

Advanced Rest API & Microservices

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Web Application:

It is an end-to-end solution for a user.

Which means, User can:

- ❑ Open it using a browser Interact with it.
- ❑ User can click on something and after some processing, its result will be reflected in the browser screen. Human-System interaction.

Web API / Web service

With Web APIs alone, a user can not interact with it, because it only returns data, not views.

- ❑ It is a system which interacts with another system
- ❑ It does not return views, it returns data
- ❑ It has an endpoint set, which can be hit by other systems to get data which it provides.

SOAP

SOAP - WS



SMTP HTTP



END POINT



APPLICATION

REST

JSON, XML, HTML



HTTP



GET, POST, PUT, DELETE

RESOURCE



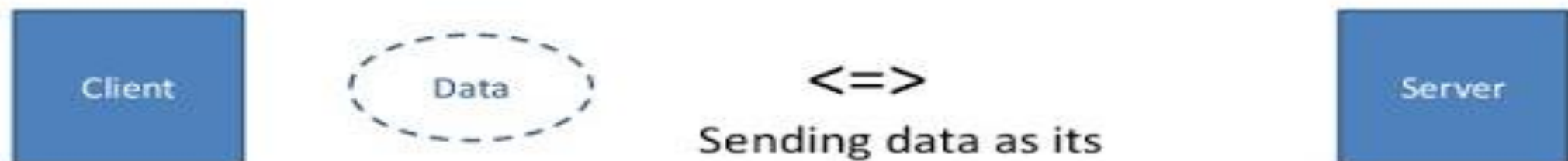
APPLICATION

SOAP vs REST

SOAP



REST

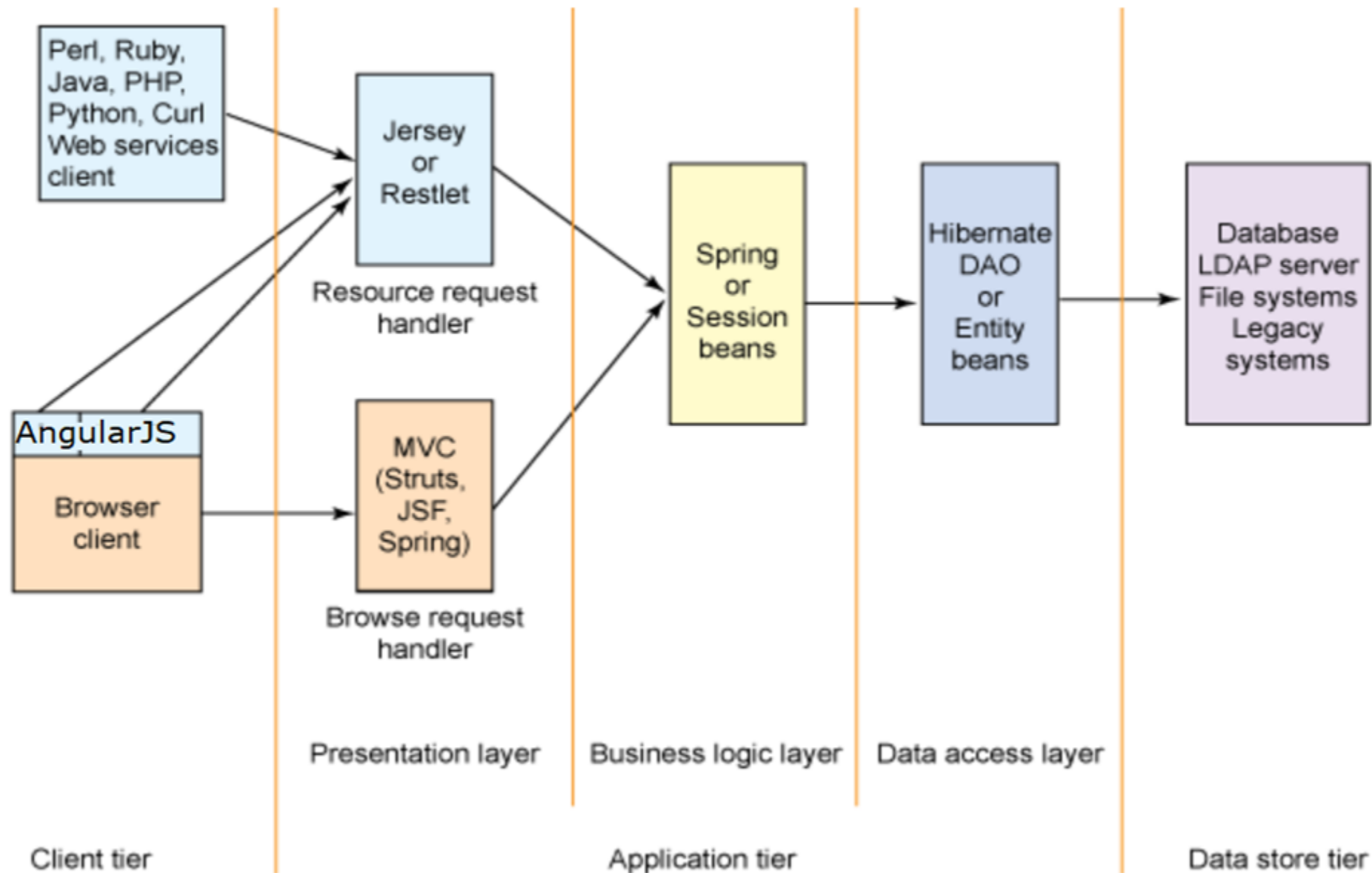


*REST are mostly used in industry


Rest API





- ❑ REpresentational State Transfer or REST is a web standards based architecture and uses HTTP protocol for data communication.
- ❑ HTTP methods like GET, PUT, DELETE, POST etc., are used in a REST based architecture

Diagram of a multi-tiered Web application environment



← → ↻ spicejet.com

 **BOOK** ADD-ONS DEALS GIFT CARD SP

 **Flights**  Hotels  Holiday Packages  Flight S


☒ One Way ☐ Round Trip ☐ Multicity

*FROM *TO *DEPART DATE

← → ↻ yatra.com

yatra Flights Hotels

Book Flights, Hotels and Holiday Packages

Depart From
New Delhi
DEL 

<html>

Web MVC

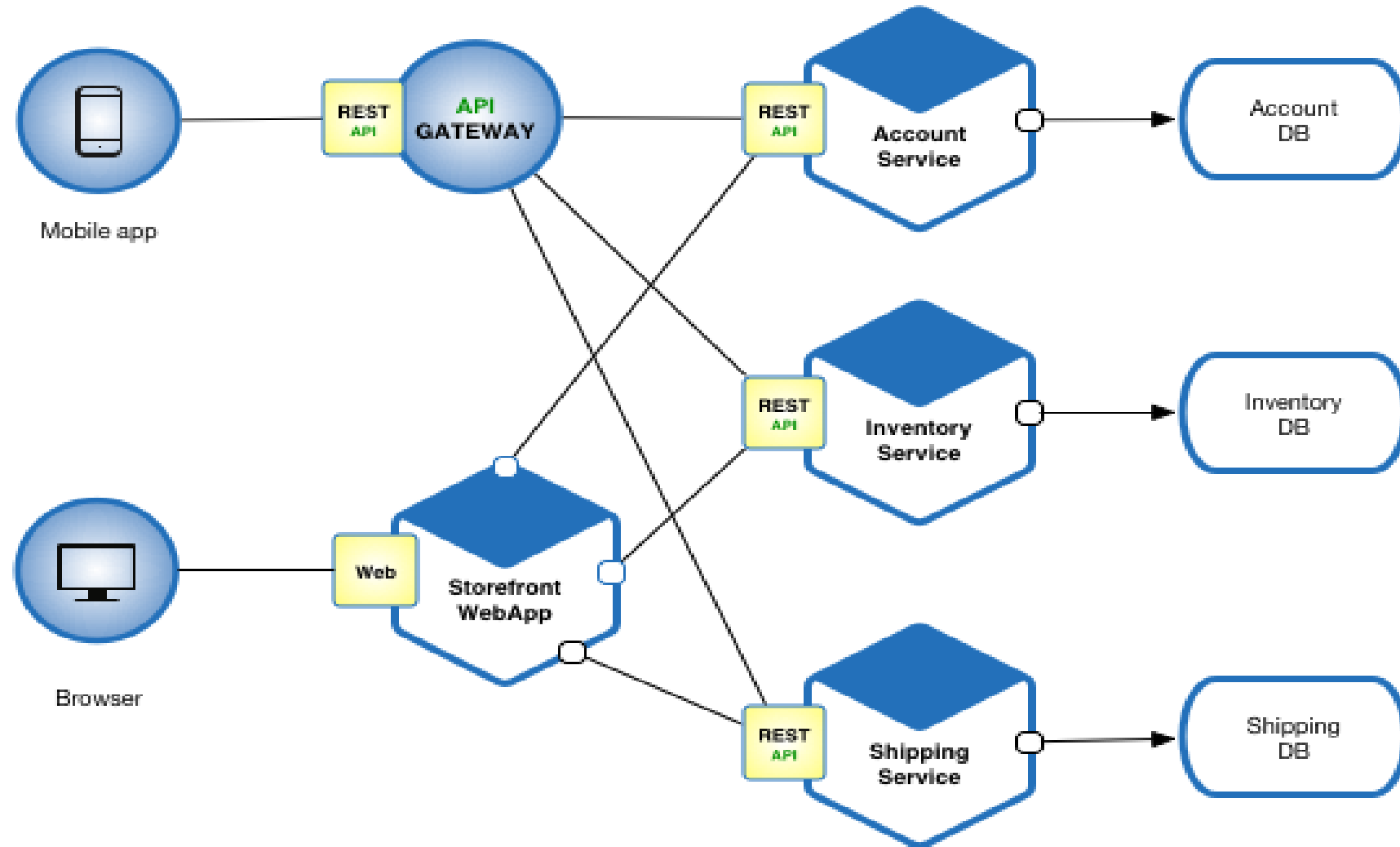
Web API

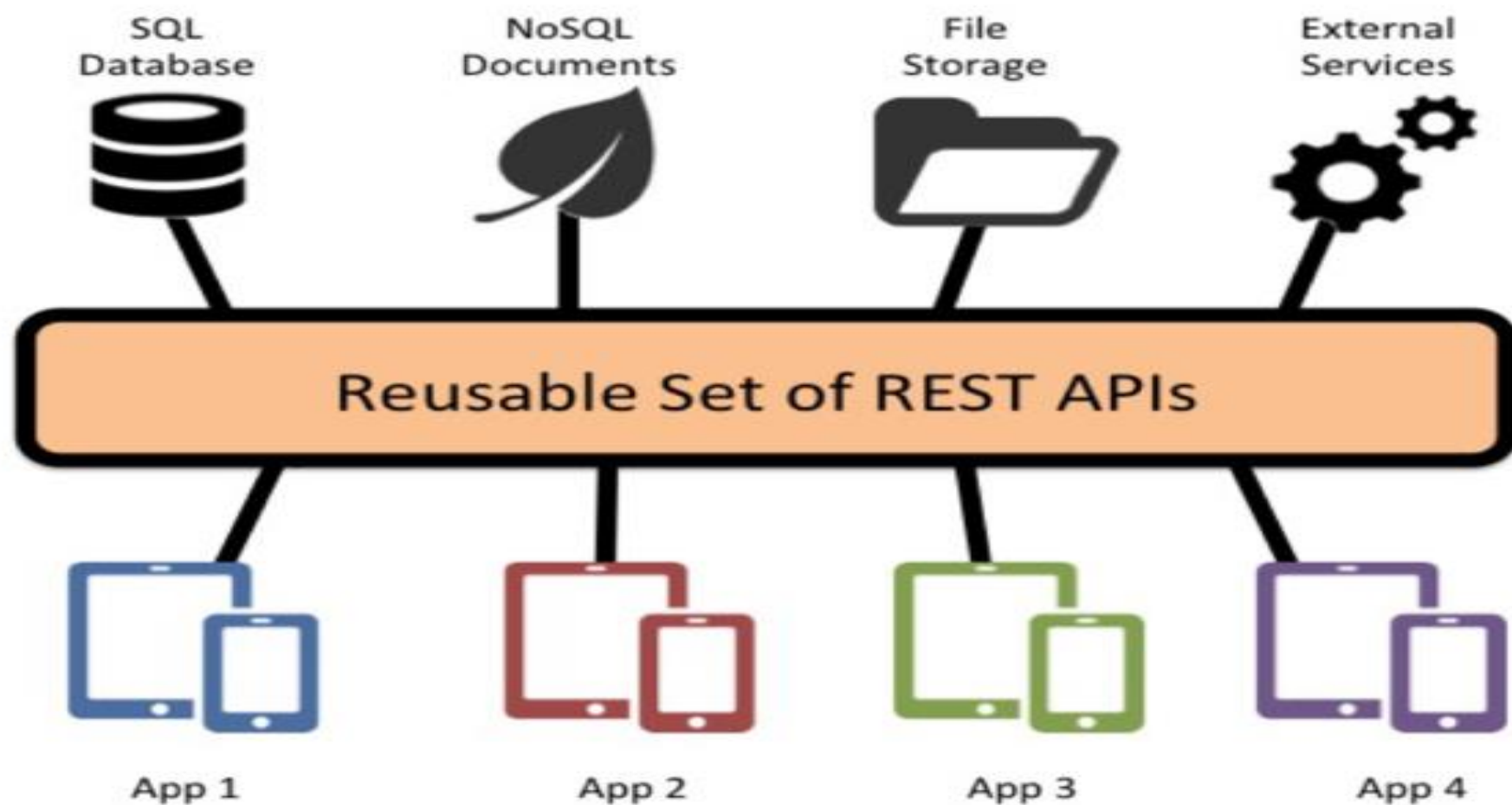
<xml />

{JSON}



Microservice Architecture







<http://www.twitter.com> [HTML]

<http://api.twitter.com> [XML / JSON]



<https://www.facebook.com> [HTML]

<https://graph.facebook.com> [XML / JSON]



Twitter offers two APIs.

The REST API allows developers to access core Twitter data and the Search API provides methods for developers to interact with Twitter Search and trends data.



Google Maps APIs Web Services

A typical Directions API web service request is generally of the following form:

`https://maps.googleapis.com/maps/api/directions/output?parameters`

Add the API key to your request

we must include an API key with every Directions API request.

In the following example, replace YOUR_API_KEY with your API key.

