

Zero To Master

# Spring Security along with JWT, OAUTH2

# SPRING SECURITY

## Most Common Questions?

### SECURITY

How can I implement security to my web/mobile applications so that there won't be any security breaches in my application ?

### PASSWORDS

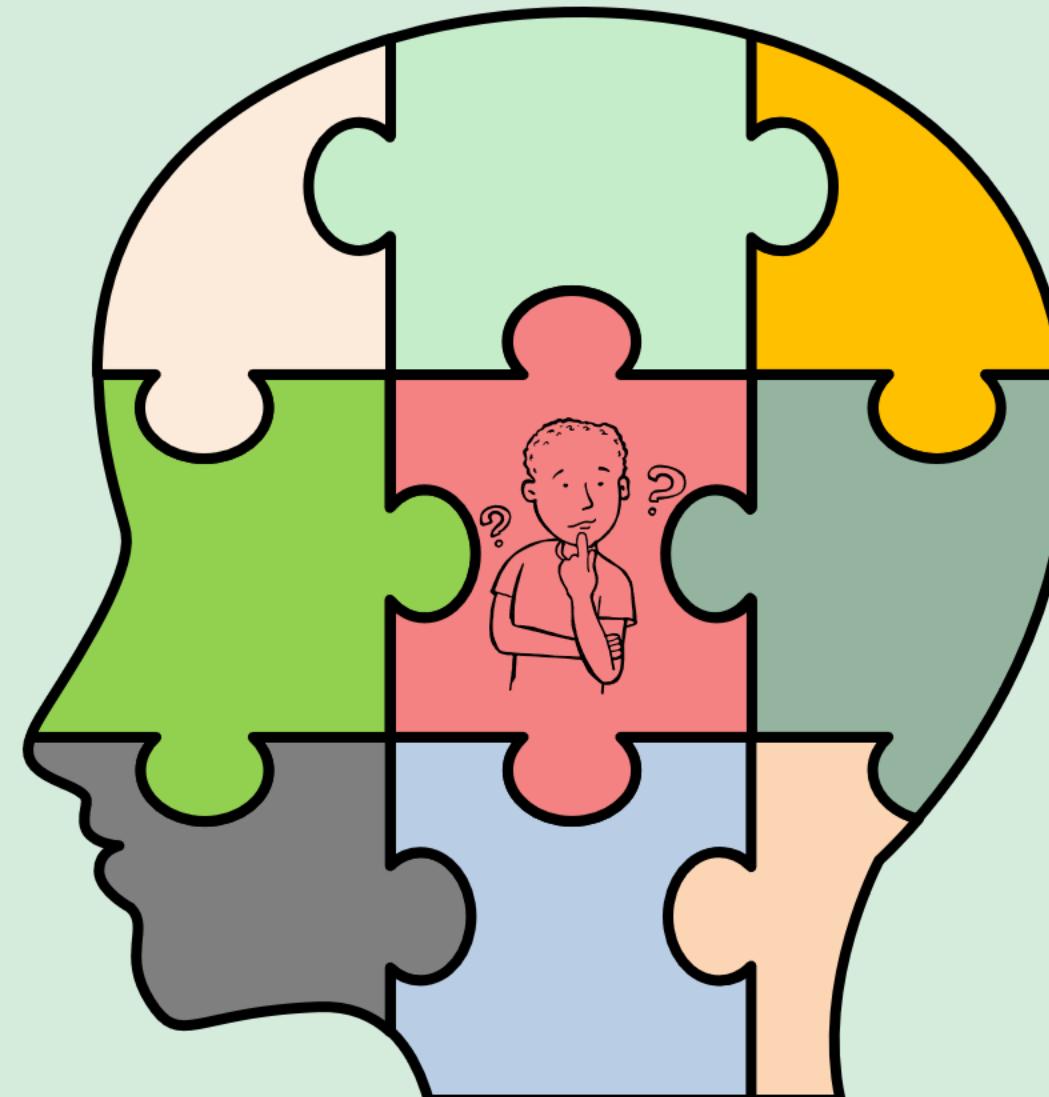
How to store passwords, validate them, encode, decode them using industry standard encryption algorithms ?

### USERS & ROLES

How to maintain the user level security based on their roles and grants associated to them ?

### MULTIPLE LOGINS

How can I implement a mechanism where the user will login only use and start using my application ?



### FINE GRAINED SECURITY

How can I implement security at each level of my application using authorization rules ?

### CSRF & CORS

What is CSRF attacks and CORS restrictions. How to overcome them?

### JWT & OAUTH2

What is JWT and OAUTH2. How I can protect my web application using them?

### PREVENTING ATTACKS

How to prevent security attacks like Brute force, stealing of data, session fixation

# COURSE AGENDA



Welcome to the  
world of Spring  
Security



Securing a web app  
using Spring  
Security

Important Interfaces,  
Classes, Annotations  
of Spring Security

Configuring  
Authentication &  
Authorization for a  
web app

# COURSE AGENDA



Implementing  
role based access  
using ROLES,  
AUTHORITIES



Different strategies  
that Spring security  
provides when  
coming to passwords



Method level  
security using  
Spring Security



How to handle most  
common attacks like  
CORS, CSRF with  
Spring Security

# COURSE AGENDA



Deep dive on JWT & its role in Authentication & Authorization

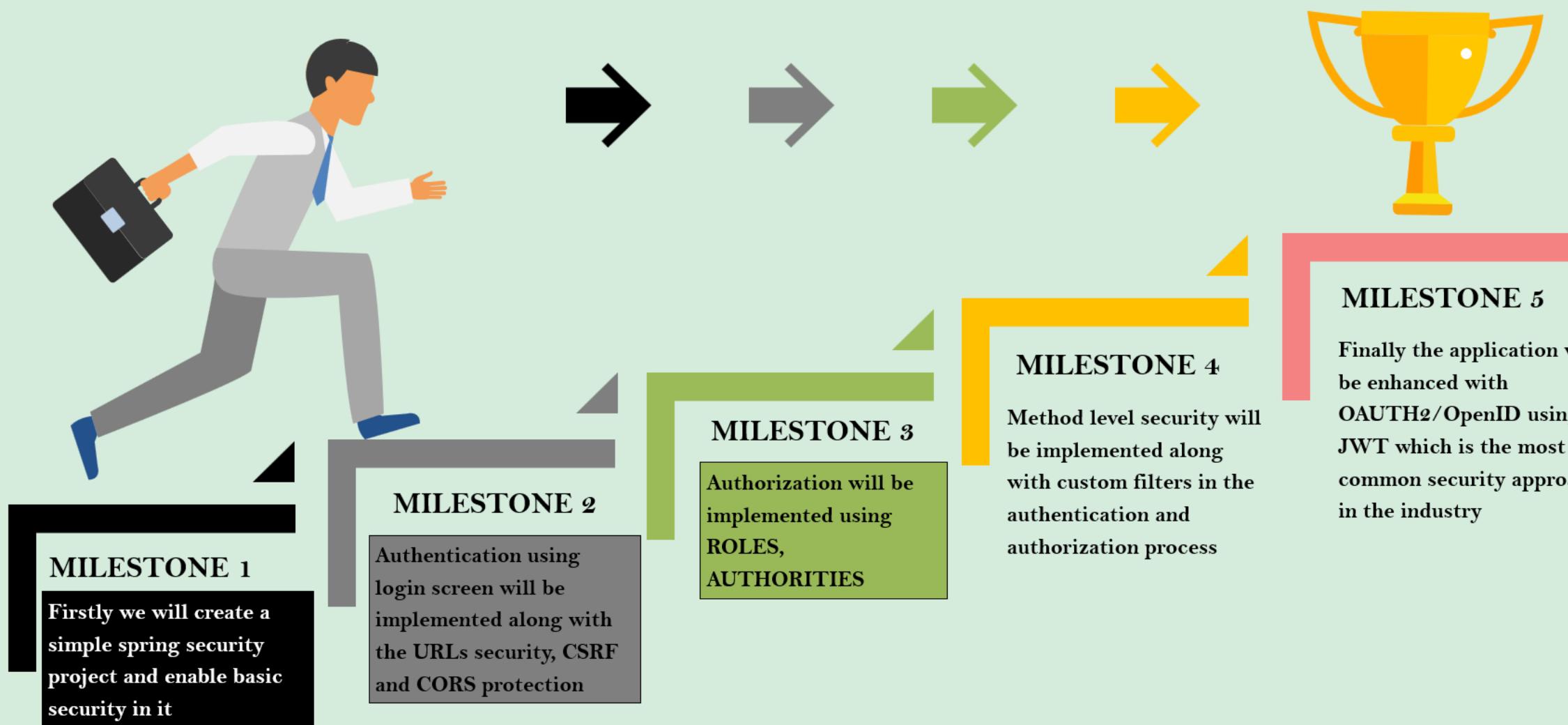
Deep dive on OAUTH2, OpenID & securing a web application using the same

Exploring Authorization servers available like Keycloak

Important topics of Security like Hashing, Tokens & many more

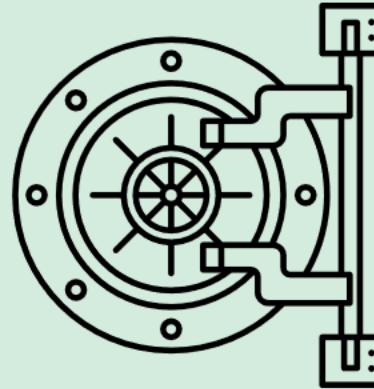
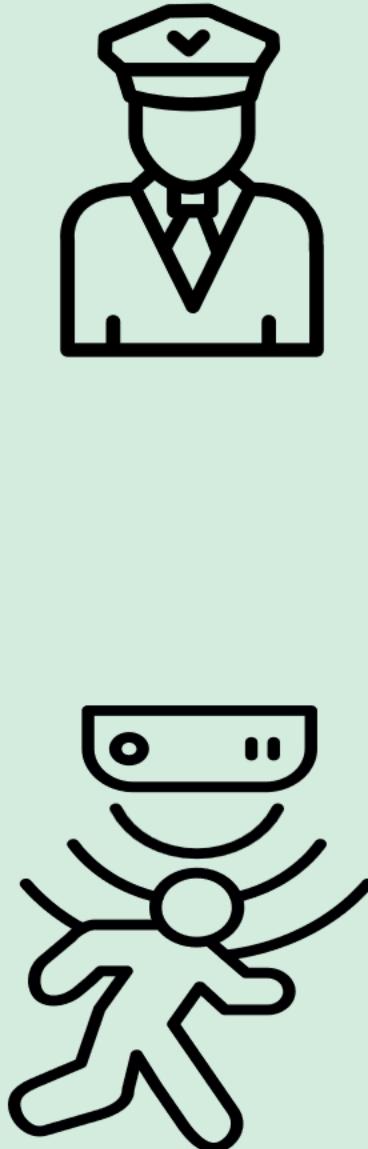
# SPRING SECURITY

## PROJECT ROADMAP



# INTRODUCTION TO SECURITY

## WHAT & WHY

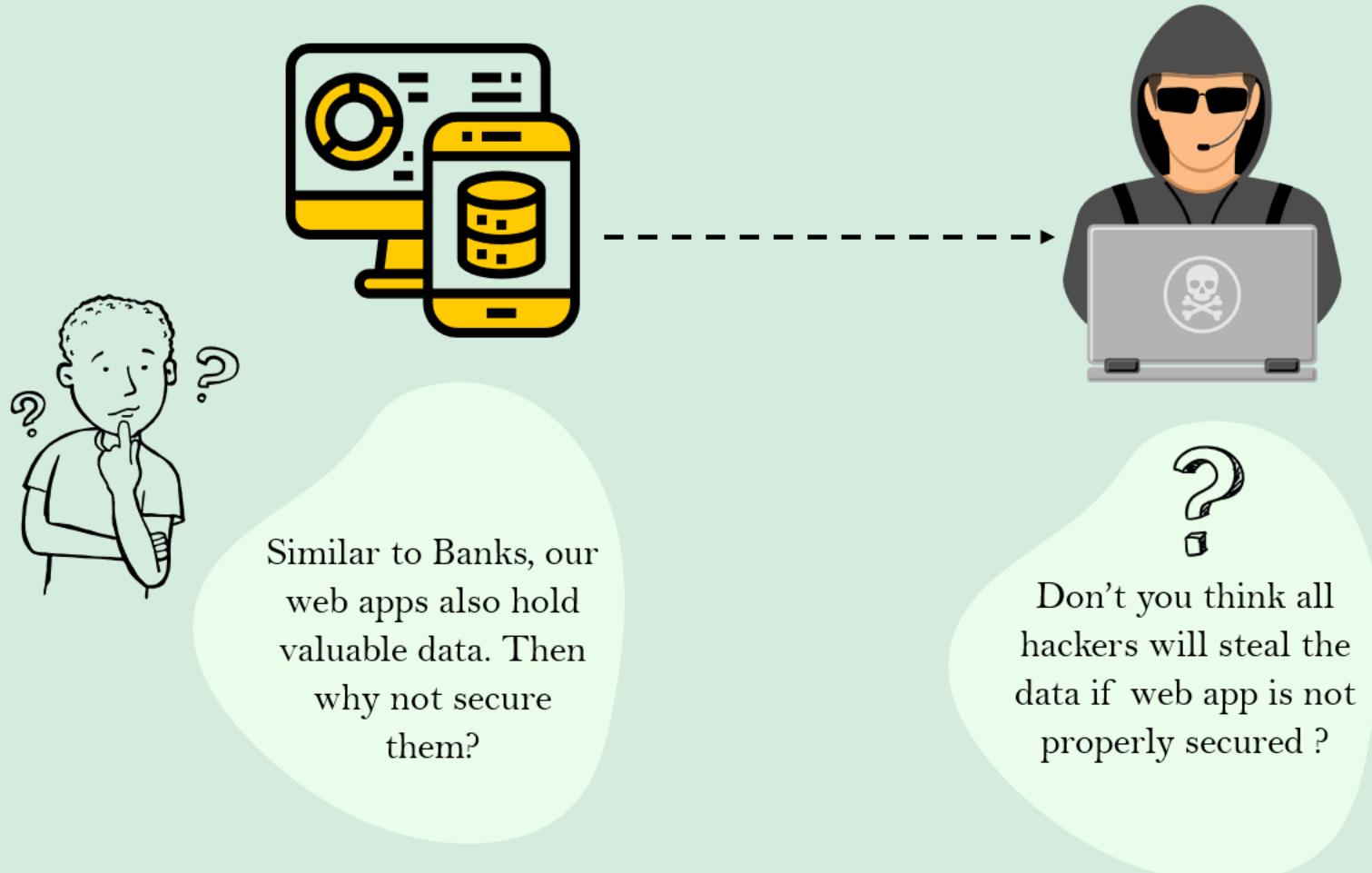


Have you ever observed how well Banks are protected?

Why Banks are well secured ? Because they hold valuable assets inside it

# INTRODUCTION TO SECURITY

## WHAT & WHY



# INTRODUCTION TO SECURITY

## WHAT & WHY

Don't think like they're trying to protect only data

### WHAT IS SECURITY?

Security is for protecting your data and business logic inside your web applications.

FQ  
BL  
Data  
UI  
NFQ  
Security  
Performance  
Scalability  
Availability

### SECURITY IS AN NON FUN REQ

Security is very important similar to scalability, performance and availability. No client will specifically asks that I need security.

### SECURITY FROM DEV PHASE

Security should be considered right from development phase itself along with business logic

Planning      Design      Dev      Test      Deployment →

### DIFFERENT TYPES OF SECURITY

Security for a web application will be implemented in different way like using firewalls, HTTPS, SSL, Authentication, Authorization etc.

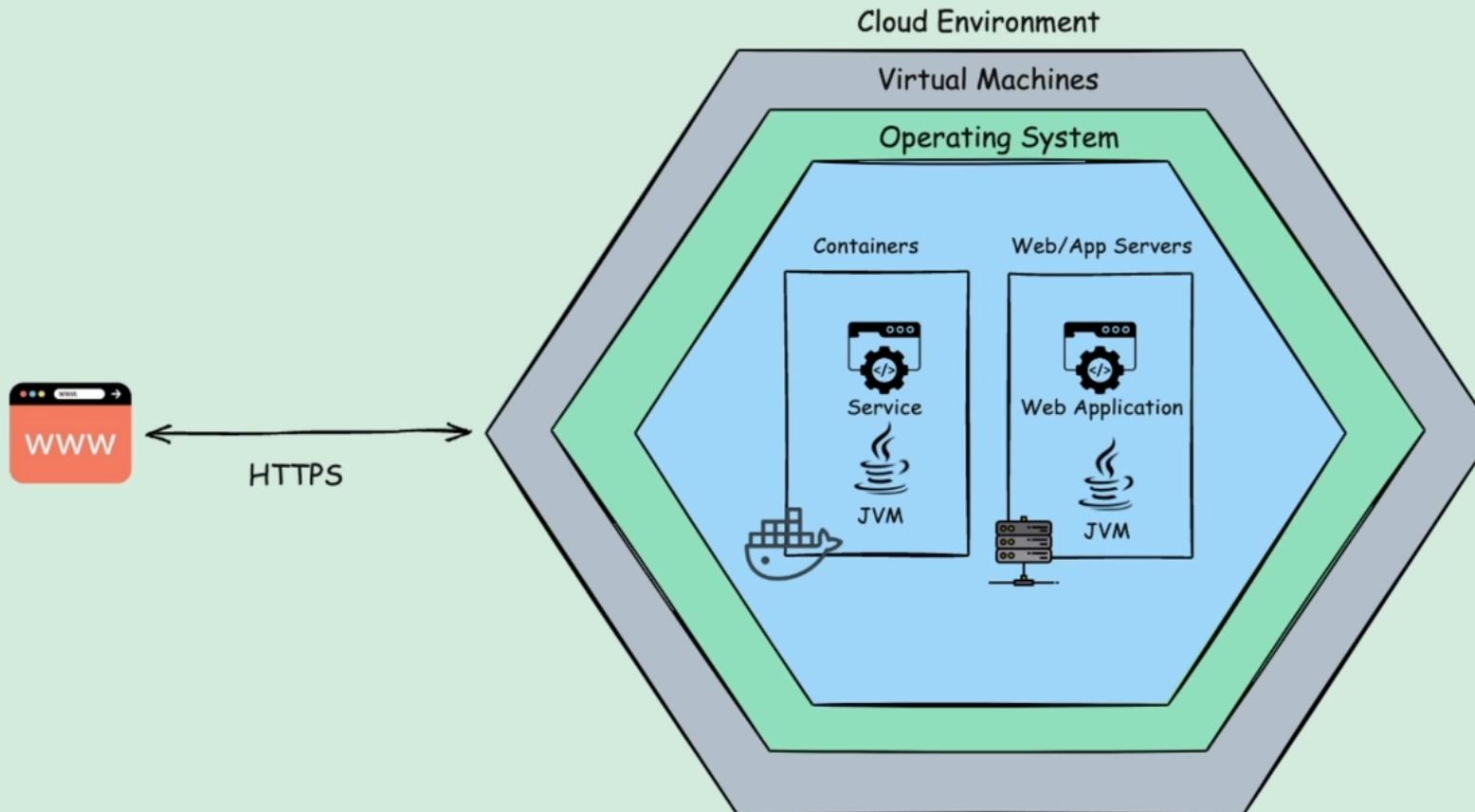
### WHY SECURITY IMPORTANT?

Security doesn't mean only loosing data or money but also the brand and trust from your users which you have built over years.

### AVOIDING MOST COMMON ATTACKS

Using Security we should also avoid most common security attacks like CSRF, Broken Authentication inside our application.

# Typical security measures for an app



## Cloud Environment

Handle DDoS Attacks  
Firewalls

## Virtual Machines

Secure Access  
Network Security

## Operating System

Regular Updates and Patching  
Antivirus & Malware protection

## Containers

Use Trusted Images  
Minimize Attack Surface  
Implement Container Isolation

## Web/App Server

Regular Security Updates  
Access Control  
Web Application Firewall (WAF)

## Web Apps/Services

Authentication  
Authorization  
Protection from exploits like CSRF,  
CORS etc.

# WHY SPRING SECURITY ?



Application security is not fun and challenging to implement with our custom code/framework.

Spring Security built by a team at Spring who are good at security by considering all the security scenarios. Using Spring Security, we can secure web apps with minimum configurations. So there is no need to re-invent the wheel here.



Spring Security handles the common security vulnerabilities like CSRF, CORs etc. For any security vulnerabilities identified, the framework will be patched immediately as it is being used by many organizations.

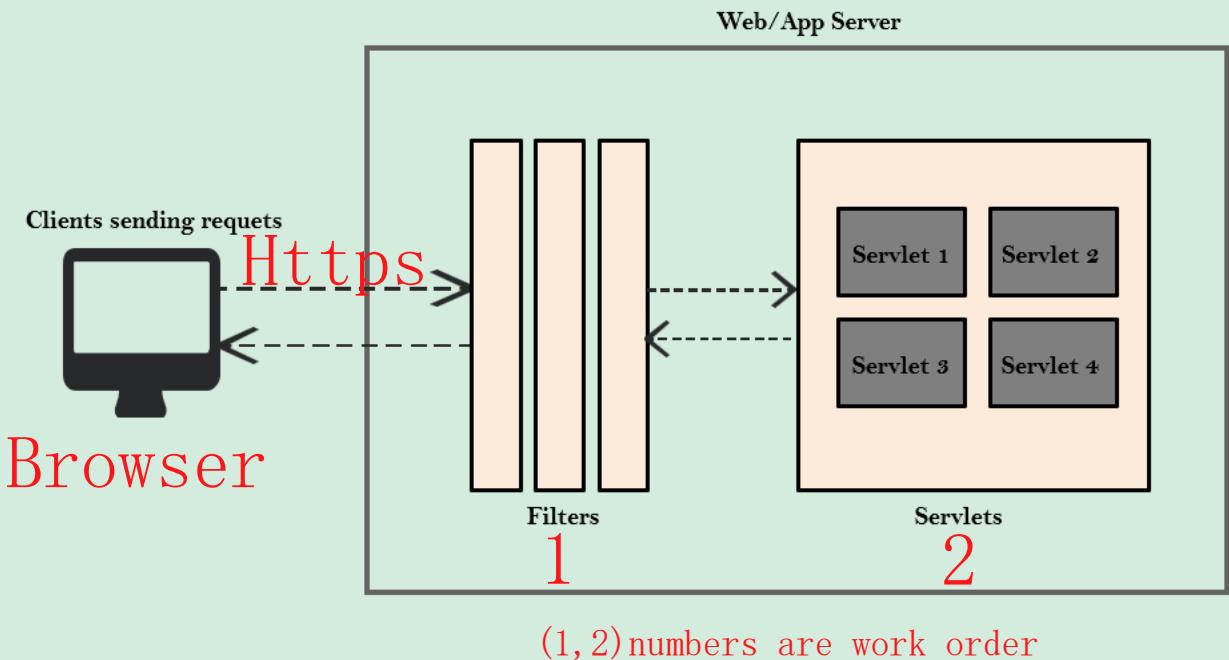


Using Spring Security we can secure our pages/API paths, enforce roles, method level security etc. with minimum configurations easily.



Spring Security supports various standards of security to implement authentication, like using username/password authentication, JWT tokens, OAuth2, OpenID etc.

# SERVLETS & FILTERS



Web server or app server

Tomcat, JBoss

Convert Http request to Http ServletRequest Object

## ★ Typical Scenario inside a web application

In Java web apps, **Servlet Container (Web Server)** takes care of translating the **HTTP** messages for Java code to understand. One of the mostly used servlet container is **Apache Tomcat**. **Servlet Container** converts the **HTTP** messages into **ServletRequest** and hand over to **Servlet** method as a parameter. Similarly, **ServletResponse** returns as an output to **Servlet Container** from **Servlet**. So everything we write inside Java web apps are driven by **Servlets**

## ★ Role of Filters

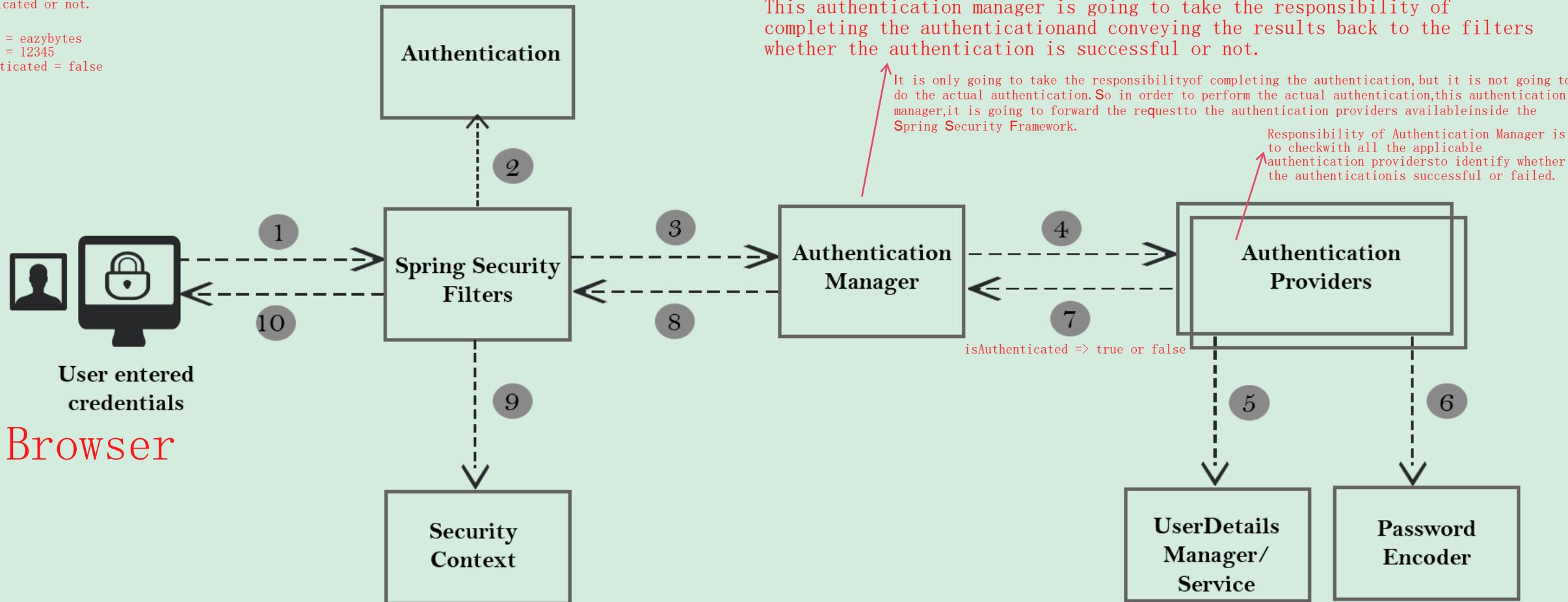
Filters inside Java web applications can be used to intercept each request/response and do some pre work before our business logic. So using the same filters, **Spring Security** enforce security based on our configurations inside a web application.

- 1 - ) To identify if user is authenticated or not
- 2 - ) ...

# SPRING SECURITY INTERNAL FLOW

Authentication object represents user credentials and it also has an information to identify if the user is authenticated or not.

```
username = eazybytes
password = 12345
isAuthenticated = false
```



This authentication manager is going to take the responsibility of completing the authentication and conveying the results back to the filters whether the authentication is successful or not.

It is only going to take the responsibility of completing the authentication, but it is not going to do the actual authentication. So in order to perform the actual authentication, this authentication manager, it is going to forward the request to the authentication providers available inside the Spring Security Framework.

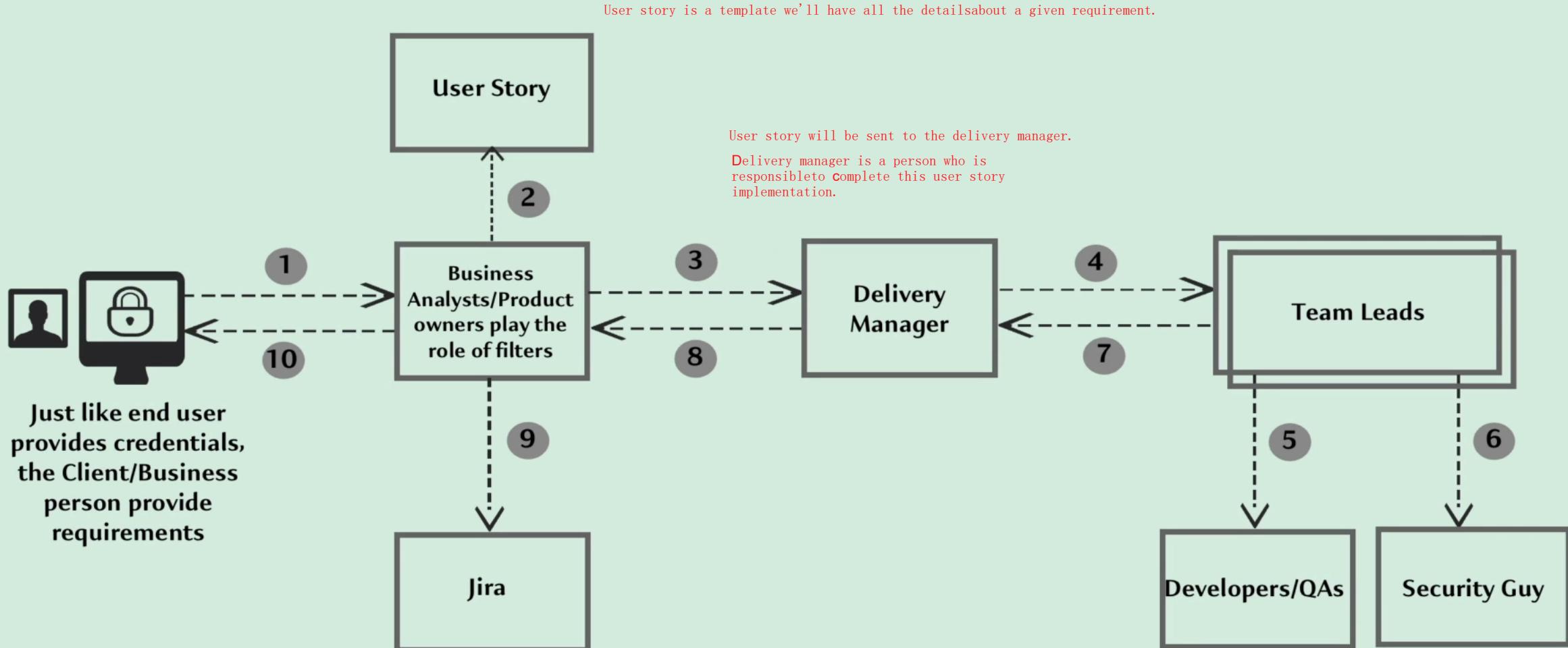
Responsibility of Authentication Manager is to check with all the applicable authentication providers to identify whether the authentication is successful or failed.

