildOutput(ICredit credit, IAccount account)
{
    var output = new DepositOutput(
        credit,
        account.GetCurrentBalance());

    this._depositOutputPort.Standard(output);
}
```

Use Case

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Walkthrough an Use Case

```
public async Task<IAccount> GetAccount(AccountId id)
{
    Account account = await this._context
        .Accounts
        .Where(a => a.Id.Equals(id))
        .SingleOrDefaultAsync()
        .ConfigureAwait(false);

    if (account is null)
    {
        return null!;
    }

    var credits = this._context
        .Credits
        .Where(e => e.AccountId.Equals(id))
        .ToList();

    var debits = this._context
        .Debits
        .Where(e => e.AccountId.Equals(id))
        .ToList();

    account.Credits
        .AddRange(credits);
    account.Debits
        .AddRange(debits);

    return account;
}
```

Repository

Walkthrough an Use Case

```
public async Task Execute(DepositInput input)
{
    if (input is null)
    {
        this._depositOutputPort
            .WriteError(Messages.InputIsNull);
        return;
    }

    IAccount account = await this._accountRepository
        .GetAccount(input.AccountId)
        .ConfigureAwait(false);

    if (account is null)
    {
        this._depositOutputPort
            .NotFound(Messages.AccountDoesNotExist);
        return;
    }

    ICredit credit = await this._accountService
        .Deposit(account, input.Amount)
        .ConfigureAwait(false);

    await this._unitOfWork
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    this.BuildOutput(credit, account);
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}
```

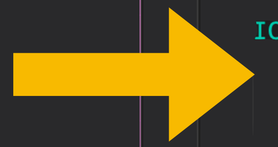

Use Case

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Walkthrough an Use Case

Domain Service

```
public async Task<ICredit> Deposit(IAccount account, PositiveMoney amount)
{
    if (account is null)
    {
        throw new ArgumentNullException(nameof(account));
    }

    ICredit credit = account.Deposit(this._accountFactory, amount);
    await this._accountRepository.Update(account, credit)
        .ConfigureAwait(false);

    return credit;
}
```

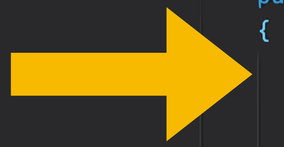
Walkthrough an Use Case

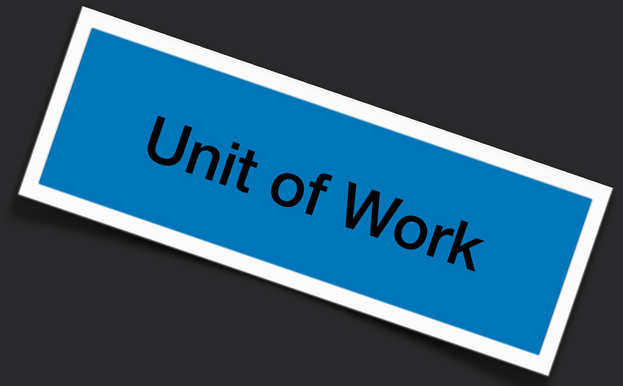
Repository

```
public async Task Update(IAccount account, ICredit credit) => await this._context
    .Credits
    .AddAsync((Credit)credit)
    .ConfigureAwait(false);
```

Walkthrough an Use Case

```
public sealed class UnitOfWork : IUnitOfWork, IDisposable
{
    3 references
    private readonly MangaContext _context;
    2 references
    private bool _disposed;

    0 references
    public UnitOfWork(MangaContext context) => this._context = context;

    /// <inheritdoc />
    public void Dispose()
    {
        this.Dispose(true);
        GC.SuppressFinalize(this);
    }