`https://maps.googleapis.com/maps/api/directions/json
?origin=Toronto&destination=Montreal&key=YOUR_API_KEY`

What is

Representational State Transfer

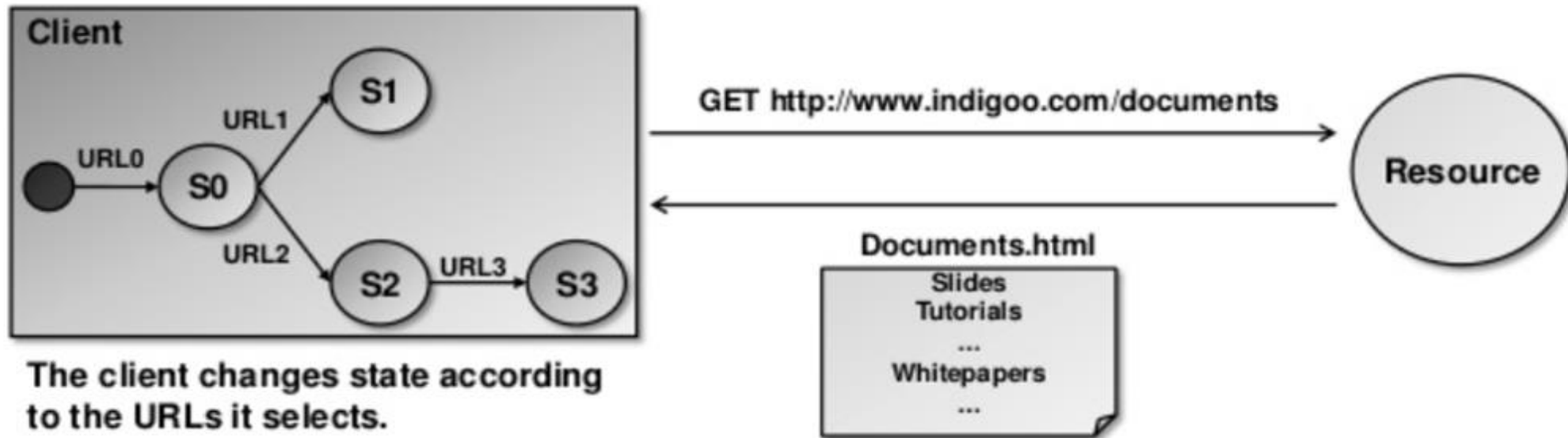
REST, unlike SOAP, is not a WS (web service) standard but an architectural style for web applications.

REST was devised by Roy Fielding in his doctoral dissertation:

*"Representation State Transfer is intended to evoke an image of how a well-designed Web application behaves: a **network of web pages** (a virtual state-machine), where the **user progresses through an application by selecting links** (state transitions), resulting in the next page (representing the next state of the application) being transferred to the user and rendered for their use."*

- REST is not a standard or protocol, REST is an **architectural style**.
- REST makes use of existing web standards (HTTP, URL, XML, JSON, MIME types).
- REST is **resource oriented**. Resources (pieces of information) are addressed by URIs and passed from server to client (or the other way round).

To understand the REST principle, look at what happens in a web access of a browser:



The client changes state according to the URLs it selects.

1. The client references a web resource using a URL.
 2. The web server returns a *representation* of the resource in the form of an HTML document.
 3. This resource places the client into a new *state*.
 4. The user clicks on a link in the resource (e.g. Documents.html) which results in another resource access.
 5. The new resource places the client in a new state.
- ➔ The client application changes (=transfers) *state* with each resource *representation*.

REST is based on existing web (WWW, HTTP) principles and protocols:

Resources:

Application state and functionality are abstracted into resources (everything is a resource).

Addressability of resources:

Every resource is uniquely addressable using hyperlinks.

Uniform interface for accessing resources:

All resources share a uniform interface for the transfer of state between client and resource, consisting of

- a constrained (=limited) set of well-defined operations (GET, PUT, POST, DELETE).**
- a constrained set of content types (text/html, text/xml etc.).**

Why REST

Scalability of WWW:

The WWW has proven to be:

- a. scalable (growth)
- b. simple (easy to implement, easy to use)

REST rationale:

If the web is good enough for humans, it is good enough for machine-to-machine (M2M) interaction.

The concepts behind RPC-WS (SOAP, XML-RPC) are different. RPC-WS make very little use of WWW-concepts and technologies. Such WS define an XML-based interface consisting of operations that run on top of HTTP or some other transport protocol. However, the features and capabilities of HTTP are not exploited.

The motivation for REST was to create an **architectural model** for web services that uses the same principles that made the WWW such a success.

The goal of REST is to achieve the same scalability and simplicity.

- ➔ REST uses proven concepts and technologies.
- ➔ REST keeps things as simple as possible.

Architectural Constraints

REST defines 6 architectural constraints which make any web service – a true RESTful API.

- ☐ **Uniform interface**
- ☐ **Client–server**
- ☐ **Stateless**
- ☐ **Cacheable**
- ☐ **Layered system**
- ☐ **Code on demand (optional)**

Uniform interface

A resource in the system should have only one logical URI, and that should provide a way to fetch related or additional data.

Any single resource should not be too large and contain each and everything in its representation.

Whenever relevant, a resource should contain links (HATEOAS) pointing to relative URIs to fetch related information.

The resource representations across the system should follow specific guidelines such as naming conventions, link formats, or data format (XML or/and JSON).

“Once a developer becomes familiar with one of your APIs, he should be able to follow similar approach for other APIs.”

Client-server

Client application and server application MUST be able to evolve separately without any dependency on each other.

A client should know only resource URIs, keep it simple.

“Servers and clients may also be replaced and developed independently, as long as the interface between them is not altered.”

Stateless

Roy fielding got inspiration from HTTP, so it reflects in this constraint.

Make all client-server interactions stateless.

The server will not store anything about the latest HTTP request the client made. It will treat every request as new. No session, no history.

“No client context shall be stored on the server between requests. The client is responsible for managing the state of the application.”

Cacheable

Caching of data and responses is of utmost important wherever they are applicable/possible.

Caching brings performance improvement for the client-side and better scope for scalability for a server because the load has reduced. Improve network performance.

In REST, caching shall be applied to resources when applicable, and then these resources **MUST declare themselves cacheable. Caching can be implemented on the server or client-side.**

“Well-managed caching partially or completely eliminates some client-server interactions, further improving scalability and performance.”

Layered system

Layers (or tiers) are aimed at the decomposition of the system functionality.

Decomposition of system functionality into client, server and intermediary.

REST allows you to use a layered system architecture where we deploy the APIs on server A, and store data on server B and authenticate requests in Server C, for example.

Client will not have any idea about these servers.

Code on demand (optional)

This constraint is optional. Most of the time, we will be sending the static representations of resources in the form of XML or JSON.

But when the client need some executable code, the server can return the same.

e.g., Clients may call your API to get a UI widget rendering code. It is permitted.

REST protocol

REST is not a protocol like SOAP.

But REST defines some core characteristics that make a system REST-ful.

REST does not define something new, it simply makes use of existing protocols and standards (HTTP, URI).

Addressing resources:

REST uses plain *URIs* (actually URLs) to address and name resources.

Access to resources:

Unlike RPC-WS where the access method (*CRUD*) is mapped to and smeared over SOAP messages, REST uses the available HTTP methods as a resource interface:

Create (<i>C</i>)	→ HTTP POST
Read (<i>R</i>)	→ HTTP GET
Update (<i>U</i>)	→ HTTP PUT
Delete (<i>D</i>)	→ HTTP DELETE

REST assumes the methods GET, HEAD, PUT, DELETE to be idempotent (invoking the method multiple times on a specific resource has the same effect as invoking it once)

REST assumes the methods GET and HEAD to be safe (do not change the resource's state on the server, i.e. resource will not be modified or deleted)

Resource representations:

REST uses standard resource representations like HTML, XML, JSON, GIF, JPEG. Commonly used representations are XML and JSON (preferable to XML if the data needs to be transferred in a more compact and readable form).

Media types:

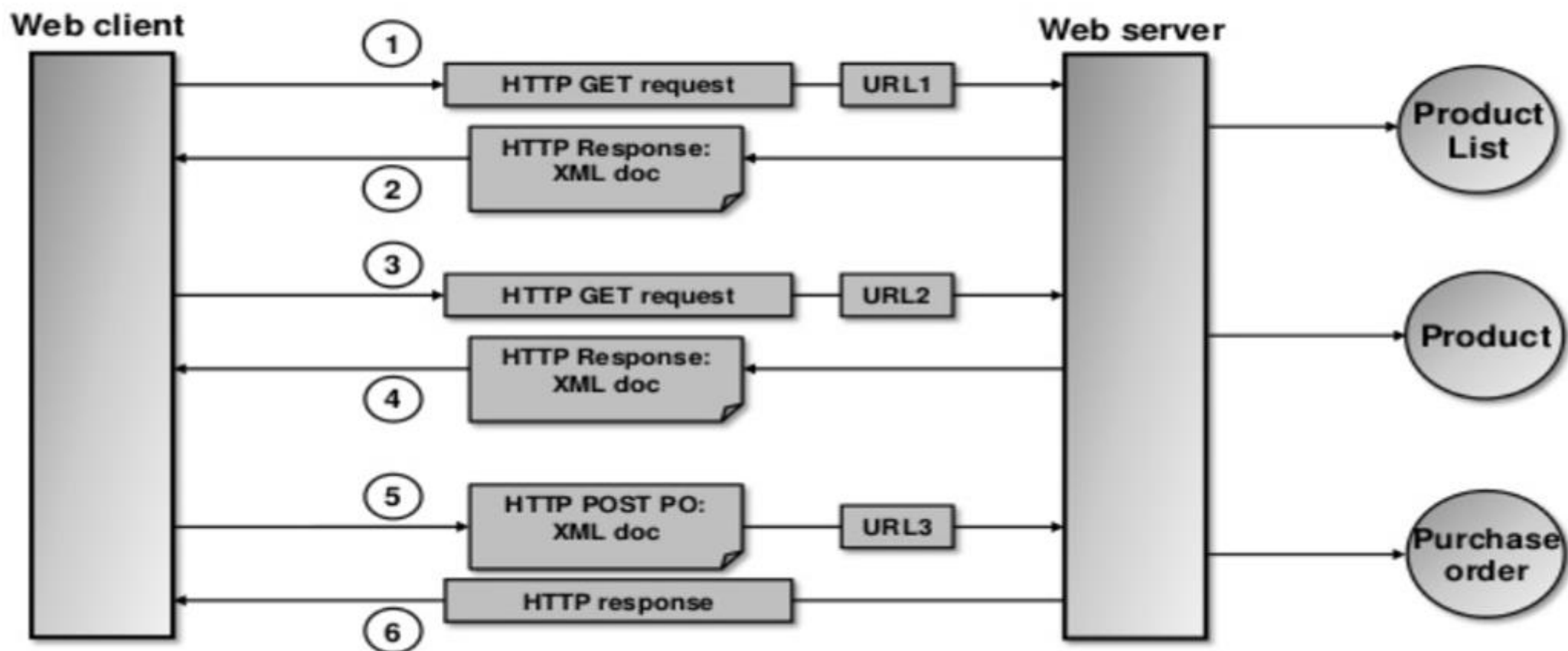
REST uses the HTTP header *Content-type* (MIME types like text/html, text/plain, text/xml, text/javascript for JSON etc.) to indicate the encoding of the resource.

State:

Application state is to be maintained on the client. The server does not have to maintain a state variable for each client (this improves scalability).

Resource state (resource creation, update, deletion), however, is maintained on the server.

Example of a REST-ful access (1/3):



What is difference between action based and resource base URI ?

Action-based URIs:

- ☐ Focus on the action being performed
- ☐ Usually include a verb
- ☐ Often rely on external sources to identify the resource being acted on (e.g., session state)

Resource-based URIs:

- ☐ Focus on the resource being acted on
- ☐ Usually consist of nouns
- ☐ Rely on HTTP verbs to define the action being performed (e.g., GET, PUT, POST, and DELETE)

There are two types URIs

- ❑ Instance resource URI's
- ❑ Collection resource URI's

Instance Resource URIs

first level:

/profiles/{profileName}
/messages/{messageId}

second level:

/messages/{messageId}/comments/{CommentId}
/messages/{messageId}/likes/{likeId}
/messages/{messageId}/shares/{shareId}
/profiles/{profileName}/messages/{messageId}

Collection Resource URIs

/messages

/messages/{messageId}/comments

/messages/{messageId}/likes

/messages/{messageId}/shares

HTTP Methods

GET: Retrieve data from a specified resource

POST: Submit data to be processed to a specified resource

PUT: Update a specified resource

DELETE: Delete a specified resource

HEAD: Same as get but does not return a body

OPTIONS: Returns the supported HTTP methods

PATCH: Update partial resources

Http response contain metadata. Http Status code is one among them.

HTTP Status Codes		
Level 200 (Success) 200 : OK 201 : Created 203 : Non-Authoritative Information 204 : No Content	Level 400 400 : Bad Request 401 : Unauthorized 403 : Forbidden 404 : Not Found 409 : Conflict	Level 500 500 : Internal Server Error 503 : Service Unavailable 501 : Not Implemented 504 : Gateway Timeout 599 : Network timeout 502 : Bad Gateway

Http Status Code

- In the case of html page, based on the status code; appropriate message is sent to client.
- But, in REST; client is another piece of code.

Message Headers: [Accept & Content-Type]

Accept and Content-type are both headers sent from a Rest client to a service.

Accept header is a way for a client to specify the media type of the response content it is expecting.

Content-type is a way to specify the media type of request being sent from the client to the server.

Content types are : application/xml, application/json

Note : It is also called Context Negotiation.

JAX-RS Vs Spring MVC(@RestController)



JSR 370: Java™ API for RESTful Web Services (JAX-RS 2.1) Specification

JAX-RS 2.1

JAX-RS is a specification for implementing REST web services in Java, currently defined by the JSR-370.

Jersey is the JAX-RS reference implementation, however there are other implementations such as RESTEasy and Apache CXF.



Spring Framework

The Spring Framework is a full framework that allows us to create Java enterprise applications.

The REST capabilities are provided by the Spring MVC module (same module that provides model-view-controller capabilities).

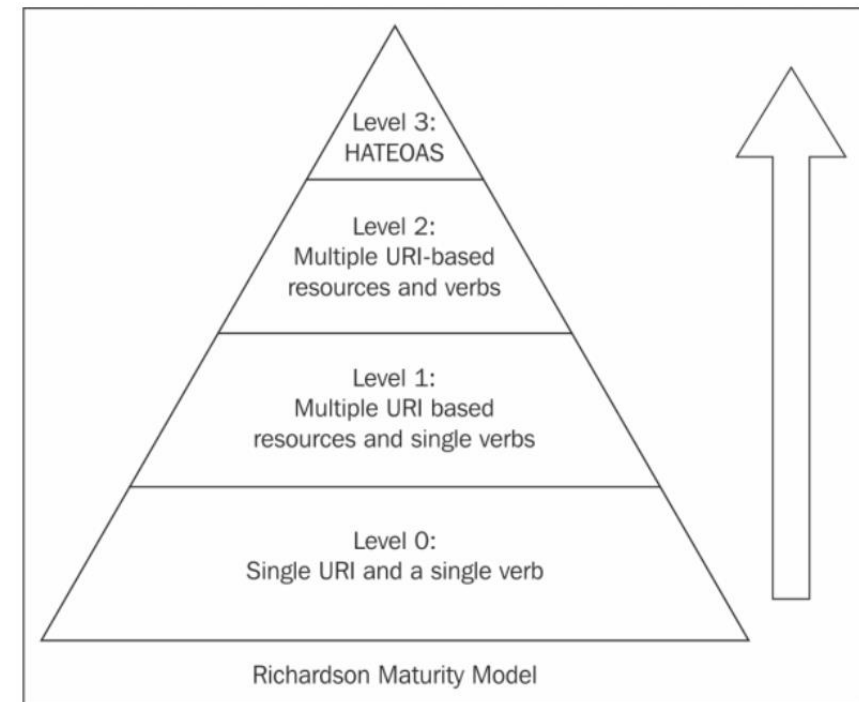
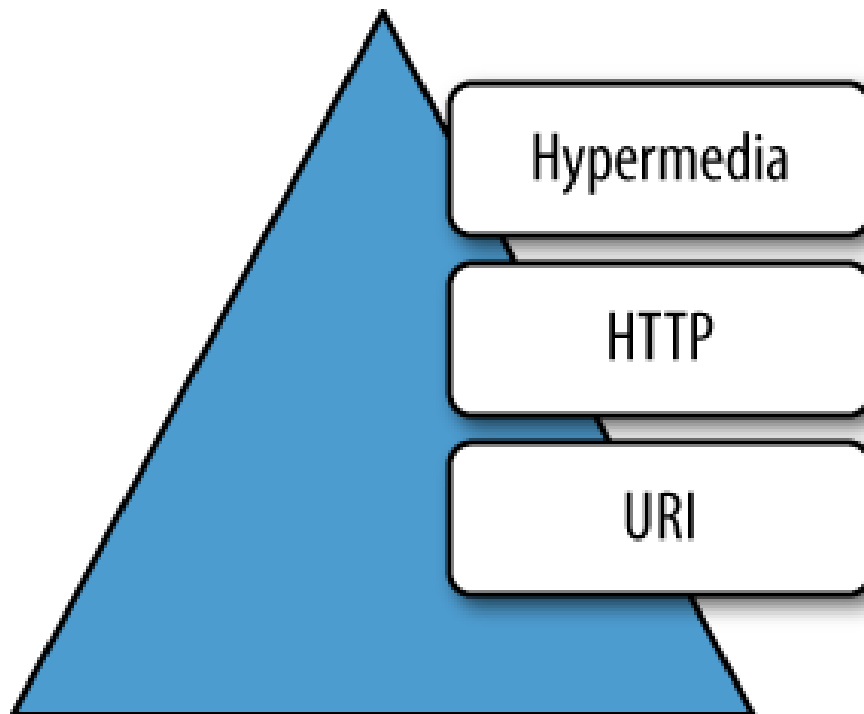
It is not a JAX-RS implementation and can be seen as a Spring alternative to the JAX-RS standard.