So now my Spring Security filters, they know whether the authentication is successful or not. Regardless of whether the authentication is successful or not, they're going to store the authentication details in a security context. So they will store these authentication object against a session ID which is created for a given browser.

Once the first request is processed and there is an entry inside the security context for a session ID from next time onwards, the security filters, they're not going to invoke the authentication manager. Instead they're going to leverage the details present inside the security context to send the successful response or to send an error response.

Load user details

# Analogy of Spring Security Internal flow with SDLC



# SPRING SECURITY INTERNAL FLOW

## ★ Spring Security Filters

*A series of Spring Security filters intercept each request & work together to identify if Authentication is required or not. If authentication is required, accordingly navigate the user to login page or use the existing details stored during initial authentication.*

## ★ Authentication

*Filters like UsernamePasswordAuthenticationFilter will extract username/password from HTTP request & prepare Authentication type object. Because Authentication is the core standard of storing authenticated user details inside Spring Security framework.*

## ★ AuthenticationManager

*Once received request from filter, it delegates the validating of the user details to the authentication providers available. Since there can be multiple providers inside an app, it is the responsibility of the AuthenticationManager to manage all the authentication providers available.*

## ★ AuthenticationProvider

*AuthenticationProviders has all the core logic of validating user details for authentication.*

## ★ UserDetailsService/UserDetailsManager

*UserDetailsService/UserDetailsManager helps in retrieving, creating, updating, deleting the User Details from the DB/storage systems.*

## ★ PasswordEncoder

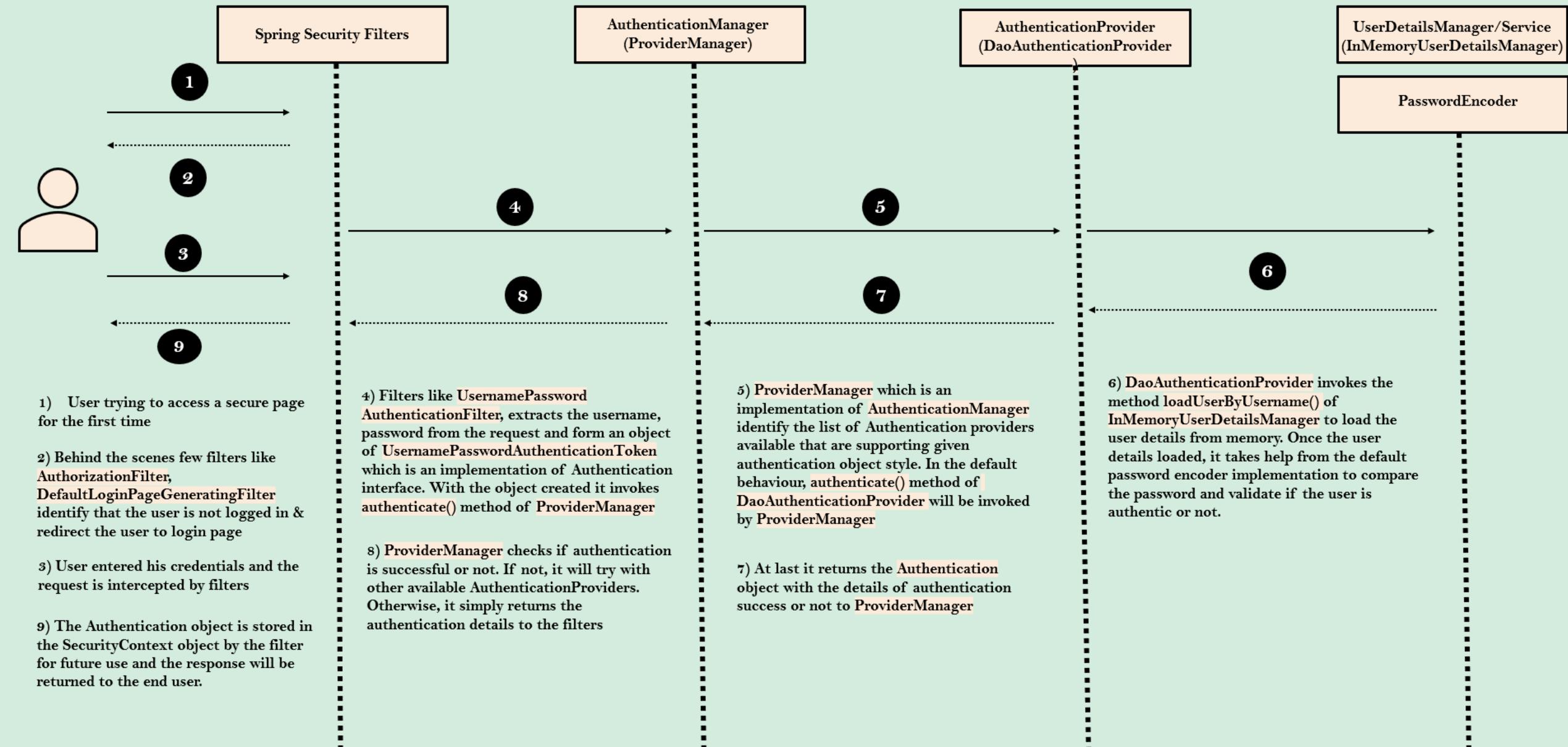
*Service interface that helps in encoding & hashing passwords. Otherwise we may have to live with plain text passwords ☹*

## ★ SecurityContext

*Once the request has been authenticated, the Authentication will usually be stored in a thread-local SecurityContext managed by the SecurityContextHolder. This helps during the upcoming requests from the same user.*

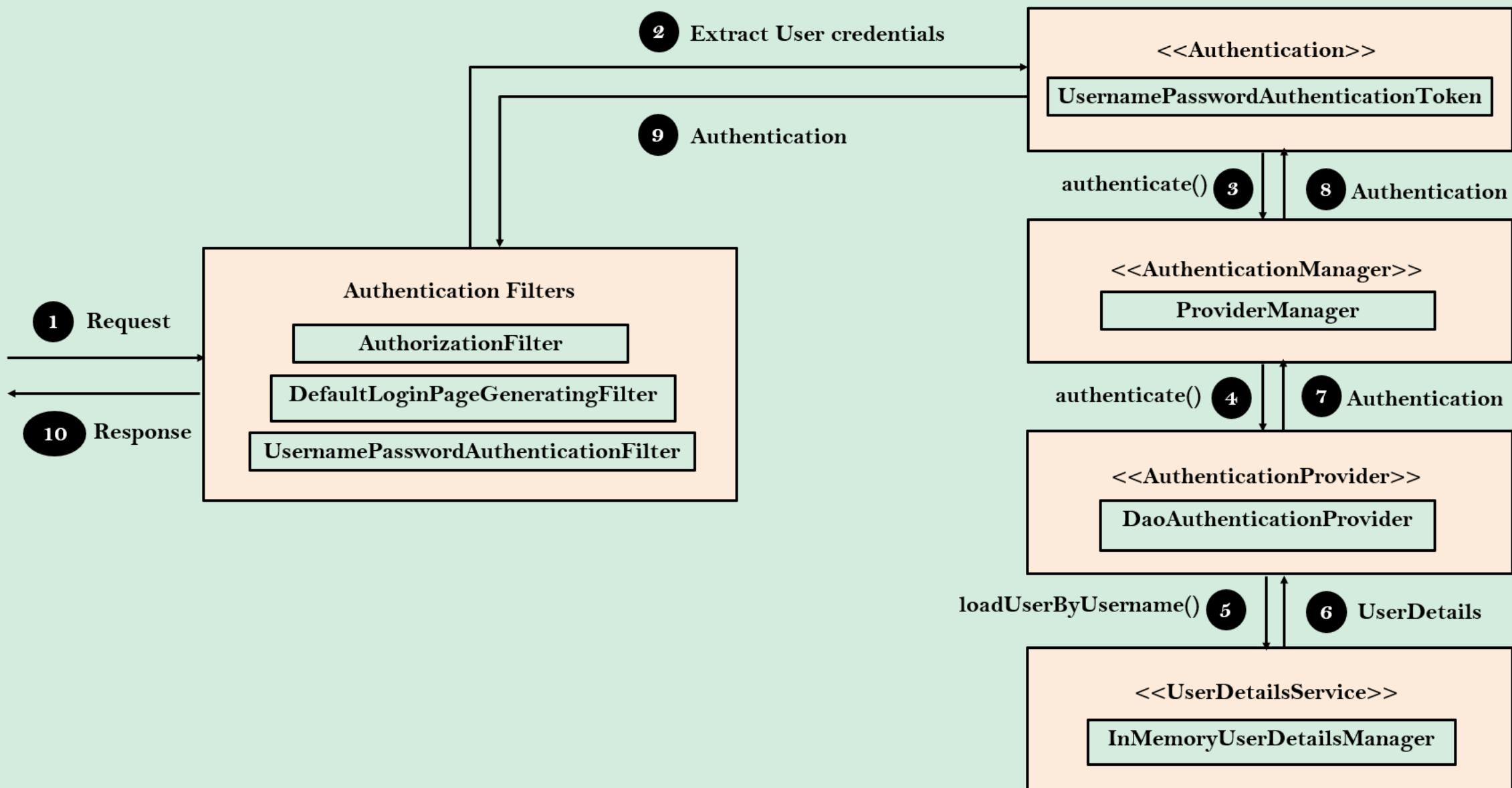
# SEQUENCE FLOW

## SPRING SECURITY DEFAULT BEHAVIOUR

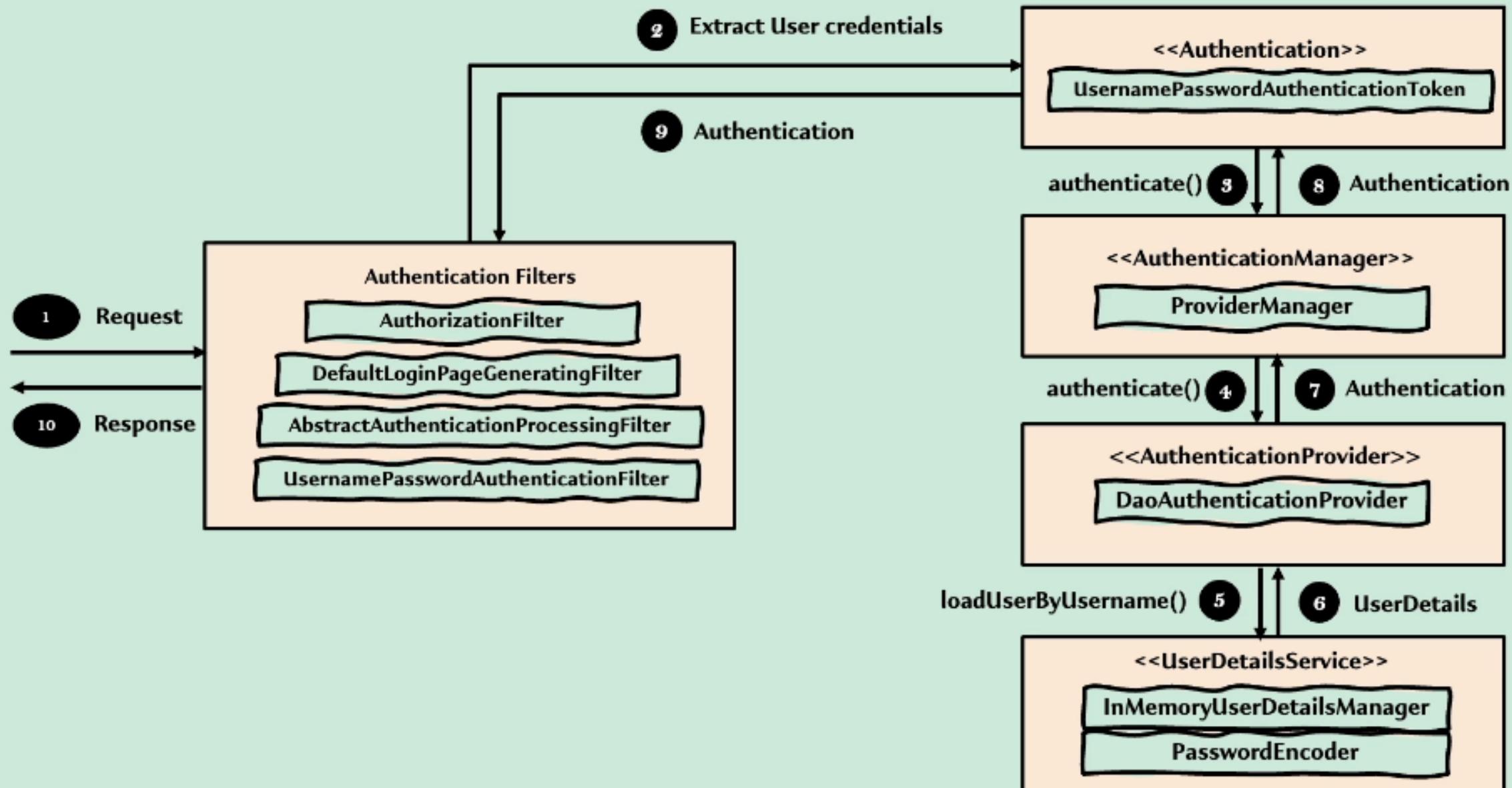


# SEQUENCE FLOW

## SPRING SECURITY DEFAULT BEHAVIOUR



# Spring Security Internal flow for Default behaviour



# BACKEND REST SERVICES

FOR EAZYBANK APPLICATION

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## Services with out any security

*/contact – This service should accept the details from the Contact Us page in the UI and save to the DB.*

*/notices – This service should send the notice details from the DB to the ‘NOTICES’ page in the UI*



## Services with security

*/myAccount – This service should send the account details of the logged in user from the DB to the UI*

*/myBalance – This service should send the balance and transaction details of the logged in user from the DB to the UI*

*/myLoans – This service should send the loan details of the logged in user from the DB to the UI*

*/myCards – This service should send the card details of the logged in user from the DB to the UI*



# DEFAULT SECURITY CONFIGURATIONS

## INSIDE SPRING SECURITY FRAMEWORK

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```
< > ^ □ =
```

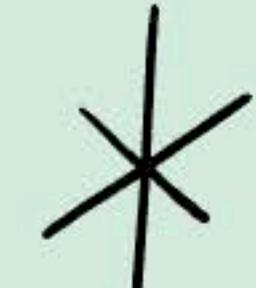
*By default, Spring Security framework protects all the paths present inside the web application. This behaviour is due to the code present inside the method `defaultSecurityFilterChain(HttpSecurity http)` of class `SpringBootWebSecurityConfiguration`*

```
@Bean
@Order(SecurityProperties.BASIC_AUTH_ORDER)
SecurityFilterChain defaultSecurityFilterChain(HttpSecurity http) throws Exception {
    http.authorizeHttpRequests((requests) -> requests.anyRequest().authenticated());
    http.formLogin(withDefaults());
    http.httpBasic(withDefaults());
    return http.build();
}
```



# CUSTOM SECURITY CONFIGURATIONS

## INSIDE SPRING SECURITY FRAMEWORK

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```
@Configuration
public class ProjectSecurityConfig {

    @Bean
    SecurityFilterChain defaultSecurityFilterChain(HttpSecurity http) throws Exception {

        http.authorizeHttpRequests((requests) -> requests
            .requestMatchers("/myAccount", "/myBalance", "/myLoans", "/myCards").authenticated()
            .requestMatchers("/notices", "/contact").permitAll()
            .formLogin(Customizer.withDefaults())
            .httpBasic(Customizer.withDefaults());
        return http.build();
    }
}
```

# DENY ALL SECURITY CONFIGURATIONS

## INSIDE SPRING SECURITY FRAMEWORK

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NOT RECOMMENDED  
FOR PRODUCTION

We can deny all the requests coming towards our web application APIs, Paths using Spring Security framework like shown below,

```
@Configuration
public class ProjectSecurityConfig {

    @Bean
    SecurityFilterChain defaultSecurityFilterChain(HttpSecurity http) throws Exception {

        http.authorizeHttpRequests((requests) -> requests.anyRequest().denyAll())
            .formLogin(Customizer.withDefaults())
            .httpBasic(Customizer.withDefaults());
        return http.build();

    }
}
```

# PERMIT ALL SECURITY CONFIGURATIONS

## INSIDE SPRING SECURITY FRAMEWORK

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NOT RECOMMENDED  
FOR PRODUCTION

We can permit all the requests coming towards our web application APIs, Paths using Spring Security framework like shown below,

```
@Configuration
public class ProjectSecurityConfig {

    @Bean
    SecurityFilterChain defaultSecurityFilterChain(HttpSecurity http) throws Exception {

        http.authorizeHttpRequests((requests) -> requests.anyRequest().permitAll())
            .formLogin(Customizer.withDefaults())
            .httpBasic(Customizer.withDefaults());
        return http.build();
    }
}
```

# CONFIGURE USERS

## USING *InMemoryUserDetailsManager*

NOT RECOMMENDED  
FOR PRODUCTION

*Instead of defining a single user inside application.properties, as a next step we can define multiple users along with their authorities with the help of InMemoryUserDetailsManager & UserDetails*

*Approach 1 where we use  
withDefaultPasswordEncoder() method  
while creating the user details*

```
@Bean
public InMemoryUserDetailsManager userDetailsService() {
    UserDetails admin = User.withDefaultPasswordEncoder()
        .username("admin")
        .password("12345")
        .authorities("admin")
        .build();

    UserDetails user = User.withDefaultPasswordEncoder()
        .username("user")
        .password("12345")
        .authorities("read")
        .build();

    return new InMemoryUserDetailsManager(admin, user);
}
```

# CONFIGURE USERS

## USING *InMemoryUserDetailsManager*

NOT RECOMMENDED  
FOR PRODUCTION

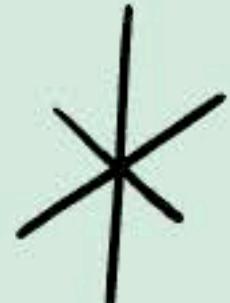
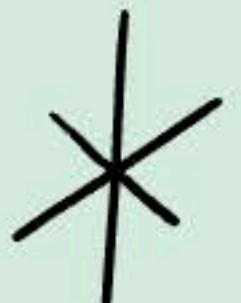
*Instead of defining a single user inside application.properties, as a next step we can define multiple users along with their authorities with the help of InMemoryUserDetailsManager & UserDetails*



*Approach 2 where we create a bean of PasswordEncoder separately*

```
@Bean
public InMemoryUserDetailsManager userDetailsService() {
    UserDetails admin = User.withUsername("admin").password("12345").authorities("admin").build();
    UserDetails user = User.withUsername("user").password("12345").authorities("read").build();
    return new InMemoryUserDetailsManager(admin, user);
}

/**
 * NoOpPasswordEncoder is not recommended for production usage.
 * Use only for non-prod.
 *
 * @return PasswordEncoder
 */
@Bean
public PasswordEncoder passwordEncoder() {
    return NoOpPasswordEncoder.getInstance();
}
```



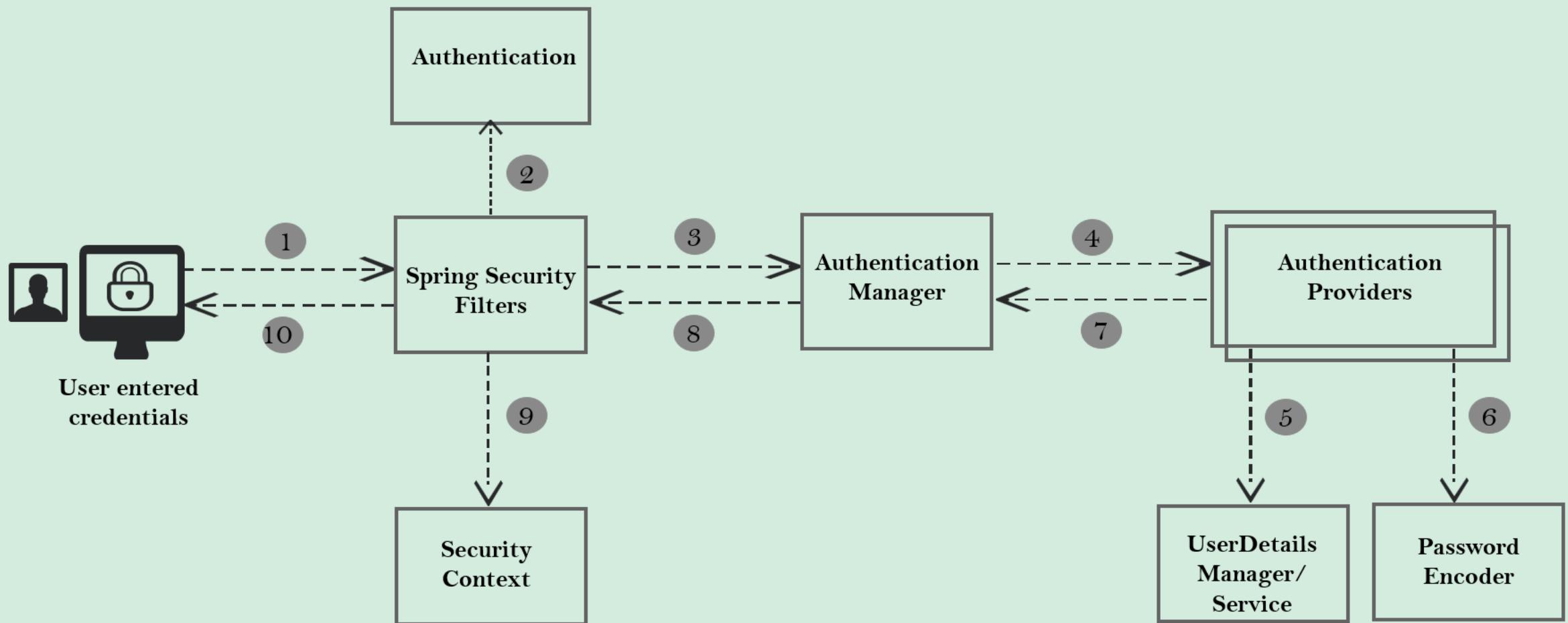
# CompromisedPasswordChecker

RECOMMENDED  
FOR PRODUCTION

Using CompromisedPasswordChecker implementation, we can check if a password has been compromised. This feature is released as part of Spring Security 6.3 version.

```
@Bean  
public CompromisedPasswordChecker compromisedPasswordChecker() {  
    return new HaveIBeenPwnedRestApiPasswordChecker();  
}
```

# SPRING SECURITY INTERNAL FLOW



# USER MANAGEMENT

## IMPORTANT CLASSES & INTERFACES

Core interface which loads user-specific data.

An extension of the UserDetailsService which provides the ability to create new users and update existing ones.

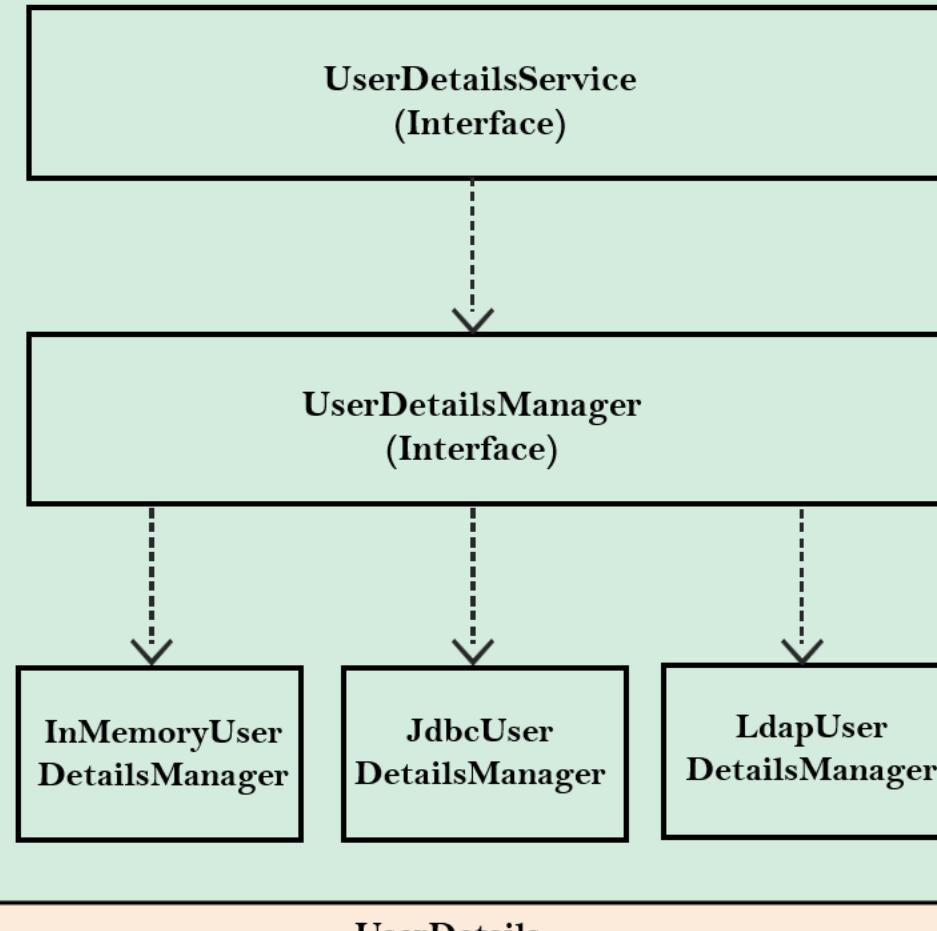
Sample implementation classes provided by the Spring Security team

### READ

- ✓ `loadUserByUsername(String username)`

### CRUD

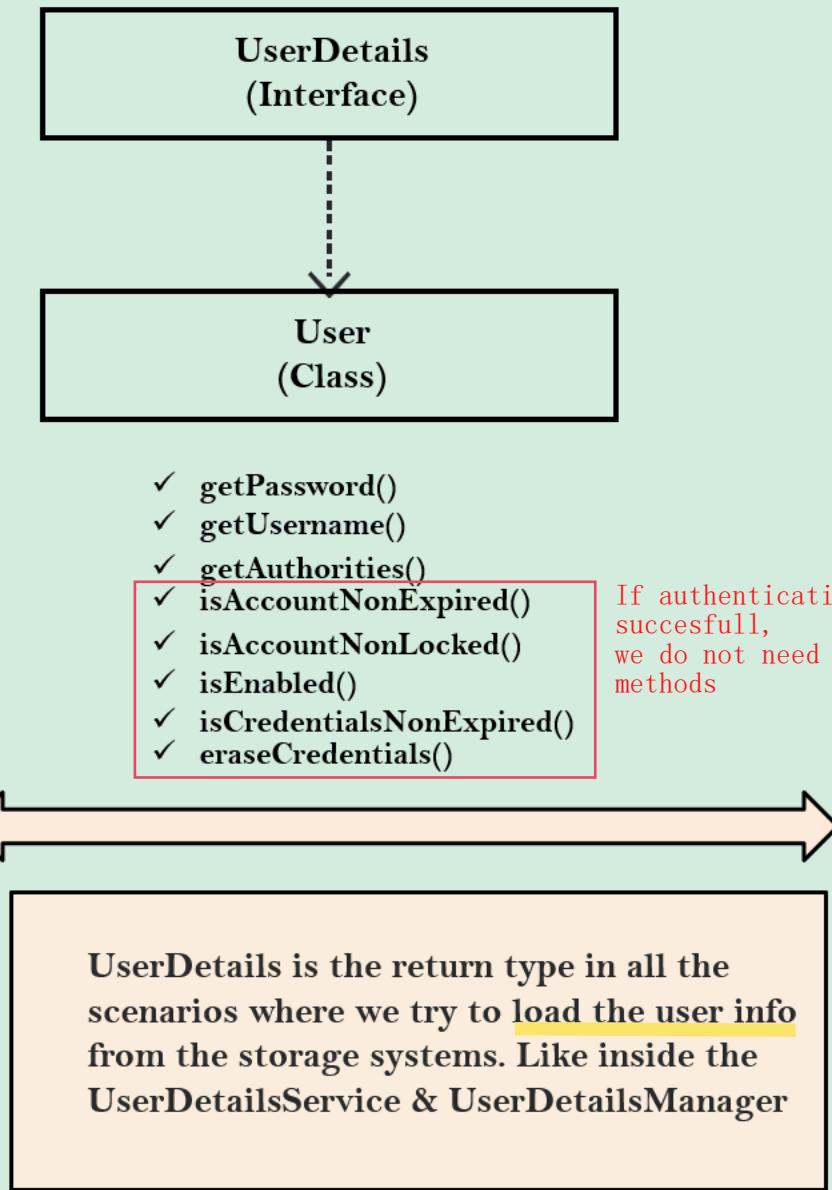
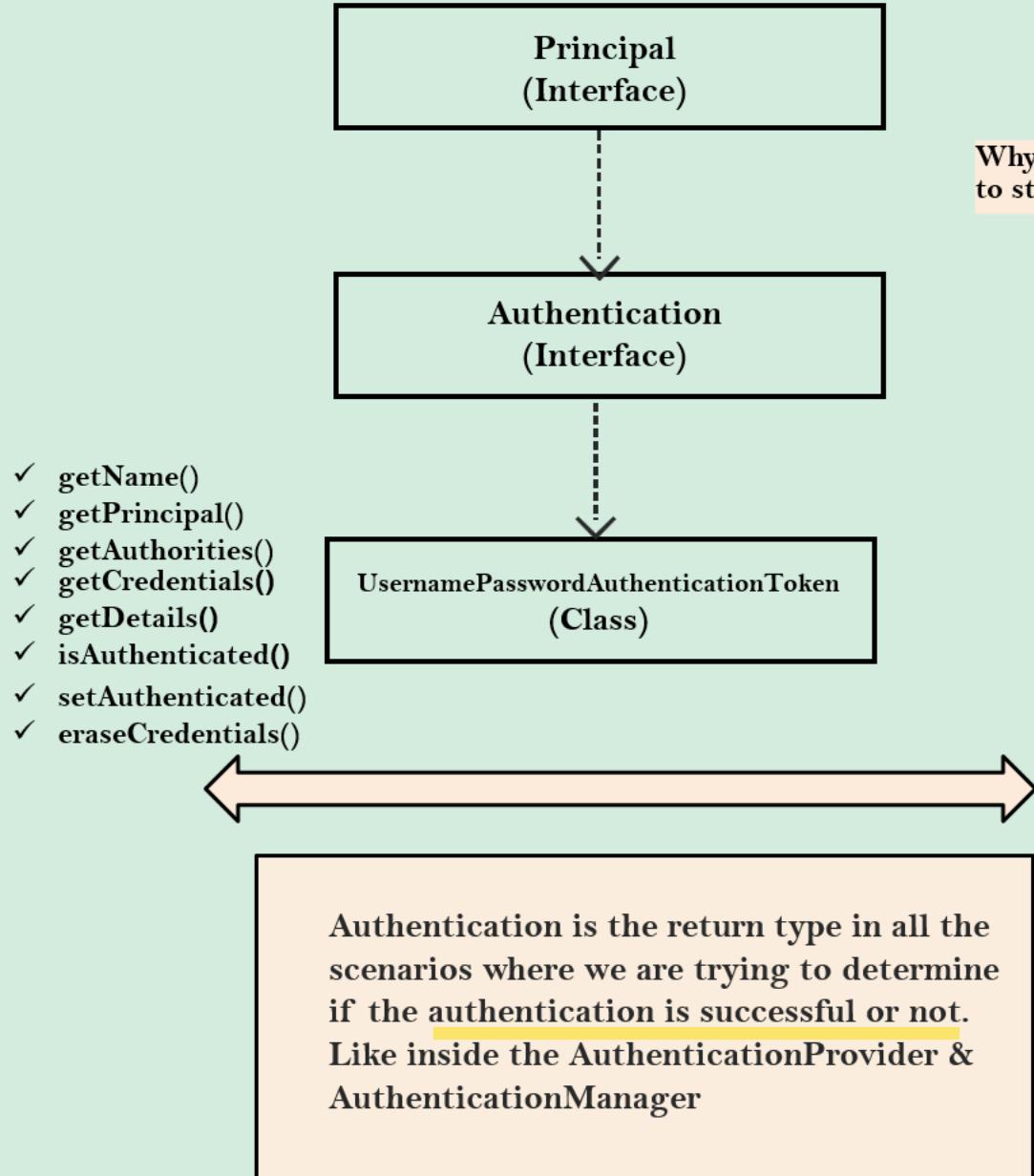
- ✓ `createUser(UserDetails user)`
- ✓ `updateUser(UserDetails user)`
- ✓ `deleteUser(String username)`
- ✓ `changePassword(String oldPwd, String newPwd)`
- ✓ `userExists(String username)`



All the above interfaces & classes uses an interface **UserDetails** & its implementation which provides core user information.