    /// <inheritdoc />
    4 references
    public async Task<int> Save()
    {
        int affectedRows = await this._context
            .SaveChangesAsync()
            .ConfigureAwait(false);
        return affectedRows;
    }

    private void Dispose(bool disposing)
    {
        if (!this._disposed)
        {
            if (disposing)
            {
                this._context.Dispose();
            }
        }

        this._disposed = true;
    }
}
```





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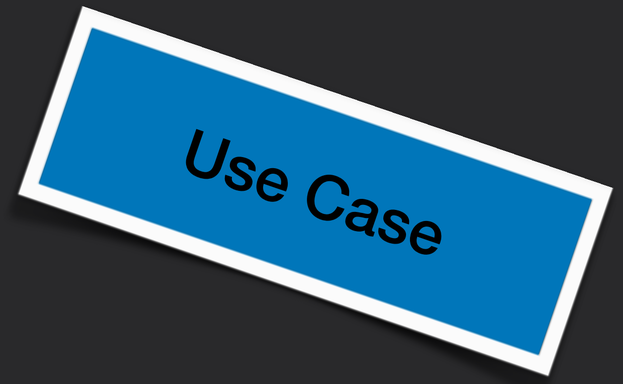
Walkthrough an Use Case

```
public async Task Execute(DepositInput input)
{
    if (input is null)
    {
        this._depositOutputPort
            .WriteError(Messages.InputIsNull);
        return;
    }

    IAccount account = await this._accountRepository
        .GetAccount(input.AccountId)
        .ConfigureAwait(false);

    if (account is null)
    {
        this._depositOutputPort
            .NotFound(Messages.AccountDoesNotExist);
        return;
    }

    ICredit credit = await this._accountService
        .Deposit(account, input.Amount)
        .ConfigureAwait(false);

    await this._unitOfWork
        .Save()
        .ConfigureAwait(false);

    this.BuildOutput(credit, account);
}

1 reference
private void BuildOutput(ICredit credit, IAccount account)
{
    var output = new DepositOutput(
        credit,
        account.GetCurrentBalance());

    this._depositOutputPort.Standard(output);
}
```

Walkthrough an Use Case




```
public sealed class DepositPresenter : IDepositOutputPort
{
    /// <summary>
    /// </summary>
    /// <returns></returns>
    4 references
    public IActionResult ViewModel { get; private set; } = new NoContentResult();

    /// <summary>
    /// </summary>
    /// <param name="message"></param>
    8 references
    public void NotFound(string message) => this.ViewModel = new NotFoundObjectResult(message);

    /// <summary>
    /// </summary>
    /// <param name="output"></param>
    8 references
    public void Standard(DepositOutput output)      You, 7 days ago • Fix Naming (#201)
    {
        var depositEntity = (Credit)output.Transaction;
        var depositResponse = new DepositResponse(
            depositEntity.Amount.ToMoney().ToDecimal(),
            Credit.Description,
            depositEntity.TransactionDate,
            output.UpdatedBalance.ToDecimal());
        this.ViewModel = new ObjectResult(depositResponse);
    }

    /// <summary>
    /// </summary>
    /// <param name="message"></param>
    8 references
    public void WriteError(string message) => this.ViewModel = new BadRequestObjectResult(message);
}
```

Walkthrough an Use Case

