

Layered Architecture

Software Architecture

Richard Thomas

February 24, 2025

Ogres are like onions.

Ogres have layers, onions have layers...
You get it? We both have layers.

- *Shrek*

In the beginning...

There was the big ball of mud *[Foote and Yoder, 1997]*



Figure: Image from "How to Avoid Spaghetti Code" [Gulsah, 2020].

Problem

Any change can affect any other part of the software.

“Solution”

Modularity



Problem

Lack of discipline lets any module communicate with any other module.



2

²From <https://pixabay.com/photos/lego-to-play-to-build-module-1629073/>.

“Solution”

Layered Architecture



Figure: *Traditional* 4-tier, layered architecture.



Figure: *Traditional* 4-tier, layered architecture.



Figure: *Traditional* 4-tier, layered architecture.



Figure: *Traditional* 4-tier, layered architecture.



Figure: *Traditional* 4-tier, layered architecture.

Question

Can you identify an example of layered architecture?

Question

Can you identify an example of layered architecture?

Answer

Pick any website.

Definition 0. Layer Isolation Principle

Layers should not depend on implementation details of another layer. Layers should only communicate through well defined interfaces (*contracts*).

Definition 0. Neighbour Communication Principle

Components can communicate across layers only through directly neighbouring layers.

Definition 0. Downward Dependency Principle

Higher-level layers depend on lower layers, but lower-level layers do not depend on higher layers.

Definition 0. Upward Notification Principle

Lower layers communicate with higher layers using general interfaces, callbacks and/or events. Dependencies are minimised by not relying on specific details published in a higher layer's interface.

Definition 0. Sidecar Spanning Principle

A sidecar layer contains interfaces that support complex communication between layers (e.g. design patterns like the observer pattern) or external services (e.g. a logging framework).

Good architectural design...

Applies these principles to deliver simple, modular designs that support modifiability.



Figure: J2EE layered architecture (from *Requirements Analysis and System Design* [Maciaszek, 2007]).



Figure: PCBMER layered architecture with sidecars (adapted from *Requirements Analysis and System Design* [Maciaszek, 2007]).

PCBMER Layers

Presentation Displays bean data, implements UI logic, and updates beans.

PCBMER Layers

Presentation Displays bean data, implements UI logic, and updates beans.

Controller Implements application specific logic and instantiates beans.

PCBMER Layers

Presentation Displays bean data, implements UI logic, and updates beans.

Controller Implements application specific logic and instantiates beans.

Bean Data transfer objects used by the Presentation layer.

PCBMER Layers

Presentation Displays bean data, implements UI logic, and updates beans.

Controller Implements application specific logic and instantiates beans.

Bean Data transfer objects used by the Presentation layer.

Mediator Manages business transactions, enforces business rules, instantiates business objects in the Entity layer, and manages the entity memory cache.

PCBMER Layers

Presentation Displays bean data, implements UI logic, and updates beans.

Controller Implements application specific logic and instantiates beans.

Bean Data transfer objects used by the Presentation layer.

Mediator Manages business transactions, enforces business rules, instantiates business objects in the Entity layer, and manages the entity memory cache.

Entity Classes representing persistent business objects.

PCBMER Layers

Presentation Displays bean data, implements UI logic, and updates beans.

Controller Implements application specific logic and instantiates beans.

Bean Data transfer objects used by the Presentation layer.

Mediator Manages business transactions, enforces business rules, instantiates business objects in the Entity layer, and manages the entity memory cache.

Entity Classes representing persistent business objects.

Resource Manages interactions with external persistent data sources.

References

[Foote and Yoder, 1997] Foote, B. and Yoder, J. (1997).

Big ball of mud.

Pattern languages of program design, 4:654–692.

[Gulsah, 2020] Gulsah (2020).

How to avoid spaghetti code.

<https://tech.zensurance.com/posts/spaghetti-code>.

note = "Accessed: 2022-02-18".

[Maciaszek, 2007] Maciaszek, L. A. (2007).

Requirements Analysis and System Design.

Addison-Wesley Harlow, 3rd edition.