# USERDETAILS & AUTHENTICATION

## RELATION BETWEEN THEM



# AUTHENTICATION

## USING *JdbcUserDetailsManager*

*Instead of creating users inside the memory of web server, we can store them inside a DB and with the help of *JdbcUserDetailsManager*, we can perform authentication.*

*Please note to create table as per the *JdbcUserDetailsManager* class & insert user records inside them.  
NoOpPasswordEncoder is not recommended for prod apps.*

```
@Bean
public UserDetailsService userDetailsService(DataSource dataSource){
    return new JdbcUserDetailsManager(dataSource);
}

@Bean
public PasswordEncoder passwordEncoder(){
    return NoOpPasswordEncoder.getInstance();
}
```

# USERDETAILSSERVICE IMPLEMENTATION

## FOR CUSTOM USER FETCHING LOGIC

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*When we want to load the user details based on our own tables, columns, custom logic, then we need to create a bean that implements UserDetailsService and overrides the method loadUserByUsername()*

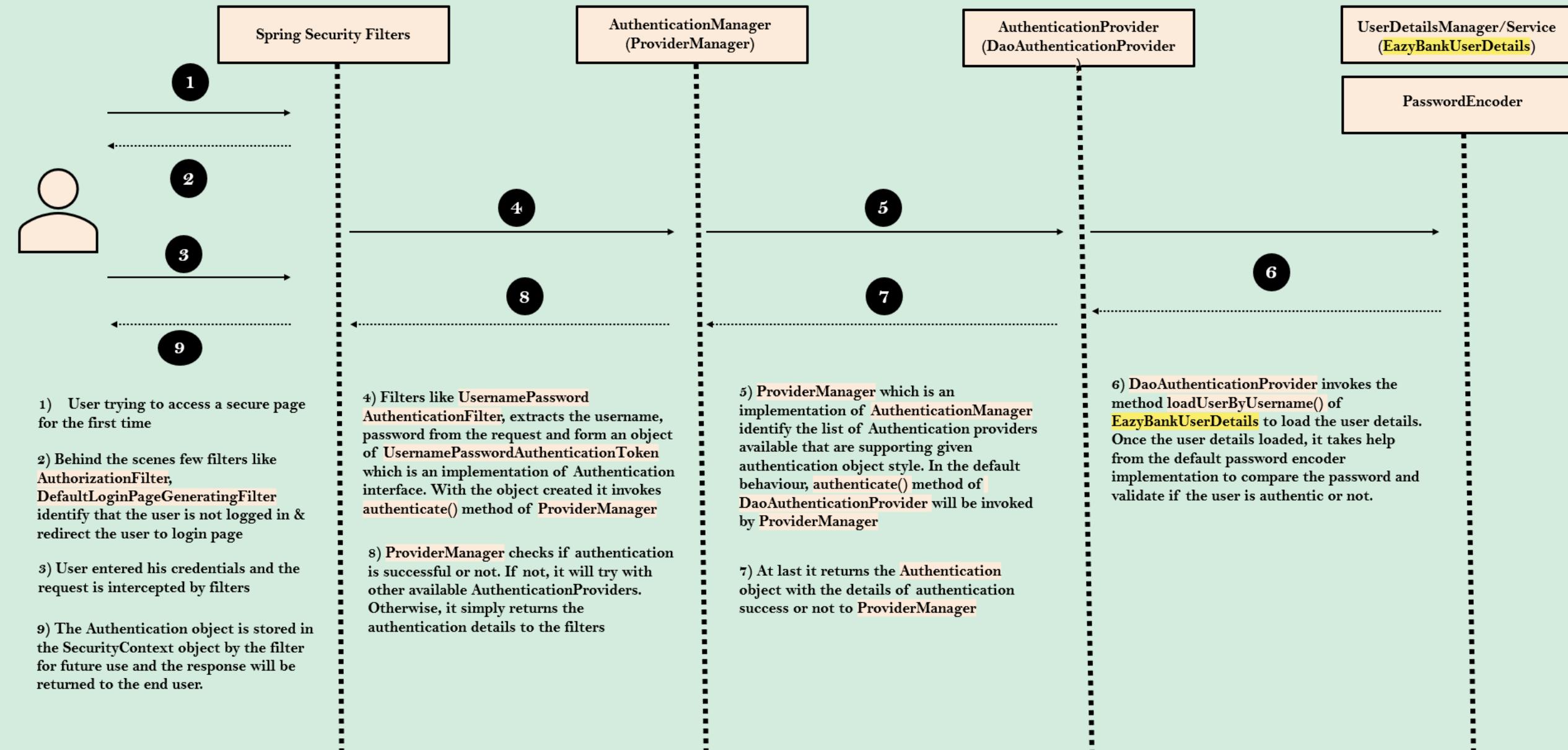
```
@Service
public class EazyBankUserDetails implements UserDetailsService {

    @Autowired
    private CustomerRepository customerRepository;

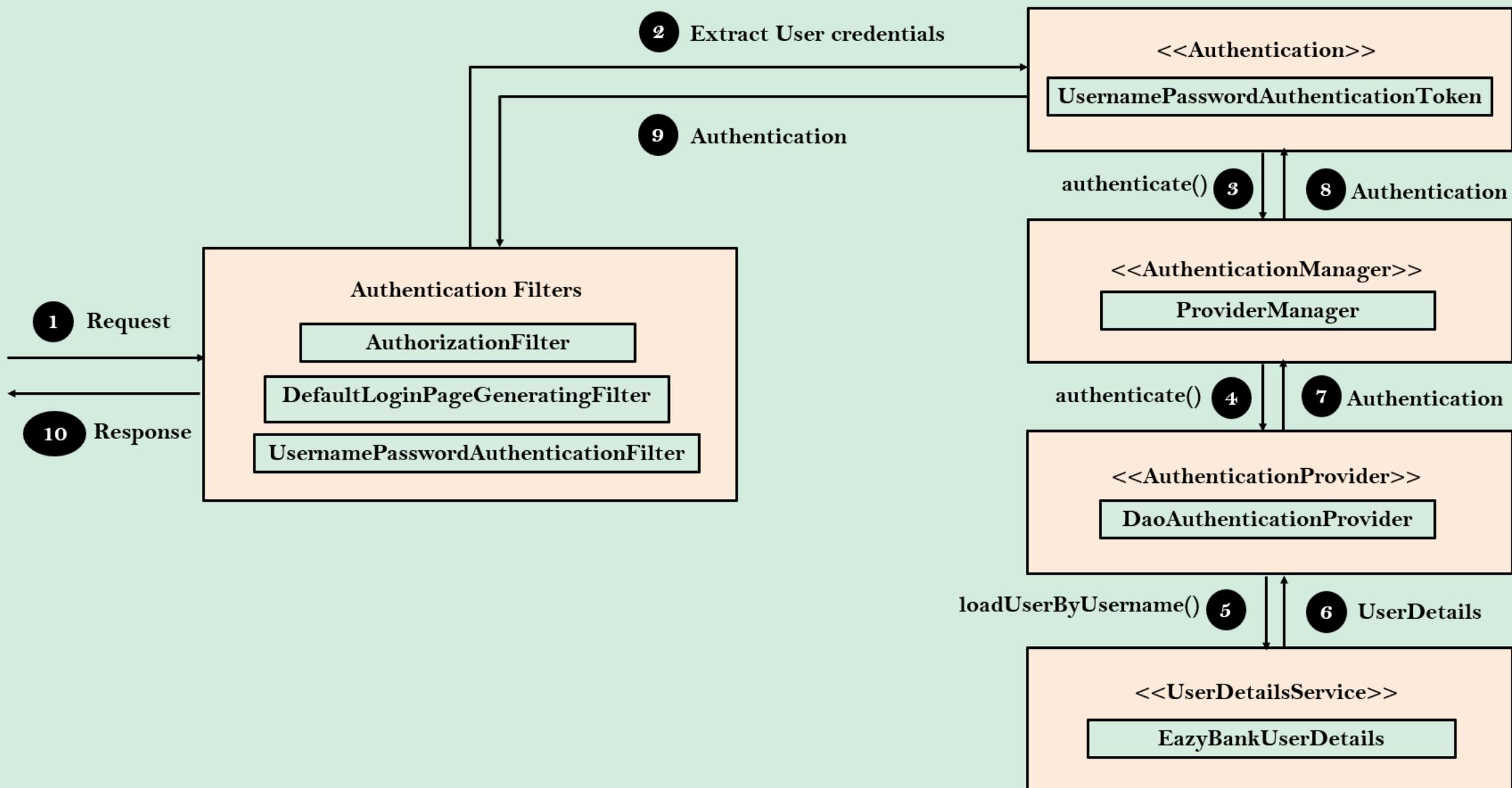
    @Override
    public UserDetails loadUserByUsername(String username) throws UsernameNotFoundException {
        String userName, password;
        List<GrantedAuthority> authorities;
        List<Customer> customer = customerRepository.findByEmail(username);
        if (customer.size() == 0) {
            throw new UsernameNotFoundException("User details not found for the user : " + username);
        } else{
            userName = customer.get(0).getEmail();
            password = customer.get(0).getPwd();
            authorities = new ArrayList<>();
            authorities.add(new SimpleGrantedAuthority(customer.get(0).getRole()));
        }
        return new User(userName,password,authorities);
    }
}
```

# SEQUENCE FLOW

## WITH OUR OWN USERDETAILSSERVICE IMPLEMENTATION



# SEQUENCE FLOW WITH OUR OWN USERDETAILSSERVICE IMPLEMENTATION



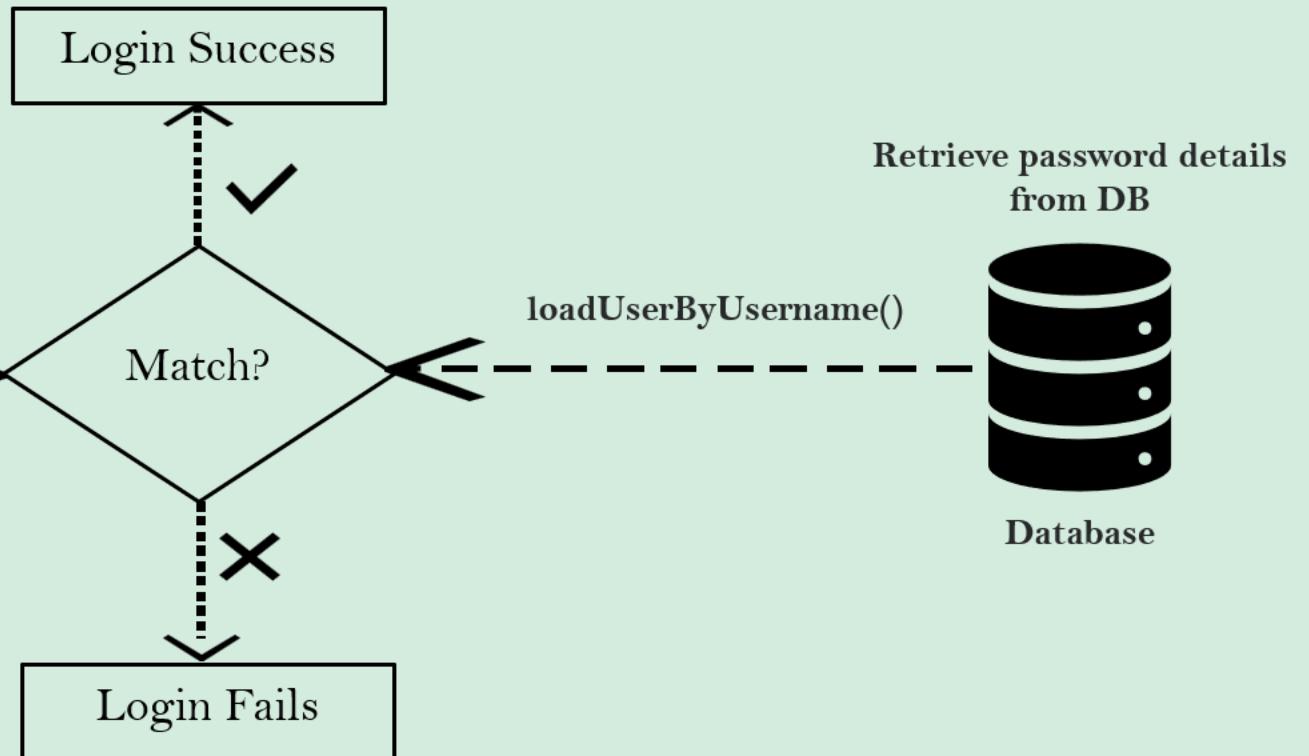
# HOW PASSWORDS VALIDATED

With default PasswordEncoder

NOT RECOMMENDED  
FOR PRODUCTION

User entered credentials

|              |  |
|--------------|--|
| Username     | <input type="text" value="Admin"/>     |
| Password     | <input type="password" value="12345"/> |
| <b>LOGIN</b> |  |



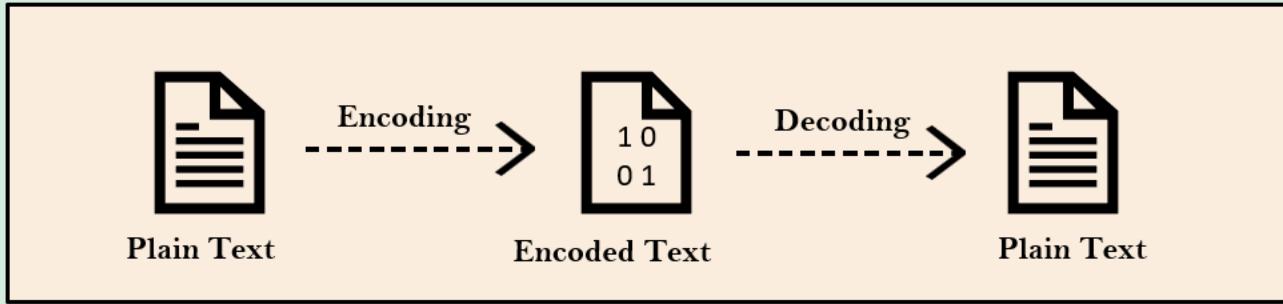
Storing the passwords in a plain text inside a storage system like DB will have Integrity & Confidentiality issues. So this is not a recommended approach for Production applications.

## Different ways of Pwd management

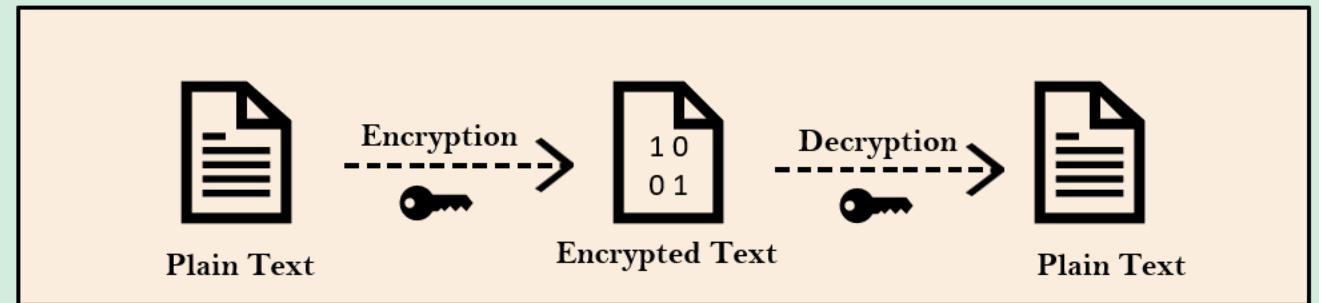
| Encoding  | Encryption   | Hashing  |
|---|--|--|
| <ul style="list-style-type: none"><li>✓ Encoding is defined as the process of converting data from one form to another and has nothing to do with cryptography.</li><li>✓ It involves no secret and completely reversible.</li><li>✓ Encoding can't be used for securing data. Below are the various publicly available algorithms used for encoding.</li></ul> | <ul style="list-style-type: none"><li>✓ Encryption is defined as the process of transforming data in such a way that guarantees confidentiality.</li><li>✓ To achieve confidentiality, encryption requires the use of a secret which, in cryptographic terms, we call a "key".</li><li>✓ Encryption can be reversible by using decryption with the help of the "key". As long as the "key" is confidential, encryption can be considered as secured.</li></ul> | <ul style="list-style-type: none"><li>✓ In hashing, data is converted to the hash value using some hashing function.</li><li>✓ Data once hashed is non-reversible. One cannot determine the original data from a hash value generated.</li><li>✓ Given some arbitrary data along with the output of a hashing algorithm, one can verify whether this data matches the original input data without needing to see the original data</li></ul> |
| Ex: ASCII, BASE64, UNICODE  |  | <p>digest value</p>  |

# Encoding Vs Encryption Vs Hashing

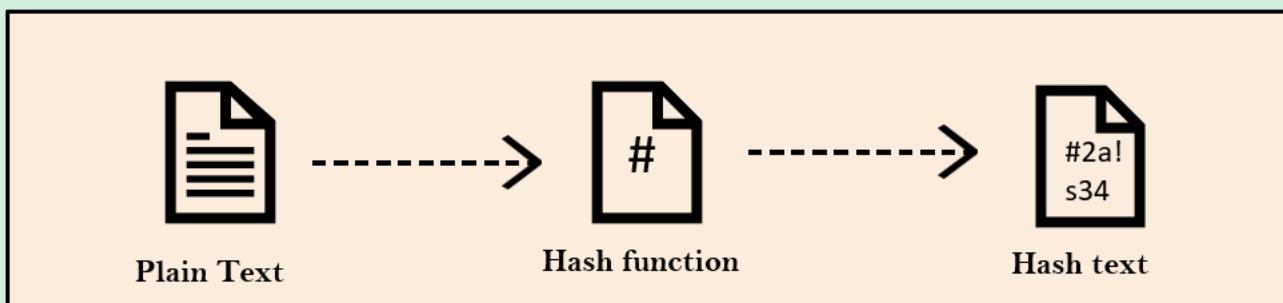
## Encoding & Decoding



## Encryption & Decryption



## Hashing (Only 1-way)

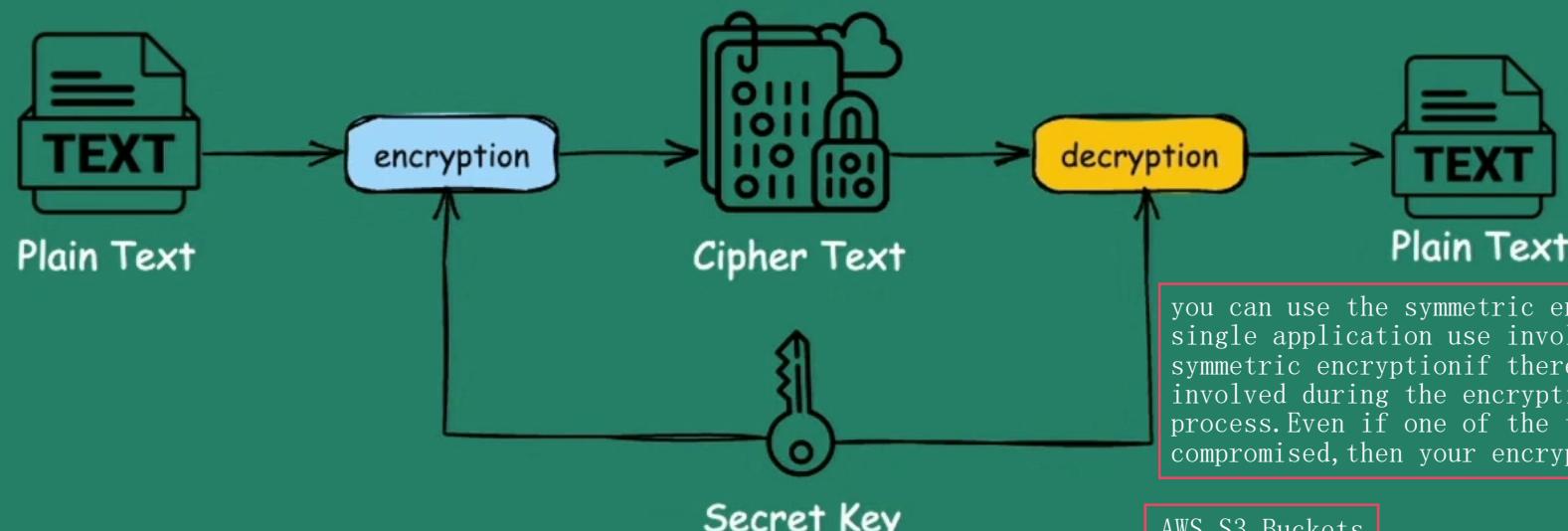


# DEEP DIVE OF ENCRYPTION

Encryption is essential in our daily routines, whether you're messaging friends on WhatsApp, ensuring a website's authenticity through your browser, or entering your credit card details while shopping online. It safeguards your data from potential threats and unauthorized access, ensuring privacy and security.

Central to any encryption process are the **encryption algorithm** and the **key**. While numerous encryption algorithms exist, there are generally two types of keys: **symmetric** and **asymmetric**.

**Symmetric encryption** - In symmetric key encryption, the same key used to encrypt the data is used to decrypt the data. Some famous symmetric encryption algorithms include AES, known for its security and used globally; Triple DES, an enhancement of DES providing better security; and Blowfish, notable for its speed and variable key lengths. Each offers distinct advantages for protecting data. symmetric key encryption is generally used for encrypting data at rest



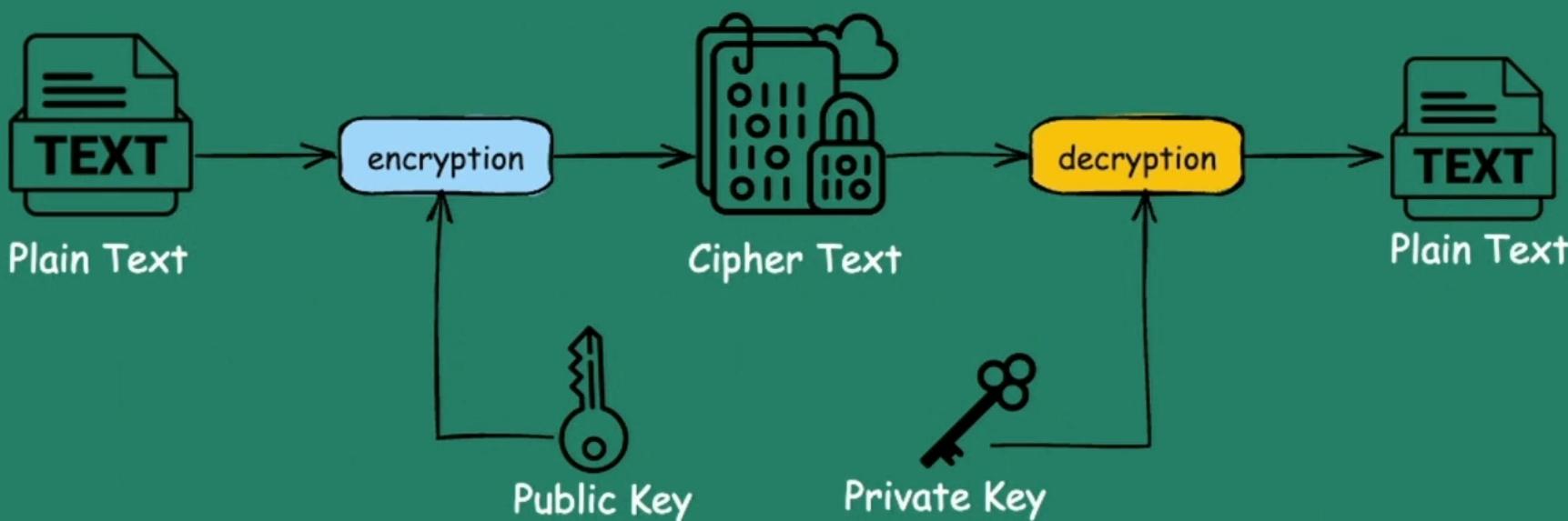
you can use the symmetric encryption if there is only a single application use involved. Don't try to use a symmetric encryption if there are multiple parties involved during the encryption and decryption process. Even if one of the third party application is compromised, then your encryption is going to be useless.

AWS S3 Buckets

AWS is going to do behind the scenes whenever a new data is being stored into the S3 buckets, it is going to encrypt the data with the secret key, which is known only to the AWS. AWS is also going to give you an option if you want to provide your own secret key. With that, even if someone gets hold onto the data, which is present inside the S3 buckets, it is going to be useless for them because the data is encrypted and they can't get the secret key either from the AWS or either from the organization. And whenever the organization is trying to read the data from these S3 buckets, AWS behind the scenes, it is going to decrypt the data using the secret key and send the data in a plain format to the organization who owns the data.

# DEEP DIVE OF ENCRYPTION

**Asymmetric encryption** - Asymmetric encryption functions like a unique lock with two distinct keys: one for locking (encrypting) and one for unlocking (decrypting). You keep the private key, which unlocks the message, secure with you, while freely distributing the public key to anyone who wants to send you an encrypted message. They use this public key to encrypt their message, and only you can decrypt it using your private key. This system ensures secure communication, as it relies on a pair of keys: a public key for encryption and a private key for decryption



Asymmetric key encryption is ideal for encrypting data in transit, where you need to share the key with another system. The most commonly used asymmetric algorithms include Rivest-Shamir-Adleman (RSA), Diffie-Hellman, Elliptic Curve Cryptography (ECC) and Pretty Good Privacy (PGP).

# DEEP DIVE OF HASHING

## 01

Hash functions take any data as input and produce a unique string of bytes in return. Given the same input, the hash function always reproduces the same string of bytes. The output of a hash function is often called a digest or a HASH.

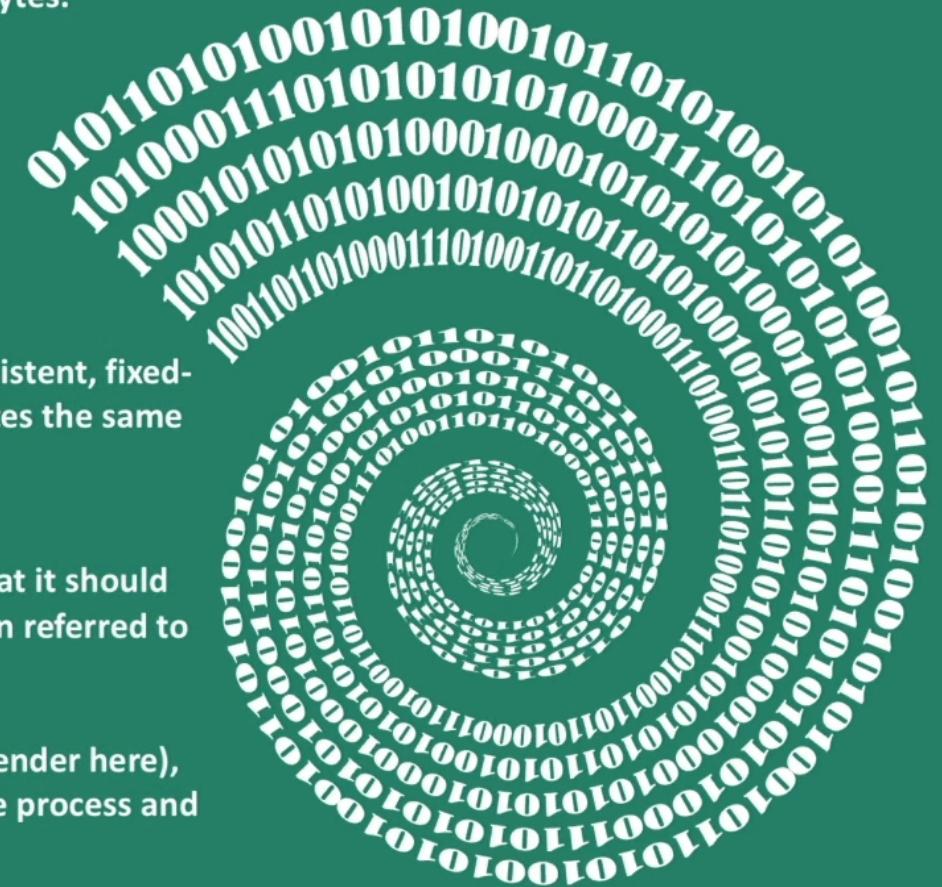


A hash function transforms input of any length (such as a file, message, or video) into a consistent, fixed-length output (e.g., 256 bits for SHA-256). When the same input is hashed, it always generates the same resulting digest or hash.

## 02

A fundamental characteristic of a hash function is its irreversibility, meaning that it should not be possible to deduce the input from its output alone. This property is often referred to as being "one-way."

In other words, given the output produced by a hash function (depicted as a blender here), it should be computationally infeasible, or practically impossible, to reverse the process and uncover the original input.



