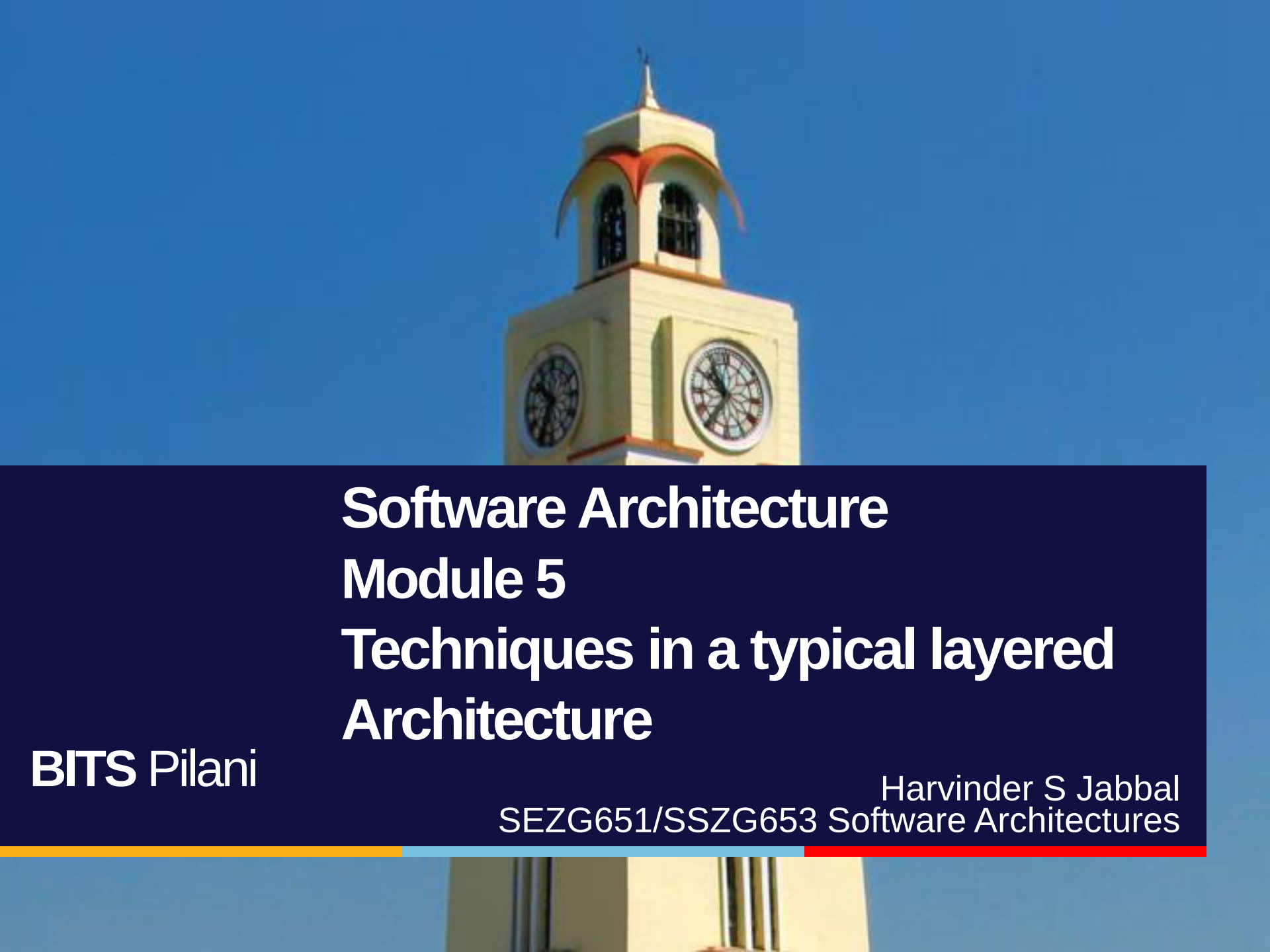

Software Architecture
Module 5
Techniques in a typical layered Architecture

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SEZG651/SSZG653 Software Architectures