The Spring ecosystem also provides a wide range of projects for creating enterprise applications, covering persistence, security, integration with social networks, batch processing, etc.

Richardson Maturity Model

Leonard Richardson analyzed a hundred different web service designs and divided them into four categories based on how much they are REST compliant.

This model of division of REST services to identify their maturity level – is called Richardson Maturity Model.



Level Zero

Level zero of maturity does not make use of any of URI, HTTP Methods, and HATEOAS capabilities.

These services have a single URI and use a single HTTP method (typically POST). For example, most Web Services (WS-*)-based services use a single URI to identify an endpoint, and HTTP POST to transfer SOAP-based payloads, effectively ignoring the rest of the HTTP verbs.

Similarly, XML-RPC based services which send data as Plain Old XML (POX). These are the most primitive way of building SOA applications with a single POST method and using XML to communicate between services.

Level One

Level one of maturity makes use of URIs out of URI, HTTP Methods, and HATEOAS.

These services employ many URIs but only a single HTTP verb – generally HTTP POST. They give each individual resource in their universe a URI. Every resource is separately identified by a unique URI – and that makes them better than level zero.

Level Two

Level two of maturity makes use of URIs and HTTP out of URI, HTTP Methods, and HATEOAS.

Level two services host numerous URI-addressable resources. Such services support several of the HTTP verbs on each exposed resource – Create, Read, Update and Delete (CRUD) services.

Here the state of resources, typically representing business entities, can be manipulated over the network.

Here service designer expects people to put some effort into mastering the APIs – generally by reading the supplied documentation.

Level 2 is the good use-case of REST principles, which advocate using different verbs based on the HTTP request methods and the system can have multiple resources.

Level Three

Level three of maturity makes use of all three i.e. URIs and HTTP and HATEOAS.

This is the most mature level of Richardson's model which encourages easy discoverability and makes it easy for the responses to be self-explanatory by using HATEOAS.

The service leads consumers through a trail of resources, causing application state transitions as a result.

HATEOAS

Hypermedia is an extension to what is known as hypertext, or the ability to open new Web pages by clicking text links on a Web browser.

Hypermedia extends upon this by allowing the user to click images, movies, graphics and other media apart from text to create a nonlinear network of information

HATEOAS (Hypermedia as the Engine of Application State) is a constraint of the REST application architecture.

A hypermedia-driven site provides information to navigate the site's REST interfaces dynamically by including hypermedia links with the responses.

Spring HATEOAS provides some APIs to ease creating REST representations that follow the HATEOAS principle when working with Spring and especially Spring MVC.

```
<dependency>  
<groupId>org.springframework.hateoas</groupId>  
<artifactId>spring-hateoas</artifactId>  
<version>0.23.0.RELEASE</version> </dependency>
```


A HATEOAS-based response would look like this:

```
{  
  "name": "Alice",  
  "links": [ {  
    "rel": "self",  
    "href": http://localhost:8080/customer/1  } ] }
```

This response not only has the person's name, but includes the self-linking URL where that person is located.

rel means relationship. In this case, it's a self-referencing hyperlink.

More complex systems might include other relationships. For example, an order might have a "rel":"customer" relationship, linking the order to its customer (/customer/order/...)

href is a complete URL that uniquely defines the resource.

GET - <http://localhost:8080/accounts/12345>

Accept : application/json

```
HTTP/1.1 200 OK
Content-Type: application/vnd.acme.account+json
Content-Length: ...

{
  "account": {
    "account_number": 12345,
    "balance": {
      "currency": "usd",
      "value": 100.00
    },
    "links": {
      "deposit": "/accounts/12345/deposit",
      "withdraw": "/accounts/12345/withdraw",
      "transfer": "/accounts/12345/transfer",
      "close": "/accounts/12345/close"
    }
  }
}
```

Representation models

To easily create hypermedia enriched representations, Spring HATEOAS provides a set of classes with `RepresentationModel` at their root. It's basically a container for a collection of `Links` and has convenient methods to add those to the model.

`RepresentationModel`

`EntityModel`

`CollectionModel`

`PagedModel`

public class **EntityModel**<T>
extends RepresentationModel<EntityModel<T>>
Base class for DTOs to collect links.

public class **CollectionModel**<T>
extends RepresentationModel<CollectionModel<T>>
implements Iterable<T>
General helper to easily create a wrapper for a collection of entities.

public class **PagedModel**<T>
extends CollectionModel<T>
DTO to implement binding response representations of pageable collections.

Server-side support [Building links in Spring MVC]

Spring HATEOAS provides a `WebMvcLinkBuilder` that lets you create links by pointing to controller classes. The following example shows how to do so:

```
import static org.sfw.hateoas.server.mvc.WebMvcLinkBuilder.*;
```

```
Link link = linkTo(PersonController.class).withRel("people");
```

The `WebMvcLinkBuilder` uses Spring's `ServletUriComponentsBuilder` under the hood to obtain the basic URI information from the current request

Swagger

Mostly front-end and back-end components often separate a web application.

Usually, we expose APIs as a back-end component for the front-end component or third-party app integrations.

In such a scenario, it is essential to have proper specifications for the back-end APIs.

At the same time, the API documentation should be informative, readable, and easy to follow.

Moreover, reference documentation should simultaneously describe every change in the API.

Swagger is an open-source software framework backed by a large ecosystem of tools that helps developers design, build, document, and consume RESTful web services. While most users identify Swagger by the Swagger UI tool, the Swagger toolset includes support for automated documentation, code generation, and test-case generation.

SpringFox

Automated JSON API documentation for API's built with Spring

Springfox implementation of the Swagger specification.

To add it to our Maven project, we need a dependency in the pom.xml file.

```
<dependency>  
  <groupId>io.springfox</groupId>  
  <artifactId>springfox-swagger2</artifactId>  
  <version>2.9.2</version>  
</dependency>
```

Integrating Swagger 2 into the Project

The configuration of Swagger mainly around the Docket bean.

```
@Configuration
@EnableSwagger2
public class SpringFoxConfig {
    @Bean
    public Docket api() {
        return new Docket(DocumentationType.SWAGGER_2)
            .select()
            .apis(RequestHandlerSelectors.any())
            .paths(PathSelectors.any())
            .build();
    }
}
```

Swagger UI

Swagger UI is a built-in solution which makes user interaction with the Swagger-generated API documentation much easier.

To use Swagger UI, one additional Maven dependency is required:

```
<dependency>
  <groupId>io.springfox</groupId>
  <artifactId>springfox-swagger-ui</artifactId>
  <version>2.9.2</version>
</dependency>
```

We can test it in our browser by visiting <http://localhost:8080/your-app-root/swagger-ui.html>

Springfox Plugin

In order to add specific features to the API specifications, we can create a Springfox plugin. A plugin can offer various features, from enriching the models and properties to the custom API listings and defaults.

Springfox supports the plugin creation through its spi module. The spi module provides a few interfaces like the `ModelBuilderPlugin`, `ModelPropertyBuilderPlugin`, and `ApiListingBuilderPlugin` that act as an extensibility hook to implement a custom plugin.

To demonstrate the capabilities, let's create a plugin to enrich the email property of the User model.

```
@Component
@Order(Validators.BEAN_VALIDATOR_PLUGIN_ORDER)
public class EmailAnnotationPlugin implements
ModelPropertyBuilderPlugin {
    @Override
    public boolean supports(DocumentationType delimiter) {
        return true;
    }
}
```

```
@Override
public void apply(ModelPropertyContext context) {
    Optional<Email> email = annotationFromBean(context,
Email.class);
    if (email.isPresent()) {
        context.getBuilder().pattern(email.get().regexp());
        context.getBuilder().example("email@email.com");
    }
}
```

So, the API specifications will show the pattern and example values of the property annotated with the @Email annotation.

Next, we'll add the @Email annotation to the User entity:

```
@Entity
public class User {
    //...
    @Email(regexp="^.@.\\..*", message = "Email should be valid")
    private String email;
}
```

To enable the EmailAnnotationPlugin in the SpringFoxConfig class by registering as a bean:

```
@Import({BeanValidatorPluginsConfiguration.class})
public class SpringFoxConfig {
```

Filtering API for Swagger's Response

We can also restrict Swagger's response by passing parameters to the `apis()` and `paths()` methods of the Docket class.

RequestHandlerSelectors allows using the `any` or `none` predicates, but can also be used to filter the API according to the base package, class annotation, and method annotations.

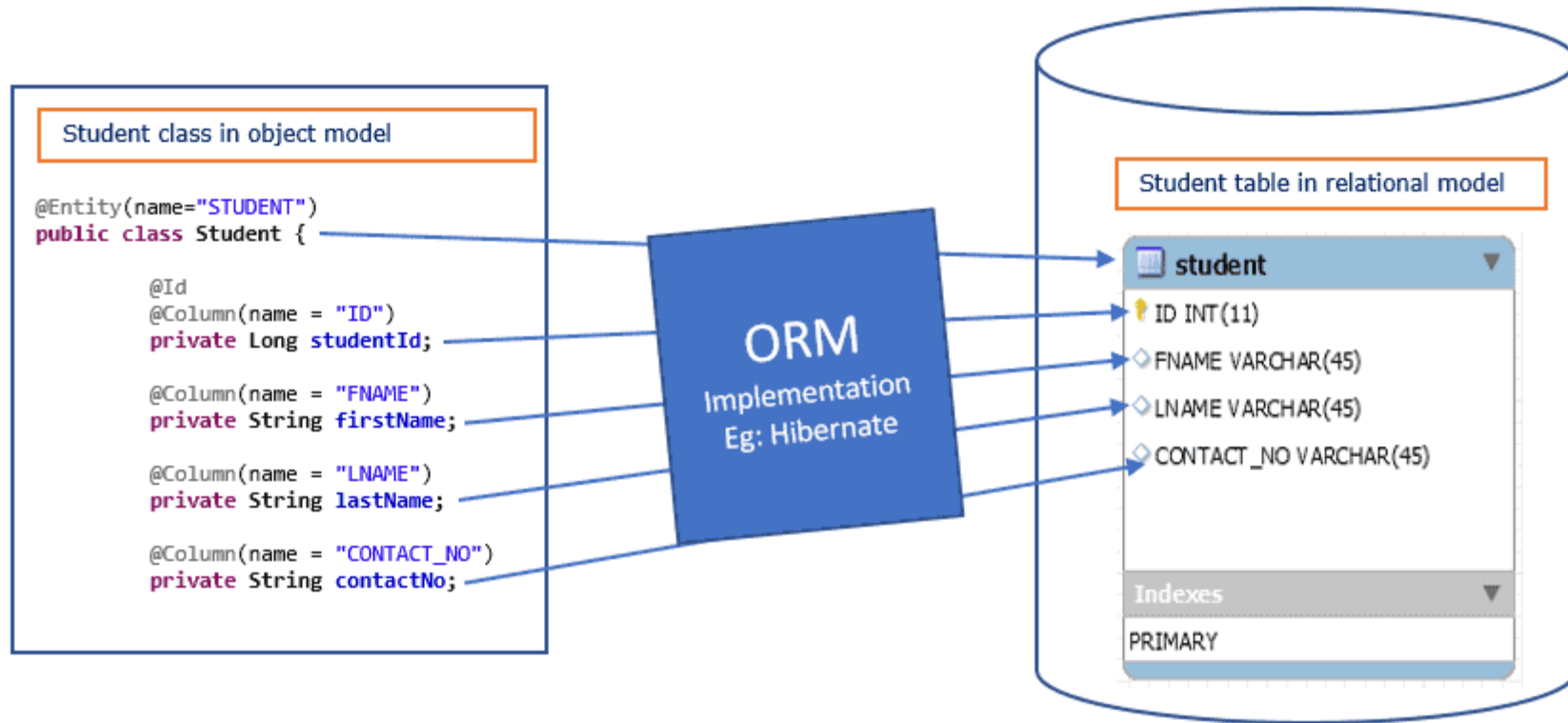
PathSelectors provides additional filtering with predicates which scan the request paths of your application. You can use `any()`, `none()`, `regex()`, or `ant()`.

Data Access Layer

What is Object Relational Mapping (ORM)?

ORM or Object Relational Mapping is a system that implements the responsibility of mapping the Object to Relational Model.

That means it is responsible to store Object Model data into Relational Model and further read the data from Relational Model into Object Model.



ORM implements responsibility of mapping the Object to Relational Model.