```
public sealed class AccountsController : ControllerBase
{
    /// <summary>
    ///     Deposit on an account.
    /// </summary>
    /// <response code="200">The updated balance.</response>
    /// <response code="400">Bad request.</response>
    /// <response code="500">Error.</response>
    /// <param name="mediator"></param>
    /// <param name="presenter"></param>
    /// <param name="request">The request to deposit.</param>
    /// <returns>The updated balance.</returns>
    [Authorize]
    [HttpPatch("Deposit")]
    [ProducesResponseType(StatusCodes.Status200OK, Type = typeof(DepositResponse))]
    [ProducesResponseType(StatusCodes.Status400BadRequest)]
    [ProducesResponseType(StatusCodes.Status500InternalServerError)]
    0 references
    public async Task<IActionResult> Deposit(
        [FromServices] IMediator mediator, [FromServices] DepositPresenter presenter,
        [FromForm][Required] DepositRequest request)
    {
        var input = new DepositInput(request.AccountId, request.Amount);
        await mediator.PublishAsync(input)
            .ConfigureAwait(false);
        return presenter.ViewModel;
    }
}
```

Controller

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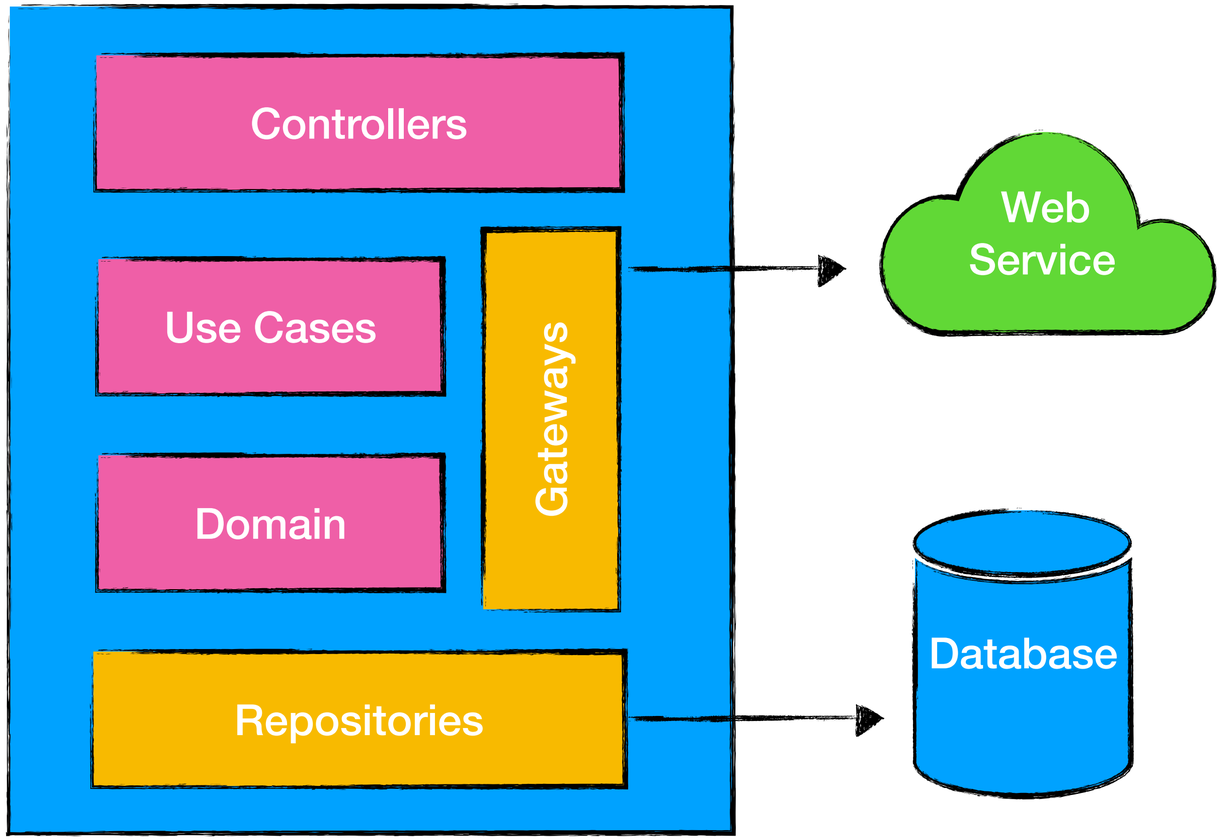
Testing Strategy

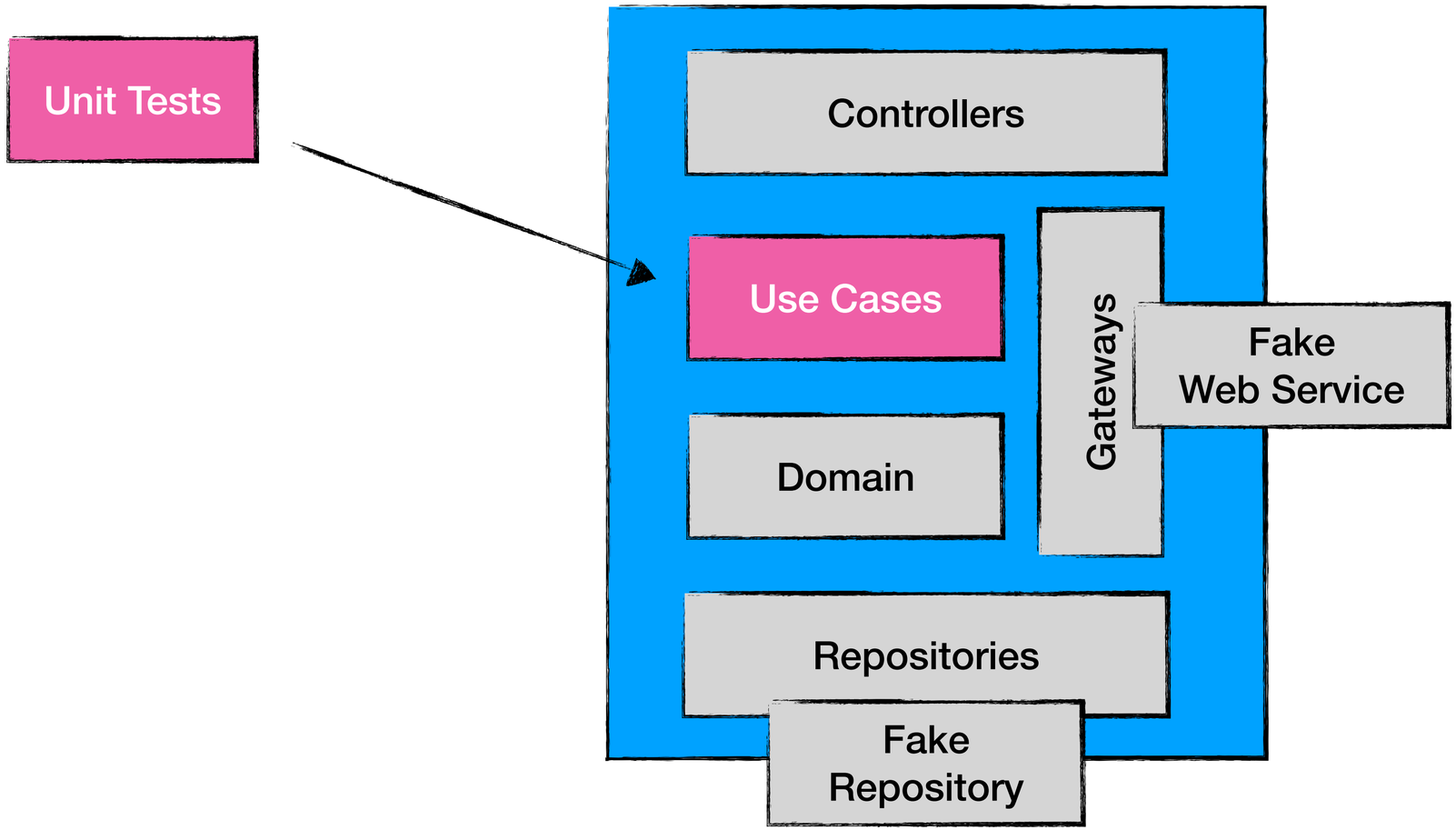
Tests Overview

	In Process	Out of Process
Memory	Within the application memory	Reads I/O. Secondary memory.
Speed	Fast	Slow
Setup Effort	Easy to design a variety of cases	Requires extensive setup