Contents

- Typical layers in Layered architecture
- Techniques used in different layers

Typical layered architecture

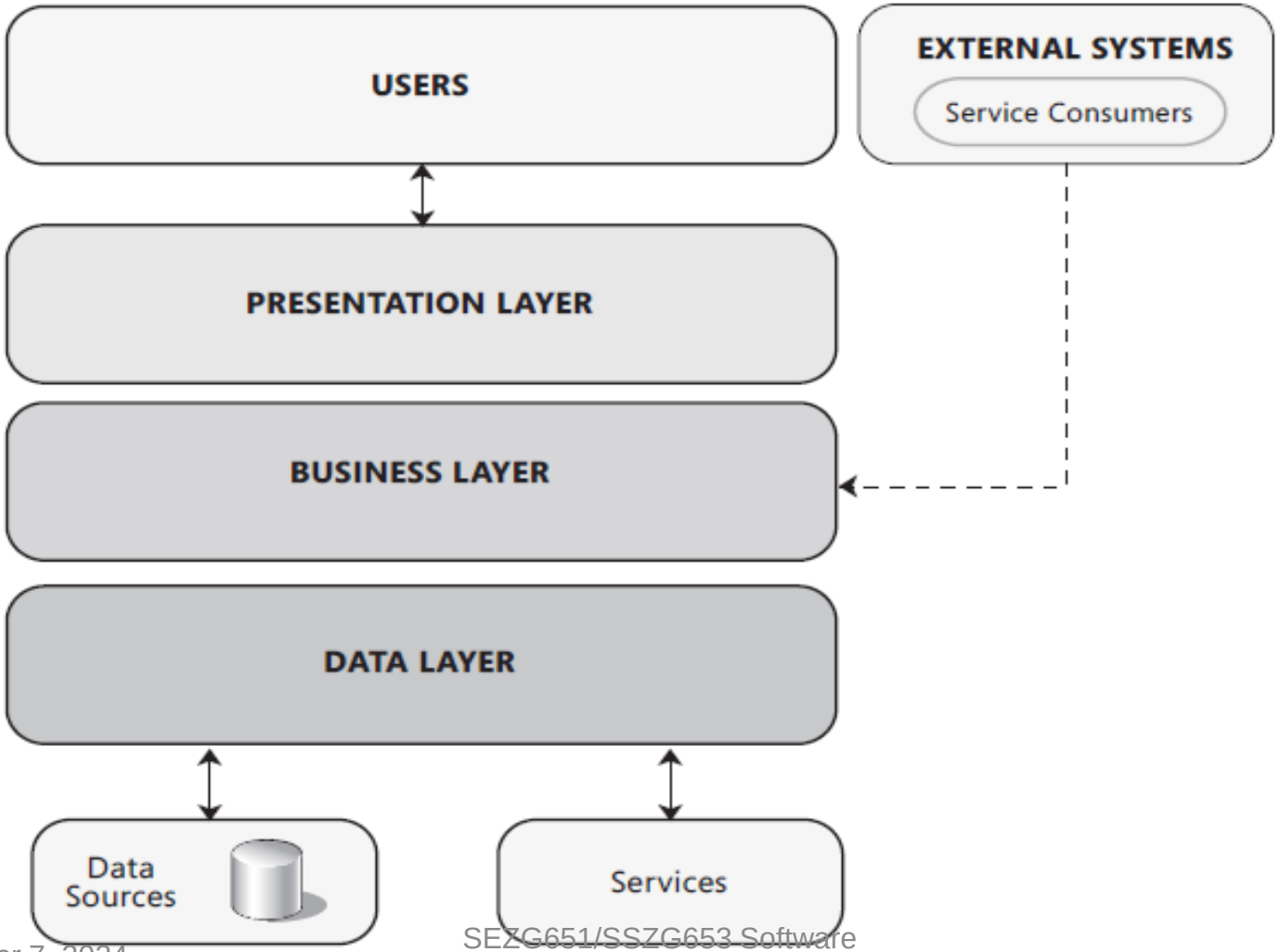
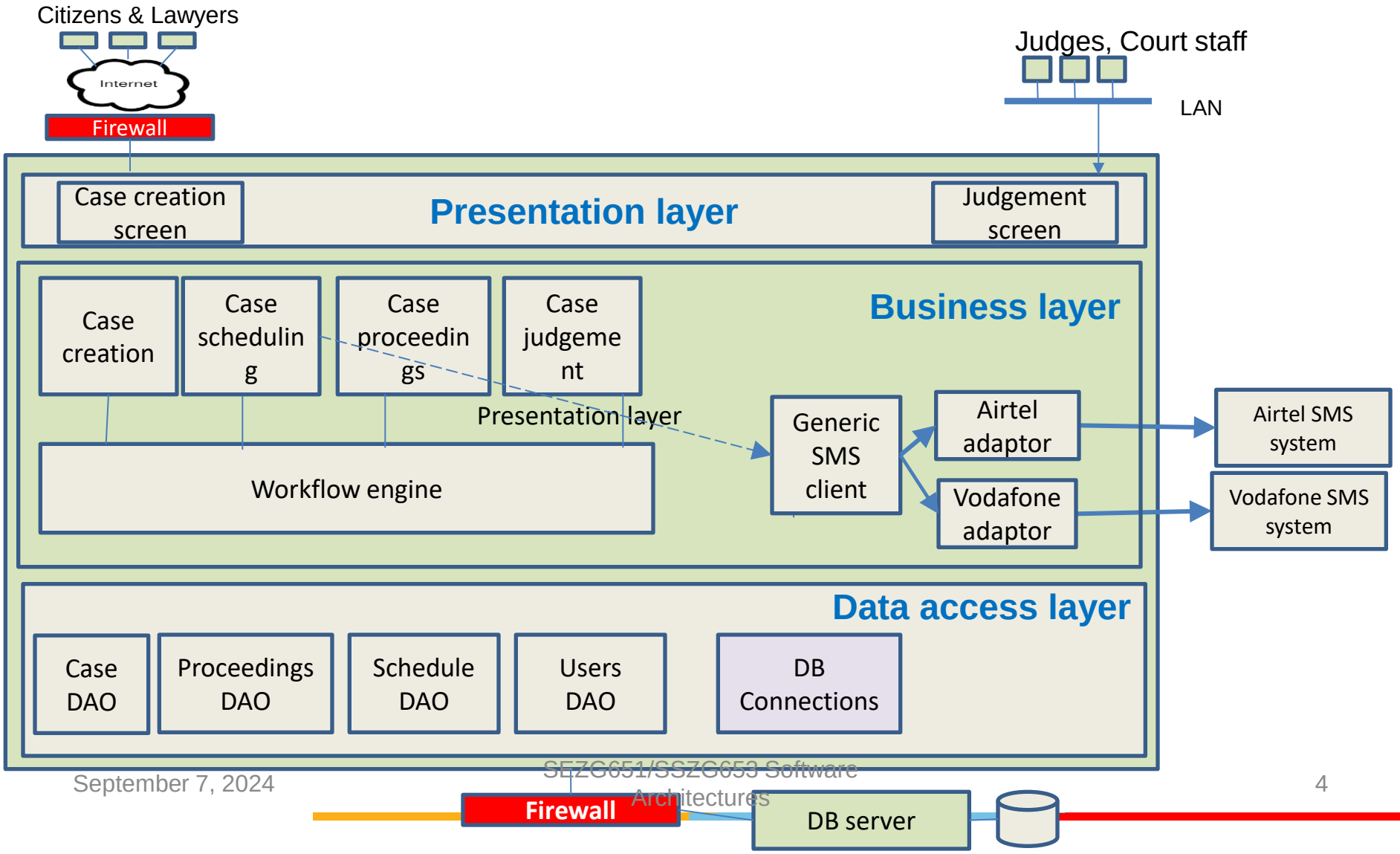
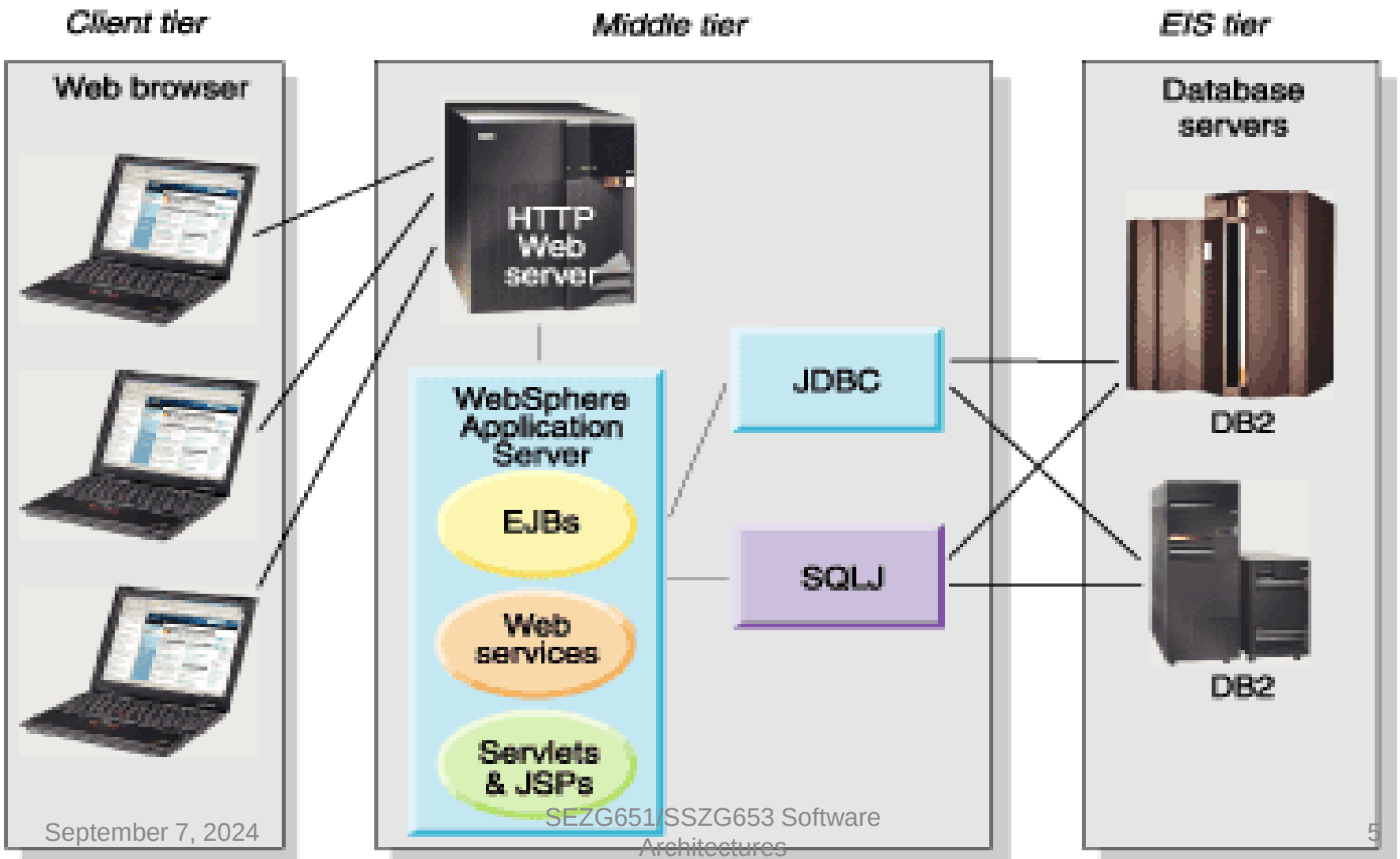


Figure 1
The logical architecture view of a layered system

Example of layers in Judiciary system



Typical layered architecture



Benefits

- What are the benefits of layered architecture?