Popular ORM tools/frameworks in Java:

Hibernate – Open Source

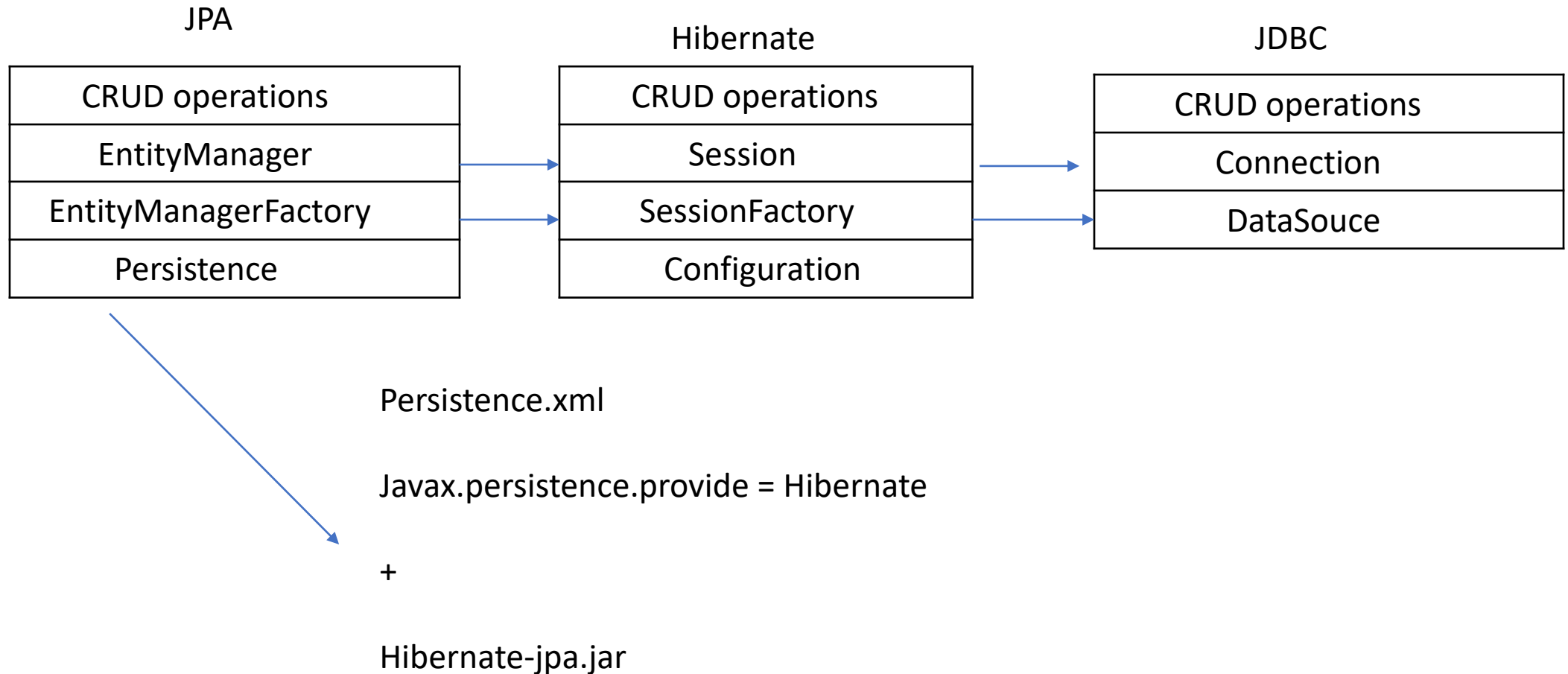
Top Link – By Oracle

Eclipse Link – Eclipse Persistence Platform

Open JPA – By Apache

MyBatis – Open Source – Formerly known as iBATIS

JPA / Hibernate / JDBC



```
@Entity
Class User
{
    Long id;
    String name;
    ....
    getName(){}

    setName(){}
}
```

```
interface IUserDao
{

    List<User> getUsers();

    User getUser(long id);

    void updateUser(User user);

    void deleteUser(User user);

}
```

```
@Repository
Class UserDao implements IUserDao
{

    @Autowired
    EntityManager manager;

    List<User> getUsers()
    { return manager.createQuery("from User"); }

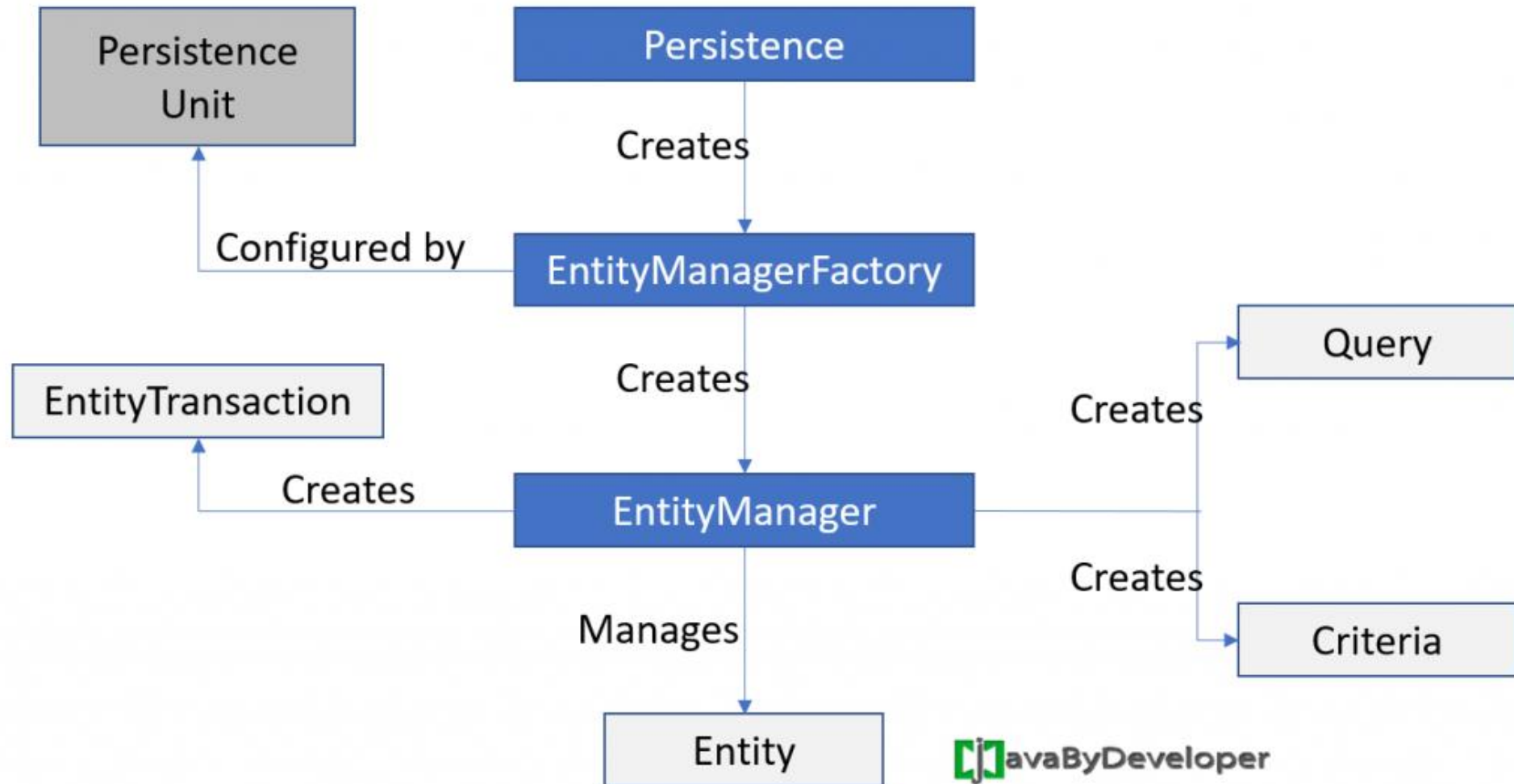
    User getUser(long id)
    { return manager.find(User.class, id); }

    void updateUser(User user) { ... }

    void deleteUser(User user) { ... }

}
```

JPA Architecture:



Spring Data – REST

The Java Persistence API (JPA) is a specification of Java. It is used to persist data between Java object and relational database. JPA acts as a bridge between object-oriented domain models and relational database systems.

As JPA is just a specification, it doesn't perform any operation by itself. It requires an implementation.

So, ORM tools like Hibernate, TopLink and iBatis implements JPA specifications for data persistence.

Spring Data

Spring Data's provide a familiar and consistent, Spring-based programming model for data access while still retaining the special traits of the underlying data store.

It makes it easy to use data access technologies, relational and non-relational databases, map-reduce frameworks, and cloud-based data services

Features

- ❑ Powerful repository and custom object-mapping abstractions
- ❑ Dynamic query derivation from repository method names
- ❑ Support for transparent auditing (created, last changed)
- ❑ Possibility to integrate custom repository code
- ❑ Easy Spring integration via JavaConfig and custom XML namespaces
- ❑ Advanced integration with Spring MVC controllers
- ❑ Experimental support for cross-store persistence

Main modules

Spring Data Commons - Core Spring concepts underpinning every Spring Data project.

Spring Data JPA - Makes it easy to implement JPA-based repositories.

Spring Data KeyValue - Map-based repositories and SPIs to easily build a Spring Data module for key-value stores.

Spring Data LDAP - Provides Spring Data repository support for Spring LDAP.

Spring Data MongoDB - Spring based, object-document support and repositories for MongoDB.

Spring Data REST - Exports Spring Data repositories as hypermedia-driven RESTful resources.

Spring Data for Apache Cassandra - Spring Data module for Apache Cassandra.

org.springframework.data.repository

Interface Repository<T,ID>

Type Parameters:

T - the domain type the repository manages

ID - the type of the id of the entity the repository manages

All Known Subinterfaces:

CrudRepository<T,ID>, PagingAndSortingRepository<T,ID>,
ReactiveCrudRepository<T,ID>, ReactiveSortingRepository<T,ID>,
RevisionRepository<T,ID,N>, RxJava2CrudRepository<T,ID>,
RxJava2SortingRepository<T,ID>

CrudRepository Methods:

`count()`

Returns the number of entities available.

`delete(T entity)`

Deletes a given entity.

`deleteAll(Iterable<? extends T> entities)`

Deletes the given entities.

`deleteById(ID id)`

Deletes the entity with the given id.

`save(S entity)`

Saves a given entity.

`saveAll(Iterable<S> entities)`

Saves all given entities.

org.springframework.data.repository
Interface **PagingAndSortingRepository**<T,ID>

public interface PagingAndSortingRepository<T,ID>
extends CrudRepository<T,ID>

Extension of CrudRepository to provide additional methods to retrieve entities using the pagination and sorting abstraction.

PagingAndSortingRepository methods are:

`findAll(Pageable pageable)`

Returns a Page of entities meeting the paging restriction provided in the Pageable object.

`findAll(Sort sort)`

Returns all entities sorted by the given options.

JpaRepository - which extends PagingAndSortingRepository and, in turn, the CrudRepository.

It provides JPA related methods such as flushing the persistence context and delete records in a batch.

org.springframework.data.jpa.repository
Interface JpaRepository<T,ID>

All Superinterfaces:

CrudRepository<T,ID>, PagingAndSortingRepository<T,ID>,
QueryByExampleExecutor<T>, Repository<T,ID>

All Known Implementing Classes:

QuerydslJpaRepository, SimpleJpaRepository

Methods are :

`deleteAllInBatch()`

Deletes all entities in a batch call.

`deleteInBatch(Iterable<T> entities)`

Deletes the given entities in a batch which means it will create a single Query.

`flush()`

Flushes all pending changes to the database.

....

Methods inherited from interface

org.springframework.data.repository.PagingAndSortingRepository

❑ findAll

Methods inherited from interface

org.springframework.data.repository.CrudRepository

❑ count, delete, deleteAll, deleteAll, deleteById, existsById, findById, save

Methods inherited from interface

org.springframework.data.repository.query.QueryByExampleExecutor

❑ count, exists, findAll, findOne

public @interface **RepositoryRestResource**

Annotate a Repository with this to customize export mapping and rels.

Simplifies building hypermedia-driven REST web services on top of Spring Data repositories.

Examples

The following code represents a Customer object.

```
class Customer
{
    String name;
}
```

A simple JSON presentation is traditionally rendered as:

```
{
    "name" : "Great"
}
```

The customer data is there, but the data contains nothing about its relevant links.

A HATEOAS-based response would look like this:

```
{  
  "name": "Great",  
  "links": [ {  
    "rel": "self",  
    "href": http://localhost:8080/customer/1  } ]  
}
```

This response not only has the person's name, but includes the self-linking URL where that person is located.

rel means relationship. In this case, it's a self-referencing hyperlink.

More complex systems might include other relationships. For example, an order might have a "rel":"customer" relationship, linking the order to its customer.

href is a complete URL that uniquely defines the resource.

Note : XML is also accepted as a standard response format

Spring Security

The two dimensions of System Security

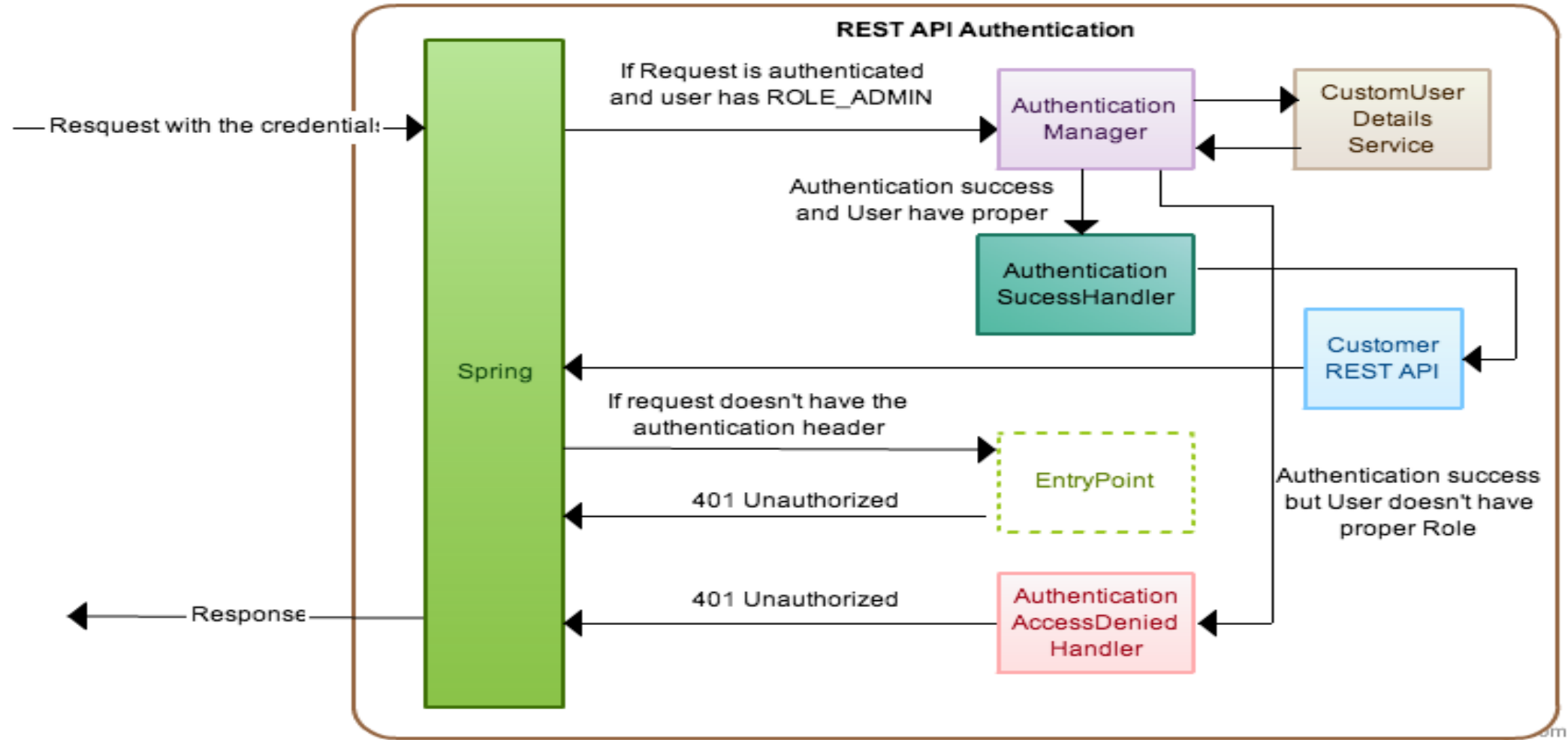
- Authentication

- Identifying the user as an authorized user
- Limiting the time the user can operate in the system before re-identifying himself
- Securing that all requests for the duration of the session come from the identified user

- Authorization

- Constraining the operations the logged in user can perform in accordance with his assigned roles

The SPRING Security Model



In web.xml

```
<filter>  
<filter-name>springSecurityFilterChain</filter-name>  
<filter-class>  
org.springframework.web.filter.DelegatingFilterProxy  
</filter-class>  
</filter>
```

```
<filter-mapping>  
<filter-name>springSecurityFilterChain</filter-name>  
<url-pattern>/*</url-pattern>  
</filter-mapping>
```

Java Configuration – Replaces web.xml

```
public class SecurityWebInitializer
    extends AbstractSecurityWebApplicationInitializer
{
    // optionally override methods
}
```

Java Configuration – WebSecurityConfig

```
@Configuration
@EnableWebMvcSecurity
public class WebSecurityConfig
    extends WebSecurityConfigurerAdapter
{
    ...
}
```

Spring Security Configuration

@Configuration

@EnableWebSecurity

public class SecurityConfig extends WebSecurityConfigurerAdapter {

 @Autowired

 public void configureGlobal(AuthenticationManagerBuilder auth) throws Exception {
 auth.inMemoryAuthentication().withUser("test").password("123456").roles("USER");
 auth.inMemoryAuthentication().withUser("admin").password("123456").roles("ADMIN");
 auth.inMemoryAuthentication().withUser("dba").password("123456").roles("DBA");
 }

 @Override

 protected void configure(HttpSecurity http) throws Exception {

 http.authorizeRequests()
 .antMatchers("/admin/**").access("hasRole('ROLE_ADMIN')")
 .antMatchers("/dba/**").access("hasRole('ROLE_ADMIN') or hasRole('ROLE_DBA')")
 .and().formLogin();

 }

}

The equivalent of the Spring Security xml file :

```
<http auto-config="true">
    <intercept-url pattern="/admin**" access="ROLE_ADMIN" />
    <intercept-url pattern="/dba**" access="ROLE_ADMIN,ROLE_DBA" />
    <form-login />
</http>

<authentication-manager>
    <authentication-provider>
        <user-service>
            <user name="test" password="123456" authorities="ROLE_USER" />
            <user name="admin" password="123456" authorities="ROLE_ADMIN" />
            <user name="dba" password="123456" authorities="ROLE_DBA" />
        </user-service>
    </authentication-provider>
</authentication-manager>
```


Example:

```
protected void configure(HttpSecurity http) throws Exception
{
    http.authorizeRequests()
        .anyRequest().authenticated()
        .and().httpBasic();
}
```

The above default configuration makes sure any request to the application is authenticated with form based login or HTTP basic authentication.