If you give the same plain text value to the same hash function, you're always going to get the same hash value.

Hash value length is fix.

## Dictionary Attack (Sözlük Saldırısı):

Nedir? Sözlük saldırısı, saldırganın önceden oluşturulmuş bir liste (sözlük) kullanarak şifreleri tahmin etmeye çalıştığı bir yöntemdir. Bu listede, yaygın şifreler, kelimeler ve kombinasyonlar bulunur.

Örnek: Elinizde "123456", "password", "letmein" gibi yaygın şifrelerden oluşan bir liste var. Bu listeyi kullanarak bir web sitesinde kullanıcıların şifrelerini denersiniz. Eğer şifre listedeki bir kelimeyse, saldırı başarılı olur.

## Rainbow Table:

Nedir? Rainbow table, şifrelerin hash (özet) değerlerini çözmek için kullanılan önceden hesaplanmış bir veri tablosudur. Bu tabloda, yaygın şifreler ve bunların hash değerleri bulunur. Saldırgan, veritabanından elde ettiği hash değerlerini bu tabloyla karşılaştırarak şifreyi bulmaya çalışır.

Örnek: Diyelim ki bir veritabanında "5f4dcc3b5aa765d61d8327deb882cf99" gibi bir hash değeri var. Rainbow table'dan bu hash değerinin "password" kelimesine karşılık geldiğini bulursunuz. Böylece, şifrenin "password" olduğunu öğrenmiş olursunuz.

## Basit Fark:

Sözlük saldırısında, saldırgan doğrudan yaygın şifreleri dener.

Rainbow table saldırısında ise saldırgan, şifrelerin hash değerlerini çözmek için önceden hesaplanmış tabloları kullanır.

# HASHING PASSWORDS

Let's try to understand how to overcome the challenges of Brute force attacks and Rainbow table attacks,

1. To prevent rainbow table attacks, **salts** are commonly used. Salts are random values that are unique for each user and are made public. The salt value is stored as part of the resulting hash itself. Specifically, the salt is included in the hash string along with the actual hashed password. The salt is typically stored at the beginning of the hash string and is used during the password verification process to generate the same hash again for comparison. Since each user has a unique hash function, attackers can't precompute large tables of passwords (rainbow tables) to test against the entire database of stolen password hashes.

**Plain text password + Random salt value + Hashing Algo = Protection from Rainbow attacks**

2. Brute force attacks issue can be solved with password hashes, which are designed to be slow. The normal hashing process is quite fast, due to which attackers can do the trial and error by trying any number of plain password to check against hashed password. We can make attacker life tough by using password hashing algorithms like **PBKDF2, bcrypt, scrypt and Argon2**. These algorithms slows the hashing process and demands lots of CPU cost, memory cost.

These algorithms are specifically designed to slow down the hashing process, thereby increasing the time and resources required for an attacker to guess passwords. They achieve this by introducing additional computational costs, such as CPU and memory, into the hashing process. By making it more computationally expensive to hash passwords, these algorithms make brute force attacks less practical and deter attackers from attempting them.

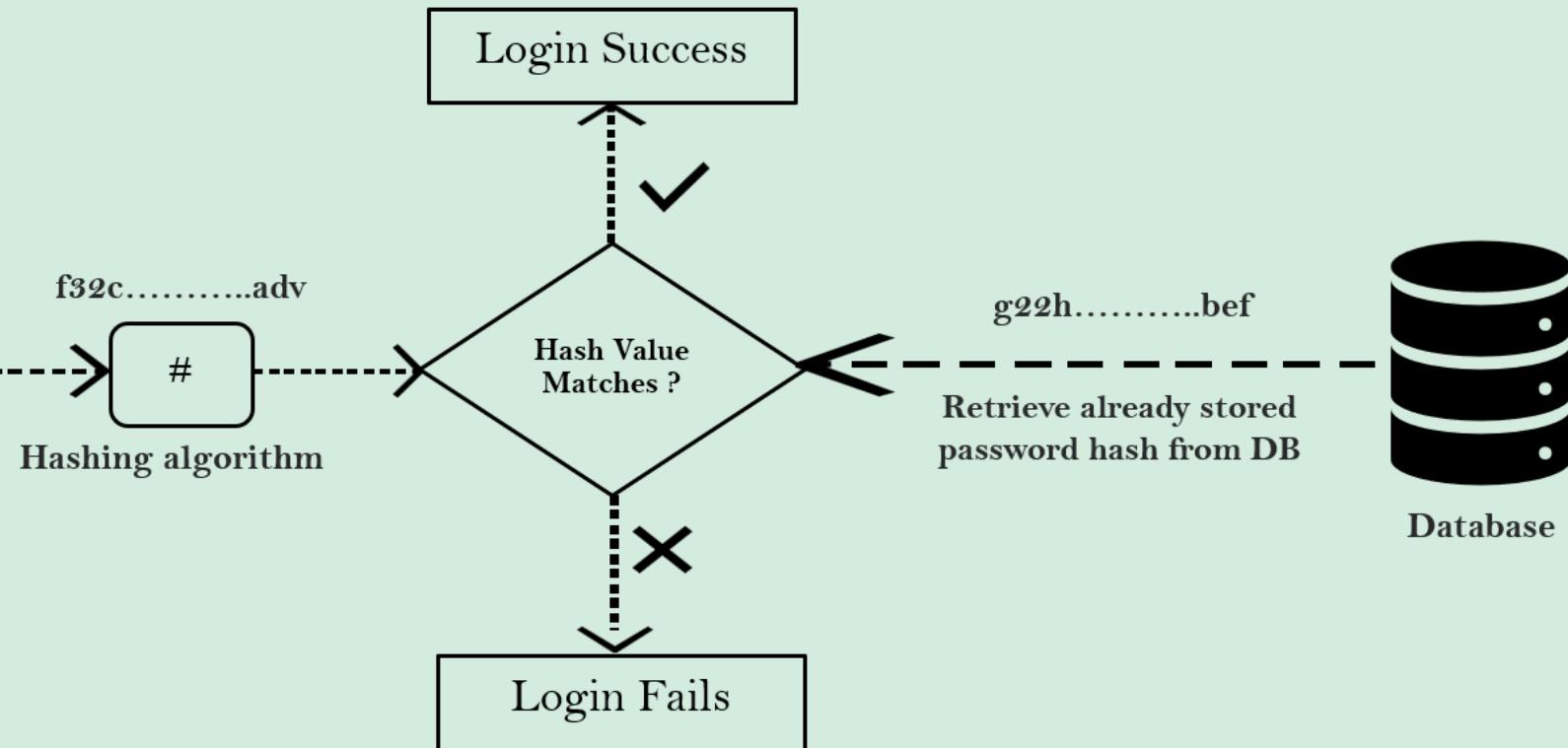
**Spring Security provides industry recommended Password Encoders that are capable of generating random salt and leverage password hashing algorithms like bcrypt**

# HOW PASSWORDS VALIDATED

## With Hashing & PasswordEncoders

User entered credentials

|              |  |
|--------------|--|
| Username     | <input type="text" value="Admin"/>     |
| Password     | <input type="password" value="12345"/> |
| <b>LOGIN</b> |  |



Storing & managing the passwords with hashing is the recommended approach for Production applications. With various PasswordEncoders available inside Spring Security, it makes our life easy.

# DETAILS OF PASSWORDENCODER

## Methods inside PasswordEncoder Interface

```
public interface PasswordEncoder {  
  
    String encode(CharSequence rawPassword);  
  
    boolean matches(CharSequence rawPassword, String encodedPassword);  
  
    default boolean upgradeEncoding(String encodedPassword) {  
        return false;  
    }  
}
```

## Different implementations of PasswordEncoder inside Spring Security

★ **NoOpPasswordEncoder** (*Not recommended for Prod apps*)

★ **StandardPasswordEncoder** (*Not recommended for Prod apps*)

★ **Pbkdf2PasswordEncoder**

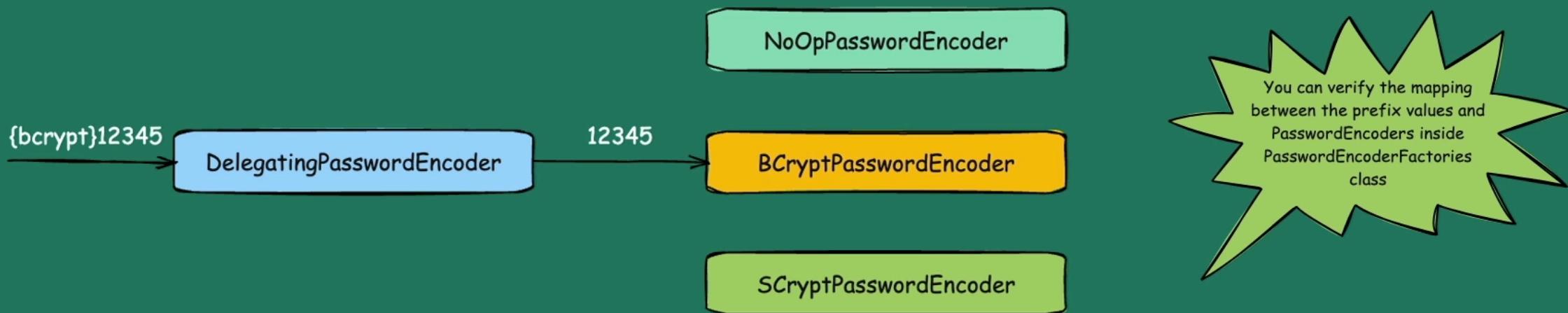
★ **BCryptPasswordEncoder**

★ **SCryptPasswordEncoder**

★ **Argon2PasswordEncoder**

When needing to switch password hashing algorithms in an application, such as due to a vulnerability, the DelegatingPasswordEncoder is handy. It allows managing multiple hash types simultaneously. For instance, it enables using a new algorithm for new users while maintaining the old one for existing credentials.

The DelegatingPasswordEncoder delegates to the correct implementation of the PasswordEncoder based on the prefix of the password.



During the user registration process, the DelegatingPasswordEncoder uses the default password encoder defined in the framework and appends the corresponding prefix to the encoded password.

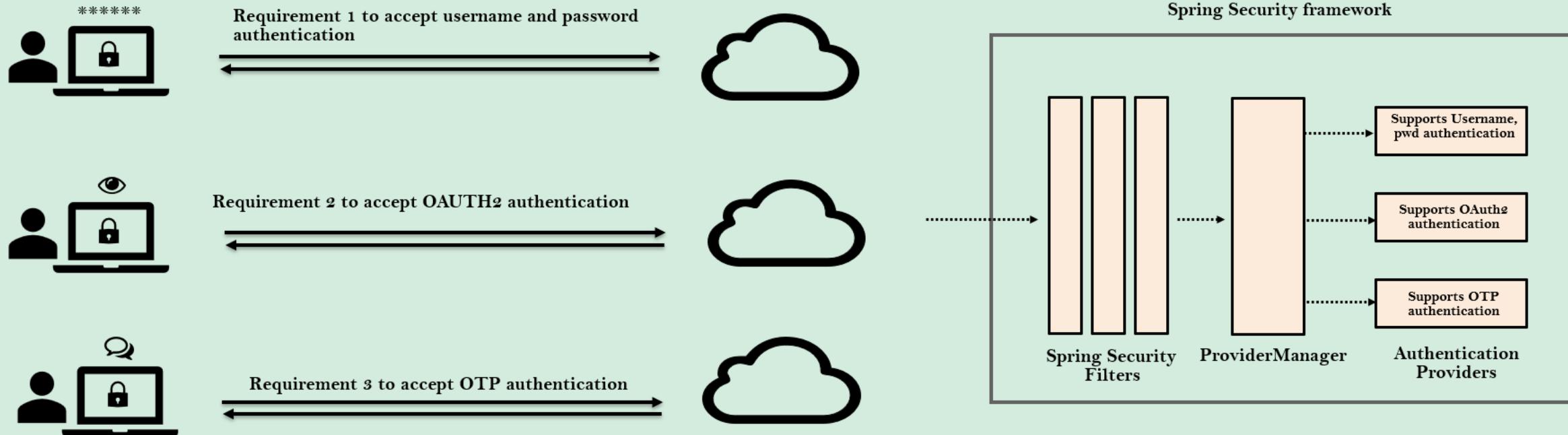
During the login operation, when we call the `matches()` method with a password that has prefix `{bcrypt}`, the call is delegated to the BCryptPasswordEncoder. Similarly based on the other prefix values, the corresponding password encoder will be selected.

Activate Windows

Windows 10 Pro 64-bit - 100% genuine - activate Windows.

# AUTHENTICATION PROVIDER

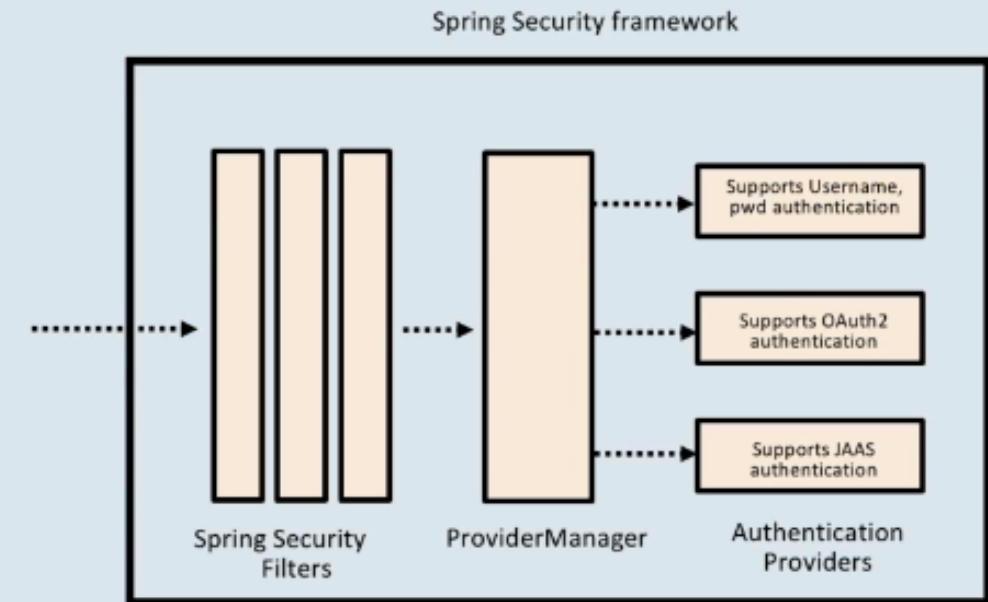
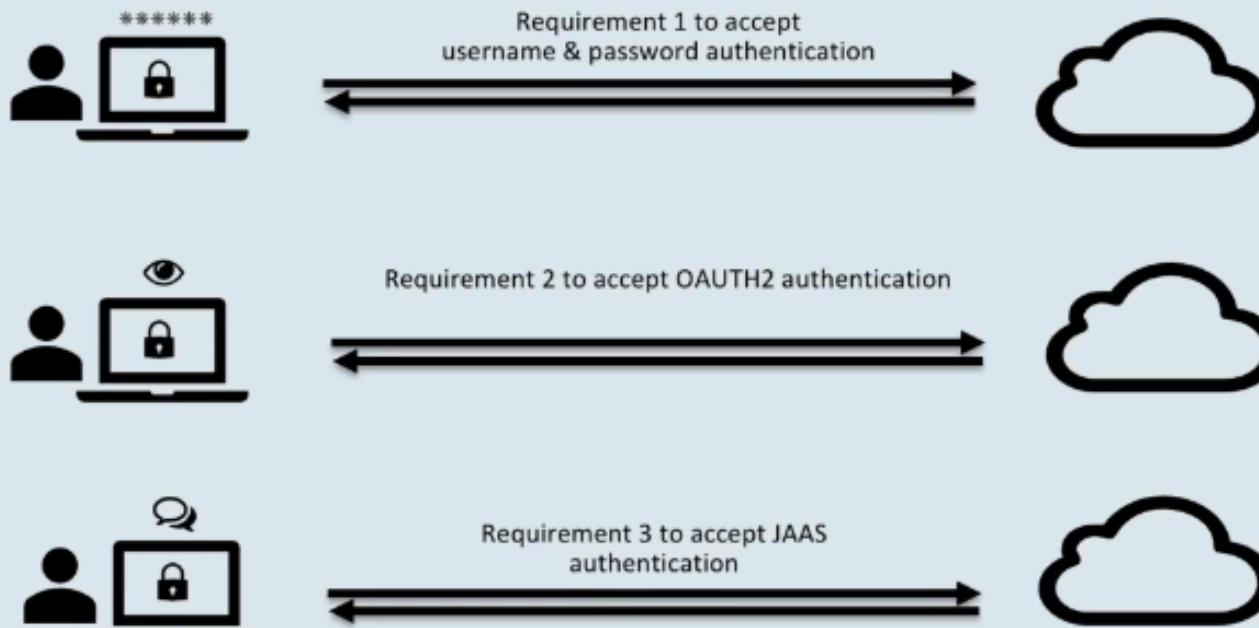
## WHY DO WE NEED IT?



- ✓ The AuthenticationProvider in Spring Security takes care of the authentication logic. The default implementation of the AuthenticationProvider is to delegate the responsibility of finding the user in the system to a UserDetailsService implementation & PasswordEncoder for password validation. But if we have a custom authentication requirement that is not fulfilled by Spring Security framework, then we can build our own authentication logic by implementing the AuthenticationProvider interface.
- ✓ It is the responsibility of the ProviderManager which is an implementation of AuthenticationManager, to check with all the implementations of Authentication Providers and try to authenticate the user.

# AUTHENTICATION PROVIDER

## WHY DO WE NEE IT?



JAAS means Java Authentication and Authorization Service.

- ✓ The AuthenticationProvider in Spring Security takes care of the authentication logic. The default implementation of the AuthenticationProvider is to delegate the responsibility of finding the user in the system to a UserDetailsService implementation & PasswordEncoder for password validation. But if we have a custom authentication requirement that is not fulfilled by Spring Security framework, then we can build our own authentication logic by implementing the AuthenticationProvider interface.
- ✓ It is the responsibility of the ProviderManager which is an implementation of AuthenticationManager, to check with all the implementations of Authentication Providers and try to authenticate the user.

JAAS means Java Authentication and Authorization Service. So, inside the Java library itself, we have a small security plugin, our authentication framework, which is provided by the Java team. Not many organizations uses this protocol these days because these days everyone's favorite is Spring Security. But you may end up in some scenarios where a certain organization may want to support login into an Legacy application with the help of this JAAS. So, based upon our discussion, it should be pretty clear for you that this organization or this scenario has a lot of complex security requirements. So for all these kind of scenarios, we need to write our own Authentication Provider implementations.

# DETAILS OF AUTHENTICATION PROVIDER

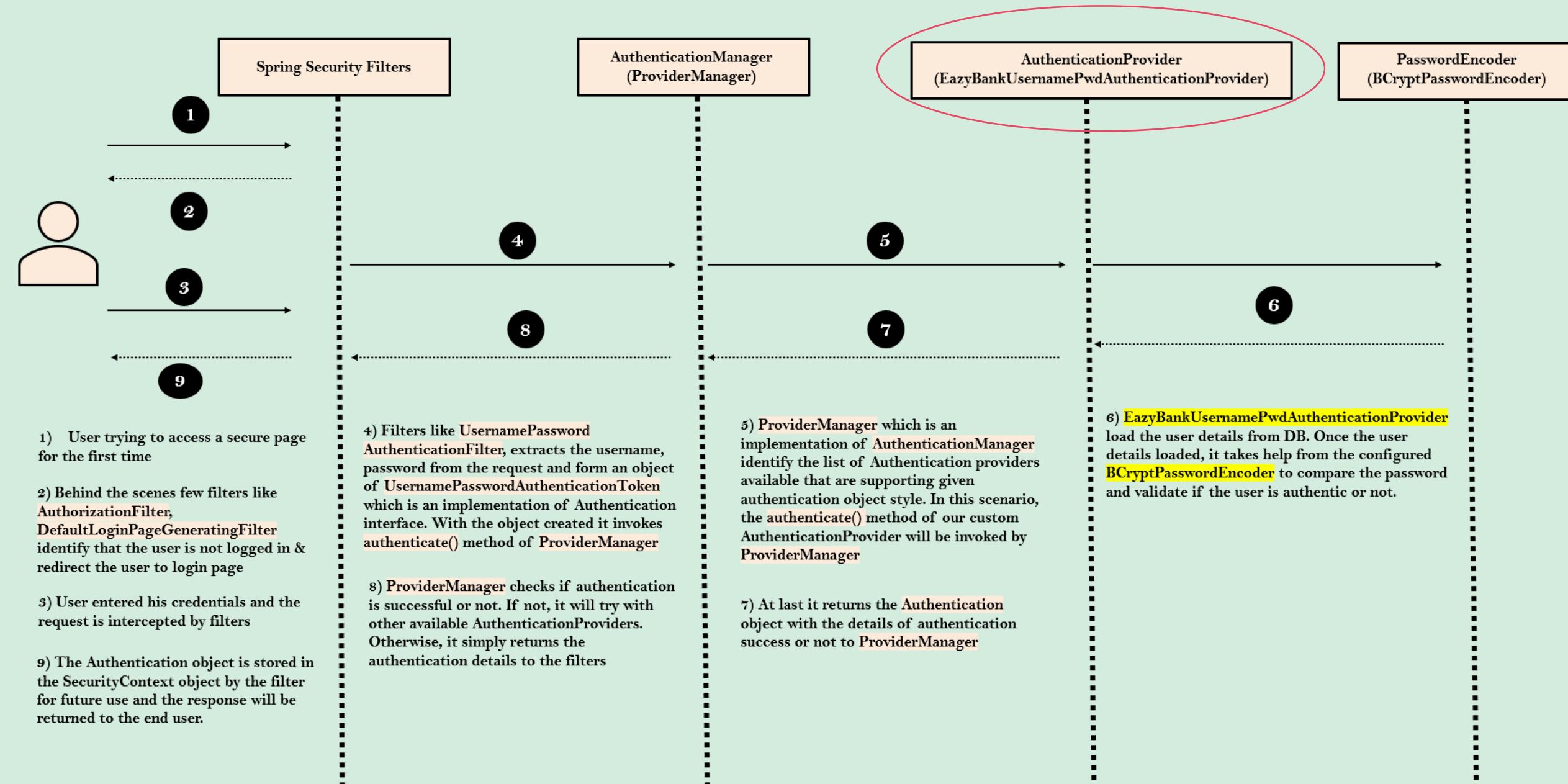
## Methods inside AuthenticationProvider Interface

```
public interface AuthenticationProvider {  
  
    Authentication authenticate(Authentication authentication)  
        throws AuthenticationException;  
  
    boolean supports(Class<?> authentication);  
}
```

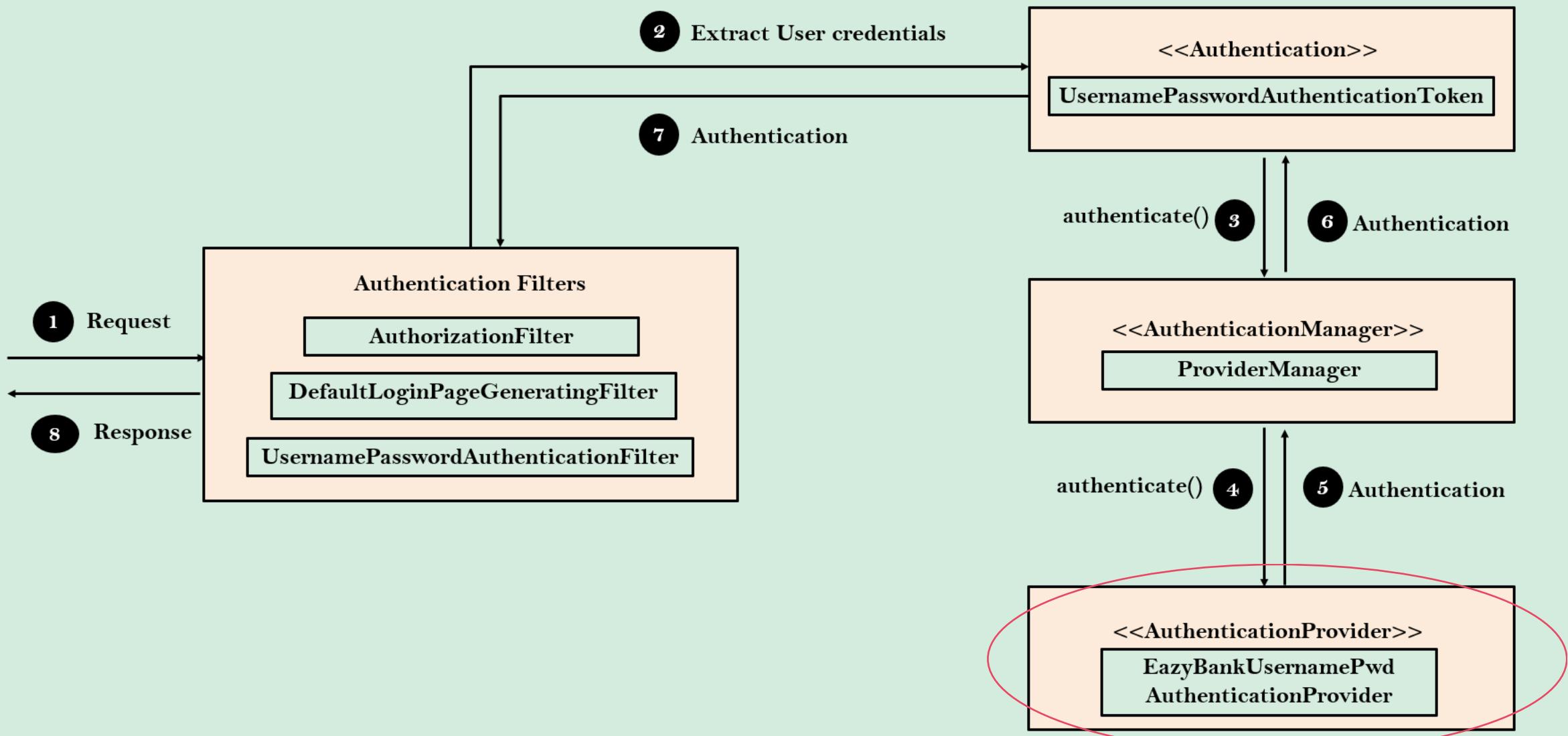
- ★ The `authenticate()` method receives and returns authentication object. We can implement all our custom authentication logic inside `authenticate()` method.
  
- ★ The second method in the `AuthenticationProvider` interface is `supports(Class<?> authentication)`. You'll implement this method to return true if the current `AuthenticationProvider` supports the type of the `Authentication` object provided.

# SEQUENCE FLOW

## WITH OUR OWN AUTHENTICATIONPROVIDER IMPLEMENTATION



# SEQUENCE FLOW WITH OUR OWN AUTHENTICATIONPROVIDER IMPLEMENTATION



## CORS & CSRF

### SPRING SECURITY APPROACH



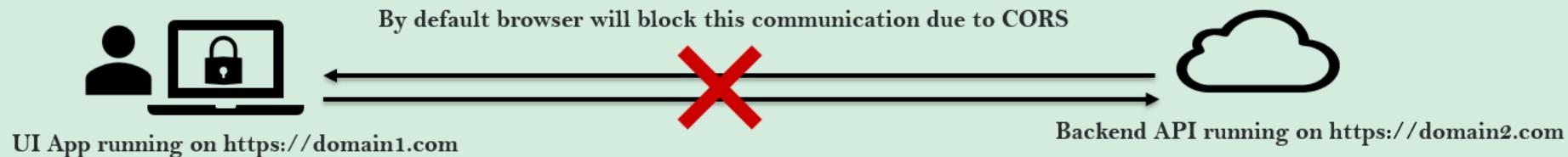
# CROSS-ORIGIN RESOURCE SHARING (CORS)

CORS is a protocol that enables scripts running on a browser client to interact with resources from a different origin. For example, if a UI app wishes to make an API call running on a different domain, it would be blocked from doing so by default due to CORS. It is a specification from W3C implemented by most browsers.

So CORS is not a security issue/attack but the default protection provided by browsers to stop sharing the data/communication between different origins.

"other origins" means the URL being accessed differs from the location that the JavaScript is running from, by having:

- a different scheme (HTTP or HTTPS)
- a different domain
- a different port



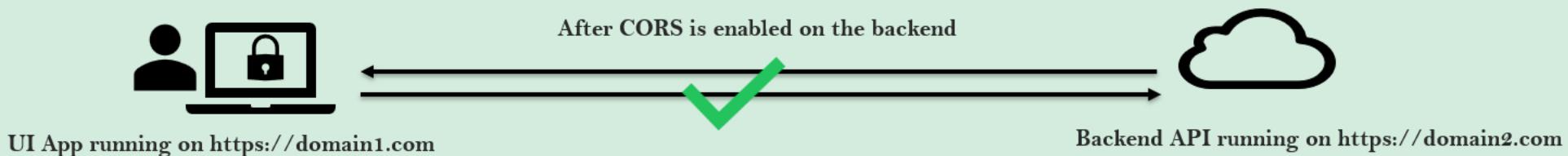
# SOLUTION TO HANDLE CORS

If we have a valid scenario, where a Web APP UI deployed on a server is trying to communicate with a REST service deployed on another server, then these kind of communications we can allow with the help of `@CrossOrigin` annotation. `@CrossOrigin` allows clients from any domain to consume the API.