Characteristics & benefits

- Clearly defined functional layers (separation of concerns)
- Loose coupling
- Reusable lower layer components
- Exchangeable parts

Techniques used in different layers

Presentation layer techniques

- Cache frequently used data such as Product catalog (Client side caching vs Server side caching)
- Use asynchronous communication between UI & Webserver to update parts of the web page without loading the whole web page (ex. AJAX)
- Different rendering for different form-factors: Responsive design

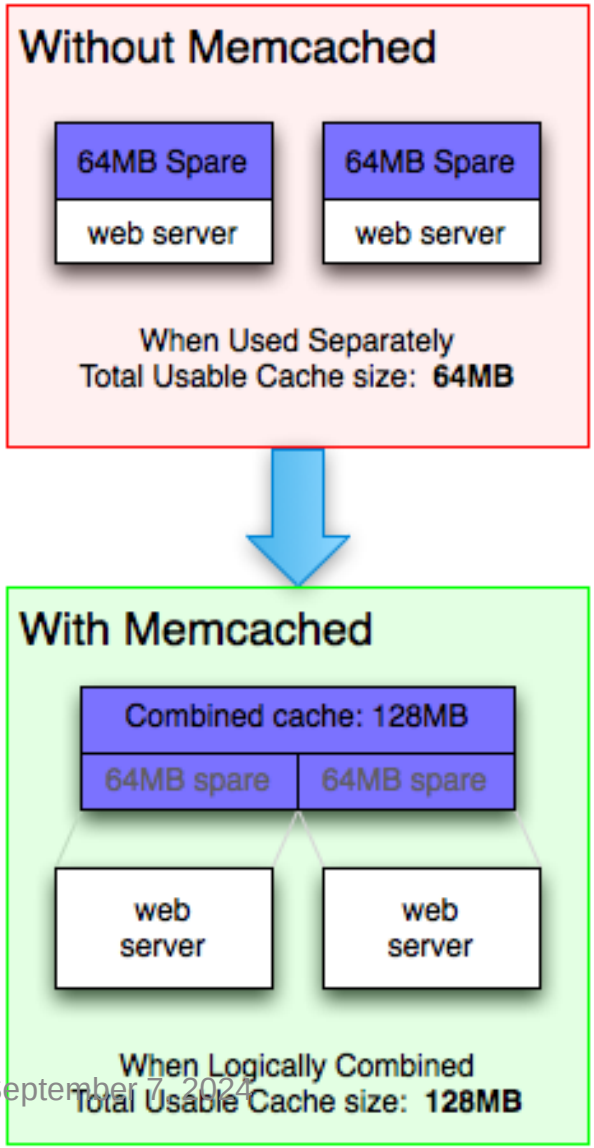
Client side caching vs Server side caching

Client-side caching: Here we store frequently used data in the browser of the client machine – example user preference such as payment method, delivery address, etc.

Server-side caching: Here we store frequently used data needed by different back-end modules on the server-side – example: Product codes and description, promotions, etc.

Combination: In practice, a combination the above 2 techniques is used.

Memcached



memcached is a high-performance, distributed memory object caching system, generic in nature, but originally intended for use in speeding up dynamic web applications by alleviating database load.

You can think of it as a short-term memory for your applications.

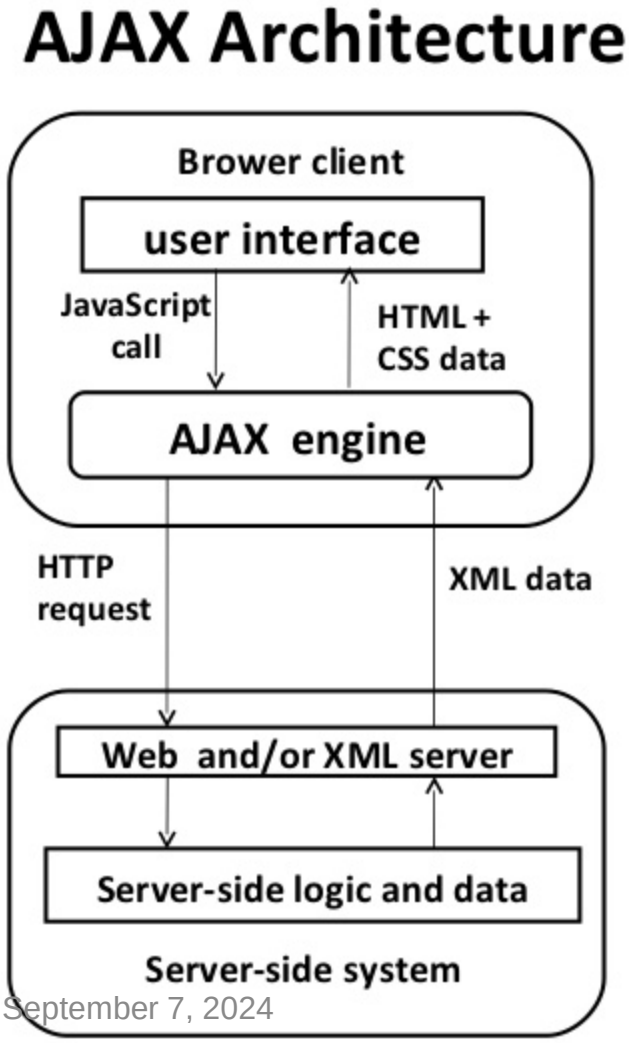
memcached allows you to take memory from parts of your system where you have more than you need and make it accessible to areas where you have less than you need.

Asynchronous communication with web server

Example use cases:

- Show product list depending on the product category selected by user
- Validating a user input such as loan amount - whether it is within permissible limits, depending on user profile
- Displaying a chat panel
- Reloading Captcha

Asynchronous communication with web server



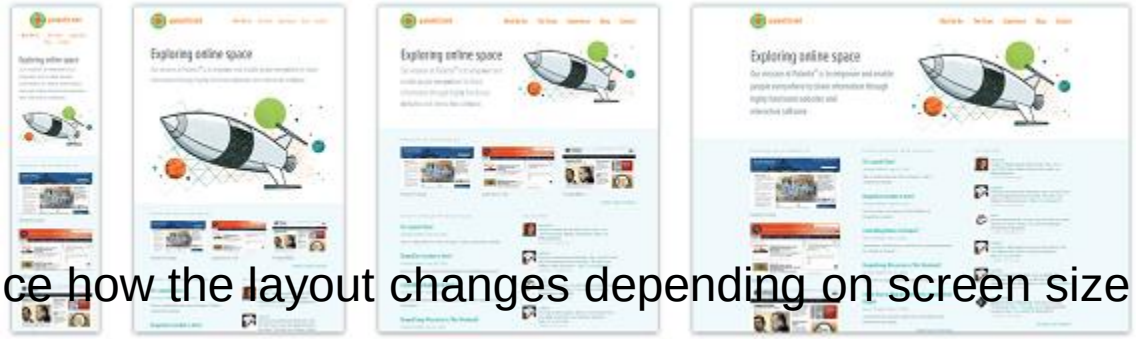
AJAX stands for **A**synchronous **Ja**vaScript and **X**ML.

AJAX is a technique for creating better, faster, and more interactive web applications with the help of XML, HTML, CSS, and Java Script.

Some famous web applications that use AJAX:

Google Maps (Drag entire map)
Google Suggest (Google suggests as you type)

Responsive web design: Examples

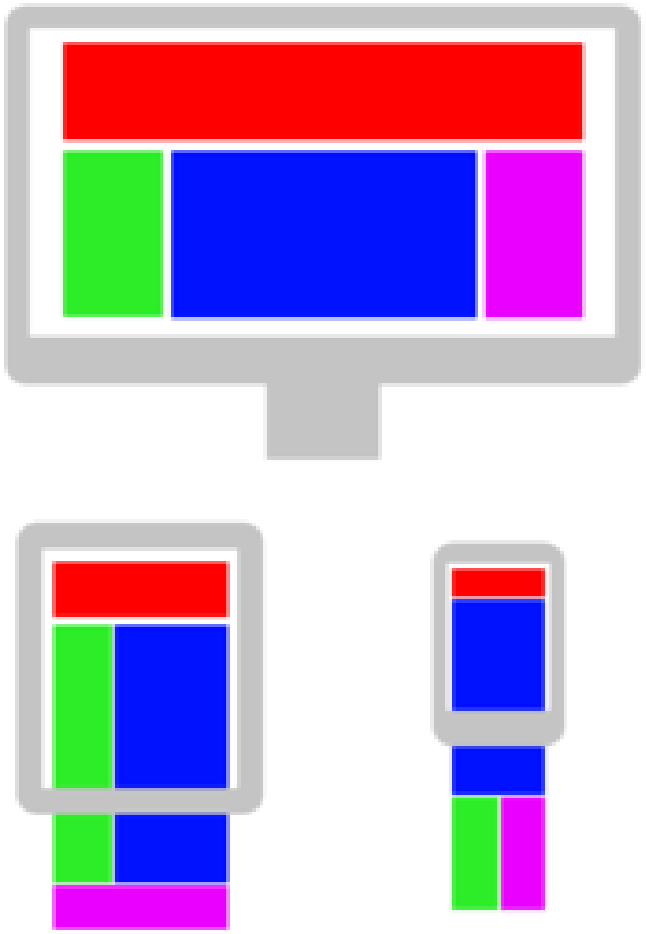


Notice how the layout changes depending on screen size

Responsive web design is an approach that renders web pages well on a variety of devices or screen sizes.