Also, it is exactly similar to the following XML configuration:

```
<http>
    <intercept-url pattern="/**" access="authenticated"/>
    <form-login />
    <http-basic />
</http>
```

org.springframework.util

Class AntPathMatcher

java.lang.Object

org.springframework.util.AntPathMatcher

All Implemented Interfaces:

PathMatcher

```
public class AntPathMatcher  
extends java.lang.Object  
implements PathMatcher
```

PathMatcher implementation for Ant-style path patterns.

Part of this mapping code has been kindly borrowed from Apache Ant.

The mapping matches URLs using the following rules:

- ? matches one character
- * matches zero or more characters
- ** matches zero or more *directories* in a path
- {spring:[a-z]+} matches the regexp [a-z]+ as a path variable named "spring"

Examples

com/t?st.jsp — matches com/test.jsp but also com/tast.jsp or com/txst.jsp

com/*.jsp — matches all .jsp files in the com directory

com/**/*.jsp — matches all test.jsp files underneath the com path

org/springframework/**/*.jsp — matches all .jsp files underneath the org/springframework path

org/**/*.servlet/bla.jsp — matches org/springframework/servlet/bla.jsp but also org/springframework/testing/servlet/bla.jsp and org/servlet/bla.jsp

The Spring 5.0 release added a very easy to use URI variable syntax: `{*foo}` to capture any number of path segments at the end of the pattern.

```
@GetMapping("/spring5/{*id}")  
public String URIVariableHandler(@PathVariable String id) {  
    return id;  
}
```

Ex:

```
uri("/spring5/sample/tutorial")  
uri("/spring5/sample")
```

```
protected void configure(HttpSecurity http) throws Exception {  
    http  
        .authorizeRequests()  
            .anyRequest().authenticated()  
            .and()  
        .formLogin();  
}
```

The default configuration above:

- ☐ Ensures that any request to our application requires the user to be authenticated
- ☐ Allows users to authenticate with form based login

It is similar the XML Namespace configuration:

```
<http>  
    <intercept-url pattern="/**" access="authenticated"/>  
    <form-login />  
</http>
```

```
protected void configure(HttpSecurity http) throws Exception {  
  
    http  
        .authorizeRequests()  
        .antMatchers("/", "/home").permitAll()  
        .anyRequest().authenticated()  
        .and()  
        .formLogin();  
  
}
```

```
protected void configure(HttpSecurity http) throws Exception
{
    http
        .authorizeRequests()
        .antMatchers("/", "/home").permitAll()
        .anyRequest().authenticated()
        .and()
        .formLogin()
        .loginPage("/login")
        .permitAll()
        .and()
        .logout()
        .permitAll();
}
```


OAuth 2.0 OVERVIEW

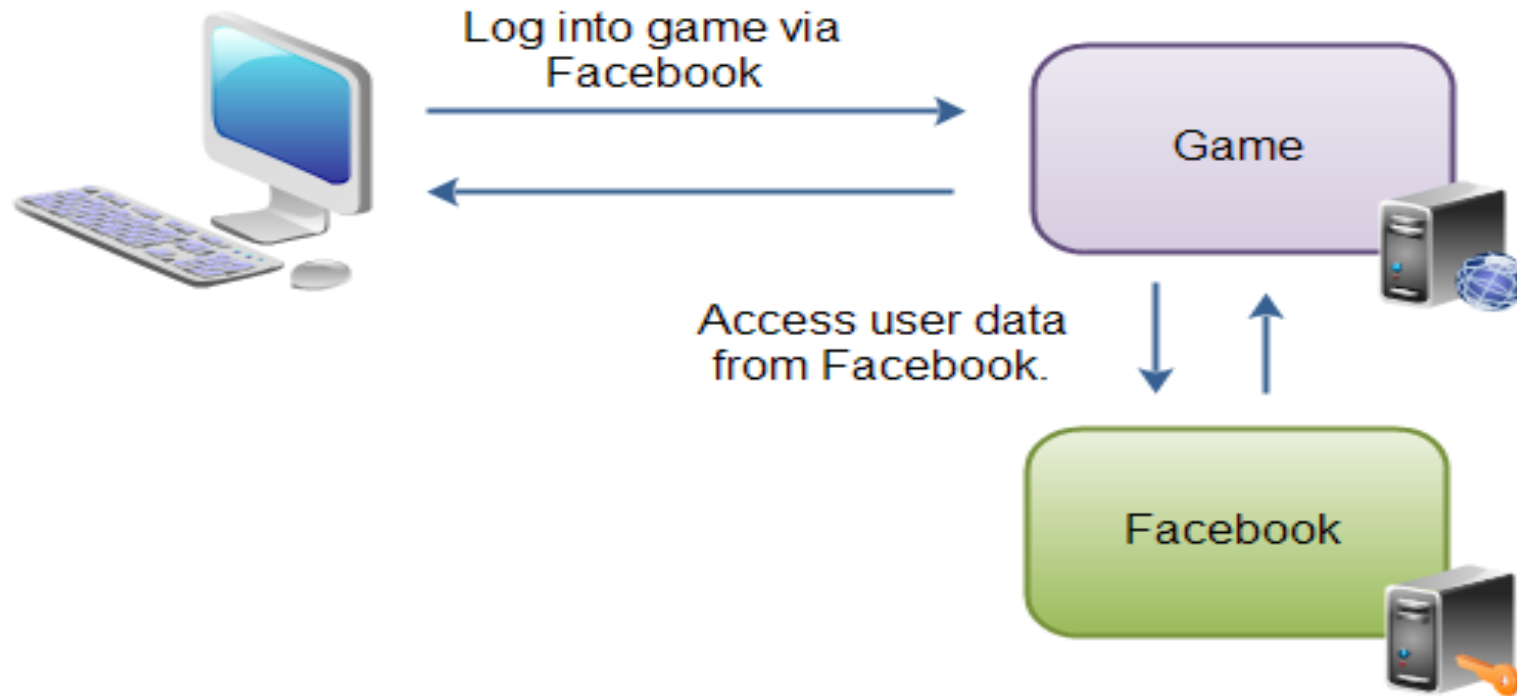
OAuth is an open standard for access delegation, commonly used as a way for Internet users to grant websites or applications access to their information on other websites but without giving them the passwords.

This mechanism is used by companies such as Amazon, Google, Facebook, Microsoft and Twitter to permit the users to share information about their accounts with third party applications or websites.

OAuth 2.0 is an open authorization protocol specification defined by IETF OAuth WG (Working Group) which enables applications to access each other's data.

The prime focus of this protocol is to define a standard where an application, say gaming site, can access the user's data maintained by another application like facebook, google or other resource server.

OAuth 2.0 is a replacement for OAuth 1.0, which was more complicated. OAuth 1.0 involved certificates etc. OAuth 2.0 is more simple. It requires no certificates at all, just SSL / TLS.



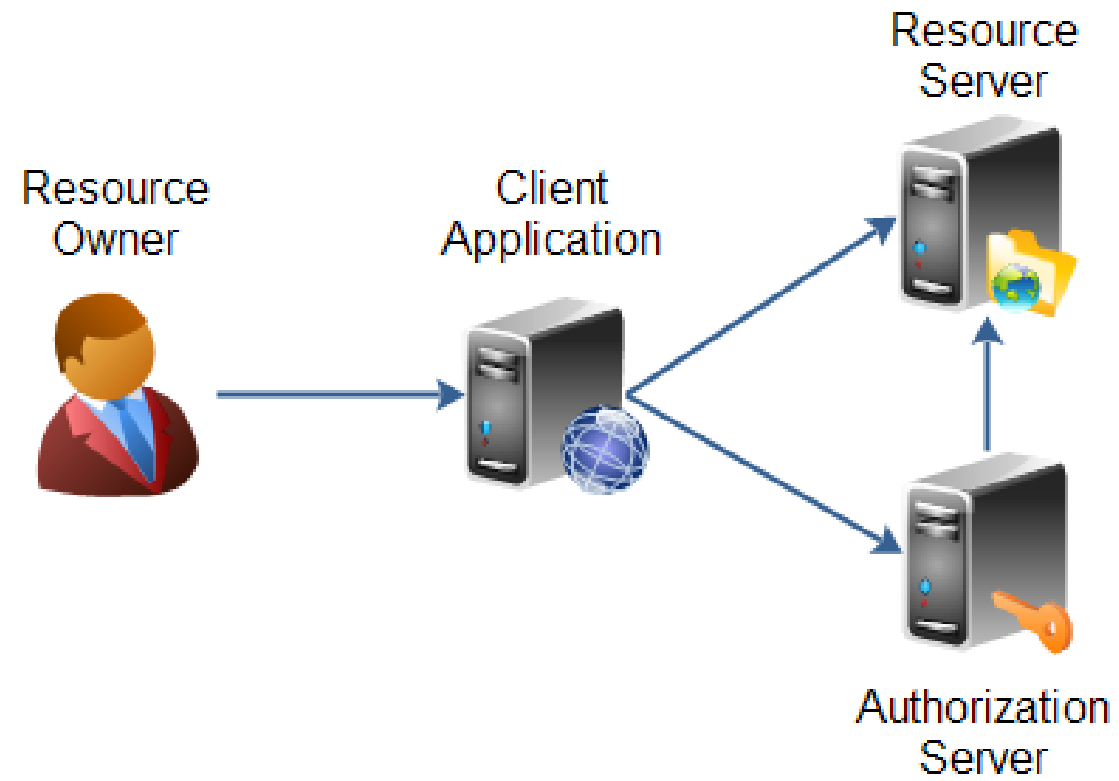
The user accesses the game web application.

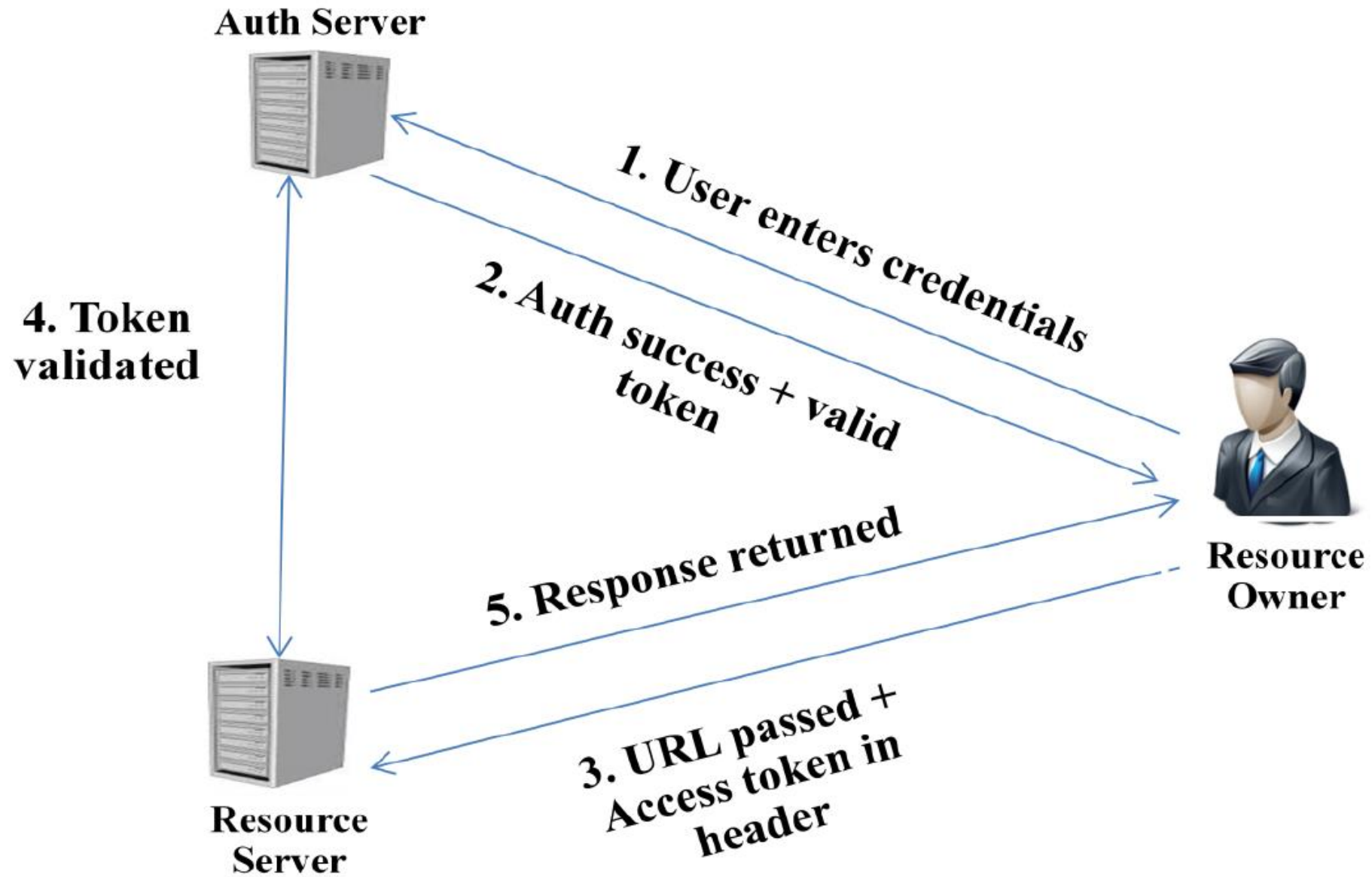
The game web application asks the user to login to the game via Facebook.