`@CrossOrigin` annotation can be mentioned on top of a class or method like mentioned below,

```
@CrossOrigin(origins = "http://localhost:4200") // Will allow on specified domain
```

```
@CrossOrigin(origins = "*") // Will allow any domain
```



# SOLUTION TO HANDLE CORS

Instead of mentioning `@CrossOrigin` annotation on all the controllers inside our web app, we can define CORS related configurations globally using Spring Security like shown below,

```
@Bean
SecurityFilterChain defaultSecurityFilterChain(HttpSecurity http) throws Exception {
    http.cors(corsCustomizer -> corsCustomizer.configurationSource(new CorsConfigurationSource() {
        @Override
        public CorsConfiguration getCorsConfiguration(HttpServletRequest request) {
            CorsConfiguration config = new CorsConfiguration();
            config.setAllowedOrigins(Collections.singletonList("http://localhost:4200"));
            config.setAllowedMethods(Collections.singletonList("*"));
            config.setAllowCredentials(true);
            config.setAllowedHeaders(Collections.singletonList(" *"));
            config.setMaxAge(3600L);
            return config;
        }
    })).authorizeHttpRequests((requests)->requests
        .requestMatchers("/myAccount", "/myBalance", "/myLoans", "/myCards", "/user").authenticated()
        .requestMatchers("/notices", "/contact", "/register").permitAll()
        .formLogin(Customizer.withDefaults())
        .httpBasic(Customizer.withDefaults());
    return http.build();
}
```

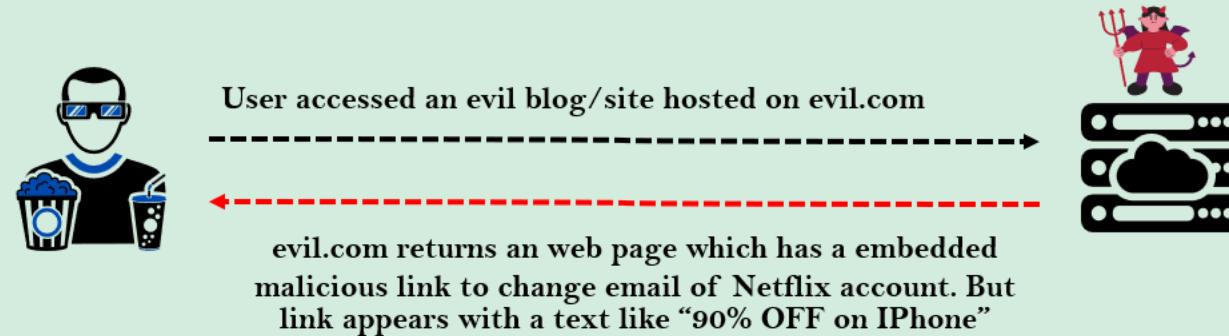
# CROSS-SITE REQUEST FORGERY (CSRF)

- A typical Cross-Site Request Forgery (CSRF or XSRF) attack aims to perform an operation in a web application on behalf of a user without their explicit consent. In general, it doesn't directly steal the user's identity, but it exploits the user to carry out an action without their will.
- Consider you are using a website `netflix.com` and the attacker's website `evil.com`.

*Step 1 : The Netflix user login to Netflix.com and the backend server of Netflix will provide a cookie which will store in the browser against the domain name Netflix.com*

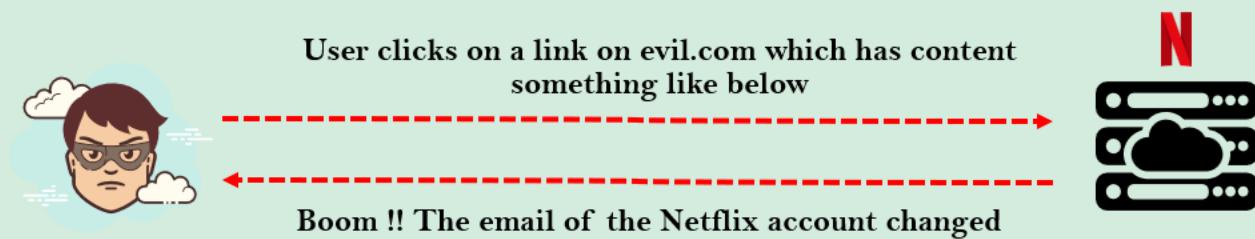


*Step 2 : The same Netflix user opens an evil.com website in another tab of the browser.*



# CROSS-SITE REQUEST FORGERY (CSRF)

*Step 3 : User tempted and clicked on the malicious link which makes a request to Netflix.com. And since the login cookie already present in the same browser and the request to change email is being made to the same domain Netflix.com, the backend server of Netflix.com can't differentiate from where the request came. So here the evil.com forged the request as if it is coming from a Netflix.com UI page.*



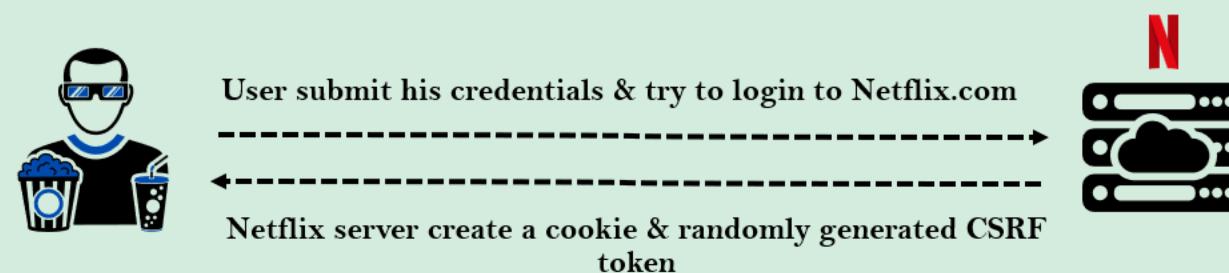
```
<form action="https://netflix.com/changeEmail"
    method="POST" id="form">
    <input type="hidden" name="email" value="user@evil.com">
</form>

<script>
    document.getElementById('form').submit()
</script>
```

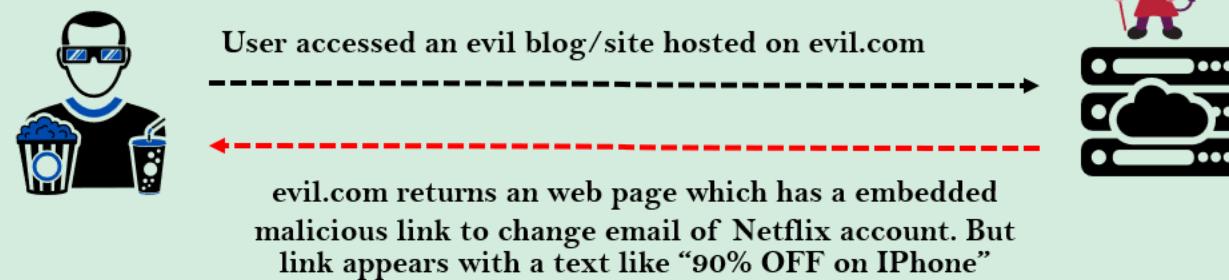
# SOLUTION TO CSRF ATTACK

- To defeat a CSRF attack, applications need a way to determine if the HTTP request is legitimately generated via the application's user interface. The best way to achieve this is through a CSRF token. A CSRF token is a secure random token that is used to prevent CSRF attacks. The token needs to be unique per user session and should be of large random value to make it difficult to guess.
- Let's see how this solve CSRF attack by taking the previous Netflix example again,

*Step 1 : The Netflix user login to Netflix.com and the backend server of Netflix will provide a cookie which will store in the browser against the domain name Netflix.com along with a randomly generated unique CSRF token for this particular user session. CSRF token is inserted within hidden parameters of HTML forms to avoid exposure to session cookies.*

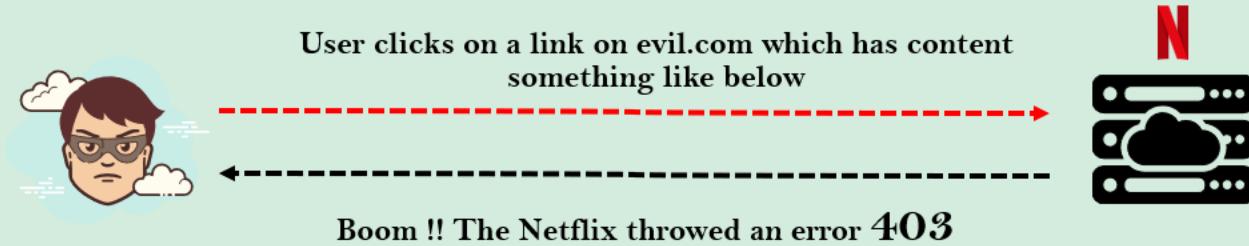


*Step 2 : The same Netflix user opens an evil.com website in another tab of the browser:*



# SOLUTION TO CSRF ATTACK

*Step 3 : User tempted and clicked on the malicious link which makes a request to Netflix.com. And since the login cookie already present in the same browser and the request to change email is being made to the same domain Netflix.com. This time the Netflix.com backend server expects CSRF token along with the cookie. The CSRF token must be same as initial value generated during login operation*



The CSRF token will be used by the application server to verify the legitimacy of the end-user request if it is coming from the same App UI or not. The application server rejects the request if the CSRF token fails to match the test.

# DISABLE CSRF PROTECTION INSIDE SPRING SECURITY

NOT RECOMMENDED  
FOR PRODUCTION

By default Spring Security blocks all HTTP POST, PUT, DELETE, PATCH operations with an error of 403, if there is no CSRF solution implemented inside a web application. We can change this default behaviour by disabling the CSRF protection provided by Spring Security.

```
@Bean
SecurityFilterChain defaultSecurityFilterChain(HttpSecurity http) throws Exception {
    http.csrf((csrf) -> csrf.disable())
        .authorizeHttpRequests((requests)->requests
            .requestMatchers("/myAccount", "/myBalance", "/myLoans", "/myCards", "/user").authenticated()
            .requestMatchers("/notices", "/contact", "/register").permitAll())
        .formLogin(Customizer.withDefaults())
        .httpBasic(Customizer.withDefaults());
    return http.build();
}
```

# CSRF ATTACK SOLUTION

## INSIDE SPRING SECURITY

eazy  
bytes

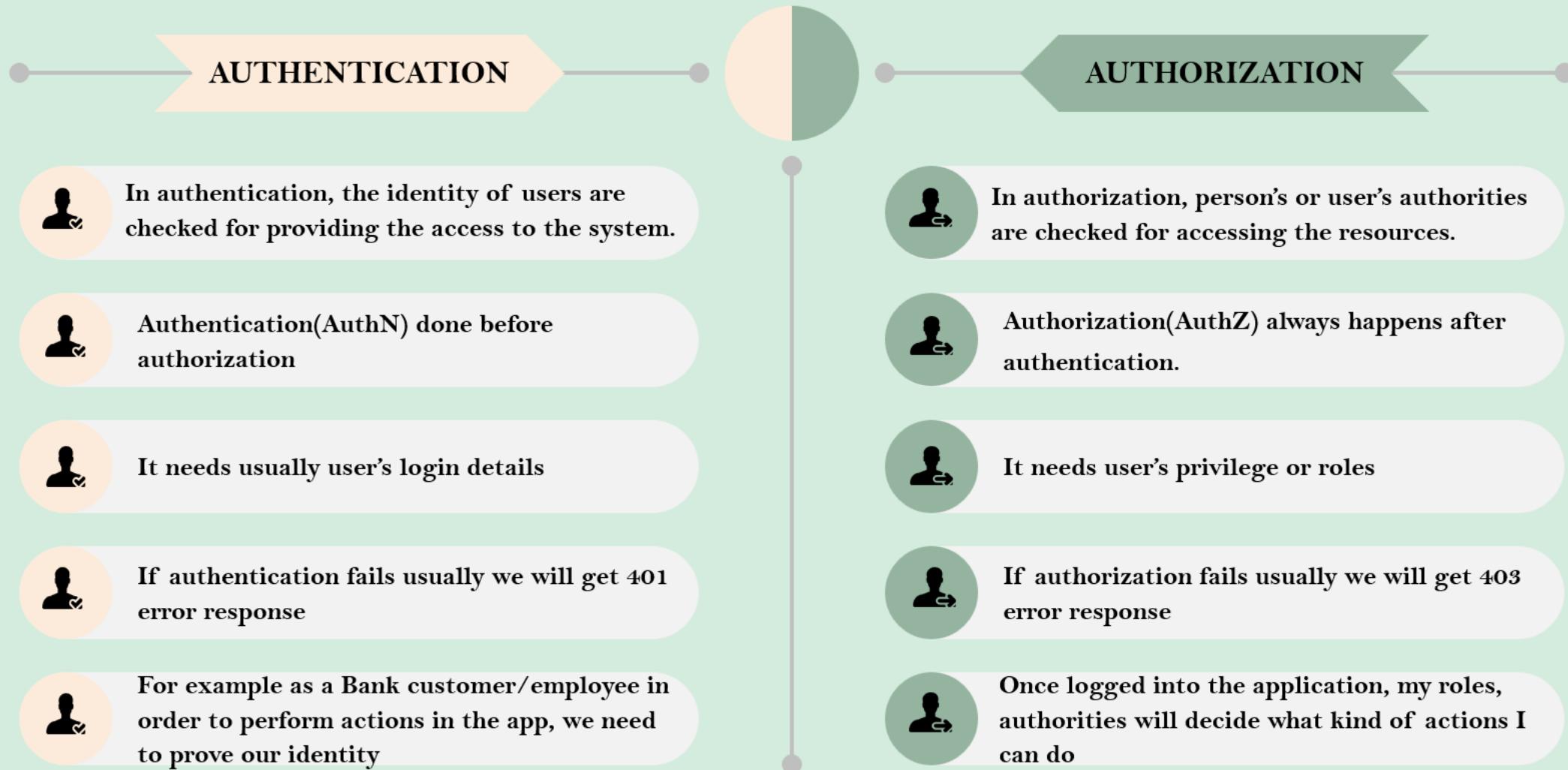
With the given configuration of Spring Security, we can let the framework to generate a random CSRF token which can be sent to UI after successful login. The same taken need to be sent by UI for every subsequent requests it is making to backend. For certain paths, we can disable CSRF with the help of ignoringRequestMatchers.

```
@Bean
SecurityFilterChain defaultSecurityFilterChain(HttpSecurity http) throws Exception {
    CsrfTokenRequestAttributeHandler requestHandler = new CsrfTokenRequestAttributeHandler();
    requestHandler.setCsrfRequestAttributeName("_csrf");

    http.securityContext((context) -> context
        .requireExplicitSave(false))
        .sessionManagement(session -> session.sessionCreationPolicy(SessionCreationPolicy.ALWAYS))
        .cors(corsCustomizer -> corsCustomizer.configurationSource(new CorsConfigurationSource() {...}))
        .csrf(csrf) -> csrf.csrfTokenHandler(requestHandler).ignoringRequestMatchers("/contact", "/register")
        .csrfTokenRepository(CookieCsrfTokenRepository.withHttpOnlyFalse())
        .addFilterAfter(new CsrfCookieFilter(), BasicAuthenticationFilter.class)
        .authorizeHttpRequests((requests)->requests
            .requestMatchers("/myAccount", "/myBalance", "/myLoans", "/myCards", "/user").authenticated()
            .requestMatchers("/notices", "/contact", "/register").permitAll())
        .formLogin(Customizer.withDefaults())
        .httpBasic(Customizer.withDefaults());
    return http.build();
}
```

# AUTHENTICATION & AUTHORIZATION

## DETAILS & COMPARISON



# HOW AUTHORITIES STORED ?

## INSIDE SPRING SECURITY

- Authorities/Roles information in Spring Security is stored inside **GrantedAuthority**. There is only one method inside **GrantedAuthority** which return the name of the authority or role.
- SimpleGrantedAuthority** is the default implementation class of **GrantedAuthority** interface inside Spring Security framework.

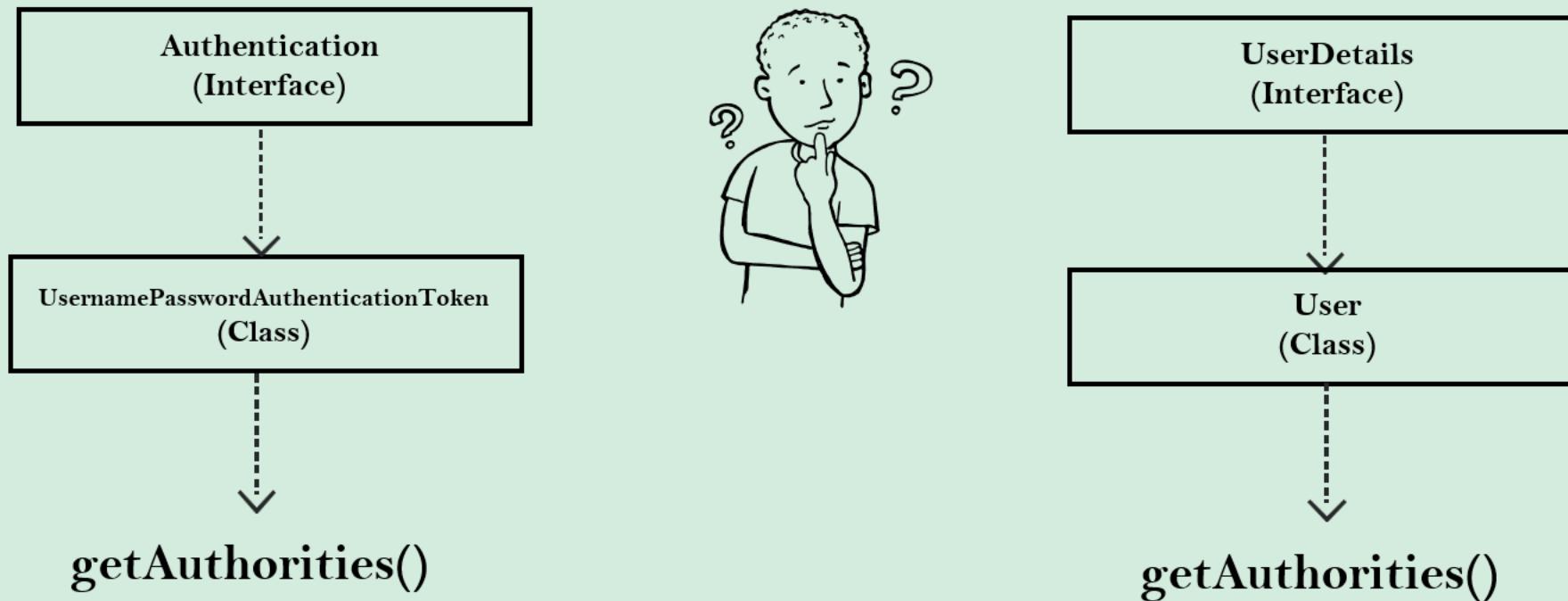
```
public interface GrantedAuthority {  
  
    String getAuthority();  
  
}
```

```
public final class SimpleGrantedAuthority implements GrantedAuthority {  
  
    private final String role;  
  
    public SimpleGrantedAuthority(String role) {  
        this.role = role;  
    }  
  
    @Override  
    public String getAuthority() {  
        return this.role;  
    }  
}
```

# HOW AUTHORITIES STORED ?

## INSIDE SPRING SECURITY

How does Authorities information stored inside the objects of UserDetails & Authentication interfaces which plays a vital role during authentication of the user ?



# CONFIGURING AUTHORITIES

## INSIDE SPRING SECURITY



In Spring Security the authorities requirements can be configured using the following ways,

**hasAuthority()** — Accepts a single authority for which the endpoint will be configured and user will be validated against the single authority mentioned. Only users having the same authority configured can invoke the endpoint.

**hasAnyAuthority()** — Accepts multiple authorities for which the endpoint will be configured and user will be validated against the authorities mentioned. Only users having any of the authority configured can invoke the endpoint.

**access()** — Using Spring Expression Language (SpEL) it provides you unlimited possibilities for configuring authorities which are not possible with the above methods. We can use operators like OR, AND inside access() method.

# CONFIGURING AUTHORITIES INSIDE SPRING SECURITY

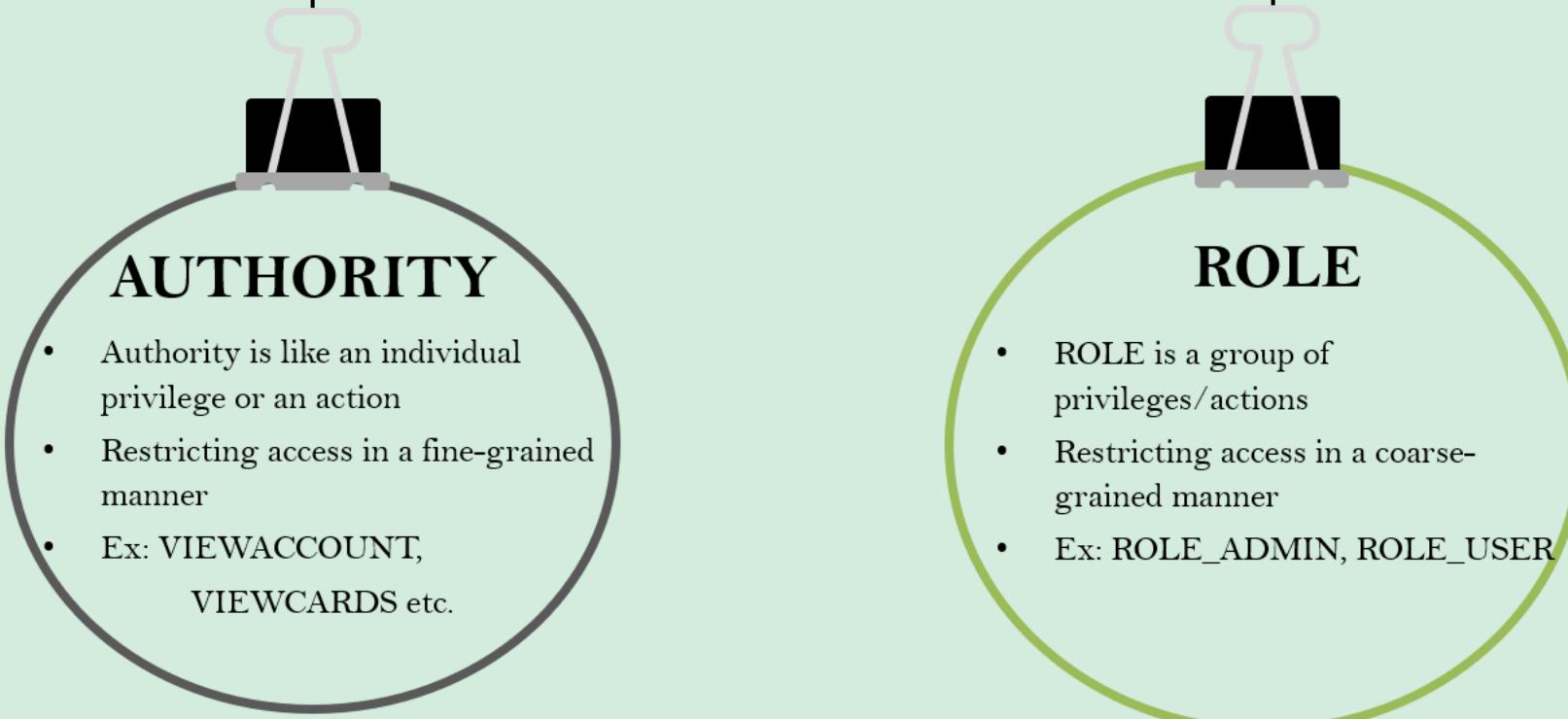
eazy  
bytes

Like shown below, we can configure authority requirements for the APIs/Paths.

```
@Bean
SecurityFilterChain defaultSecurityFilterChain(HttpSecurity http) throws Exception {
    CsrfTokenRequestAttributeHandler requestHandler = new CsrfTokenRequestAttributeHandler();
    requestHandler.setCsrfRequestAttributeName("_csrf");
    http.securityContext((context) -> context.requireExplicitSave(false))
        .sessionManagement(session -> session.sessionCreationPolicy(SessionCreationPolicy.ALWAYS))
        .cors(corsCustomizer -> corsCustomizer.configurationSource(new CorsConfigurationSource() {...}))
        .csrf((csrf) -> csrf.csrfTokenHandler(requestHandler).ignoringRequestMatchers("/contact", "/register"))
        .csrfTokenRepository(CookieCsrfTokenRepository.withHttpOnlyFalse())
        .addFilterAfter(new CsrfCookieFilter(), BasicAuthenticationFilter.class)
        .authorizeHttpRequests((requests)->requests
            .requestMatchers("/myAccount").hasAuthority("VIEWACCOUNT")
            .requestMatchers("/myBalance").hasAnyAuthority("VIEWACCOUNT", "VIEWBALANCE")
            .requestMatchers("/myLoans").hasAuthority("VIEWLOANS")
            .requestMatchers("/myCards").hasAuthority("VIEWCARDS")
            .requestMatchers("/user").authenticated()
            .requestMatchers("/notices", "/contact", "/register").permitAll())
        .formLogin(Customizer.withDefaults())
        .httpBasic(Customizer.withDefaults());
    return http.build();
}
```

# AUTHORITY vs ROLE

## INSIDE SPRING SECURITY



- The names of the authorities/roles are arbitrary in nature and these names can be customized as per the business requirement
- Roles are also represented using the same contract GrantedAuthority in Spring Security.
- When defining a role, its name should start with the **ROLE\_** prefix. This prefix specifies the difference between a role and an authority.

# CONFIGURING AUTHORITIES

## INSIDE SPRING SECURITY



In Spring Security the ROLES requirements can be configured using the following ways,

**hasRole()** — Accepts a single role name for which the endpoint will be configured and user will be validated against the single role mentioned. Only users having the same role configured can invoke the endpoint.

**hasAnyRole()** — Accepts multiple roles for which the endpoint will be configured and user will be validated against the roles mentioned. Only users having any of the role configured can call the endpoint.

**access()** — Using Spring Expression Language (SpEL) it provides you unlimited possibilities for configuring roles which are not possible with the above methods. We can use operators like OR, AND inside access() method.

### Note :

- ROLE\_ prefix only to be used while configuring the role in DB. But when we configure the roles, we do it only by its name.
- access() method can be used not only for configuring authorization based on authority or role but also with any special requirements that we have. For example we can configure access based on the country of the user or current time/date.

# CONFIGURING ROLES INSIDE SPRING SECURITY

eazy  
bytes

Like shown below, we can configure ROLES requirements for the APIs/Paths.

```
@Bean
SecurityFilterChain defaultSecurityFilterChain(HttpSecurity http) throws Exception {
    CsrfTokenRequestAttributeHandler requestHandler = new CsrfTokenRequestAttributeHandler();
    requestHandler.setCsrfRequestAttributeName("_csrf");
    http.securityContext((context) -> context.requireExplicitSave(false))
        .sessionManagement(session -> session.sessionCreationPolicy(SessionCreationPolicy.ALWAYS))
        .cors(corsCustomizer -> corsCustomizer.configurationSource(new CorsConfigurationSource() {}))
        .csrf(csrf) -> csrf.csrfTokenHandler(requestHandler).ignoringRequestMatchers("/contact", "/register")
        .csrfTokenRepository(CookieCsrfTokenRepository.withHttpOnlyFalse())
        .addFilterAfter(new CsrfCookieFilter(), BasicAuthenticationFilter.class)
        .authorizeHttpRequests((requests)->requests
            .requestMatchers("/myAccount").hasRole("USER")
            .requestMatchers("/myBalance").hasAnyRole("USER", "ADMIN")
            .requestMatchers("/myLoans").hasRole("USER")
            .requestMatchers("/myCards").hasRole("USER")
            .requestMatchers("/user").authenticated()
            .requestMatchers("/notices", "/contact", "/register").permitAll()
        .formLogin(Customizer.withDefaults())
        .httpBasic(Customizer.withDefaults());
    return http.build();
}
```

# FILTERS IN SPRING SECURITY

- ✓ Lot of times we will have situations where we need to perform some house keeping activities during the authentication and authorization flow. Few such examples are,
  - Input validation
  - Tracing, Auditing and reporting
  - Logging of input like IP Address etc.
  - Encryption and Decryption
  - Multi factor authentication using OTP
- ✓ All such requirements can be handled using HTTP Filters inside Spring Security. Filters are servlet concepts which are leveraged in Spring Security as well.

- ✓ We already saw some built-in filters of Spring security framework like UsernamePasswordAuthenticationFilter, BasicAuthenticationFilter, DefaultLoginPageGeneratingFilter etc. in the previous sections.
- ✓ A filter is a component which receives requests, processes its logic and handover to the next filter in the chain.
- ✓ Spring Security is based on a chain of servlet filters. Each filter has a specific responsibility and depending on the configuration, filters are added or removed. We can add our custom filters as well based on the need.

NOT RECOMMENDED  
FOR PRODUCTION

# FILTERS IN SPRING SECURITY

- ✓ We can always check the registered filters inside Spring Security with the below configurations,
  1. `@EnableWebSecurity(debug = true)` – We need to enable the debugging of the security details
  2. Enable logging of the details by adding the below property in application.properties

```
logging.level.org.springframework.security.web.FilterChainProxy=DEBUG
```

Attached are the some of the internal filters of Spring Security that gets executed in the authentication flow,

Security filter chain: [  
DisableEncodeUrlFilter  
WebAsyncManagerIntegrationFilter  
SecurityContextHolderFilter  
HeaderWriterFilter  
CorsFilter  
CsrfFilter  
LogoutFilter  
UsernamePasswordAuthenticationFilter  
DefaultLoginPageGeneratingFilter  
DefaultLogoutPageGeneratingFilter  
BasicAuthenticationFilter  
RequestCacheAwareFilter  
SecurityContextHolderAwareRequestFilter  
AnonymousAuthenticationFilter  
SessionManagementFilter  
ExceptionTranslationFilter  
FilterSecurityInterceptor  
]

# IMPLEMENTING CUSTOM FILTERS

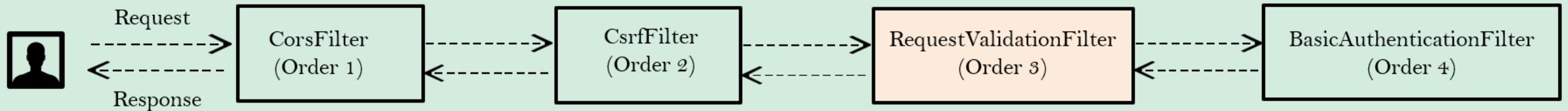
## INSIDE SPRING SECURITY

- ✓ We can create our own filters by implementing the **Filter** interface from the **jakarta.servlet** package. Post that we need to override the `doFilter()` method to have our own custom logic. This method accepts 3 parameters the `ServletRequest`, `ServletResponse` and `FilterChain`.
  - **ServletRequest**—It represents the HTTP request. We use the `ServletRequest` object to retrieve details about the request from the client.
  - **ServletResponse**—It represents the HTTP response. We use the `ServletResponse` object to modify the response before sending it back to the client or further along the filter chain.
  - **FilterChain**—The filter chain represents a collection of filters with a defined order in which they act. We use the `FilterChain` object to forward the request to the next filter in the chain.

- ✓ You can add a new filter to the spring security chain either before, after, or at the position of a known one. Each position of the filter is an index (a number), and you might find it also referred to as “the order.”
- ✓ Below are the methods available to configure a custom filter in the spring security flow,
  - **addFilterBefore(filter, class)** – adds a filter before the position of the specified filter class
  - **addFilterAfter(filter, class)** – adds a filter after the position of the specified filter class
  - **addFilterAt(filter, class)** – adds a filter at the location of the specified filter class

# ADD FILTER BEFORE IN SPRING SECURITY

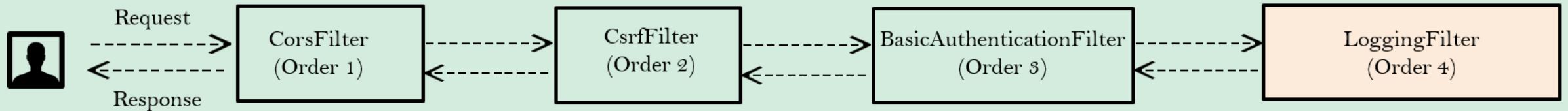
**addFilterBefore(filter, class)** – It will add a filter before the position of the specified filter class.