Consider different form factors – Use Responsive design

Ref: Wikipedia



Flexible grids

Allows varying layout depending on screen size

HTML5 and CSS3 help in specifying the display arrangement

Presentation layer

Have you used any other techniques in Presentation layer?

Business layer

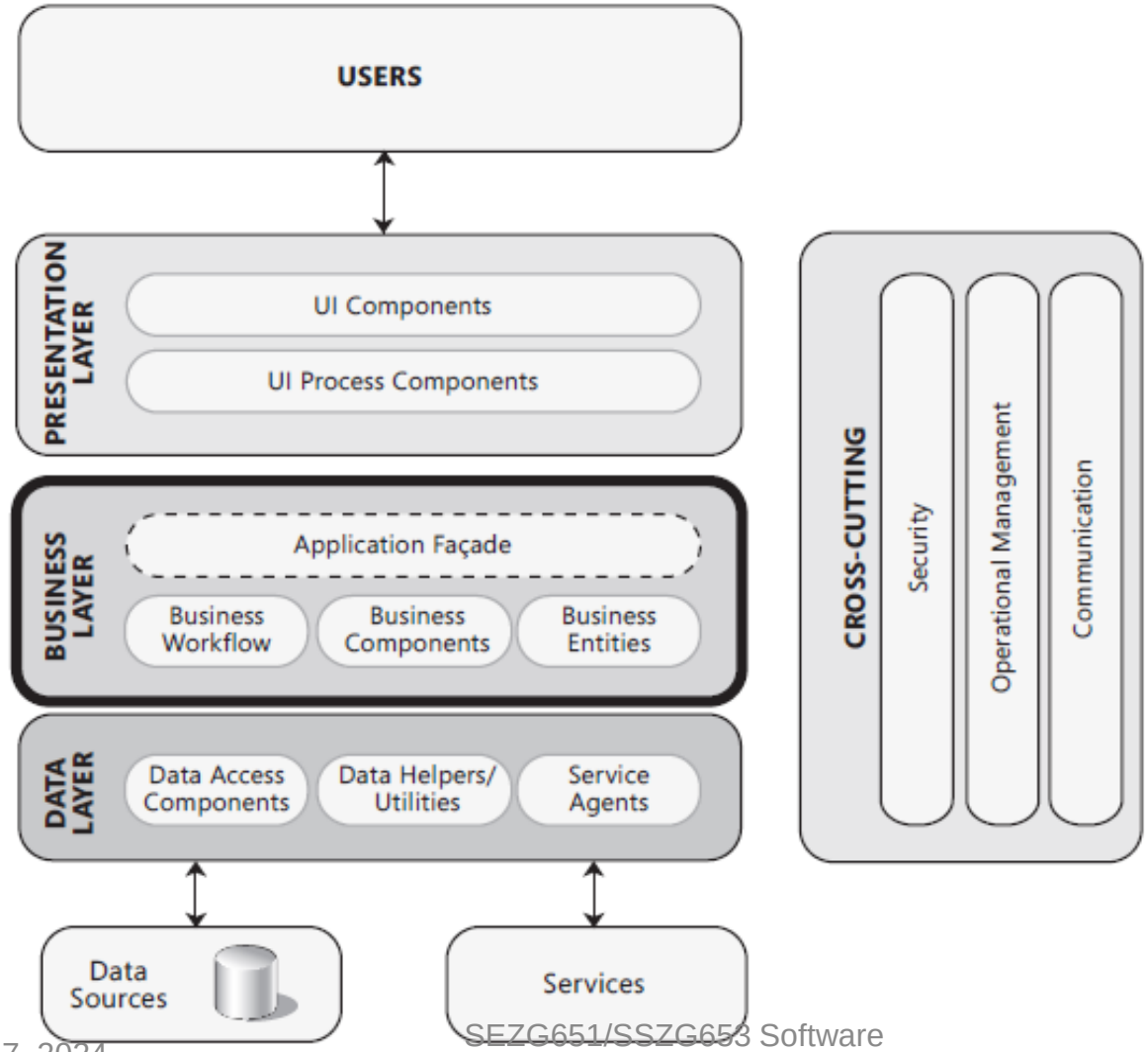
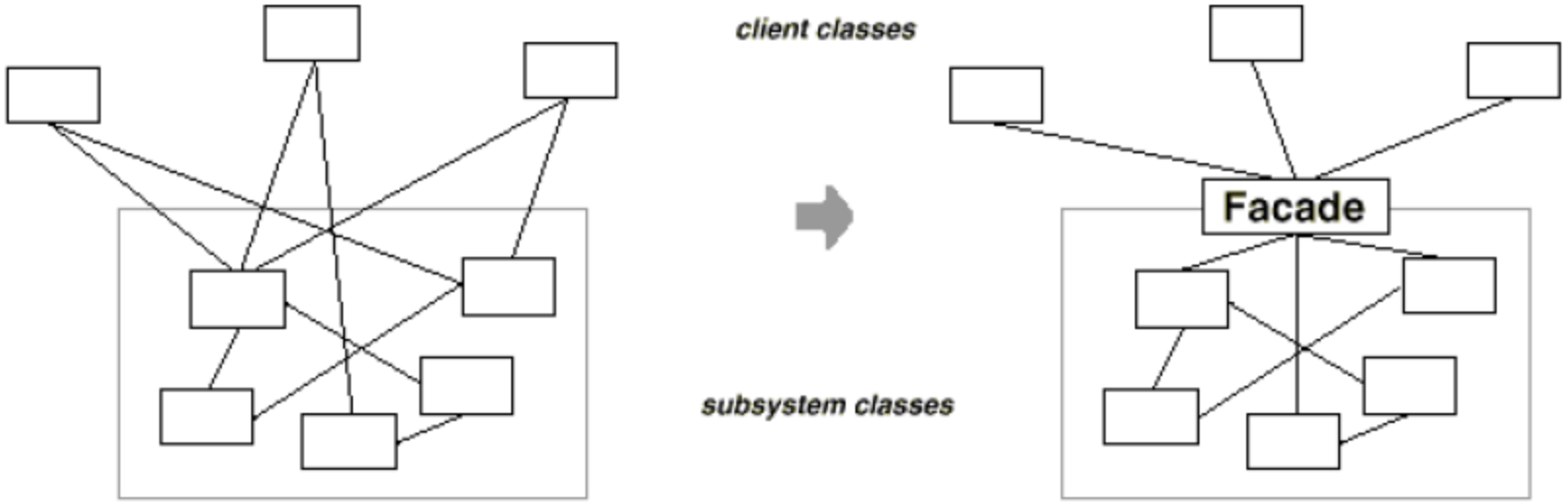


Figure 1
A typical application showing the business layer and the components it may contain

Business layer techniques

- Use Application façade to hide internal modules
- Implement session management
- Use Work flow engine, Rules engine, etc. for modifiability