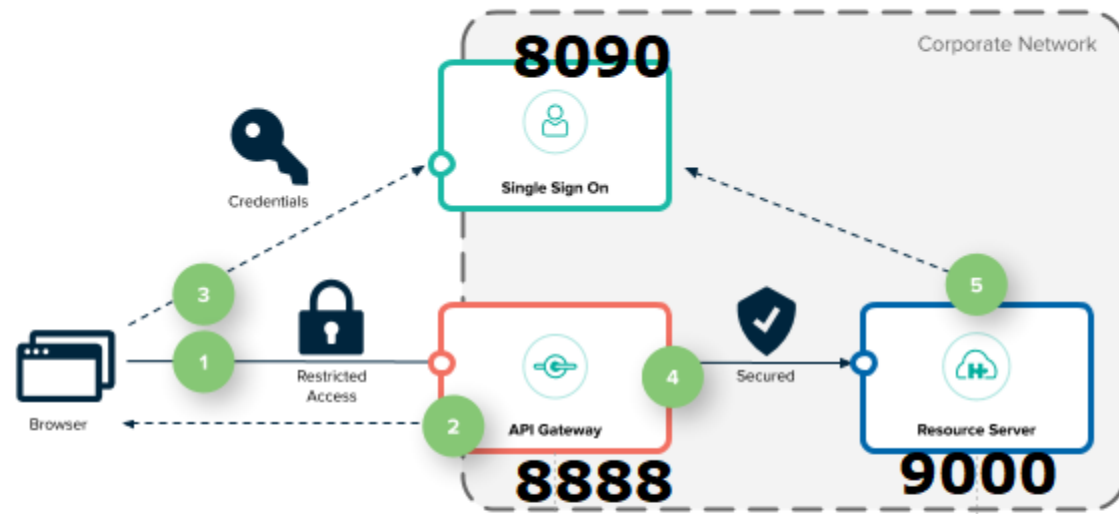
The user logs into Facebook, and is sent back to the game. The game can now access the users data in Facebook, and call functions in Facebook on behalf of the user (e.g. posting status updates).

OAuth 2.0 defines the following roles of users and applications:

- Resource Owner
- Resource Server
- Client Application
- Authorization Server







- 1 User requests **/resource**
 - 2 Gateway redirects browser to SSO
 - 3 User authenticates & authorises the app
 - 4 Request & JWT sent to the Resource Server
 - 5 Resource Server checks user's JWT token
- Users original intended path
 --- Additional OAuth / JOSE flows

```
org.springframework.boot:spring-boot-starter-webflux
org.springframework.cloud:spring-cloud-starter-gateway
org.springframework.cloud:spring-cloud-starter-security
org.springframework.boot:spring-boot-starter-oauth2-client
org.springframework.boot:spring-boot-starter-thymeleaf
org.thymeleaf.extras:thymeleaf-extras-springsecurity5
```

```
org.springframework.boot:spring-boot-starter-webflux
org.springframework.boot:spring-boot-starter-security
org.springframework.security:spring-security-oauth2-resource-server
org.springframework.security:spring-security-oauth2-jose
```




localhost:9090/product



KEYCLOAK

9090



**Spring
Cloud
Gateway**

9191



**OAuth2
Resource
Server**

9200



elasticsearch

5000



logstash

5601



kibana

9411



- ❑ The resource owner is the person or application that owns the data that is to be shared.

For instance, a user on Facebook or Google could be a resource owner. The resource they own is their data. The resource owner could also be an application. The OAuth 2.0 specification mentions both possibilities.

- ❑ The resource server is the server hosting the resources. For instance, Facebook or Google is a resource server (or has a resource server).

- ❑ The client application is the application requesting access to the resources stored on the resource server. The resources, which are owned by the resource owner. A client application could be a game requesting access to a users Facebook account.
- ❑ The authorization server is the server authorizing the client app to access the resources of the resource owner. The authorization server and the resource server can be the same server, but it doesn't have to.

Steps involved in User Authentication

1. User enters credentials which are passed over to Authorization Server in Http Authentication header in encrypted form. The communication channel is secured with SSL.
2. Authorization server authenticates the user with the credentials passed and generates a token for limited time and finally returns it in response.
3. The client application calls API to resource server, passing the token in http header or as a query string.
4. Resource server extracts the token and authorizes it with Authorization server.
5. Once the authorization is successful, a valid response is sent to the caller.

Client ID, Client Secret and Redirect URI

Before a client application can request access to resources on a resource server, the client application must first register with the authorization server associated with the resource server.

The registration is typically a one-time task. Once registered, the registration remains valid, unless the client app registration is revoked.

At registration the client application is assigned a client ID and a client secret (password) by the authorization server. The client ID and secret is unique to the client application on that authorization server.

Authorization Grant

The authorization grant is given to a client application by the resource owner, in cooperation with the authorization server associated with the resource server.

The OAuth 2.0 specification lists four different types of authorization grants. Each type has different security characteristics. The authorization grant types are:

- ☐ Authorization Code
- ☐ Implicit
- ☐ Resource Owner Password Credentials
- ☐ Client Credentials

Authorization Code

An authorization grant using an authorization code works like this

- 1) The resource owner (user) accesses the client application.
- 2) The client application tells the user to login to the client application via an authorization server (e.g. Facebook, Twitter, Google etc.).
- 3) To login via the authorization server, the user is redirected to the authorization server by the client application. The client application sends its client ID along to the authorization server, so the authorization server knows which application is trying to access the protected resources.

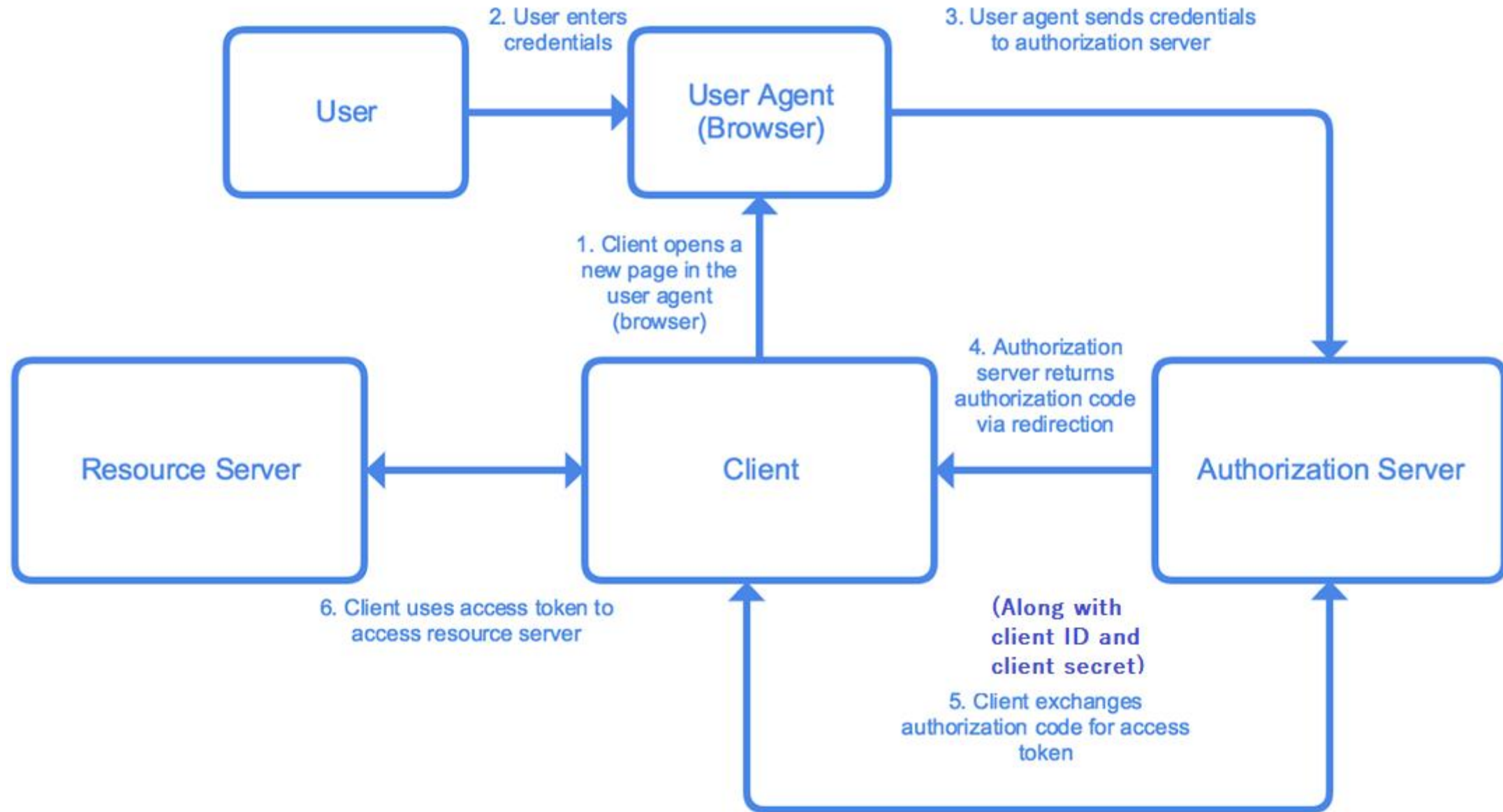


- 4) The user logs in via the authorization server. After successful login the user is asked if he wants to grant access to his resources to the client application. If the user accepts, the user is redirected back to the client application.
- 5) When redirected back to the client application, the authorization server sends the user to a specific redirect URI, which the client application has registered with the authorization server ahead of time. Along with the redirection, the authorization server sends an authorization code, representing the authorization.

6) When the redirect URI in the client application is accessed, the client application connects directly to the authorization server. The client application sends the authorization code along with its own client ID and client secret.

7) If the authorization server can accept these values, the authorization server sends back an access token.

10) The client application can now use the access token to request resources from the resource server. The access token serves as both authentication of the client, resource owner (user) and authorization to access the resources.



Implicit

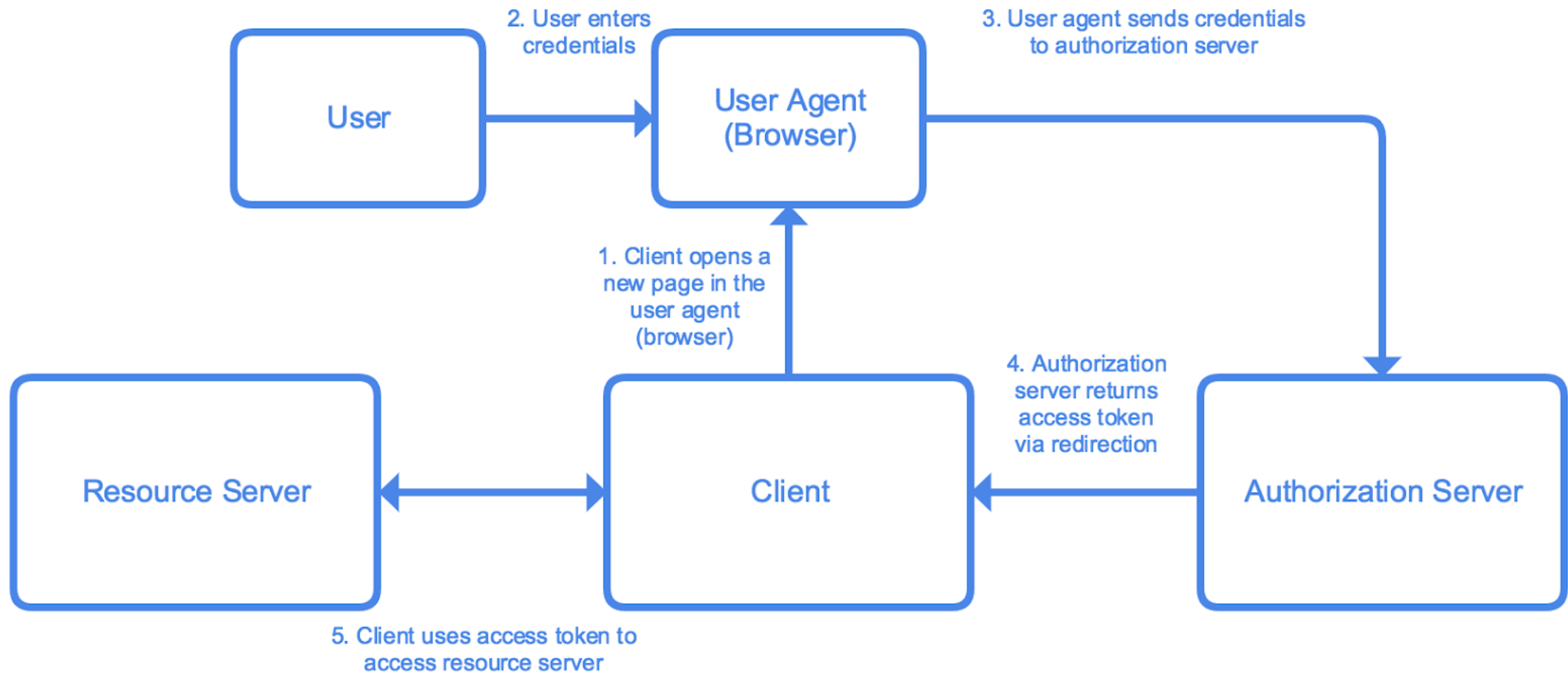
An implicit authorization grant is similar to an authorization code grant, except the access token is returned to the client application already after the user has finished the authorization. The access token is thus returned when the user agent is redirected to the redirect URI.

This of course means that the access token is accessible in the user agent, or native application participating in the implicit authorization grant. The access token is not stored securely on a web server.



The client application can only send its client ID to the authorization server. If the client were to send its client secret too, the client secret would have to be stored in the user agent or native application too. That would make it vulnerable to hacking.

Implicit authorization grant is mostly used in a user agent or native client application. The user agent or native application would receive the access token from the authorization server.