Here we add a filter just before authentication to write our own custom validation where the input email provided should not have the string ‘test’ inside it.

# ADD FILTER AFTER IN SPRING SECURITY

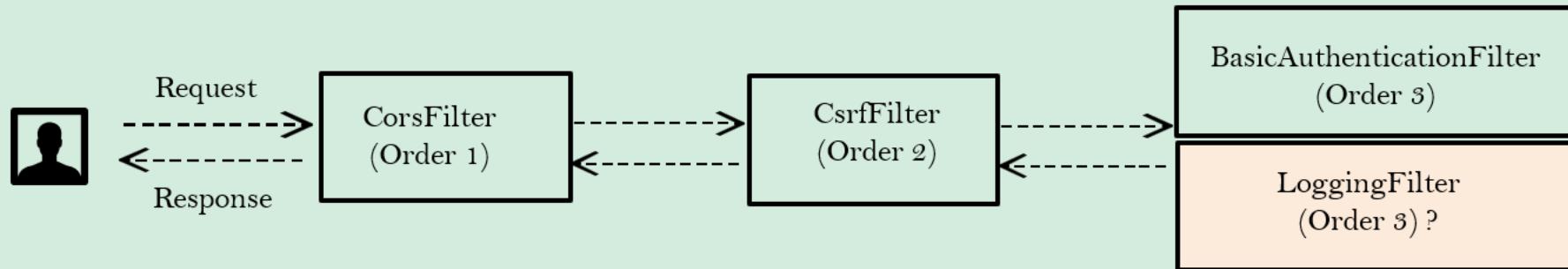
**addFilterAfter(filter, class)** – It will add a filter after the position of the specified filter class



Here we add a filter just after authentication to write a logger about successful authentication and authorities details of the logged in users.

# ADD FILTER AT IN SPRING SECURITY

**addFilterAt(filter, class)** – Adds a filter at the location of the specified filter class. But the order of the execution can't be guaranteed. This will not replace the filters already present at the same order.



Since we will not have control on the order of the filters and it is random in nature we should avoid providing the filters at same order.

## OTHER IMPORTANT FILTERS



### GenericFilterBean

This is an abstract class filter bean which allows you to use the initialization parameters and configurations defined inside the deployment descriptors



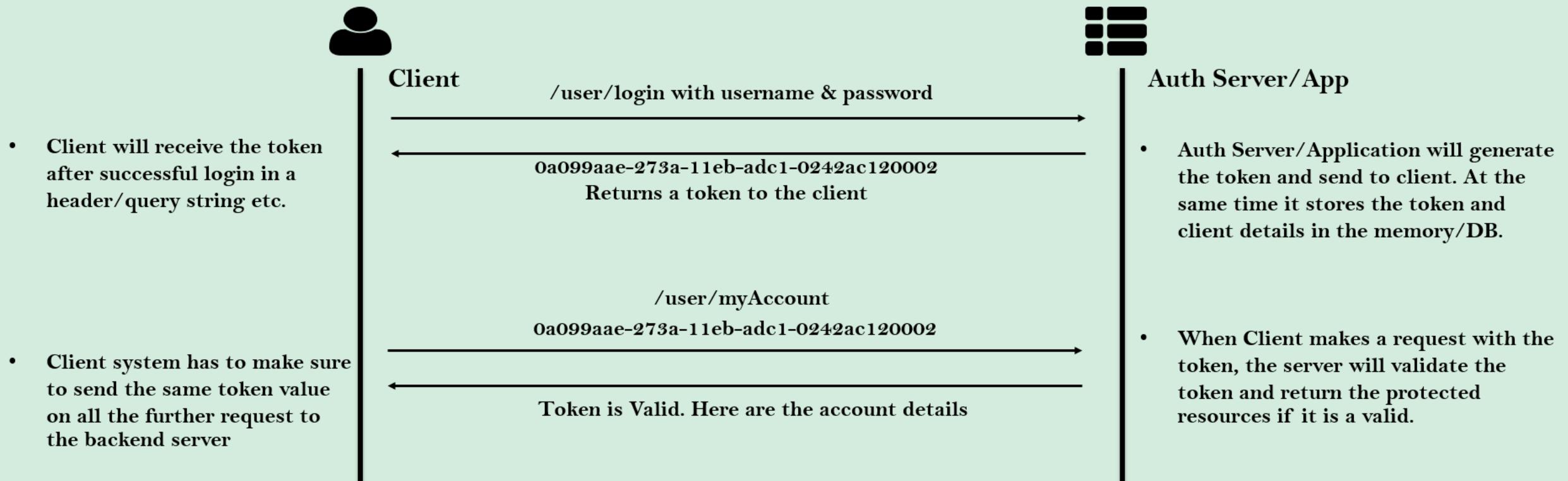
### OncePerRequestFilter

Spring doesn't guarantee that your filter will be called only once. But if we have a scenario where we need to make sure to execute our filter only once then we can use this.

# ROLE OF TOKENS

## IN AUTHN & AUTHZ

- ✓ A Token can be a plain string or format universally unique identifier (UUID) or it can be of type JSON Web Token (JWT) usually generated when the user authenticated for the first time during login.
- ✓ On every request to a restricted resource, the client sends the access token in the query string or Authorization header. The server then validates the token and, if it's valid, returns the secure resource to the client.



# ADVANTAGES OF TOKENS

- ★ Token helps us not to share the credentials for every request. It is a security risk to send credentials over the network frequently.
- ★ Tokens can be invalidated during any suspicious activities without invalidating the user credentials.
- ★ Tokens can be created with a short life span.
- ★ Tokens can be used to store the user related information like roles/authorities etc.
- ★ Reusability - We can have many separate servers, running on multiple platforms and domains, reusing the same token for authenticating the user.
- ★ Stateless, easier to scale. The token contains all the information to identify the user, eliminating the need for the session state. If we use a load balancer, we can pass the user to any server, instead of being bound to the same server we logged in on.
- ★ We already used tokens in the previous sections in the form of **CSRF** and **JSESSIONID** tokens.
  - CSRF Token protected our application from CSRF attacks.
  - JSESSIONID is the default token generated by the Spring Security which helped us not to share the credentials to the backend every time.

- ✓ JWT means JSON Web Token. It is a token implementation which will be in the JSON format and designed to use for the web requests.
- ✓ JWT is the most common and favorite token type that many systems use these days due to its special features and advantages.
- ✓ JWT tokens can be used both in the scenarios of Authorization/Authentication along with Information exchange which means you can share certain user related data in the token itself which will reduce the burden of maintaining such details in the sessions on the server side.

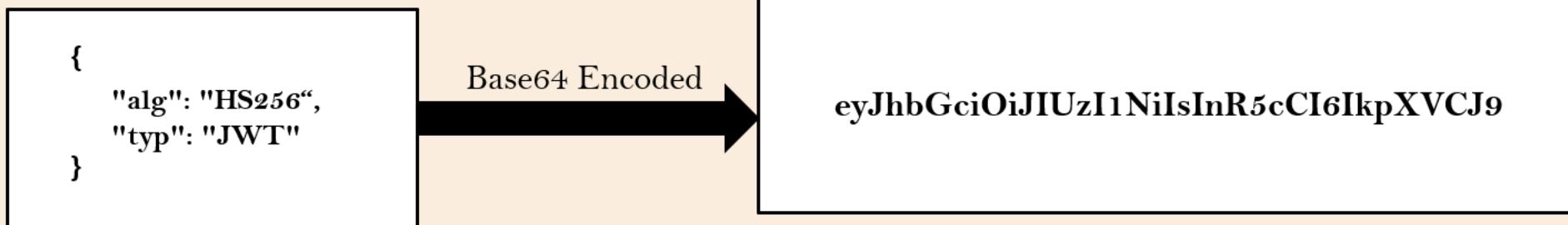
A JWT token has 3 parts each separated by a period(.) Below is a sample JWT token,

eyJhbGciOiJIUzI1NiIsInR5cCI6IkpXVCJ9.eyJzdWIiOiIxMjM0NTY3ODkwIiwibmFtZSI6IkpvaG4gRG9lIiwiWF0IjoxNTE2MjM5MDIyfQ.SflKxwRJSMeKKF2QT4fwpMeJf36POk6yJV\_adQssw5c

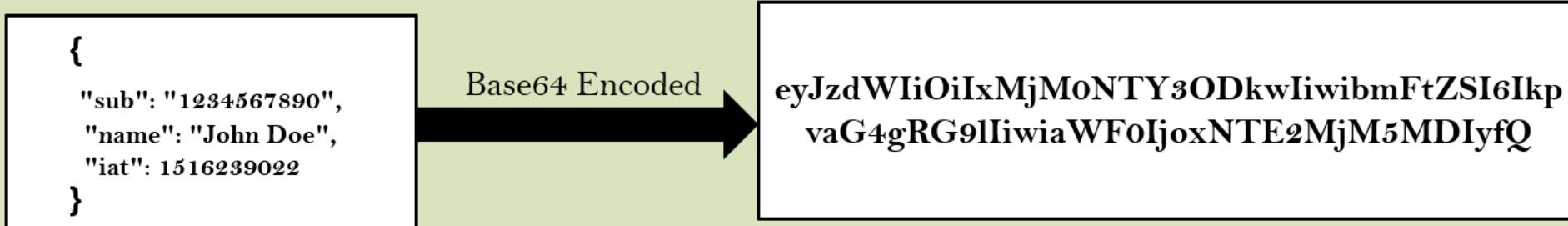
1. Header
2. Payload
3. Signature (Optional)

# JWT TOKENS

- ✓ Inside the JWT header, we store metadata/info related to the token. If I chose to sign the token, the header contains the name of the algorithm that generates the signature.



- ✓ In the body, we can store details related to user, roles etc. which can be used later for AuthN and AuthZ. Though there is no such limitation what we can send and how much we can send in the body, but we should put our best efforts to keep it as light as possible.

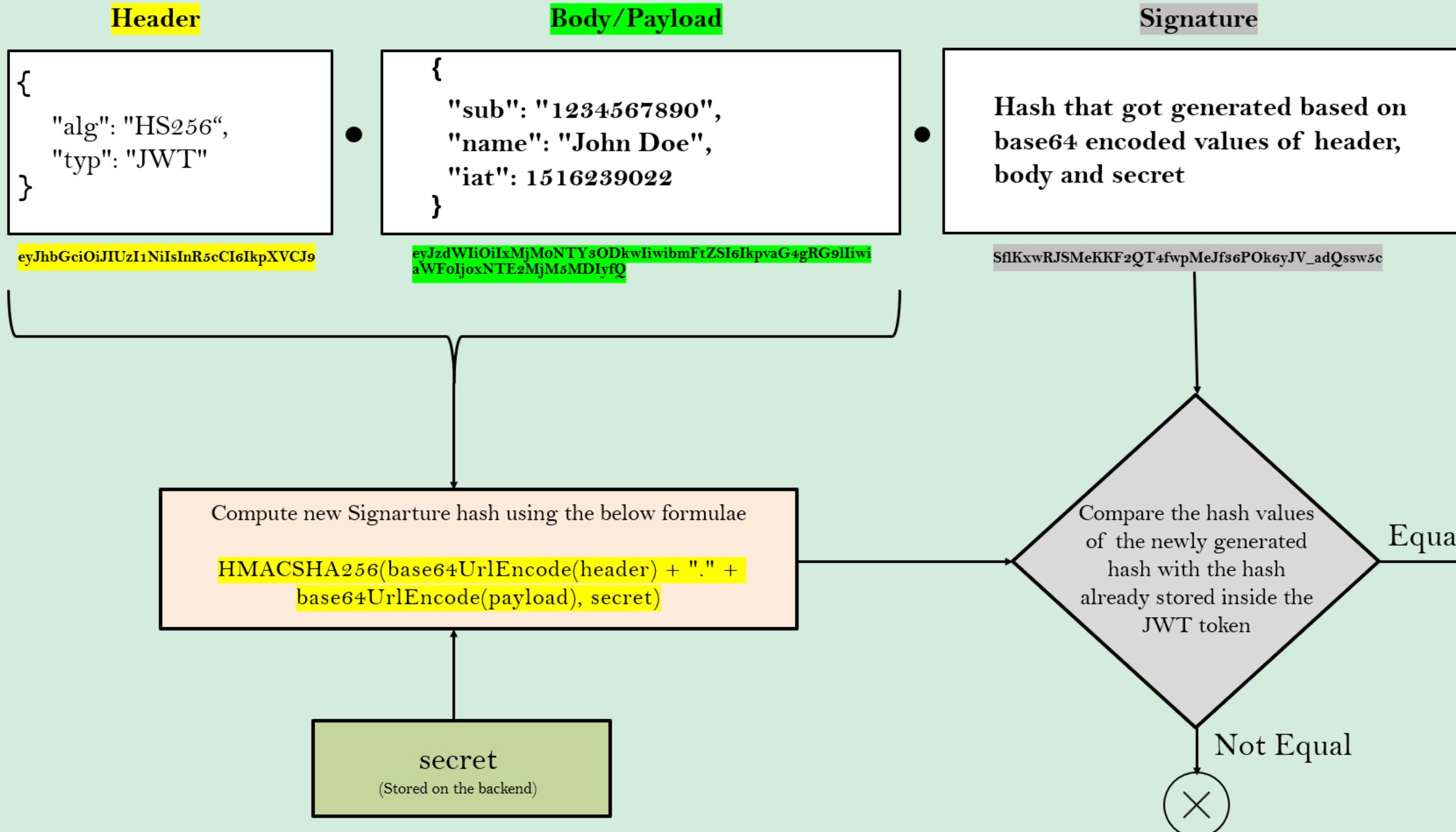


- ✓ The last part of the token is the digital signature. This part can be optional if the party that you share the JWT token is internal and that someone who you can trust but not open in the web.
- ✓ But if you are sharing this token to the client applications which will be used by all the users in the open web then we need to make sure that no one changed the header and body values like Authorities, username etc.
- ✓ To make sure that no one tampered the data on the network, we can send the signature of the content when initially the token is generated. To create the signature part you have to take the encoded header, the encoded payload, a secret, the algorithm specified in the header, and sign that.

- ✓ For example if you want to use the HMAC SHA256 algorithm, the signature will be created in the following way:  

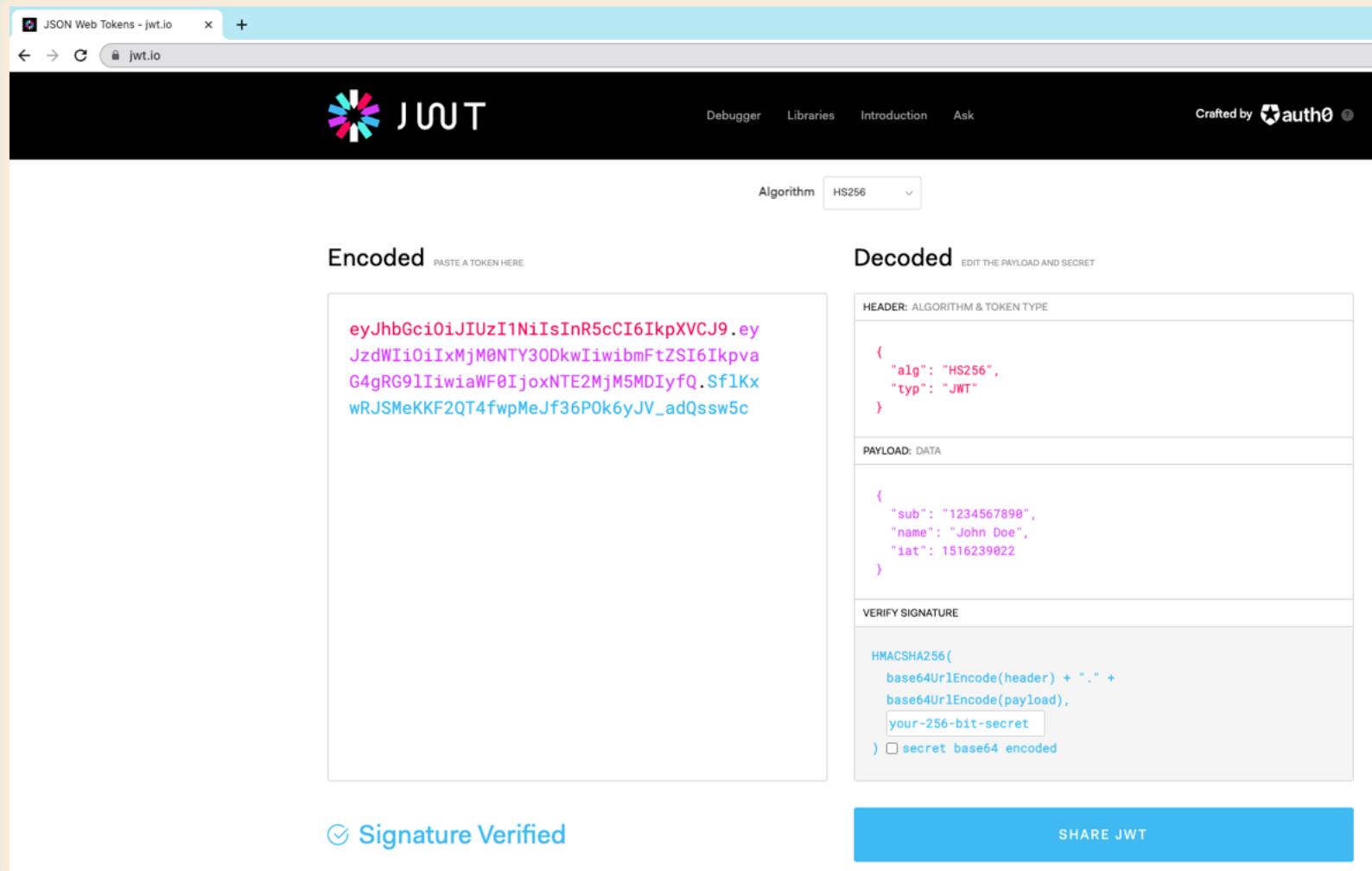
```
HMACSHA256(base64UrlEncode(header) + "." + base64UrlEncode(payload), secret)
```
- ✓ The signature is used to verify the message wasn't changed along the way, and, in the case of tokens signed with a private key, it can also verify that the sender of the JWT is who it says it is.

# VALIDATION OF JWT TOKENS



# JWT TOKENS

- ✓ If you want to play with JWT tokens and put these concepts into practice, you can use [jwt.io](https://jwt.io) debugger to decode, verify, and generate JWTs.



# METHOD LEVEL SECURITY

- ✓ As of now we have applied authorization rules on the API paths/URLs using spring security but method level security allows to apply the authorization rules at any layer of an application like in service layer or repository layer etc. Method level security can be enabled using the annotation **@EnableMethodSecurity** on the configuration class.
- ✓ Method level security will also helps authorization rules even in the non-web applications where we will not have any endpoints.

- ✓ Method level security provides the below approaches to apply the authorization rules and executing your business logic,
  - **Invocation authorization** – Validates if someone can invoke a method or not based on their roles/authorities.
  - **Filtering authorization** – Validates what a method can receive through its parameters and what the invoker can receive back from the method post business logic execution.

# METHOD LEVEL SECURITY

- ✓ Spring security will use the aspects from the AOP module and have the interceptors in between the method invocation to apply the authorization rules configured.
- ✓ Method level security offers below 3 different styles for configuring the authorization rules on top of the methods,
  - The **prePostEnabled** property enables Spring Security **@PreAuthorize** & **@PostAuthorize** annotations
  - The **securedEnabled** property enables **@Secured** annotation
  - The **jsr250Enabled** property enables **@RoleAllowed** annotation

```
@Configuration
@EnableMethodSecurity(prePostEnabled = true, securedEnabled = true, jsr250Enabled = true)
public class ProjectSecurityConfig {
    ...
}
```

- ✓ **@Secured** and **@RoleAllowed** are less powerful compared to **@PreAuthorize** and **@PostAuthorize**

# METHOD LEVEL SECURITY

- Using invocation authorization we can decide if a user is authorized to invoke a method before the method executes (preauthorization) or after the method execution is completed (postauthorization). For filtering the parameters before calling the method we can use Prefiltering,

```
@Service
public class LoansService {

    @PreAuthorize("hasAuthority('VIEWLOANS')")
    @PreAuthorize("hasRole('ADMIN')")
    @PreAuthorize("hasAnyRole('ADMIN','USER')")
    @PreAuthorize("# username == authentication.principal.username")
    public Loan getLoanDetails(String username) {
        return loansRepository.loadLoanDetailsByUserName(username);
    }
}
```

# METHOD LEVEL SECURITY

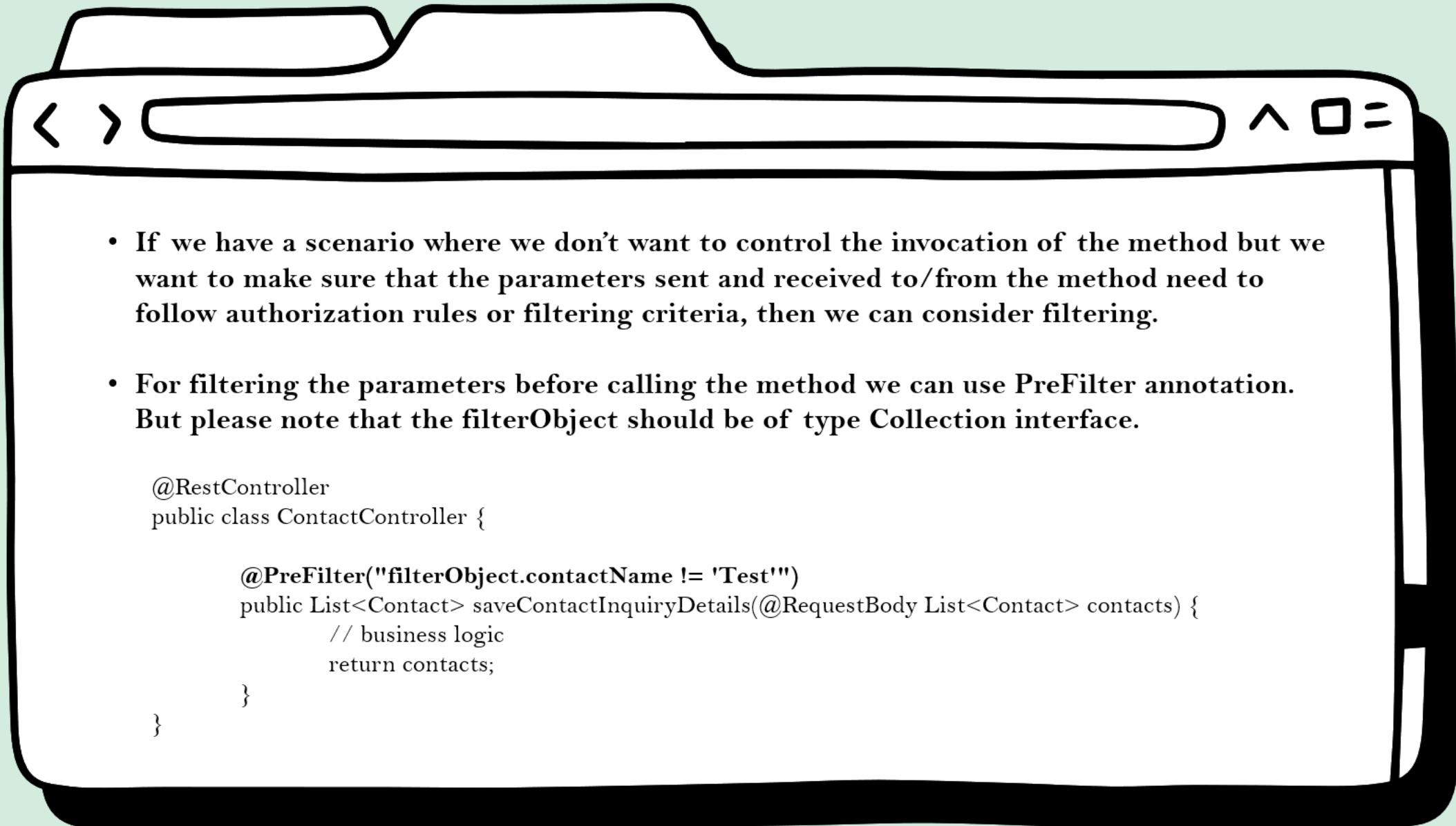
- For applying postauthorization rules below is the sample configuration,

```
@Service
public class LoanService {

    @PostAuthorize ("returnObject.username == authentication.principal.username")
    @PostAuthorize("hasPermission(returnObject, 'ADMIN')")
    public Loan getLoanDetails(String username) {
        return loanRepository.loadLoanByUserName(username);
    }
}
```

- When implementing complex authorization logic, we can separate the logic using a separate class that implements PermissionEvaluator and overwrite the method hasPermission() inside it which can be leveraged inside the hasPermission configurations.

# METHOD LEVEL SECURITY



# METHOD LEVEL SECURITY

- For filtering the parameters after executing the method we can use **PostFilter annotation**.  
But please note that the **filterObject** should be of type **Collection interface**.

```
@RestController
public class ContactController {

    @PostFilter("filterObject.contactName != 'Test'")
    public List<Contact> saveContactInquiryDetails(@RequestBody List<Contact> contacts) {
        // business logic
        return contacts;
    }
}
```

- We can use the **@PostFilter** on the Spring Data repository methods as well to filter any unwanted data coming from the database.

# OAUTH2

# INTRO TO OAUTH2

## PROBLEM THAT OAUTH2 SOLVES



Twitter App



Twitter user



**TweetAnalyzer** website that analyzes user tweets data and generates metrics from it

- ✓ **Scenario :** The twitter user want to use an third party website called **TweetAnalyzer**, to get some insights about his tweets data present inside Twitter App.

- **With Out OAuth2 :** Twitter user has to share his twitter account credentials to the TweetAnalyzer website. Using user credentials, the TweetAnalyzer website will invoke the APIs of Twitter app to fetch the tweet details and post that generates a report for the end user.

But it has a bigger disadvantage, the **TweetAnalyzer** can go fraud and make another operations on your behalf like change password, change email, make a rogue tweet etc.

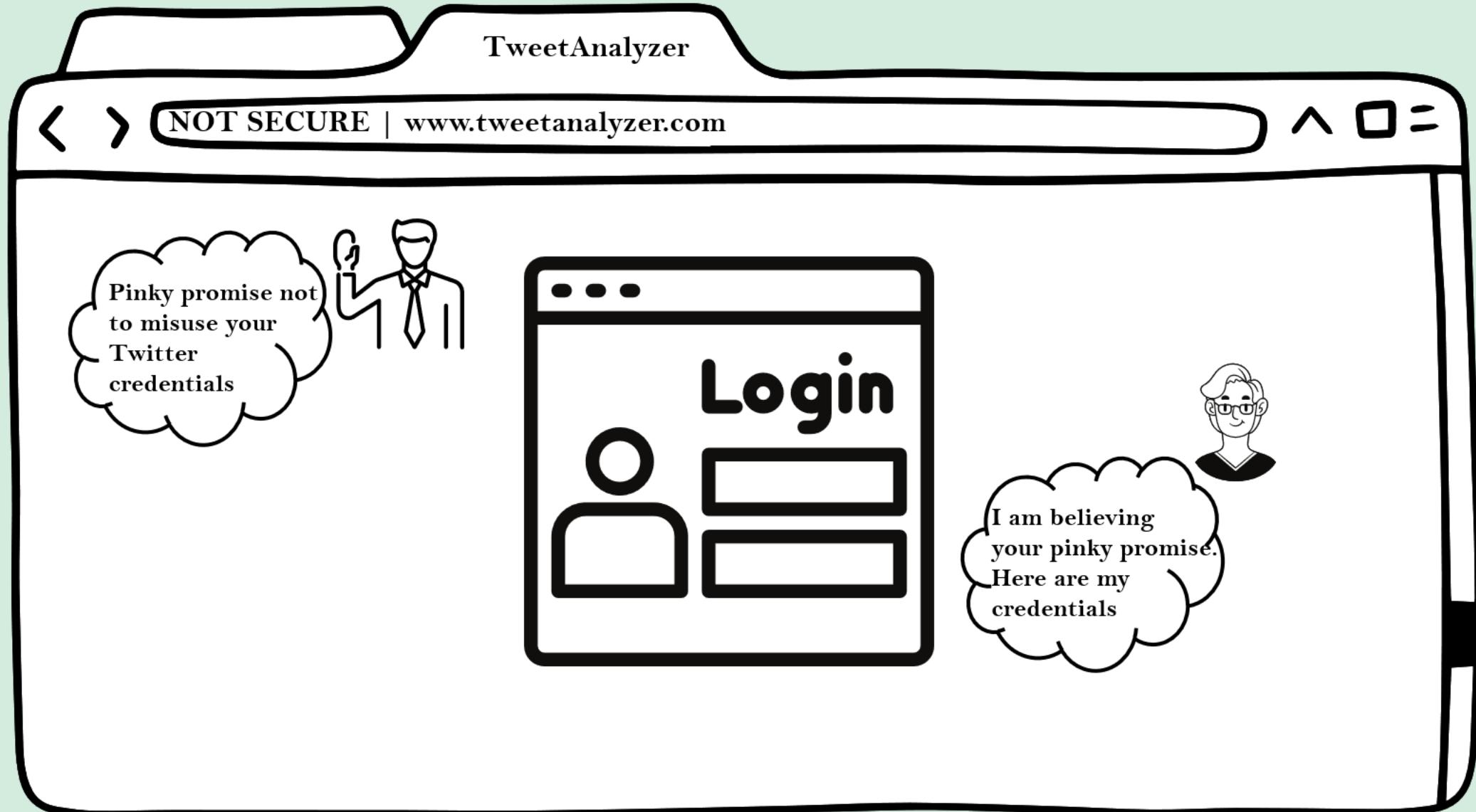
- **With OAuth2 :** Twitter user doesn't have to share his twitter account credentials to the TweetAnalyzer website. Instead he will let Twitter App to give a temporary access token to TweetAnalyzer with limited access like it can only read the tweets data.

With this approach, the TweetAnalyzer can only read the tweets data and it can't perform any other operation.