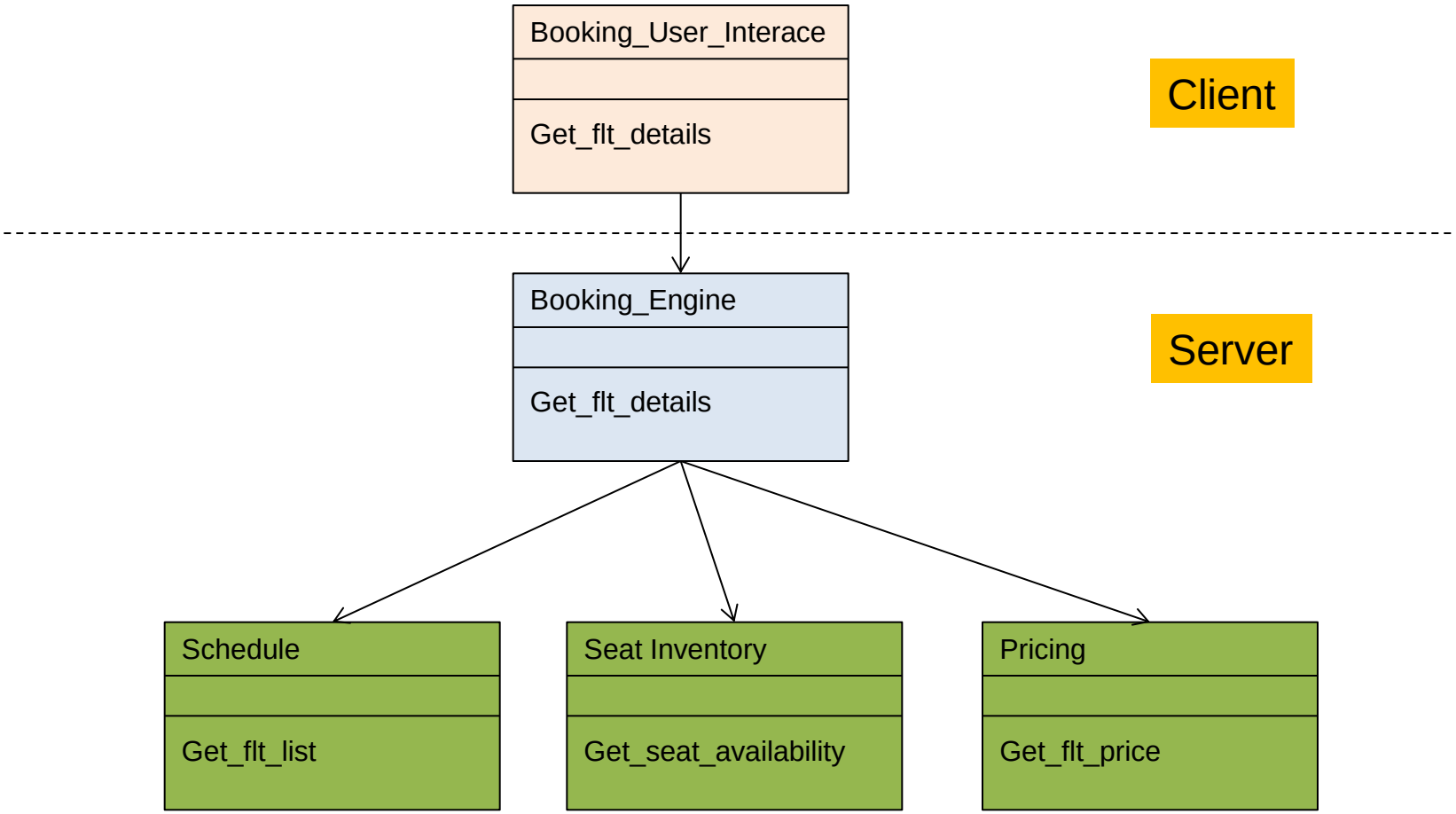
Facade: Making sub-system easier to use



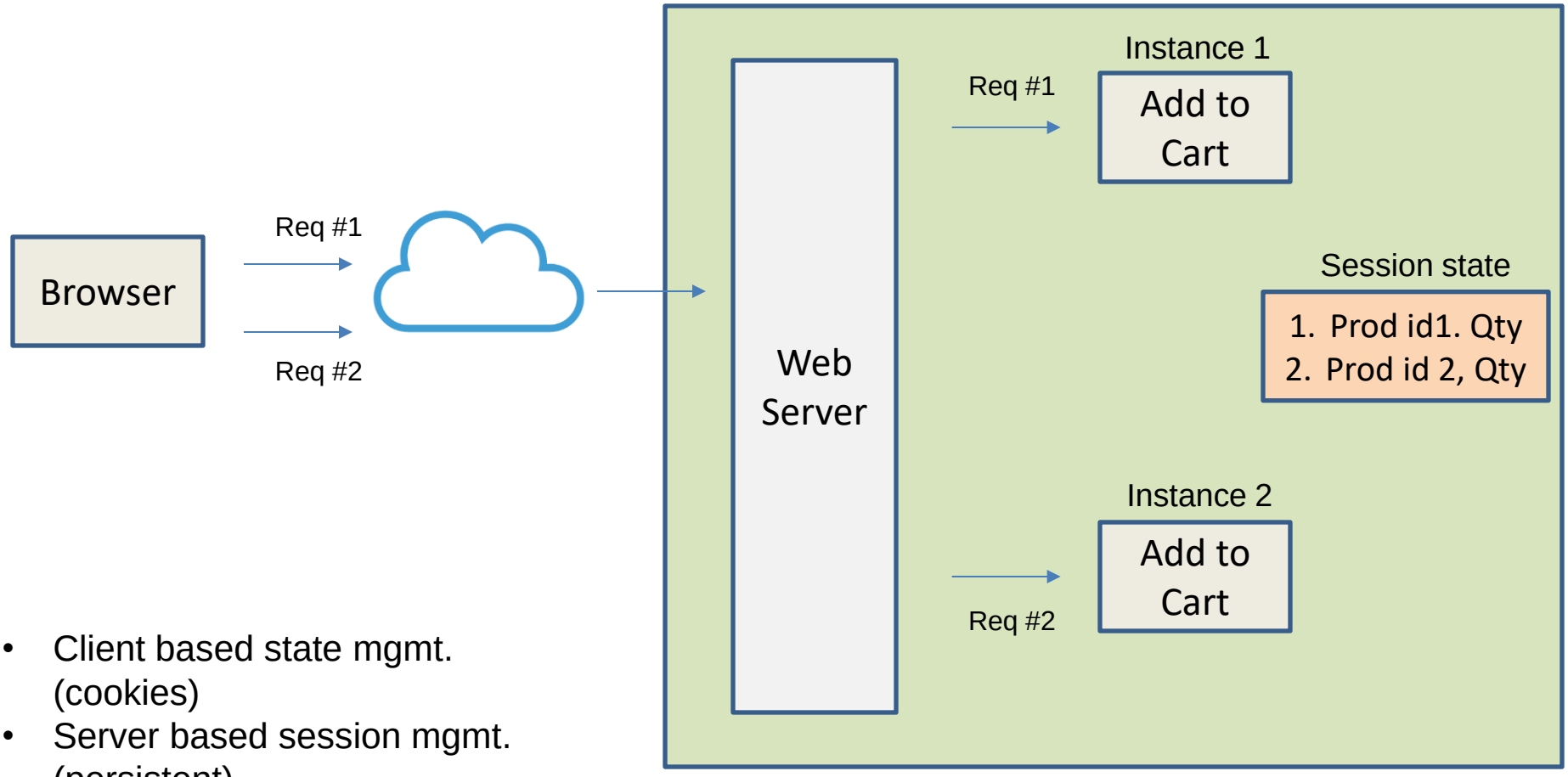
Intent:

- Provide a unified interface to a set of interfaces in a subsystem.
- Facade defines a higher-level interface that makes the subsystem easier to use.
- It typically involves a single wrapper class which contains a set of members required by client.