Implicit Flow

Use Case: Browser

Client Secret: Confidentiality can not be guaranteed

Threats Implicit Flow

Resource owners might issue a token to a malicious client (e.g. via phishing)

Attackers might steal token via other mechanisms

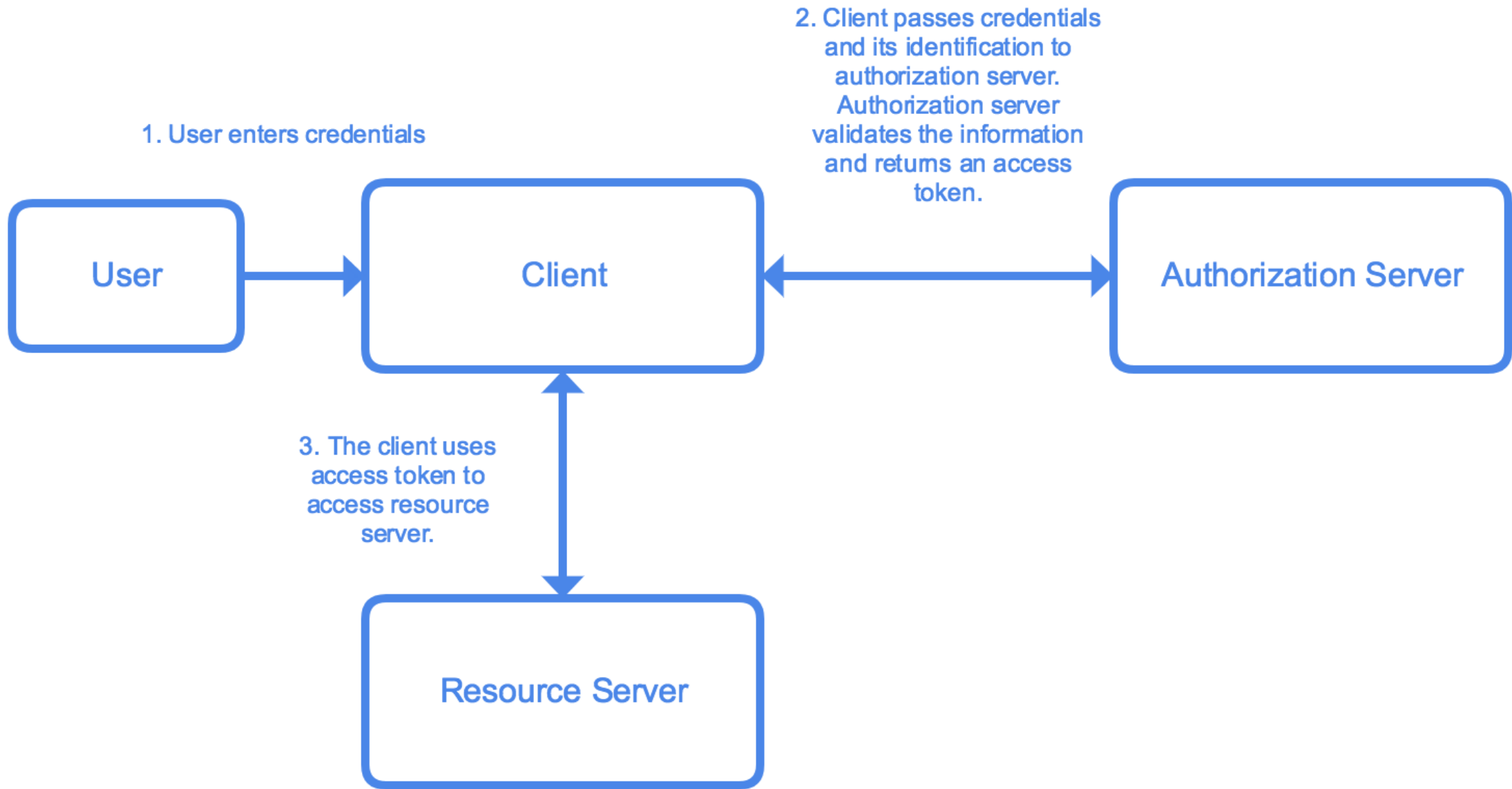
Resource Owner Password Credentials

The resource owner password credentials authorization grant method works by giving the client application access to the resource owners credentials. For instance, a user could type his Twitter user name and password (credentials) into the client application. The client application could then use the user name and password to access resources in Twitter.

Using the resource owner password credentials requires a lot of trust in the client application. You do not want to type your credentials into an application you suspect might abuse it.

The resource owner password credentials would normally be used by user agent client applications, or native client applications.

EX: Device Operating System



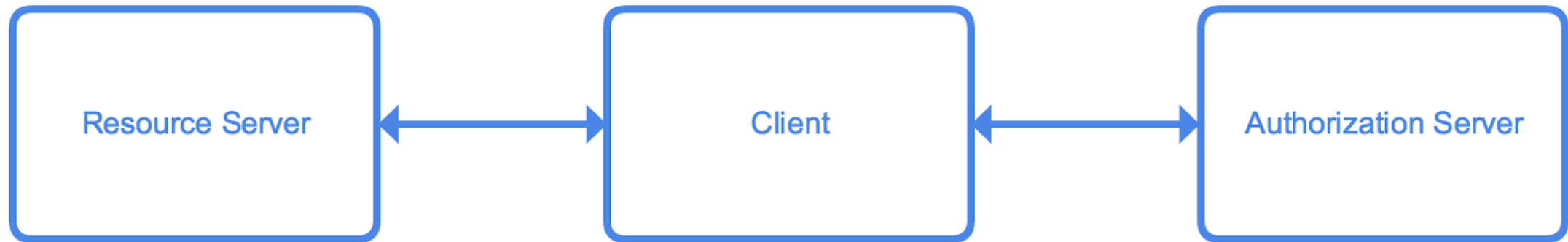
Client Credentials

Client credential authorization is for the situations where the client application needs to access resources or call functions in the resource server, which are not related to a specific resource owner (e.g. user).

For instance, obtaining a list of venues from Foursquare. This does not necessary have anything to do with a specific Foursquare user.

1. Client exchanges ID and secret for an access token.

2. Client uses access token to access resource server



Implicit and Client Credentials are flows typically reserved for special types of clients.
More specifically,

Client Type	Flow
Single-page Javascript Web Applications (for example, Google Fonts)	Implicit
Non-interactive programs for machine-to-machine communications (for example, background services and daemons)	Client Credentials

As for other clients, depending on their trustworthiness, they can use the following flows:

Client Type	Flow
Highly trusted apps (first-party apps)	Authorization Code or Resource Owner Password Credentials
Less trusted apps (third-party apps requesting access to your platform)	Authorization Code

OAuth 2.0 Authorization Code Requests and Responses

The authorization code grant consists of 2 requests and 2 responses in total.

An authorization request + response, and a token request + response.

Authorization Request

The authorization request is sent to the authorization endpoint to obtain an authorization code. Here are the parameters used in the request

response_type	Required. Must be set to code
client_id	Required. The client identifier as assigned by the authorization server, when the client was registered.
redirect_uri	Optional. The redirect URI registered by the client.
scope	Optional. The possible scope of the request.
state	Optional (recommended). Any client state that needs to be passed on to the client request URI.

Authorization Response

The authorization response contains the authorization code needed to obtain an access token.

code	Required. The authorization code.
state	Required, if present in request. The same value as sent by the client in the state parameter, if any.

Authorization Error Response

If an error occurs during authorization, two situations can occur.

The first is, that the client is not authenticated or recognized. For instance, a wrong redirect URI was sent in the request. In that case the authorization server must not redirect the resource owner to the redirect URI. Instead it should inform the resource owner of the error.

The second situation is that client is authenticated correctly, but that something else failed.

error	Required. Must be one of a set of predefined error codes. See the specification for the codes and their meaning.
error_description	Optional. A human-readable UTF-8 encoded text describing the error. Intended for a developer, not an end user.
error_uri	Optional. A URI pointing to a human-readable web page with information about the error.
state	Required, if present in authorization request. The same value as sent in the state parameter in the request.

Token Request

Once an authorization code is obtained, the client can use that code to obtain an access token. Here is the access token request parameters:

client_id	Required. The client application's id.
client_secret	Required. The client application's client secret .
grant_type	Required. Must be set to authorization_code .
code	Required. The authorization code received by the authorization server.
redirect_uri	Required, if the request URI was included in the authorization request. Must be identical then.

Token Response

The response to the access token request is a JSON string containing the access token plus some more information:

```
{ "access_token": "...", "token_type": "...", "expires_in":  
  "...", "refresh_token": "...", }
```

The `access_token` property is the access token as assigned by the authorization server.

The `token_type` property is a type of token assigned by the authorization server.

The `expires_in` property is a number of seconds after which the access token expires, and is no longer valid. Expiration of access tokens is optional.

The `refresh_token` property contains a refresh token in case the access token can expire. The refresh token is used to obtain a new access token once the one returned in this response is no longer valid.

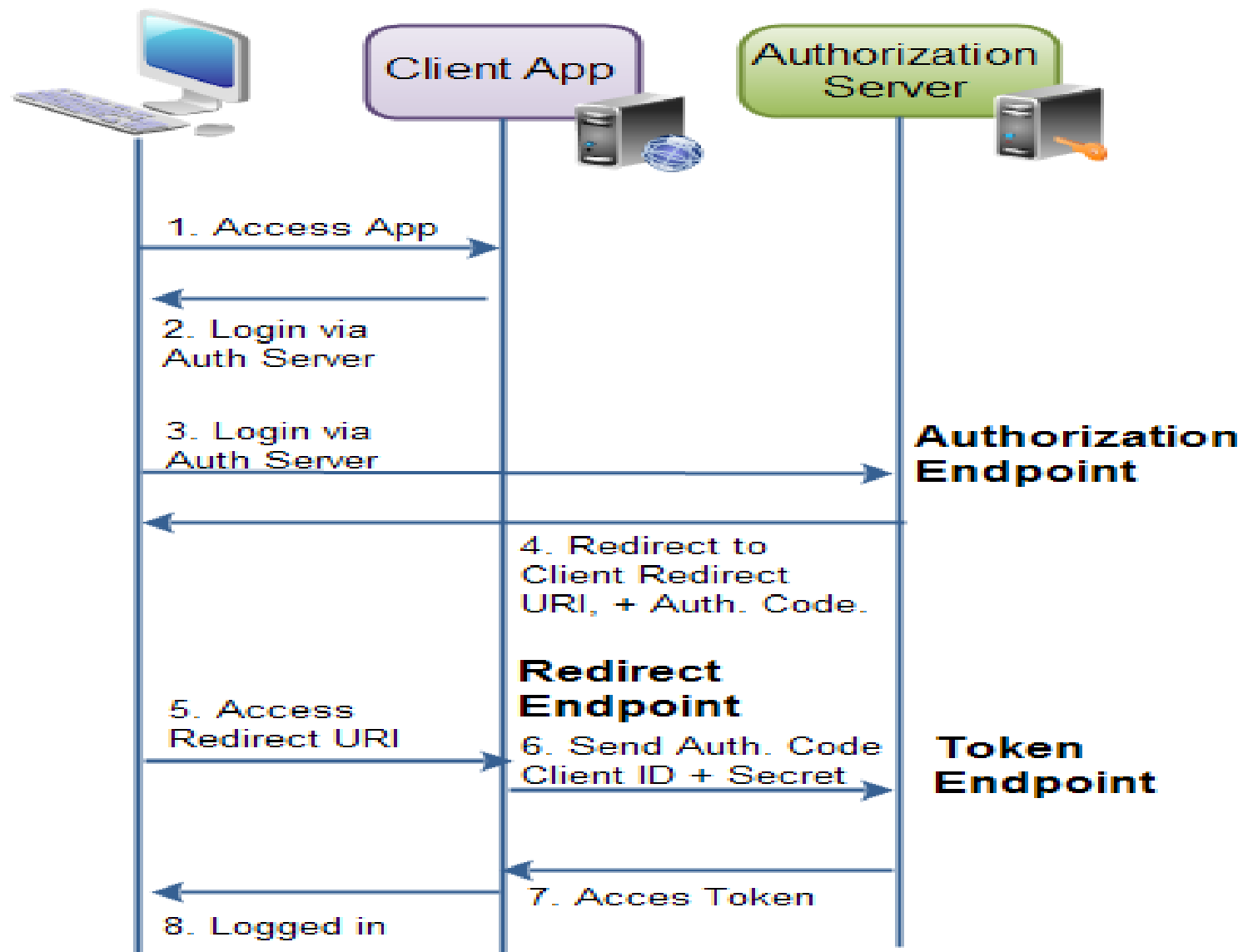
OAuth 2.0 Endpoints

OAuth 2.0 defines a set of endpoints. An endpoint is typically a URI on a web server. For instance, the address of a Java servlet, JSP page, PHP page, ASP.NET page etc.

The endpoints defined are:

- Authorization Endpoint
- Token Endpoint
- Redirection Endpoint

The authorization endpoint and token endpoint are both located on the authorization server. The redirection endpoint is located in the client application.



Authorization Endpoint

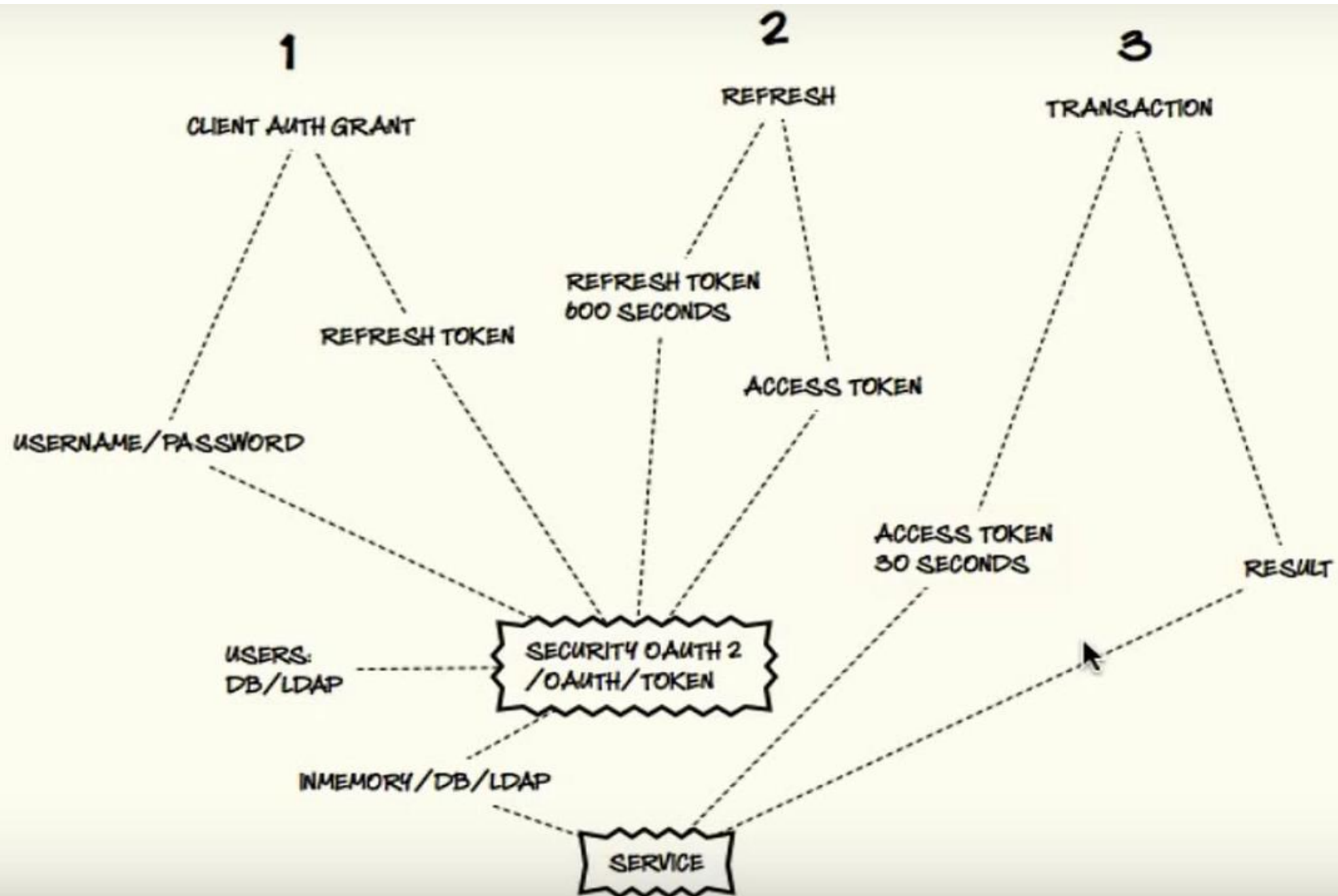
The authorization endpoint is the endpoint on the authorization server where the resource owner logs in, and grants authorization to the client application.

Token Endpoint

The token endpoint is the endpoint on the authorization server where the client application exchanges the authorization code, client ID and client secret, for an access token.

