Layered Architecture

CS 752 Software Architecture and Design Practices

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Ref: Software Architecture Patterns by Mark Richards

What constitutes a “Layer”?

- “Layered Architecture” is a software architecture style / pattern
- Layer is a collection of services / functions
- Layer has to be cohesive
- No overlap with other layers (“Separation”)
- There has to be a well-defined list of concerns for each layer
  - Logical
  - Temporal
  - Procedural
  - I/O oriented
  - Sequential
  - Functional
- Can depend on other layers or be a dependency for other layers (“provider” and “consumer”)
- Layers can “OPEN” or “CLOSED”

Closed and Open Layers

Closed Layer

- A layer is be considered to “closed” if it interaction is permitted **only across adjacent layers**

Open layer

- A layer is considered to be “open” if it provides shared services accessible **across all layers**

EXAMPLE LAYERED ARCHITECTURE

N-Tier Architecture

- Choice of different cohesion forces leads to different types of layered architecture
- N-Tier Architecture is a type of layered architecture in which FUNCTIONAL forces are dominant
- The layers in N-Tier Architecture are strictly CLOSED
- Following is an example of **Web Application N-Tier Architecture**

1-Tier Architecture

Tier	Technology	Tools
1-Tier System (Monolithic Design)	Dumb Terminals Mainframe servers Legacy Databases	COBOL IMS Etc.

2-Tier Architecture

Tiers	Technology	Tools
Client Tier	Desktop PCs Windows GUI ODBC	Microsoft Windows Visual Basic Developer 2000
Server Tier	Unix Servers Relational Databases	HP-UX, Solaris Oracle / DB2

Client / Server Architecture

3-Tier Architecture

Tiers	Technology	Tools
Presentation Tier	Browser Web Server	Firefox / IE / Chrome Apache Tomcat
Business Tier	Application Servers	IBM Websphere Oracle 10gAS
Data Tier	Unix Servers Relational Databases	HP-UX, Solaris Oracle / DB2

4-Tier Architecture

Tiers	Technology	Tools
Client Tier	Javascript, AJAX	Flash, HTML5
Presentation Tier	Web Server	Apache Tomcat
Business Tier	Application Servers	IBM Websphere Oracle 10gAS
Data Tier	Unix Servers Relational Databases	HP-UX, Solaris Oracle / DB2

And so-on for N-Tier Architectures!