Example of Application façade: Flight booking



Session management

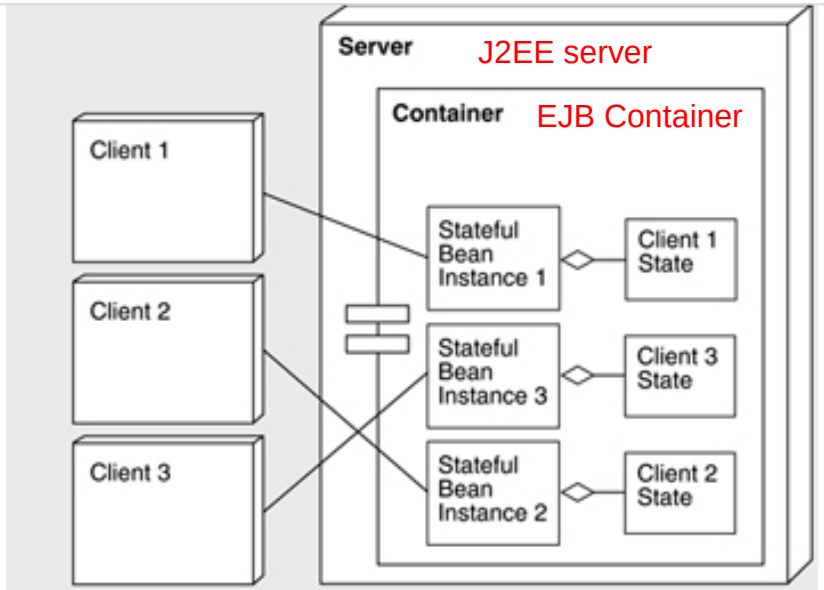


- Client based state mgmt. (cookies)
- Server based session mgmt. (persistent)

EJB: Stateless & Stateful session beans

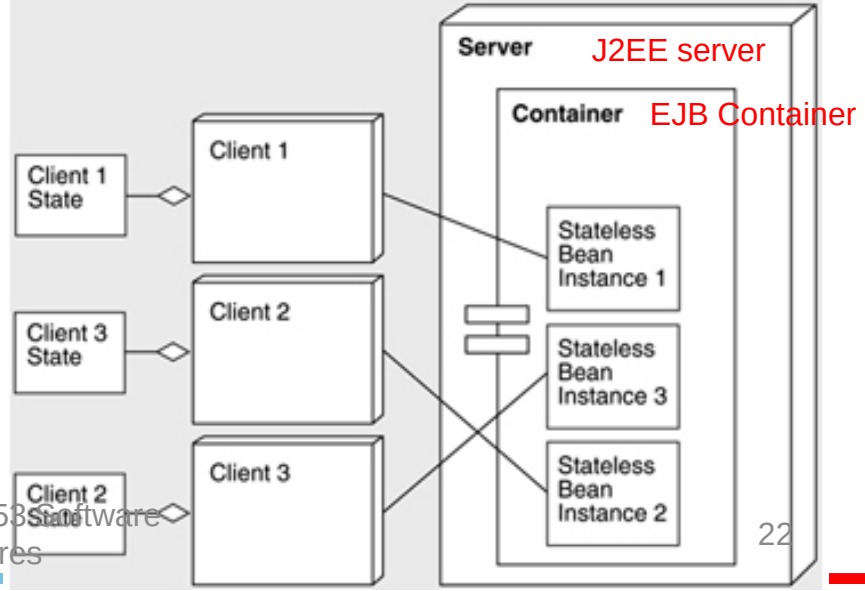
Stateful session Bean: All requests from a Client goes to the same instance of the Bean.

Bean maintains the state of the session



Stateless session Bean: Subsequent request from a client to a Bean may go to another instance of the Bean

Hence Client needs to main the state of the session



Work flow engine

Insurance policy processing

Example Activities

Once an activity is completed, the engine invokes the next step in the process
The next step / activity could be a manual one or an automated one

Popular engines: BizTalk Server, Oracle BPEL processor, IBM WebSphere Process Server

Aspect oriented design for cross cutting concerns

Aspect Oriented design aims to encapsulate cross-cutting concerns into aspects (enhancing modularity)

Examples of aspects:

- Logging & instrumentation
- Auditing: Who is doing what
- Caching
- Security

Aspect Oriented Design

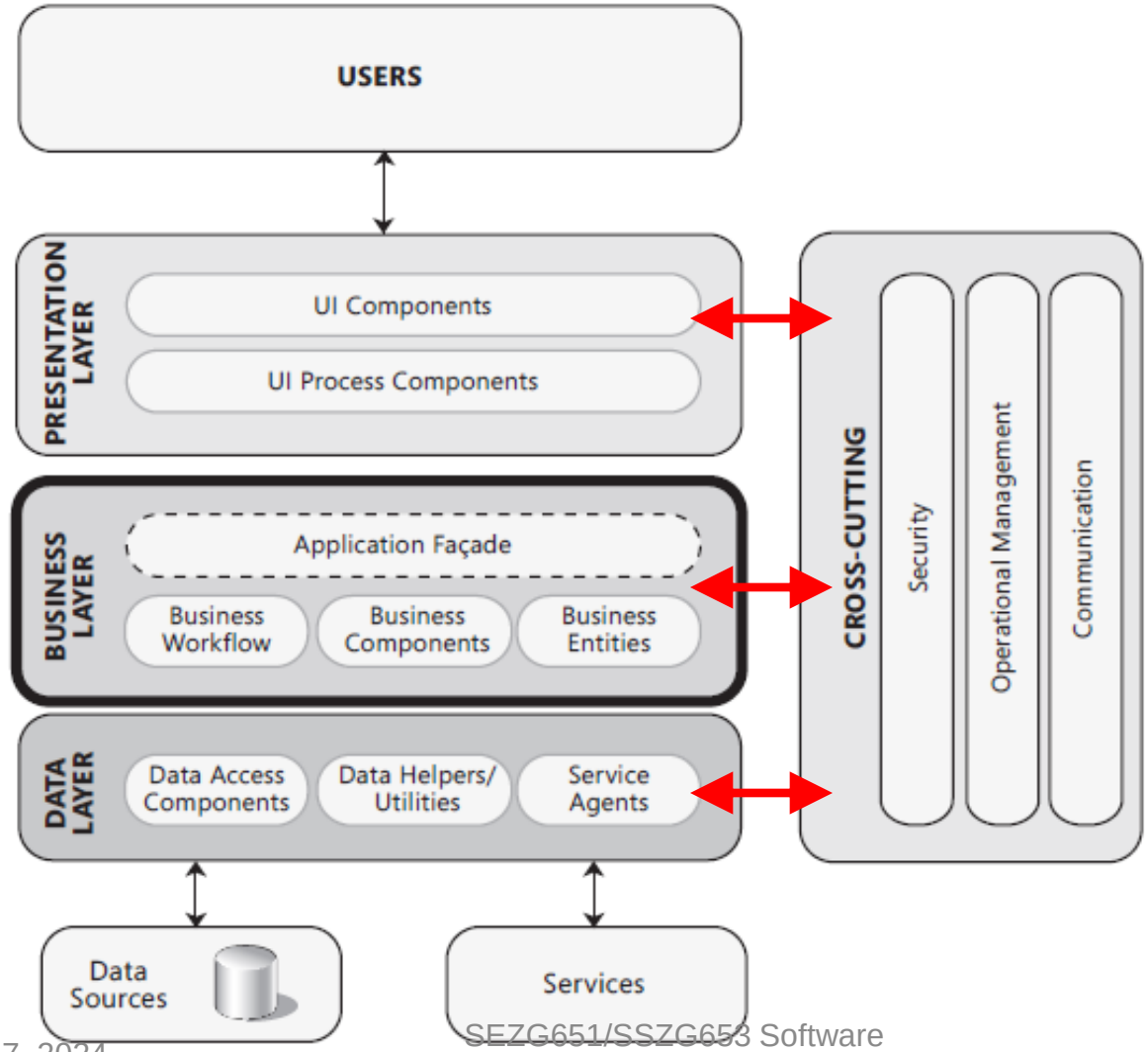


Figure 1
A typical application showing the business layer and the components it may contain

Different aspects of the system

They cut across layers

Modules in different layers call the modules in the cross-cutting sub-system at different points in time

Logging & instrumentation

- **Log actionable information** such as errors
  - “Database is unavailable”
  - Information useful to diagnose errors

- Logging is expensive. Log only the most essential data

- **Instrumentation** helps in understanding the usage & behaviour of the system
  - Request rate
  - Error rate
  - Duration of requests
  - Queue length

Ref: https://peter.bourgon.org/blog/2016/02/07/logging-v-instrumentation.html

Business layer

We saw:

- Façade
- Session mangement
- Work flow engine
- Aspect oriented design

Have you used any other technique in Business layer?

Data layer: Prominent techniques used

- Use DB connection pool, if there are too many users
- Use multiple copies of data for faster access
- Use transactions to achieve atomicity
- Use Object - Relational mapping
- Use stored procedures to improve performance
- Use parameterized SQL queries to reduce SQL injection attacks

Object-Relational mapping

- Helps in mapping objects in our program to database table

- Hibernate is a framework that provides an Object/Relational Mapping (O/RM)

SQL Injection attacks

innovate achieve lead

Do not concatenate user entered string to SQL string

- Malicious input can result in the following:
- SELECT product-data FROM table WHERE product-name = '**Toothpaste**' **OR 'x' = 'x';**
- **This will return all product data**

Use parameterized SQL queries

- SELECT product-data FROM table WHERE product-name = ?
- ? Is a parameter which contains the value entered by user

Data layer

Have you used any other technique in Data layer?