Samples	Use Cases, Domain	Repositories, Services

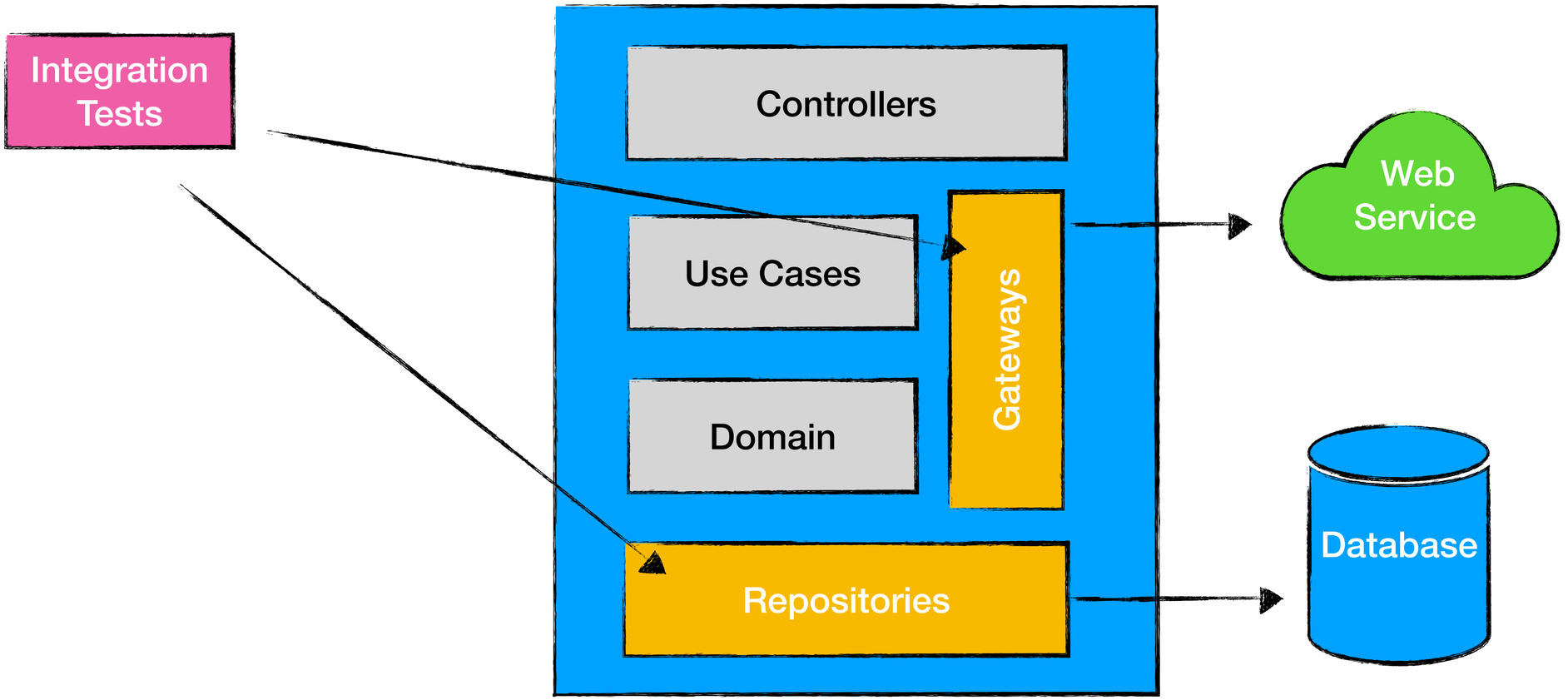
Software Skeleton



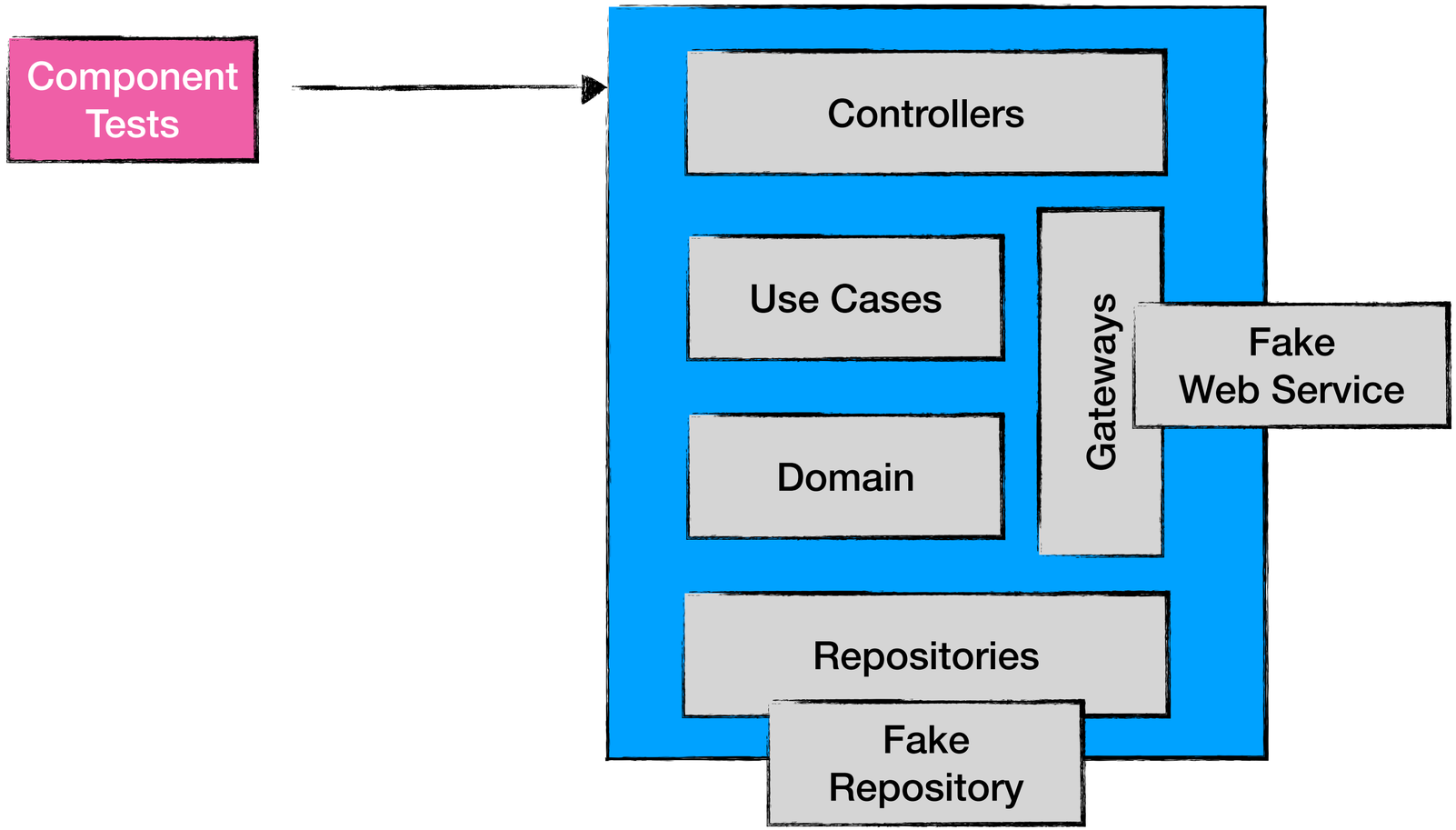
Unit Tests


Unit Tests
Controllers
Use Cases
Gateways
Fake
Web Service
Domain
Repositories
Fake
Repository

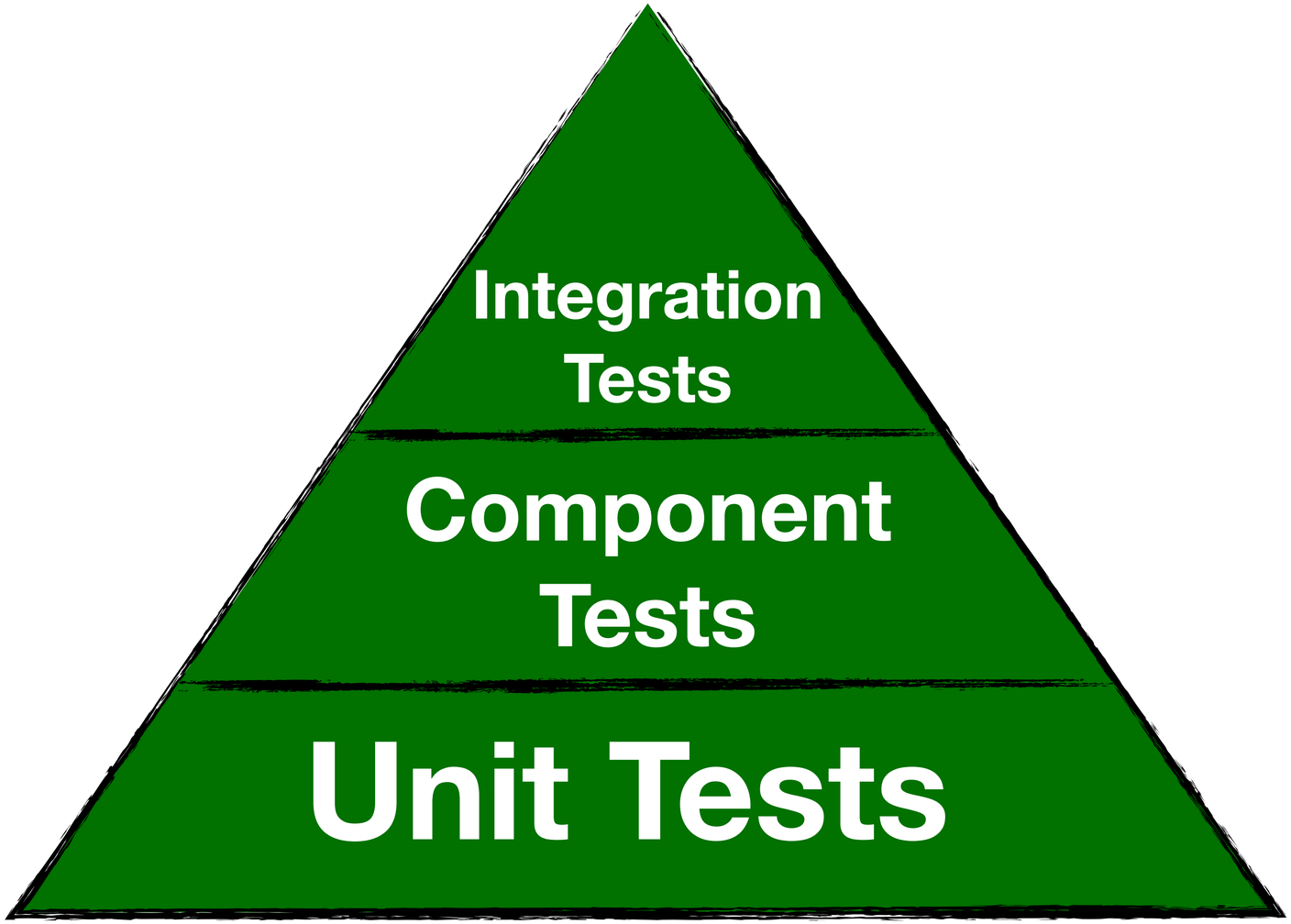
Integration Tests



Component Tests



Test Pyramid



Wrapping up Clean Architecture

- Clean Architecture is about usage and the use cases are the central organizing principle.
- Use cases implementation are guided by tests.
- The User Interface and Persistence are designed to fulfil the core needs (not the opposite!).
- Defer decisions by implementing the simplest component first.

References

https://github.com/ivanpaulovich/clean-architecture-manga

Contributors ✨