# INTRO TO OAUTH2

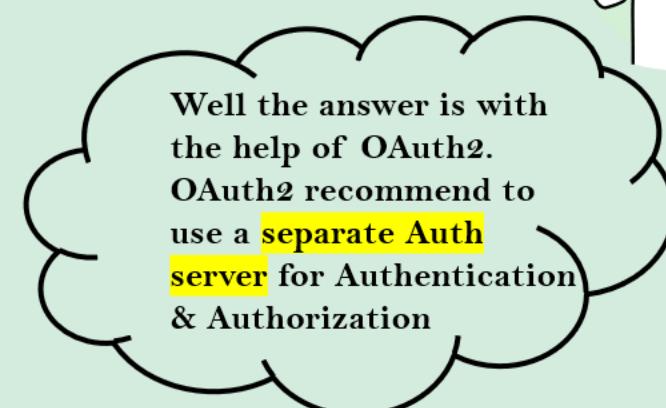
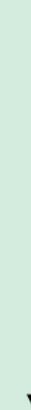
PROBLEM THAT OAUTH2 SOLVES

STONE AGE APPROACH



# INTRO TO OAUTH2

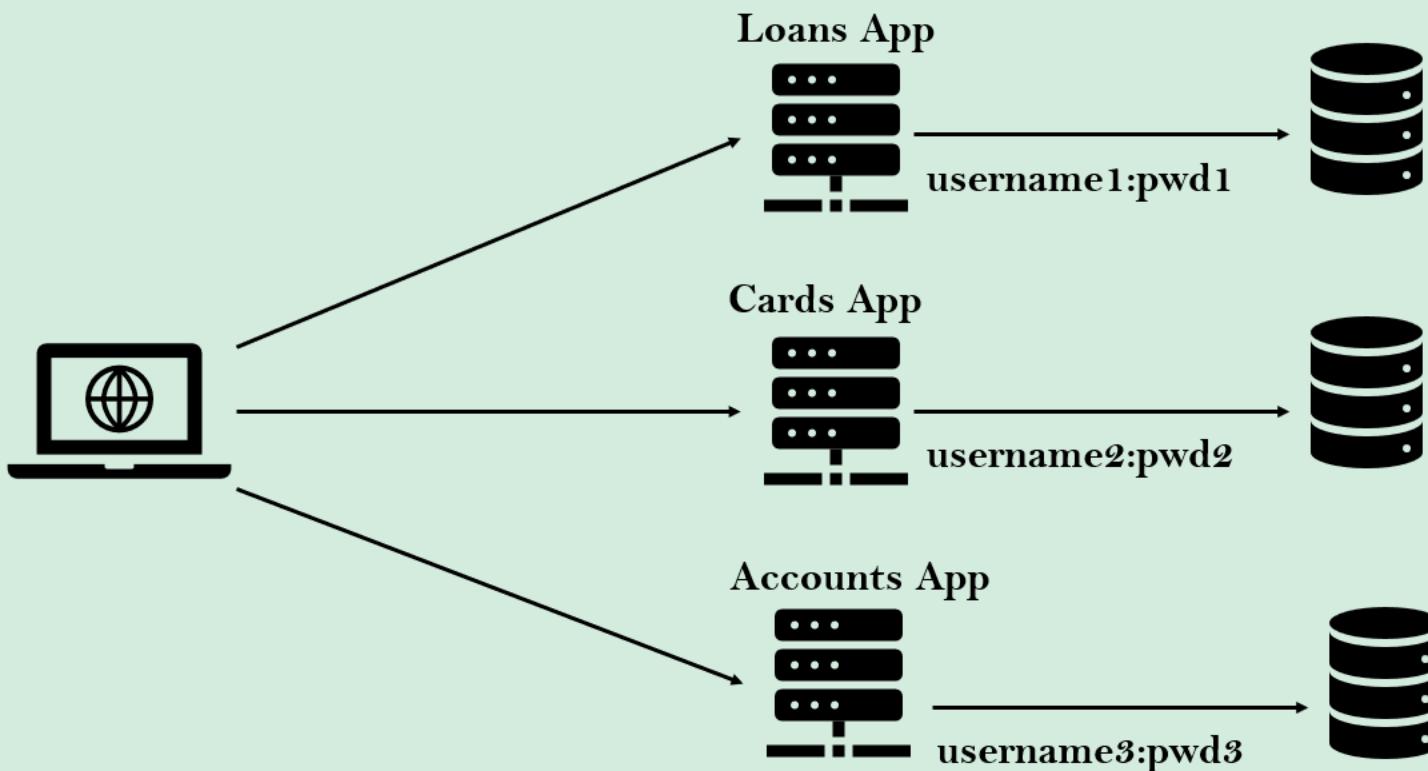
## PROBLEM THAT OAUTH2 SOLVES



# INTRO TO OAUTH2

## PROBLEM THAT OAUTH2 SOLVES

WITHOUT OAUTH2



- If a Bank has multiple websites supporting accounts, loans, cards etc. Without OAuth2, the Bank customers has to register and maintain different user profiles all the 3 systems
- Even the AuthN & AuthZ logic, security standards will be duplicated in all the 3 websites.
- Any future changes or enhancements around security, authentication etc. need to done in all the places

# INTRODUCTION TO OAUTH2

- ✓ **OAuth** stands for Open Authorization. It's a free and open protocol, built on IETF standards and licenses from the Open Web Foundation.
- ✓ **OAuth 2.0** is a security standard where you give one application permission to access your data in another application. The steps to grant permission, or consent, are often referred to as authorization or even delegated authorization. You authorize one application to access your data, or use features in another application on your behalf, without giving them your password.
- ✓ In many ways, you can think of the OAuth token as a “access card” at any office/hotel. These tokens provides limited access to someone, without handing over full control in the form of the master key.

- ✓ The OAuth framework specifies several grant types for different use cases, as well as a framework for creating new grant types.
  - **Authorization Code**
  - **PKCE**
  - **Client Credentials**
  - **Device Code**
  - **Refresh Token**
  - **Implicit Flow (Legacy)**
  - **Password Grant (Legacy)**

# OAUTH2 TERMINOLOGY



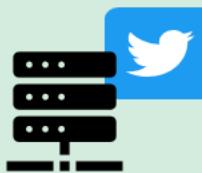
**Resource owner** – It is you the end user. In the scenario of **TweetAnalyzer**, the end user who want to use the **TweetAnalyzer** website to get insights about this tweets. In other words, the end user owns the resources (Tweets), that why we call him as Resource owner



**Client** – The TweetAnalyzer website is the client here as it is the one which interacts with Twitter after taking permission from the resource owner/end user.



**Authorization Server** – This is the server which knows about resource owner. In other words, resource owner should have an account in this server. In the scenario of **TweetAnalyzer**, the Twitter server which has authorization logic acts as Authorization server.



**Resource Server** – This is the server where the APIs, services that client want to consume are hosted. In the scenario of **TweetAnalyzer**, the Twitter server which has APIs like `/getTweets` etc. logic implemented. In smaller organizations, a single server can acts as both resource server and auth server.



**Scopes** – These are the granular permissions the Client wants, such as access to data or to perform certain actions. In the scenario of **TweetAnalyzer**, the Auth server can issue an access token to client with the scope of only `READ TWEETS`.

# OAUTH2 SAMPLE FLOW

## IN TWEETANALYZER SCENARIO

1



The TweetAnalyzer team will reach out to Twitter and express their interest in working with them by allowing their users to login with Twitter.

The Twitter team collect the details, logo etc. from TweetAnalyzer and issued a **CLIENT ID & CLIENT SECRET**



2



The Resource owner visited TweetAnalyzer website and excited about the idea and decided to use the website. But he has a question, do I need to share my Twitter account credentials to this website ? 😐

The TweetAnalyzer website has a button saying “Signup with Twitter”. The end user clicked on it and boom it has redirect the user to Twitter login page.



3



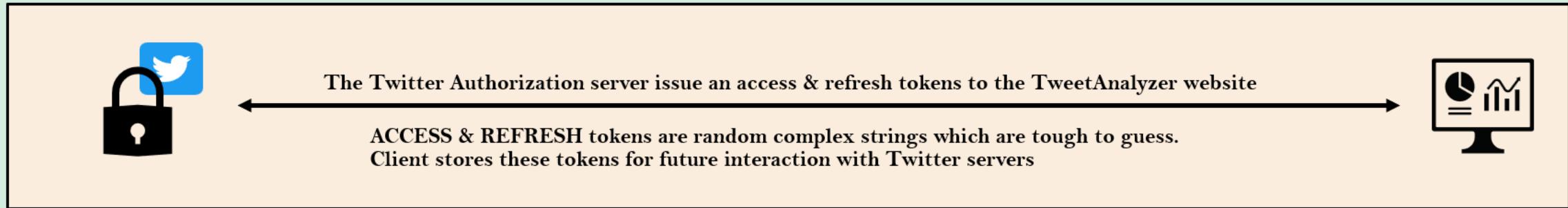
The resource owner entered his credentials confidently as it is the login page of the Twitter itself.

Post successful Authentication, the Twitter will display a consent page asking the user if he is fine to share his Tweets data **READ ONLY** scope to the client which is TweetAnalyzer app. He said YES

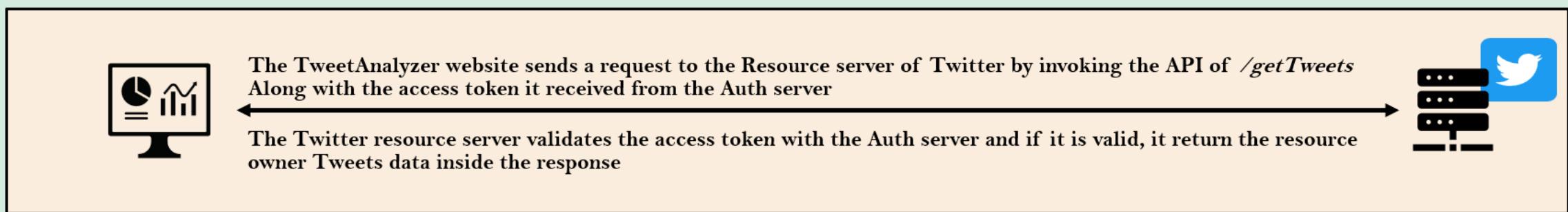


# OAUTH2 SAMPLE FLOW IN TWEETANALYZER SCENARIO

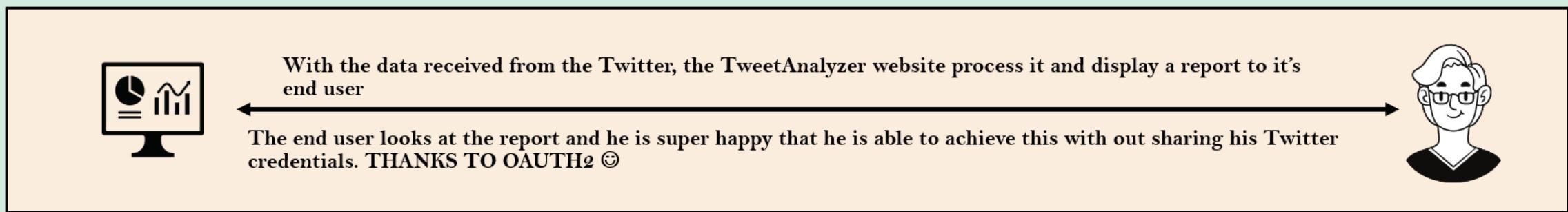
4



5

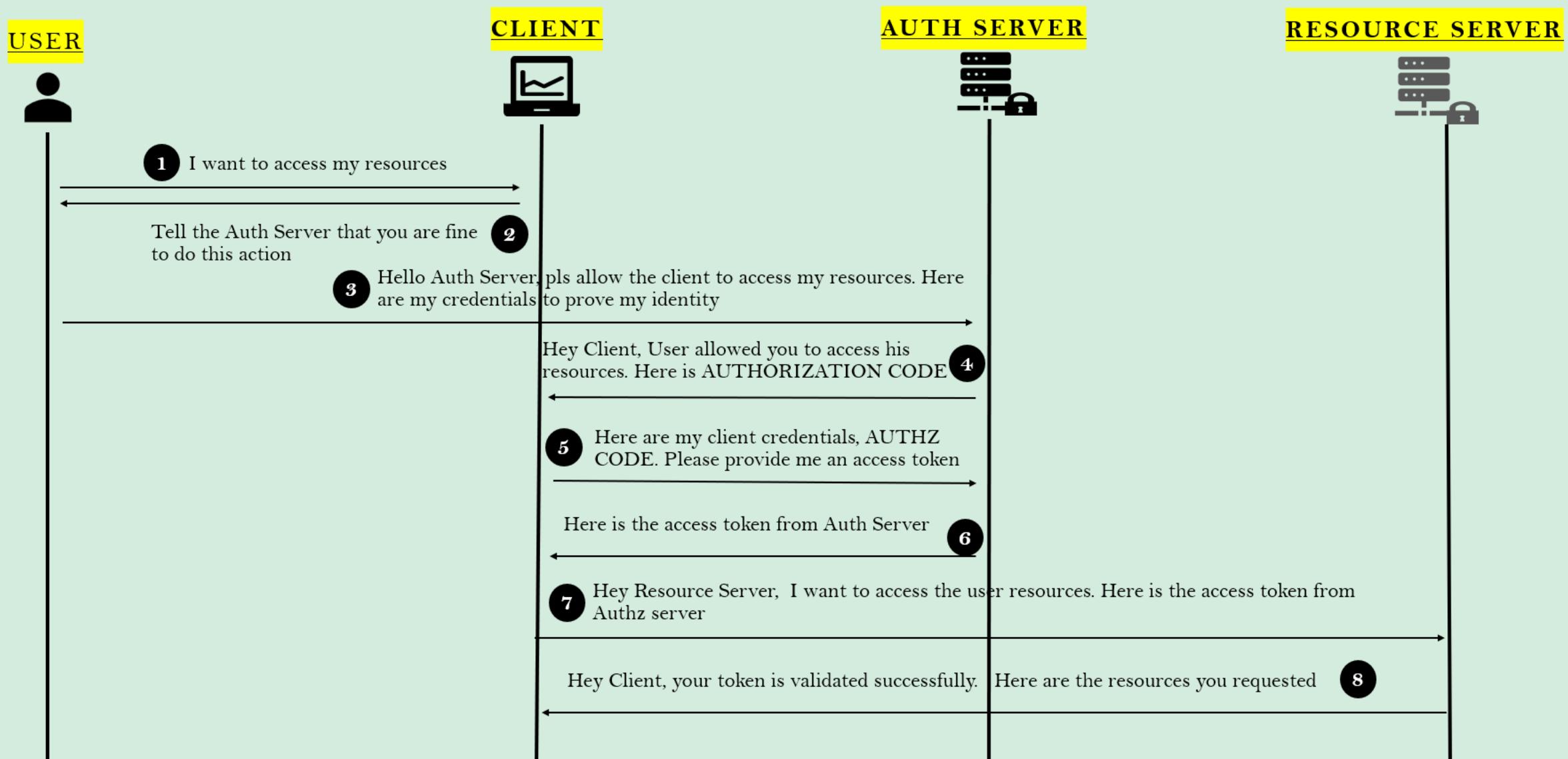


6



# OAUTH2 FLOW

## IN THE AUTHORIZATION CODE GRANT TYPE



# OAUTH2 FLOW

## IN THE AUTHORIZATION CODE GRANT TYPE

- ✓ In the steps 2 & 3, where client is making a request to Auth Server endpoint have to send the below important details,
  - **client\_id** – the id which identifies the client application by the Auth Server. This will be granted when the client register first time with the Auth server.
  - **redirect\_uri** – the URI value which the Auth server needs to redirect post successful authentication. If a default value is provided during the registration then this value is optional
  - **scope** – similar to authorities. Specifies level of access that client is requesting like READ
  - **state** – CSRF token value to protect from CSRF attacks
  - **response\_type** – With the value ‘**code**’ which indicates that we want to follow authorization code grant

- ✓ In the step 5 where client after received a authorization code from Auth server, it will again make a request to Auth server for a token with the below values,
  - **code** – the authorization code received from the above steps
  - **client\_id** & **client\_secret** – the client credentials which are registered with the auth server. Please note that these are not user credentials
  - **grant\_type** – With the value ‘authorization\_code’ which identifies the kind of grant type is used
  - **redirect\_uri**

# OAUTH2 FLOW

## IN THE AUTHORIZATION CODE GRANT TYPE

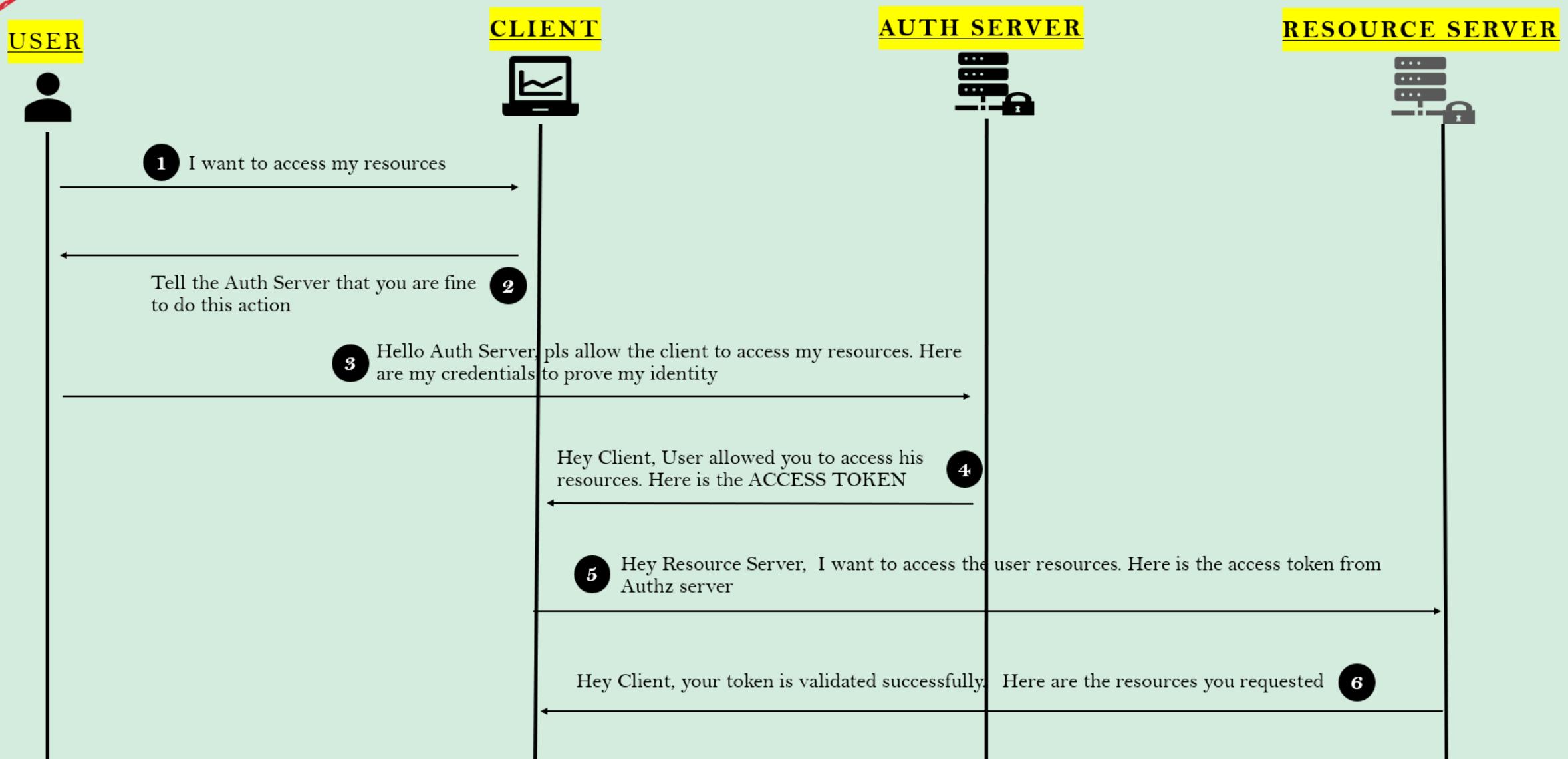
- ✓ We may wonder that why in the Authorization Code grant type client is making request 2 times to Auth server for authorization code and access token.
  - In the first step, authorization server will make sure that user directly interacted with it along with the credentials. If the details are correct, auth server send the authorization code to client
  - Once it receives the authorization code, in this step client has to prove it's identity along with the authorization code & client credentials to get the access token.

- ✓ Well you may ask why can't Auth server directly club both the steps together and provide the token in a single step. The answer is that we used to have that grant type as well which is called as '**implicit grant type**'. But this grant type is not recommended to use due to it's less secure.

NOT RECOMMENDED  
FOR PRODUCTION

# OAUTH2 FLOW

## IN THE IMPLICIT GRANT FLOW



# OAUTH2 FLOW

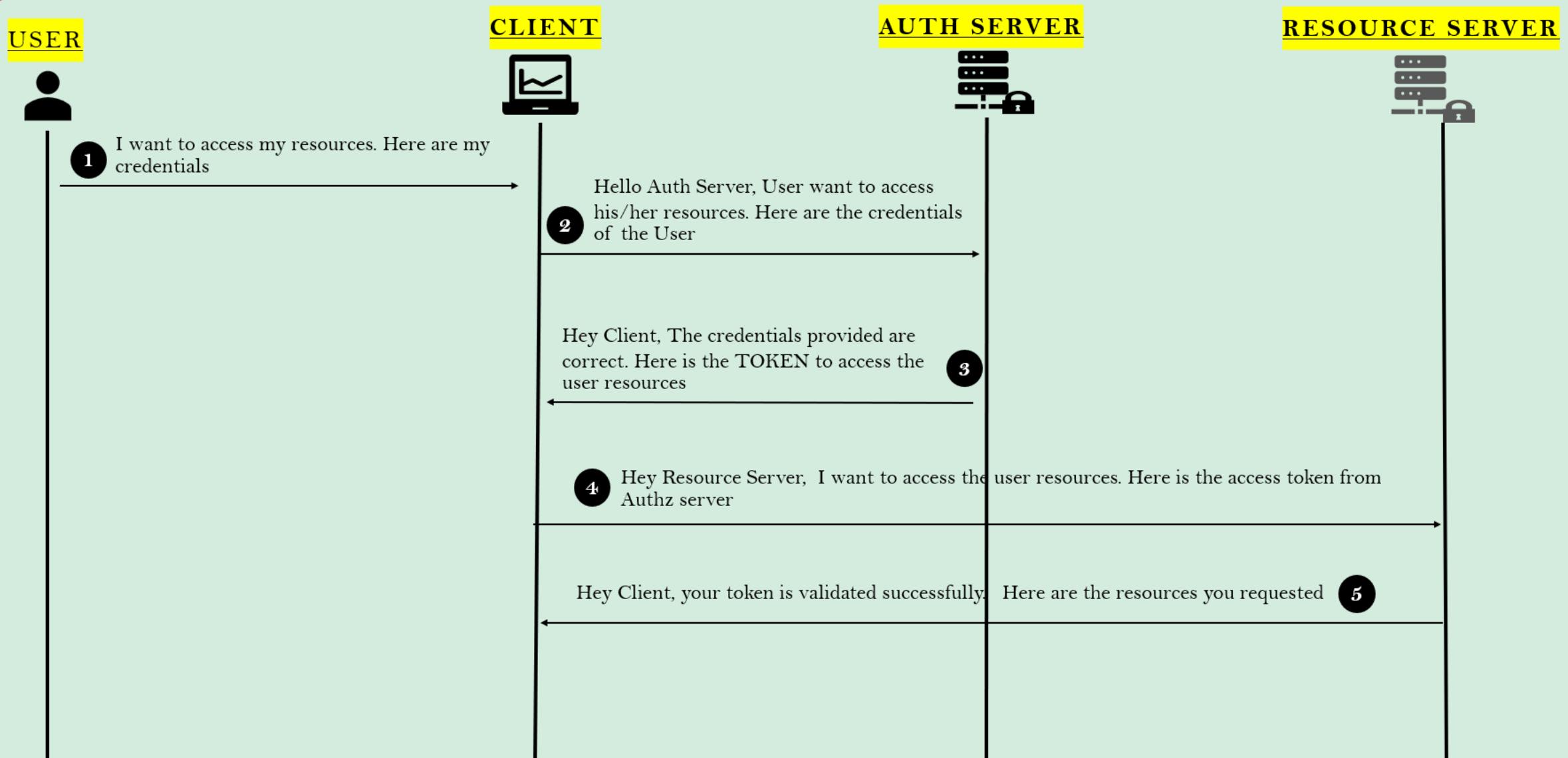
## IN THE IMPLICIT GRANT FLOW

- ✓ In the step 3, where client is making a request to Auth Server endpoint, have to send the below important details,
  - **client\_id** – the id which identifies the client application by the Auth Server. This will be granted when the client register first time with the Auth server.
  - **redirect\_uri** – the URI value which the Auth server needs to redirect post successful authentication. If a default value is provided during the registration then this value is optional
  - **scope** – similar to authorities. Specifies level of access that client is requesting like READ
  - **state** – CSRF token value to protect from CSRF attacks
  - **response\_type** – With the value ‘token’ which indicates that we want to follow implicit grant type

- ✓ If the user approves the request, the authorization server will redirect the browser back to the redirect\_uri specified by the application, adding a token and state to the fragment part of the URL.
- ✓ Implicit Grant flow is deprecated and is not recommended to use in production applications. Always use the Authorization code grant flow instead of implicit grant flow.

# OAUTH2 FLOW

## IN THE PASSWORD GRANT/RESOURCE OWNER CREDENTIALS GRANT TYPE



# OAUTH2 FLOW

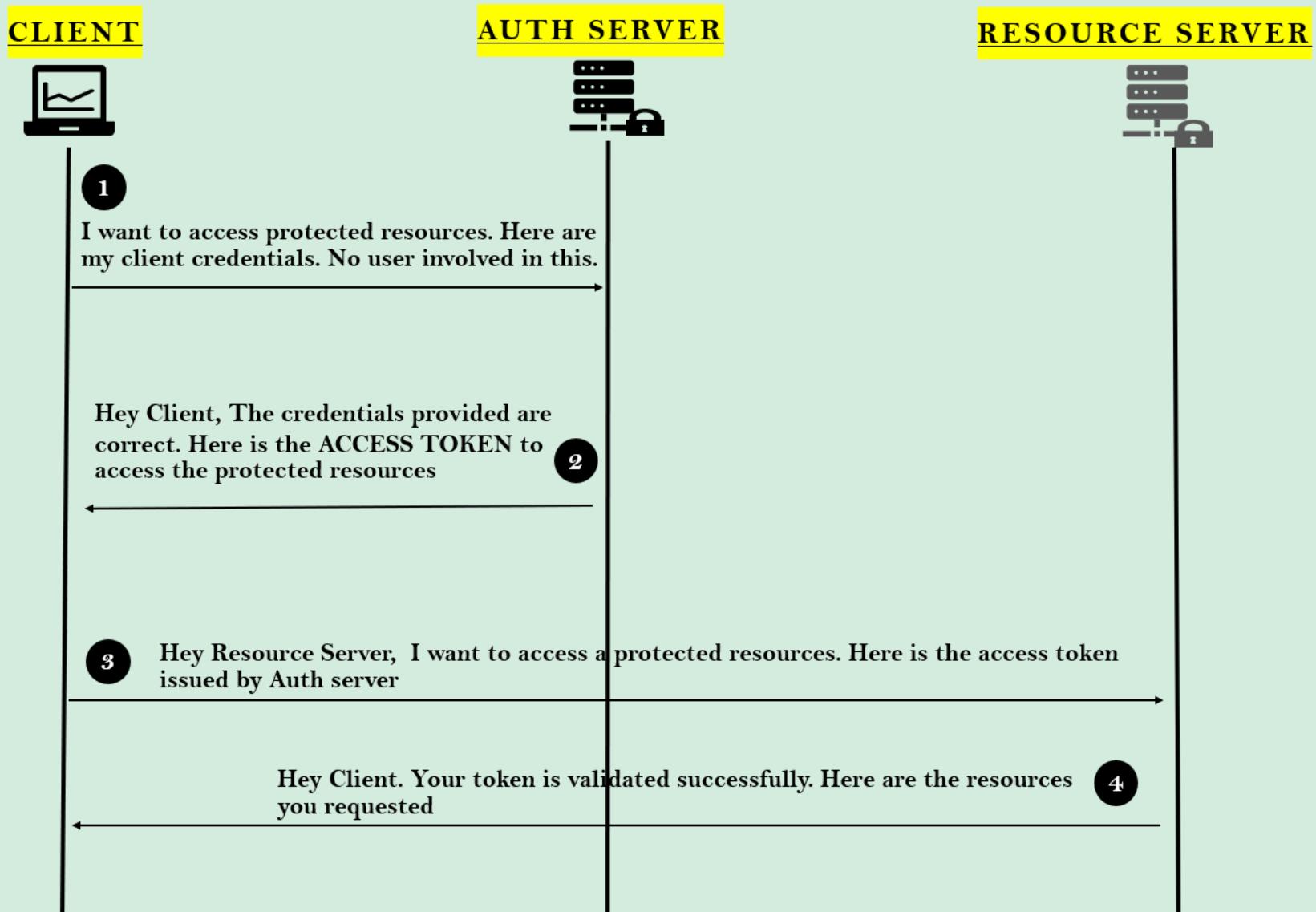
## IN THE RESOURCE OWNER CREDENTIALS GRANT TYPE

- ✓ In the step 2, where client is making a request to Auth Server endpoint have to send the below important details,
  - **client\_id & client\_secret** – the credentials of the client to authenticate itself.
  - **scope** – similar to authorities. Specifies level of access that client is requesting like READ
  - **username & password** – Credentials provided by the user in the login flow
  - **grant\_type** – With the value ‘password’ which indicates that we want to follow password grant type

- ✓ We use this authentication flow only if the client, authorization server and resource servers are maintained by the same organization.
- ✓ This flow will be usually followed by the enterprise applications who want to separate the Auth flow and business flow. Once the Auth flow is separated different applications in the same organization can leverage it.