Services layer

Provides services to external systems

Example: A bank may provide following services to external systems:

- Get Balance
- Request chequebook

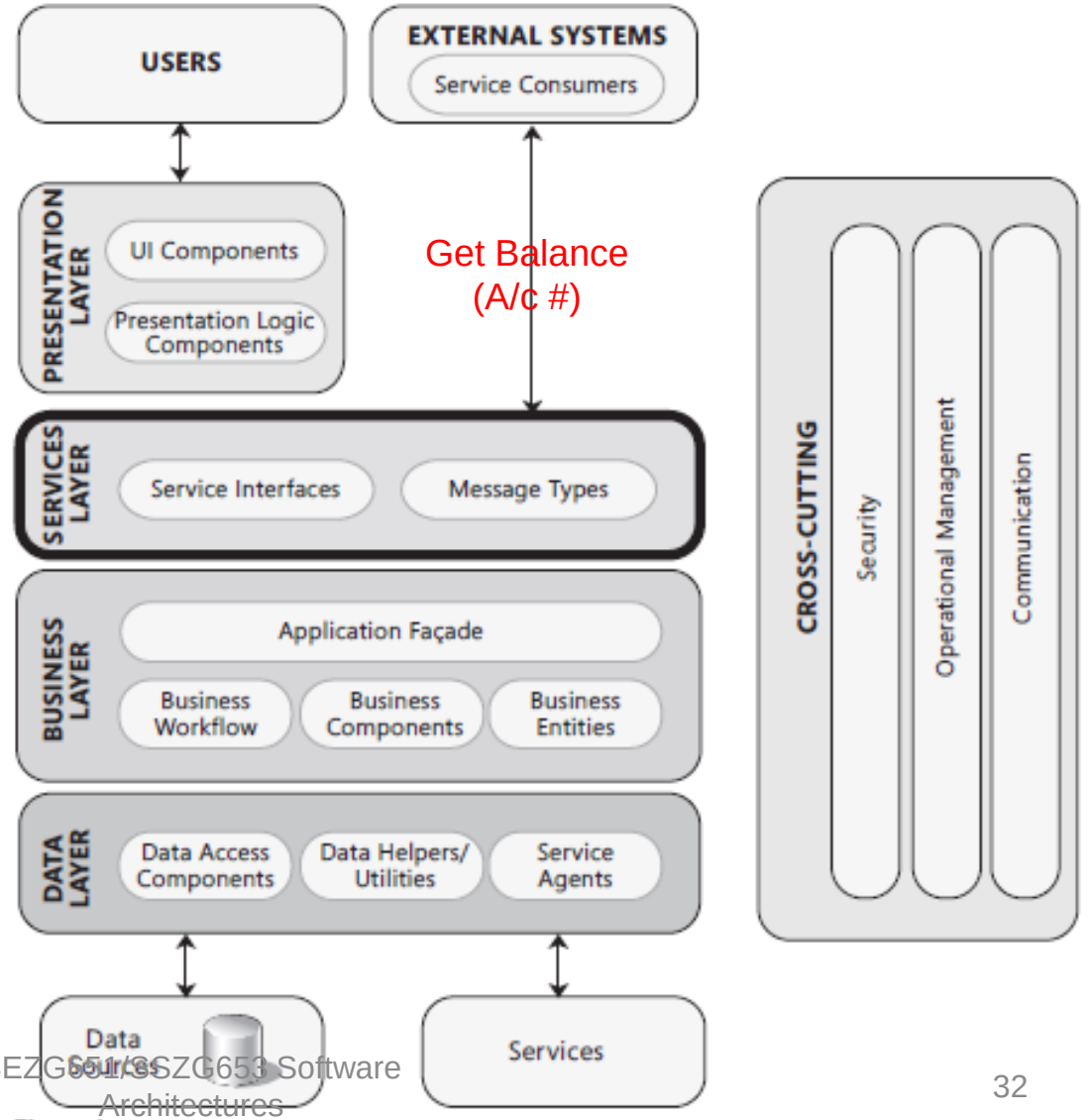


Figure 1
Overall view of a typical application showing the service layer

Service layer

Situations that need to be handled by service layer

- Handle same request coming twice
- Handle message coming out of sequence
- Handle communication failure (using retry mechanism or by queuing work and sending once communication is restored)

Question

Have you used any other techniques in a layered architecture?

Exercise 1

What are some of the components of Departure Control System in

- Presentation layer
- Business layer
- Data layer
- Service layer

Exercise: Identify components in different layers of DCS

Exercise 2

What software mechanism will you use to improve the performance in the following situation:

- One of the frequently used screens in Aadhaar system is citizen registration.
- This screen has a fields “State” and “District” and “Town”, which are Drop-down fields
- It takes time to loading this screen due to the large number of states, districts and towns in India

Solution

- Cache states, districts and towns in the backend
- Use AJAX for dynamic loading of districts and towns

Exercise 3:

- Suppose you are developing a hotel reservation system.
- You want to provide is an interface to externals applications such as Makemytrip.com, to inquire about availability of rooms and book rooms.
- What layer would you build and what will be the component (s) in that layer?

Answer

Services layer is needed to provide interface to external systems.

This layer will have components such as

- Get room availability (from date, to date) return (# rooms available by type of room)
- Reserve room (# of rooms, type of room, from date, to date) Return (Success / Failure)

Exercise 4

Suppose you are building a complex logistics system for a shipping & container company

Users wanting to send goods via containers will login to the system and place their requests

A number of modules need to be called for this:

- Find out the nearest location of an empty container
- Find a the best transporter to pick up the goods
- Find a ship that is scheduled leave to the desired destination and has spare capacity to load the container

As an architect you want to hide these modules from the client layer.

What technique will you use and in which layer?

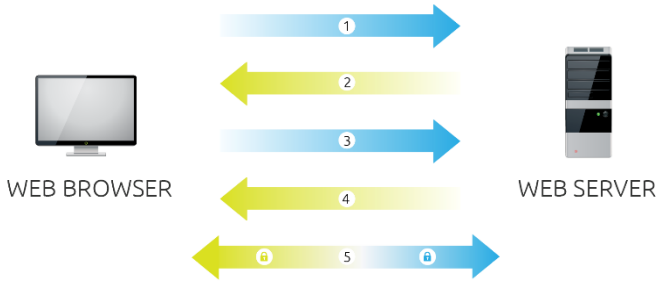
Answer

- In the Business layer, provide a unified API – façade - to place a shipping request

- The façade will in turn make use of modules to search for appropriate container, appropriate transporter, appropriate ship, etc.