Example

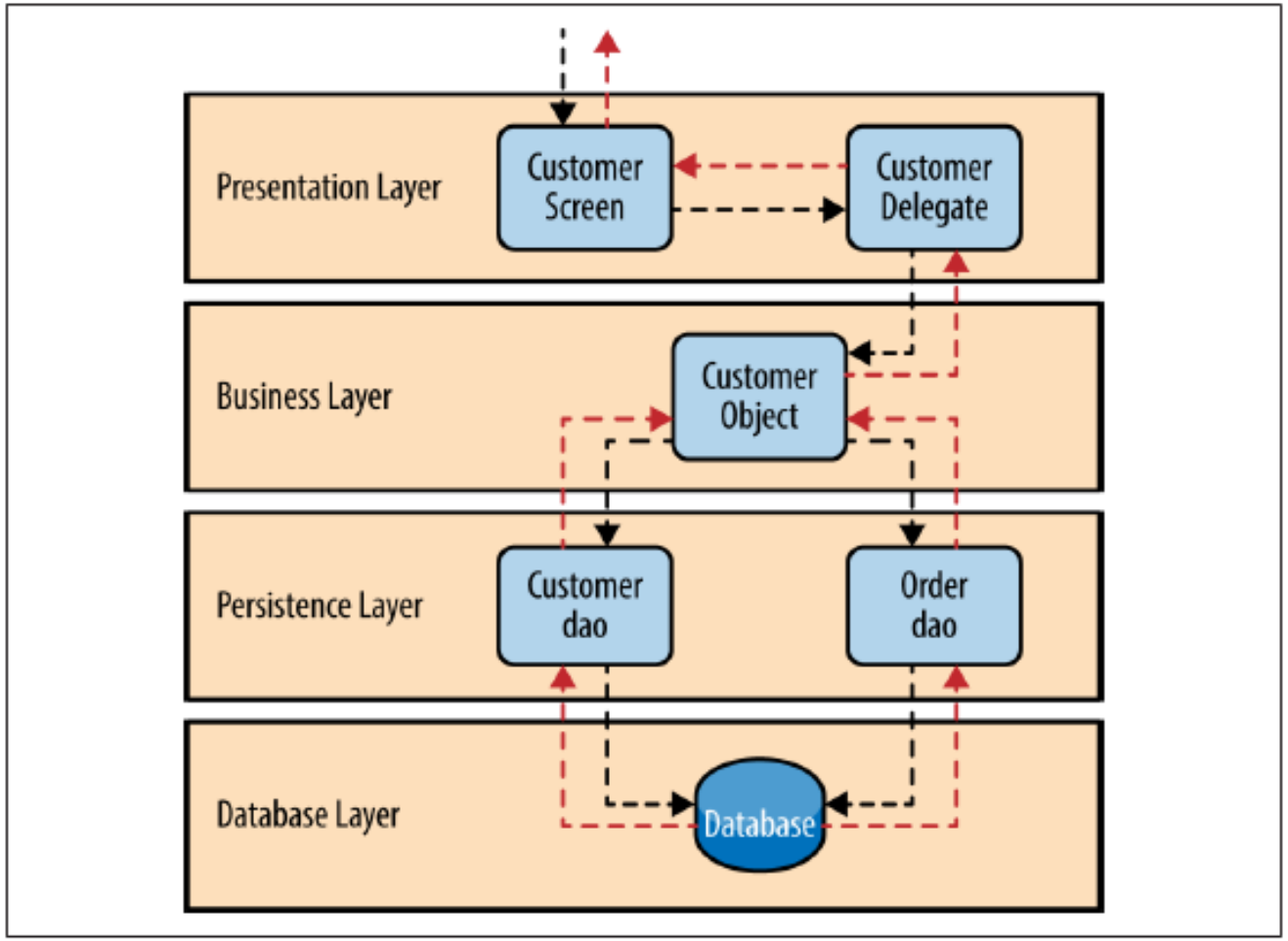

Figure 1-4. Layered architecture example

Ref: Software Architecture Patterns by Mark Richards

Closed Layer Property

- Presentation Tier not allowed to access Data Tier
- Data Tier not allowed to send data to Client Tier

Tiers	Technology	Tools
Client Tier	Javascript, AJAX	Flash, HTML5
Presentation Tier	Web Server	Apache Tomcat
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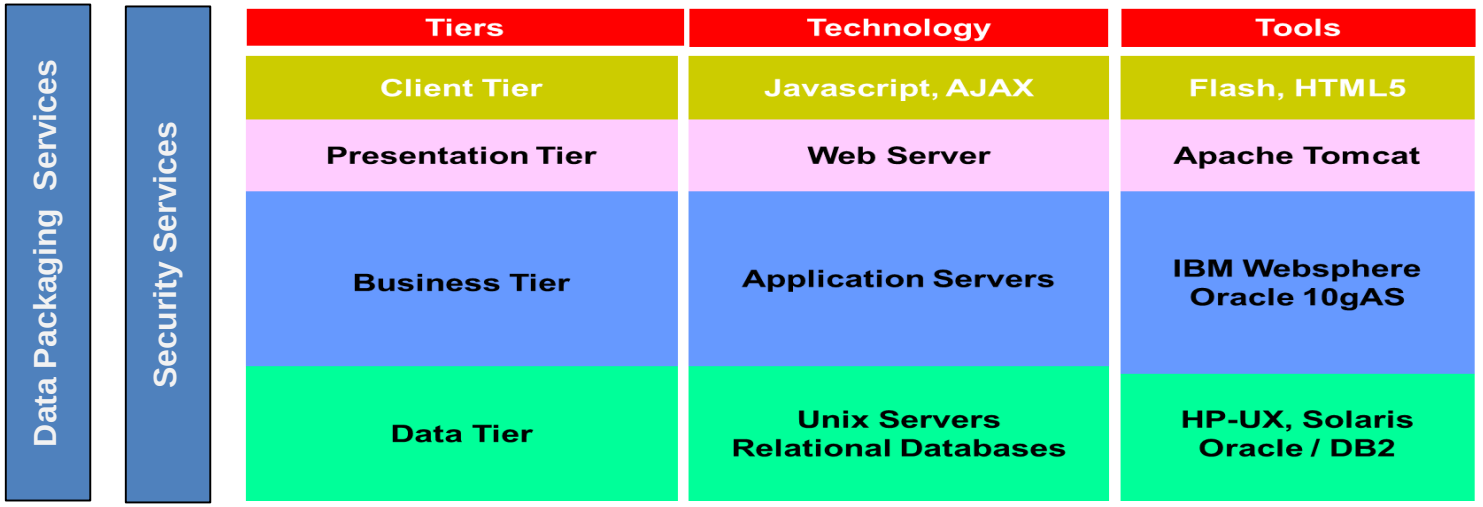
Adding Open Layers

- Presentation Tier can use authentication services provided by the security services layer
- Data Tier can use encryption keys provided by security services layer to send data to business tier



Impact on Deployment Architecture

- Greater the number of tiers greater the deployment flexibility
- Provides multiple deployment options
- N software tiers may be deployed on **UPTO** N hardware tiers
- Provides options to scale horizontally

Evaluation of Layered Architecture Style

Strengths

- Ease of engineering (dev, test, deploy)
- Better control on quality attributes
- Eases project management

Weakness

- Too many layers leads to effort fragmentation
- May be an “over-kill” for less complex solutions
- Increases monitoring and trouble-shooting complexity
- More “moving parts” leads more points of failure

HANDS ON CASE STUDY

Exercise – OAES Technical Architecture

- Create software architecture for OAES "ASSESSMENT" application software as per the given tiers

	Conceptual	Technology	Tools
1. Client Tier	1.1	1.2	1.3
2. Presentation Tier	2.1	2.2	2.3
3. Business Logic	3.1	3.2	3.3
4. Persistence Management	4.1	4.2	4.3
5. Database	5.1	5.2	5.3

OAES Technical Architecture Principles

- The architecture will follow LAYERED architecture principle
- All layers will be CLOSED by default unless specified otherwise
- Information across layers shall be transmitted securely

OAES Assessment Module

- Assessment software used in examination centers for students to write online examinations
- The software caters to the following user classes ("actors")
  - Center administrator to monitor ongoing exam
  - Students writing the exam
  - Invigilators
- Assessment software does **not** include question paper creation, registration, etc.

Exercise Deliverable

- Minimum 15 slide presentation (one slide per cell, at least!)
- **Principles** associated with each cell of the given layers
- Specific modules / tools / technologies as applicable to that cell
- Target audience for presentation: Software Designers and Developers

Summary

- Layered architecture can be created as per the desired dominant cohesive forces
- Layers need NOT be closed always
- N-Tier architecture is a popular architecture style for web-based applications

GOING FORWARD

Looking ahead

Layered

Event-Driven

Microkernel

Micro-services