Thanks goes to these wonderful people (emoji key):

 Ivan Paulovich	 Petr Sedláček	 Gus	 arulconsultant	 Guilherme Silva
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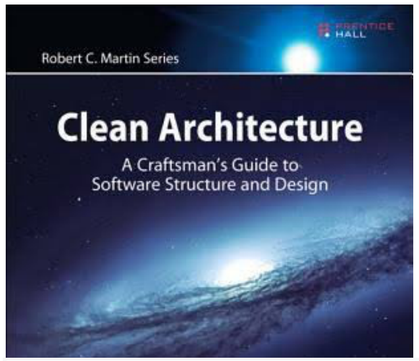
https://cleancoders.com



Clean Code: Component Design
Clean Code: SOLID Principles
Clean Code: Fundamentals

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#CleanArchitectureManga 🍄

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♡ Sponsor

Tech Lead, Software Engineer, 20+ GitHub projects about Clean Architecture, SOLID, DDD and TDD. Speaker/Streamer. Microsoft rMVP.

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Ask me 2 questions!

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CleanArchitectureVSCodeSnippets

Clean Architecture C# Snippets for Visual Studio Code

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FluentMediator

FluentMediator is an unobtrusive library that allows developers to build custom pipelines for Commands, Queries and Events.

C# ☆ 83 11

clean-architecture-manga Template

🌀 Clean Architecture with .NET Core 3.1, C# 8 and React+Redux. Use cases as central organizing structure, completely testable, decoupled from frameworks

C# ☆ 1.6k 304

todo

✅ Commad-Line Task management with storage on your GitHub 🔥

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event-sourcing-jambo

An Hexagonal Architecture with DDD + Aggregates + Event Sourcing using .NET Core, Kafka e MongoDB (Blog Engine)

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