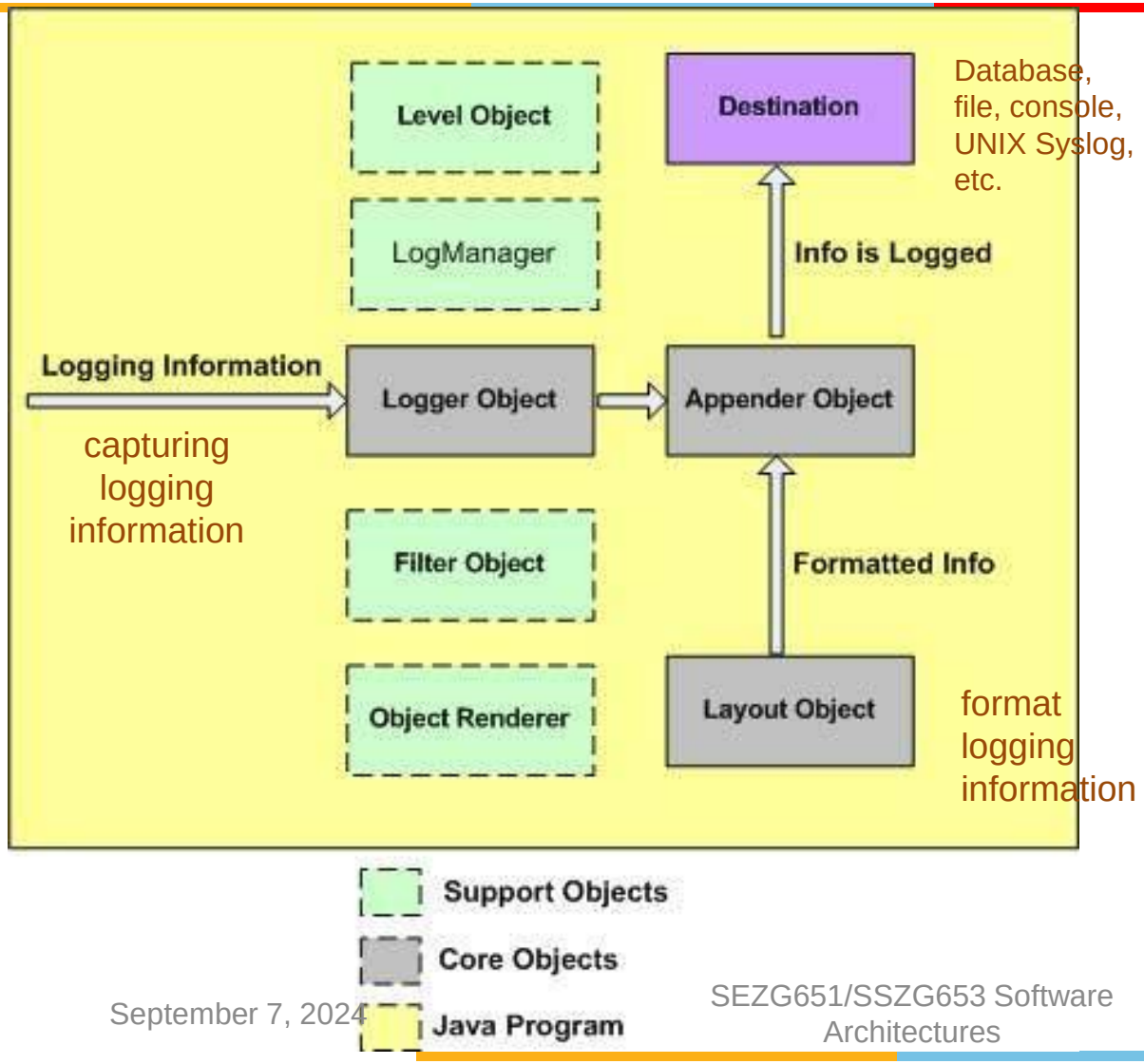
Appendix

SSL



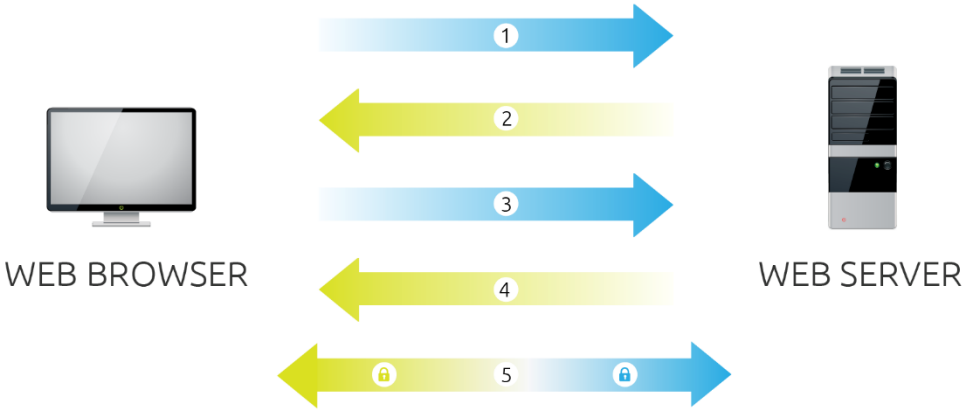
1. Browser connects to a web server (website) secured with SSL (https). Browser requests that the server identify itself.
2. Server sends a copy of its SSL Certificate, including the server's public key.
3. Browser checks the certificate root against a list of trusted CAs and that the certificate is unexpired, unrevoked, and that its common name is valid for the website that it is connecting to. If the browser trusts the certificate, it creates, encrypts, and sends back a symmetric session key using the server's public key.
4. Server decrypts the symmetric session key using its private key and sends back an acknowledgement encrypted with the session key to start the encrypted session.
5. Server and Browser now encrypt all transmitted data with the session key.

Logging: Apache Log4j



- Logging is an important component of the software development.
- A well-written logging code offers quick debugging, easy maintenance, and structured storage of an application's runtime information.
- Logging does have its drawbacks also. It can slow down an application.

SSL



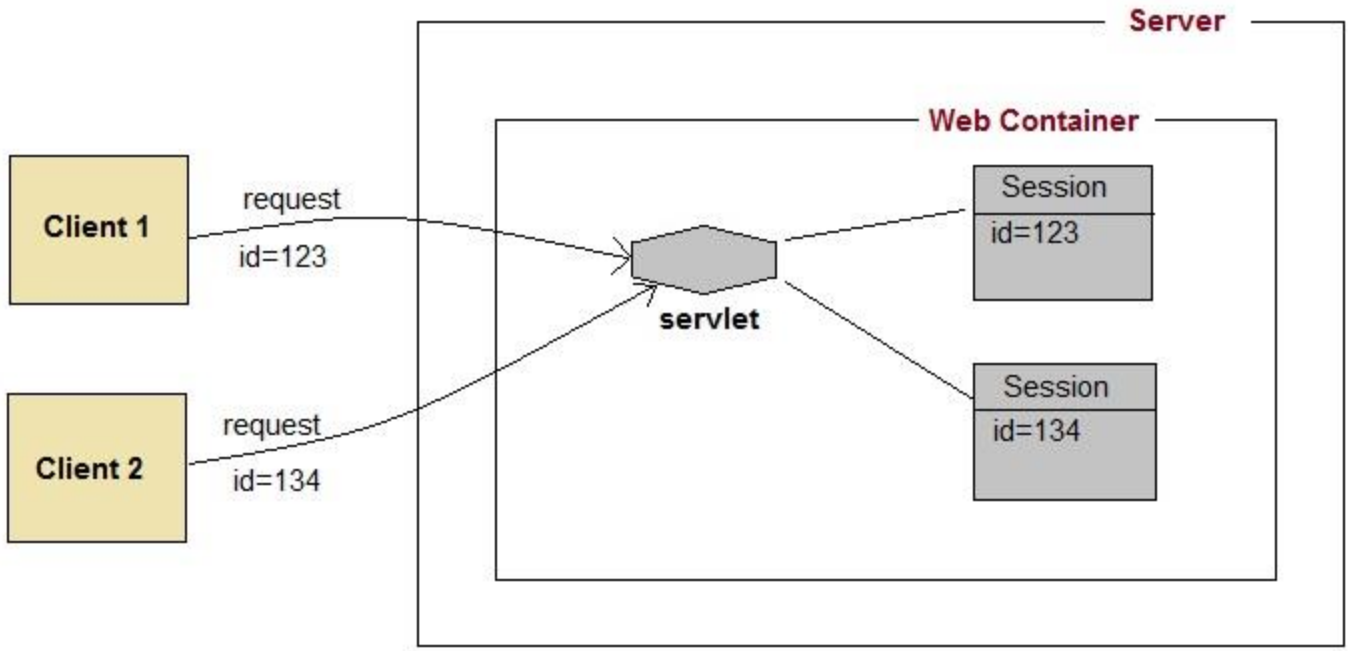
1. Browser requests that the server identify itself.
2. Server sends a copy of its SSL Certificate
3. Browser checks the certificate. and sends back a symmetric session key
4. Server sends back an acknowledgement.
5. Server and Browser now encrypt all transmitted data with the session key.

IPSec – Internet Protocol Security

IPSec is an Internet Engineering Task Force (IETF) standard suite of protocols that provides data authentication, integrity, and confidentiality as data is transferred between communication points across IP networks.

IPSec provides data security at the IP packet level.

Session management



- A web **session** is a sequence of network HTTP request and response transactions associated to the same user.

- Modern and complex web applications require the **retaining of information or status about each user** for the duration of multiple requests.