Redirect Endpoint

The redirect endpoint is the endpoint in the client application where the resource owner is redirected to, after having granted authorization at the authorization endpoint.



A Refresh Token is a special kind of token that can be used to obtain a renewed access token

request of a new Access Token/Refresh Token pair

```
$ curl -X POST -H 'Authorization: Basic dGVzdGNsaWVudDpzZWNYZXQ=' -d  
'grant_type=password&username=test&password=test' localhost:3000/oauth/token
```

```
{  
  "token_type":"bearer",  
  "access_token":"eyJ0eXAiOiJKV1QiLCJhQ3_DYKxxP2rFnD37lp4",  
  "expires_in":20,  
  "refresh_token":"fdb8fdbecf1d03ce5e6125c067733c0d51de209c"  
}
```

We can use the Refresh Token to get a new Access Token by using the token endpoint

```
curl -X POST -H 'Authorization: Basic dGVzdGNsaWVudDpzZWNYZXQ=' -d  
'refresh_token=fdb8fdbecf1d03ce5e6125c067733c0d51de209c&grant_type=refresh_token'  
localhost:3000/oauth/token
```


grant_type=authorization_code

This is example of code request:

http://localhost:8081/spring-security-oauth-server/oauth/authorize?response_type=code&client_id=myclient&redirect_uri=http://localhost:8080/auth

And this is example of token request inside implementation of rest /auth

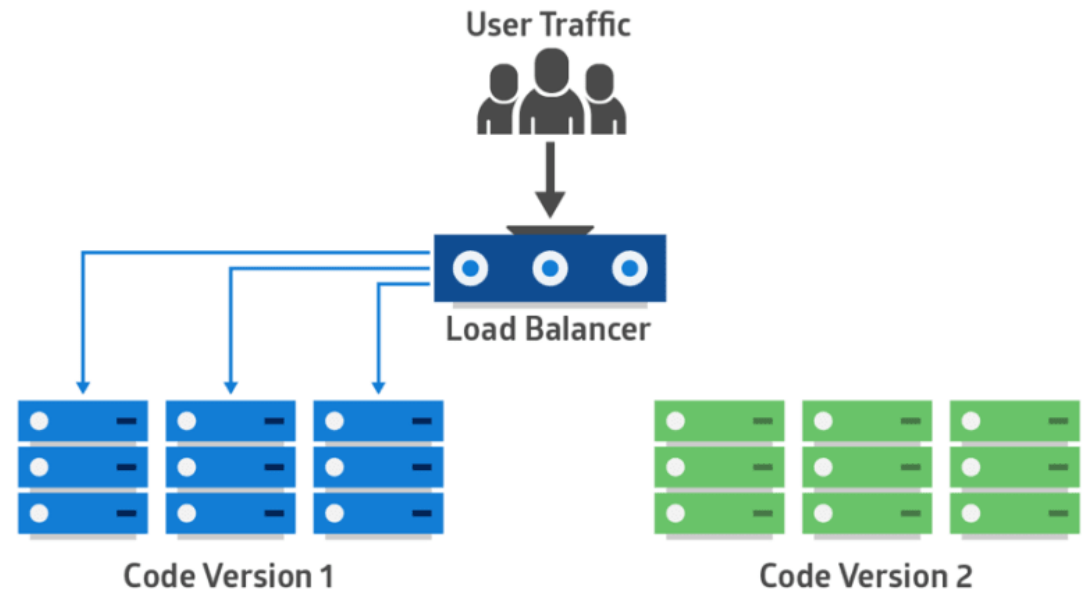
http://localhost:8081/spring-security-oauth-server/oauth/token?client_id=myclient&client_secret=123&grant_type=authorization_code&code=byZc1r&redirect_uri=http://localhost:8080/auth

Deployment Strategies

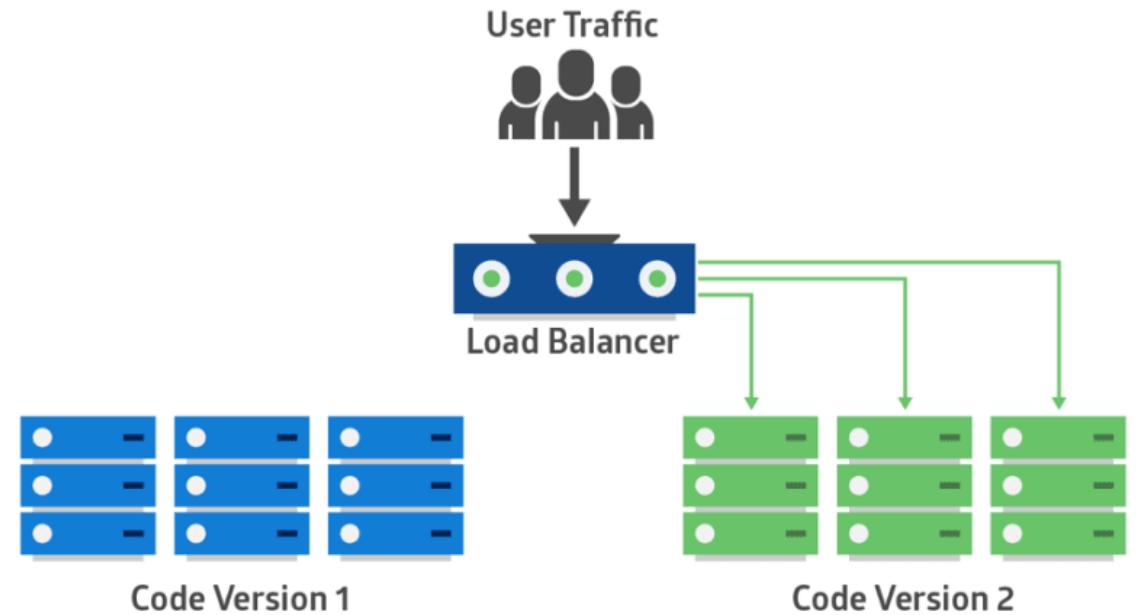
Blue-Green Deployment

This is fail-safe process. In this method, two identical production environments work in parallel.

One is the currently-running production environment receiving all user traffic (Blue). The other is a clone of it, but idle (Green). Both use the same database back-end and app configuration:



The new version of the application is deployed in the green environment and tested for functionality and performance. Once the testing results are successful, application traffic is routed from blue to green. Green then becomes the new production.



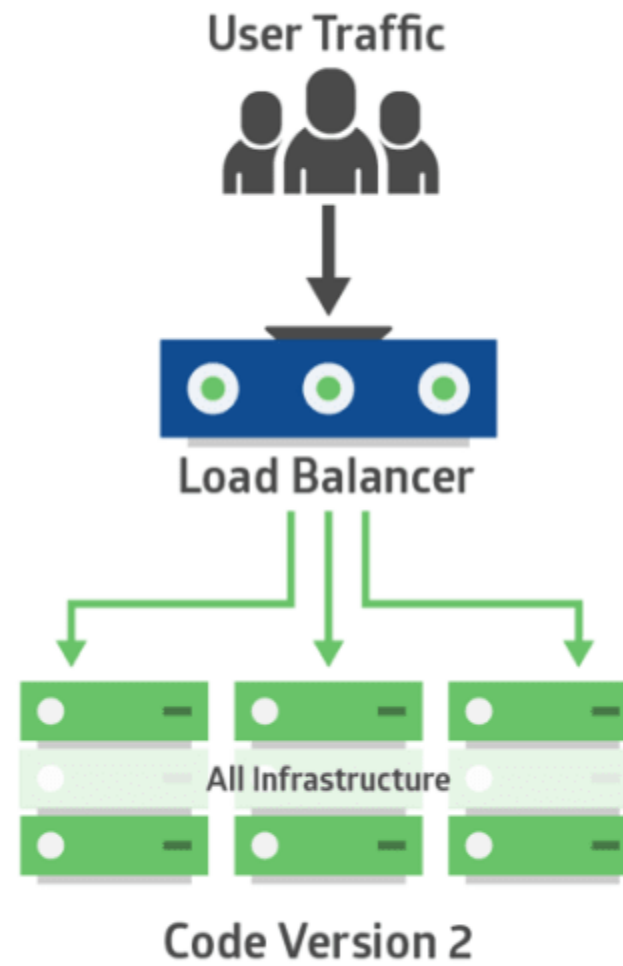
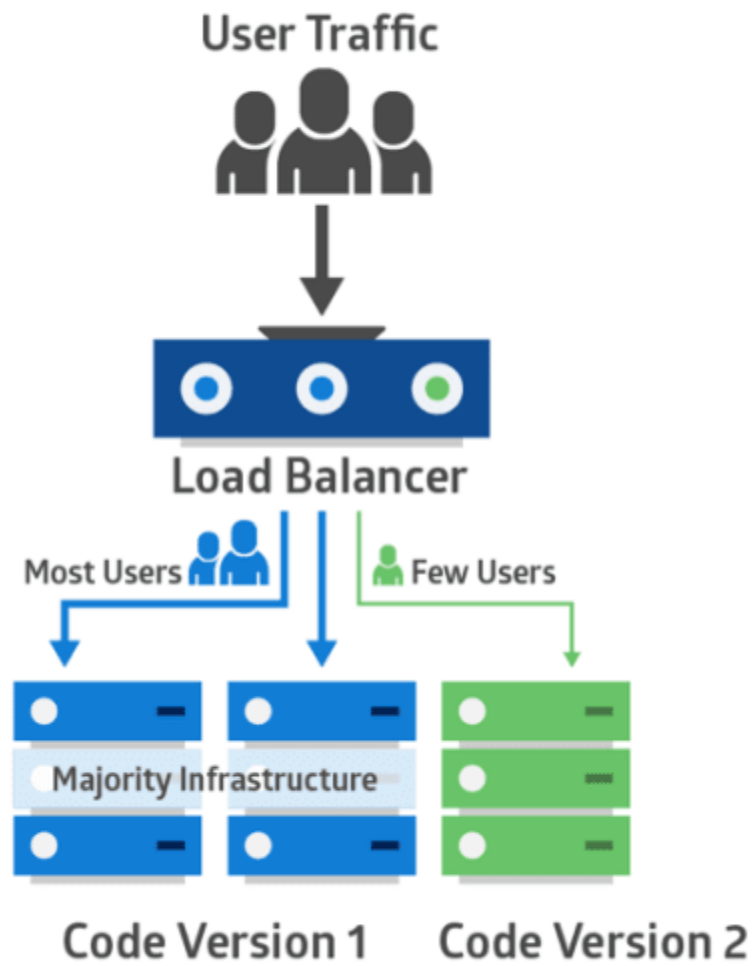
Canary Deployment

Canary deployment is like blue-green.

Instead of switching from blue to green in one step, we use a phased approach.

With canary deployment, we deploy a new application code in a small part of the production infrastructure. Once the application is signed off for release, only a few users are routed to it. This minimizes any impact.

With no errors reported, the new version can gradually roll out to the rest of the infrastructure. The image below demonstrates canary deployment:

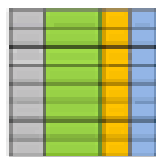


REST API Versioning Approaches

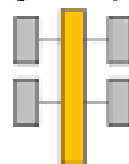
Versioning Approach	Pros	Cons
<i>URI</i>	<ul style="list-style-type: none"> • explicit and semantically dev friendly • enables version navigation and discovery • simplify versions management 	<ul style="list-style-type: none"> • new versions potentially change resource location, specifically in href cases • new versions break existing hyperlinks
<i>Query Parameter</i>	<ul style="list-style-type: none"> • API clients know which versions to use, or use the default one • API server has no problem to maintain several versions • New versions will not break existing hyperlinks 	<ul style="list-style-type: none"> • API server has to do extra parsing before routing the request • The query parameter becomes part of URI which identifies a resource; which mixes with other filtering parameters of the resource
<i>Accept Header</i>	<ul style="list-style-type: none"> • Only one URI is ever exposed hence no worries on API upgrades 	<ul style="list-style-type: none"> • Versioning is hidden in the Accept header field and it's a little hard to work with. • May have some security implication as specific media-type as defined in Accept header needs to go through Firewall for public APIs • Testing is harder as it requires carefully crafted request header
<i>Custom Header</i>	<ul style="list-style-type: none"> • Same as above 	<ul style="list-style-type: none"> • Same as above • Some routes may reject the custom field or the whole request or worse, removing the Custom header fields and let the standard headers pass through
<i>Redirect</i>	<ul style="list-style-type: none"> • Really flexible and API server controls versions to serve 	<ul style="list-style-type: none"> • Adds burden on the client to handle the redirect logic correctly, this introduces overhead as at least two requests have to be made • It's error prone too as bad programming may result in circular redirects • It's a little hacky to use redirect to support versioning globally as redirect is normally used for when a specific URI has changed and moved to a different one.

SQL Database

Relational

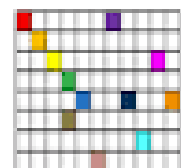


Analytical (OLAP)

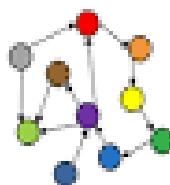


NoSQL Database

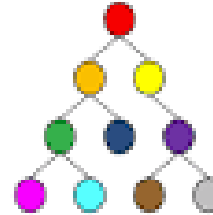
Column-Family



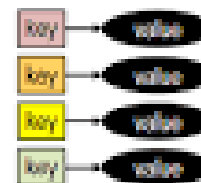
Graph



Document



Key-Value



NoSQL databases (aka "not only SQL") are non-tabular databases and store data differently than relational tables.

NoSQL databases come in a variety of types based on their data model.

The main types are document, key-value, graph etc.,

They provide flexible schemas and scale easily with large amounts of data and high user loads.

Documents

MongoDB stores data records as BSON documents. BSON is a binary representation of JSON documents, though it contains more data types than JSON.

Document Structure

MongoDB documents are composed of field-and-value pairs and have the following structure:

```
{  
  field1: value1,  
  field2: value2,  
  field3: value3,  
  ...  
  fieldN: valueN  
}
```

```
{  
  name: "sue",  
  age: 26,  
  status: "A",  
  groups: [ "news", "sports" ]  
}
```



← field: value
← field: value
← field: value
← field: value

Documents

The document is the unit of storing data in a MongoDB database.

document use JSON (JavaScript Object Notation, is a lightweight, thoroughly explorable format used to interchange data between various applications) style for storing data.

A simple example of a JSON document is as follows :

```
{ site : "w3resource.com" }
```

Often, the term "object" is used to refer a document.

Documents are analogous to the records of an RDBMS. Insert, update, and delete operations can be performed on a collection

RDBMS	MongoDB
Table	Collection
Column	Key
Value	Value
Records / Rows	Document / Object

Collections

```
{  
  "_id" : ObjectId("527b3cc65ceafed9b2254a94"),  
  "f_name" : "Zenny",  
  "sex" : "Female",  
  "class" : "VII",  
  "age" : 13,  
  "grd_point" : 28.2514  
}
```

← Document1

Document2 →

```
{  
  "_id" : ObjectId("527b3cc65ceafed9b2254a95"),  
  "f_name" : "Paul",  
  "sex" : "Male",  
  "class" : "VII",  
  "age" : 13,  
  "grd_point" : 28.2514  
}
```

```
{  
  "_id" : ObjectId("527b3cc65ceafed9b2254a97"),  
  "f_name" : "Lassy",  
  "sex" : "Female",  
  "class" : "VIII",  
  "age" : 13,  
  "grd_point" : 28.2514  
}
```

← Document3