# OAUTH2 FLOW

## IN THE CLIENT CREDENTIALS GRANT TYPE



# OAUTH2 FLOW

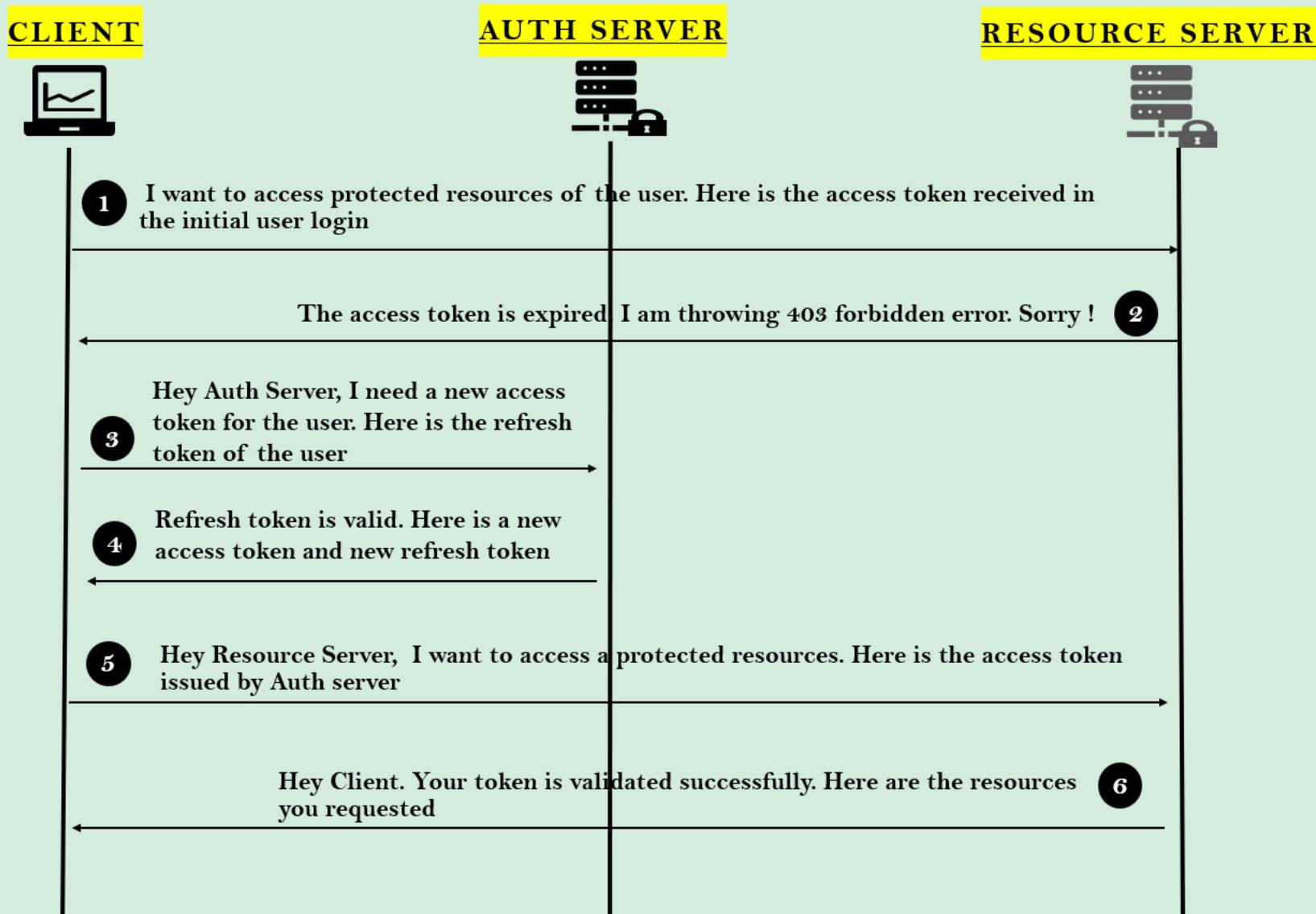
## IN THE CLIENT CREDENTIALS GRANT TYPE

- ✓ In the step 1, where client is making a request to Auth Server endpoint, have to send the below important details,
  - **client\_id & client\_secret** – the credentials of the client to authenticate itself.
  - **scope** – similar to authorities. Specifies level of access that client is requesting like READ
  - **grant\_type** – With the value ‘**client\_credentials**’ which indicates that we want to follow client credentials grant type

- ✓ This is the most simplest grant type flow in OAUTH2.
- ✓ We use this authentication flow only if there is no user and UI involved. Like in the scenarios where 2 different applications want to share data between them using backend APIs.

# OAUTH2 FLOW

## IN THE REFRESH TOKEN GRANT TYPE



## OAUTH2 FLOW

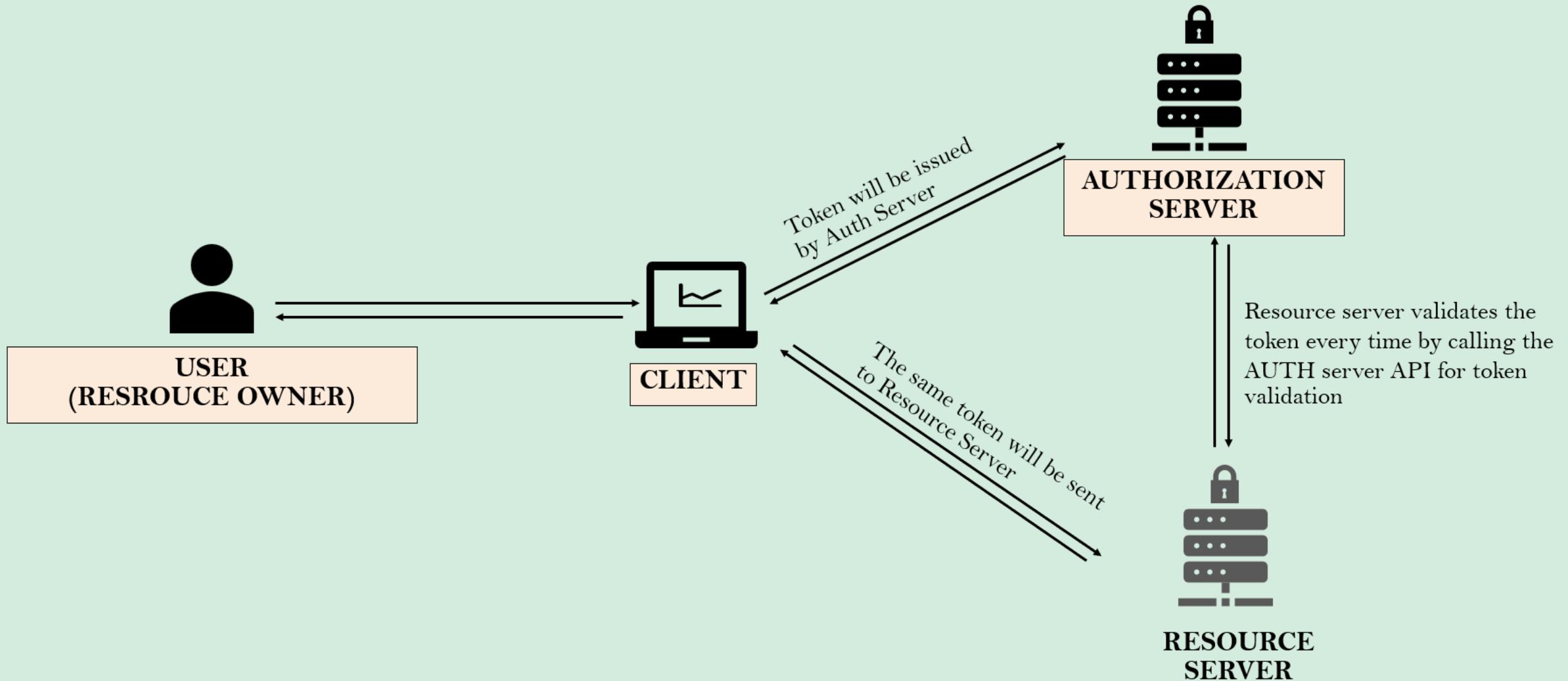
### IN THE REFRESH TOKEN GRANT TYPE

- ✓ In the step 3, where client is making a request to Auth Server endpoint have to send the below important details,
  - **client\_id & client\_secret** – the credentials of the client to authenticate itself.
  - **refresh\_token** – the value of the refresh token received initially
  - **scope** – similar to authorities. Specifies level of access that client is requesting like READ
  - **grant\_type** – With the value ‘refresh\_token’ which indicates that we want to follow refresh token grant type

- This flow will be used in the scenarios where the access token of the user is expired. Instead of asking the user to login again and again, we can use the refresh token which originally provided by the Authz server to reauthenticate the user.
- Though we can make our access tokens to never expire but it is not recommended considering scenarios where the tokens can be stole if we always use the same token
- Even in the resource owner credentials grant types we should not store the user credentials for reauthentication purpose instead we should reply on the refresh tokens.

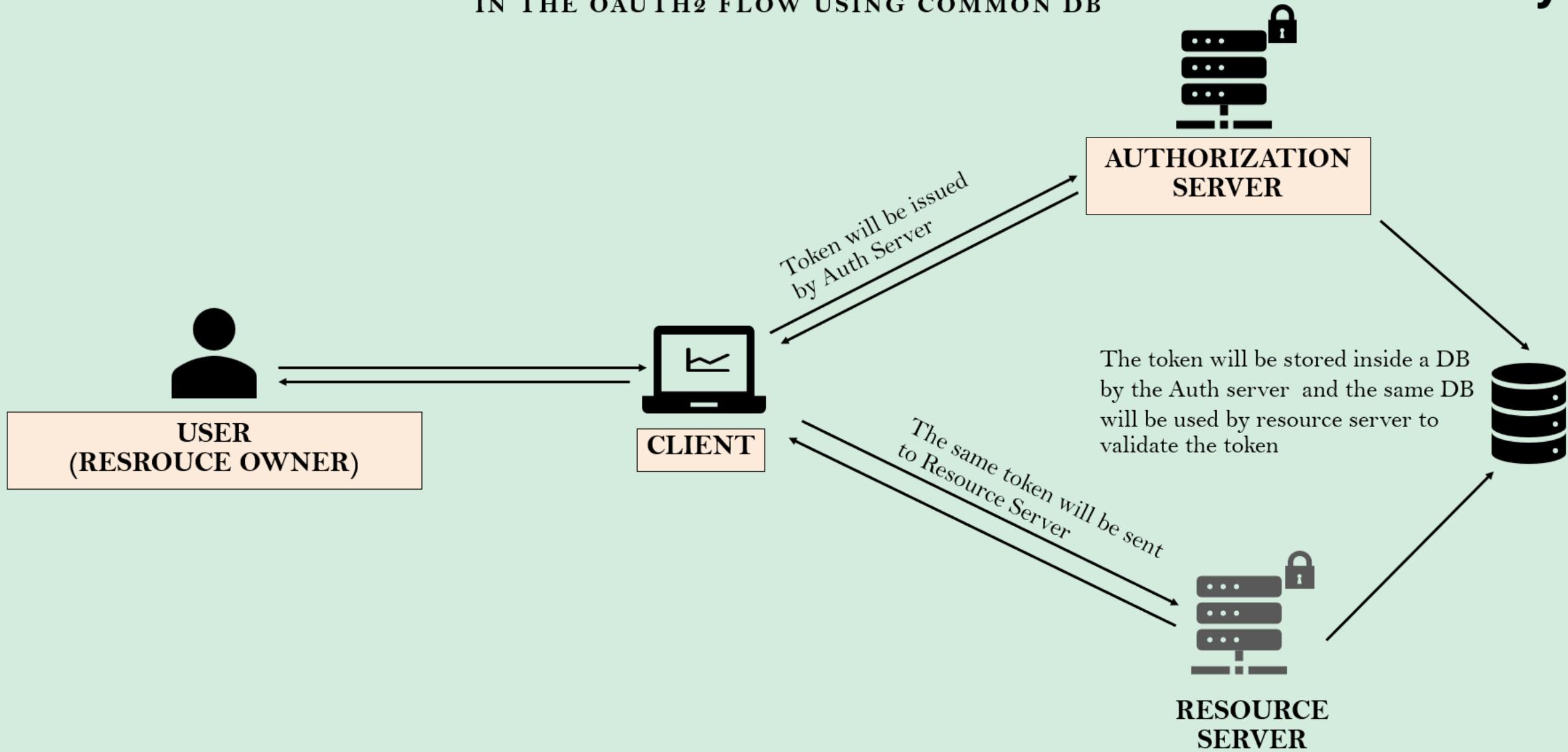
# RESOURCE SERVER TOKEN VALIDATION

IN THE OAUTH2 FLOW USING DIRECT API CALL

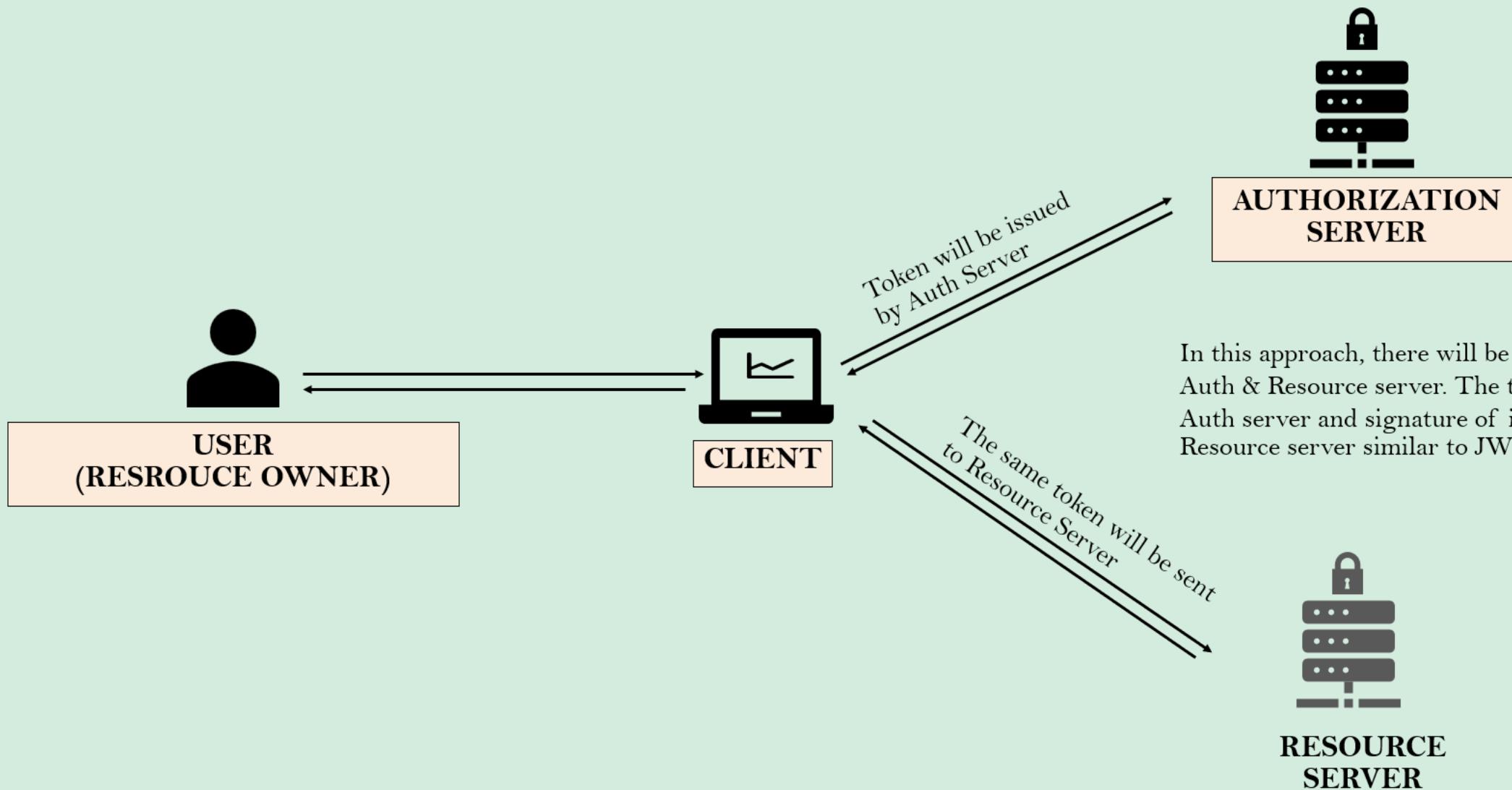


# RESOURCE SERVER TOKEN VALIDATION

IN THE OAUTH2 FLOW USING COMMON DB



# RESOURCE SERVER TOKEN VALIDATION IN THE OAUTH2 FLOW USING CERTIFICATES

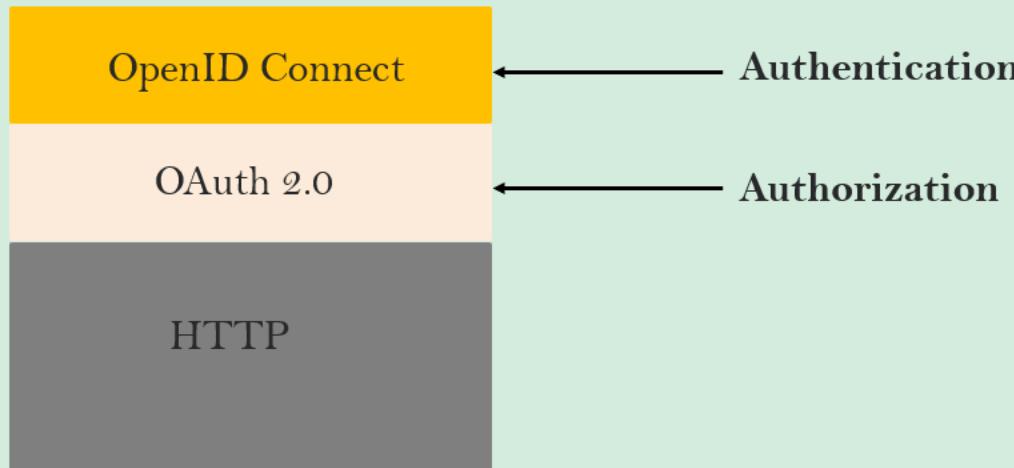


# OPENID CONNECT

WHAT IS OPENID CONNECT & WHY IT IS IMPORTANT ?

## What is OpenID Connect?

- OpenID Connect is a protocol that sits on top of the OAuth 2.0 framework. While OAuth 2.0 provides authorization via an access token containing scopes, OpenID Connect provides authentication by introducing a new ID token which contains a new set of information and claims specifically for identity.
- With the ID token, OpenID Connect brings standards around sharing identity details among the applications.



The OpenID Connect flow looks the same as OAuth. The only differences are, in the initial request, a specific scope of **openid** is used, and in the final exchange the client receives both an **Access Token** and an **ID Token**.

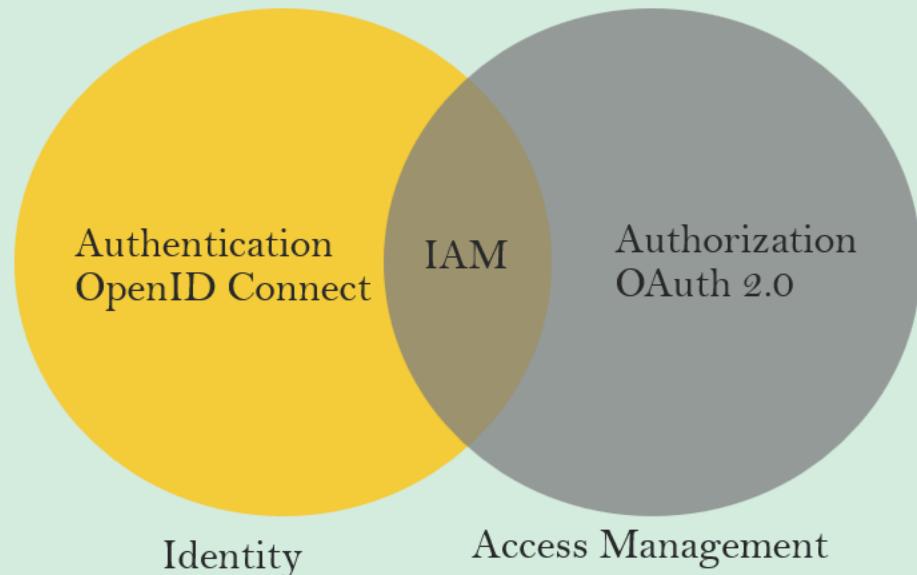
# OPENID CONNECT

WHAT IS OPENID CONNECT & WHY IT IS IMPORTANT ?

eazy  
bytes

## Why is OpenID Connect important?

- Identity is the key to any application. At the core of modern authorization is OAuth 2.0, but OAuth 2.0 lacks an authentication component. Implementing OpenID Connect on top of OAuth 2.0 completes an IAM (Identity & Access Management) strategy.
- As more and more applications need to connect with each other and more identities are being populated on the internet, the demand to be able to share these identities is also increased. With OpenID connect, applications can share the identities easily and standard way.

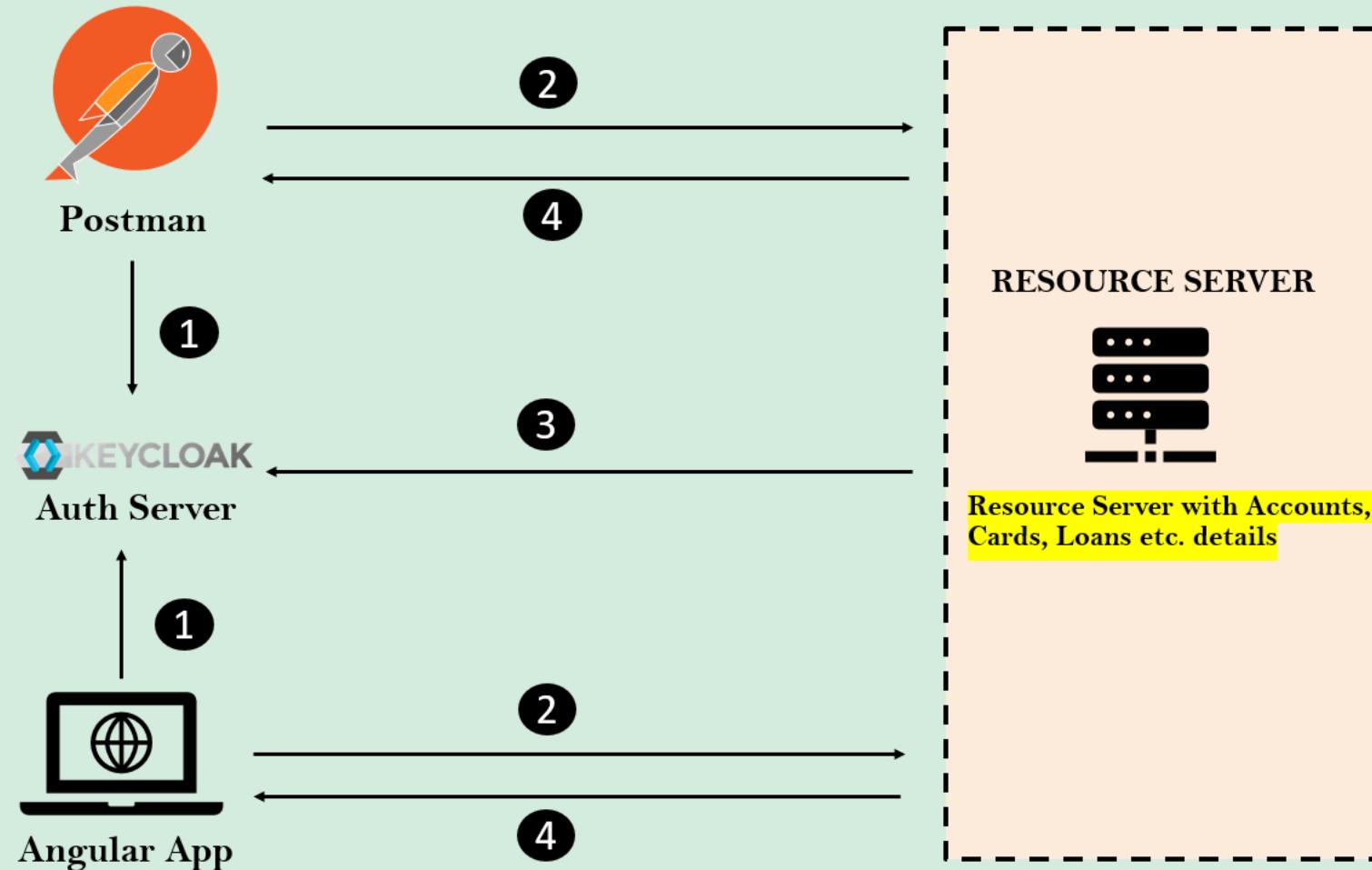


OpenID Connect adds below details to OAuth 2.0

1. OIDC standardizes the scopes to openid, profile, email, and address.
2. ID Token using JWT standard
3. OIDC exposes the standardized “/userinfo” endpoint.

# IMPLEMENT OAUTH2 INSIDE EAZYBANK APP

## USING KEYCLOAK AUTH SERVER



1. We may have either Angular like Client App or REST API clients to get the resource details from resource server. In both kinds we need to get access token from Auth Servers like KeyCloak.
2. Once the access token received from Auth Server, client Apps will connect with Resource server along with the access token to get the details around Accounts, Cards, Loans etc.
3. Resource server will connect with Auth Server to know the validity of the access token.
4. If the access token is valid, Resource server will respond with the details to client Apps.

# OAUTH2 AUTH CODE FLOW

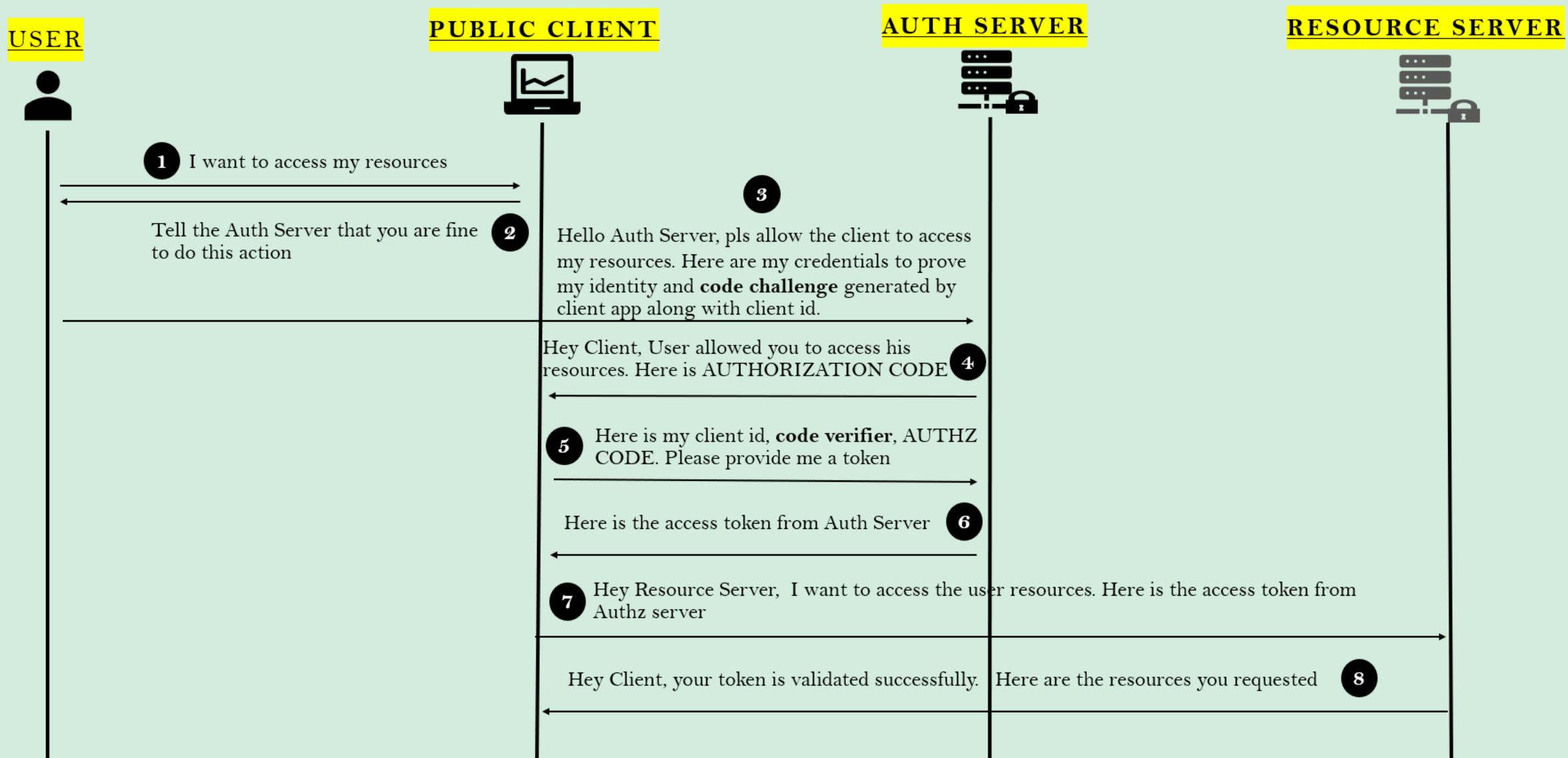
## WITH PROOF KEY FOR CODE EXCHANGE (PKCE)

- ✓ When public clients (e.g., native and single-page applications) request Access Tokens, some additional security concerns are posed that are not mitigated by the Authorization Code Flow alone. This is because public clients cannot securely store a Client Secret.
- ✓ Given these situations, OAuth 2.0 provides a version of the Authorization Code Flow for public client applications which makes use of a Proof Key for Code Exchange (PKCE).

- ✓ The PKCE-enhanced Authorization Code Flow follows below steps,
  - Once user clicks login, client app creates a cryptographically-random **code\_verifier** and from this generates a **code\_challenge**.
  - code challenge is a Base64-URL-encoded string of the SHA256 hash of the code verifier.
  - Redirects the user to the Authorization Server along with the code\_challenge.
  - Authorization Server stores the code\_challenge and redirects the user back to the application with an authorization code, which is good for one use.
  - Client App sends the authorization code and the code\_verifier(created in step 1) to the Authorization Server.
  - Authorization Server verifies the code\_challenge and code\_verifier. If they are valid it respond with ID Token and Access Token (and optionally, a Refresh Token).

# OAUTH2 AUTH CODE FLOW

WITH PROOF KEY FOR CODE EXCHANGE (PKCE)



# OAUTH2 AUTH CODE FLOW

## WITH PROOF KEY FOR CODE EXCHANGE (PKCE)

- ✓ In the steps 2 & 3, where client is making a request to Auth Server endpoint have to send the below important details,
  - **client\_id** – the id which identifies the client application by the Auth Server. This will be granted when the client register first time with the Auth server.
  - **redirect\_uri** – the URI value which the Auth server needs to redirect post successful authentication. If a default value is provided during the registration then this value is optional
  - **scope** – similar to authorities. Specifies level of access that client is requesting like READ
  - **state** – CSRF token value to protect from CSRF attacks
  - **response\_type** – With the value ‘**code**’ which indicates that we want to follow authorization code grant
  - **code\_challenge** - XXXXXXXXXXXX – The code challenge generated as previously described
  - **code\_challenge\_method** - S256 (either plain or S256)

- ✓ In the step 5 where client after received a authorization code from Auth server, it will again make a request to Auth server for a token with the below values,
  - **code** – the authorization code received from the above steps
  - **client\_id & client\_secret (optional)** – the client credentials which are registered with the auth server. Please note that these are not user credentials
  - **grant\_type** – With the value ‘authorization\_code’ which identifies the kind of grant type is used
  - **redirect\_uri**
  - **code\_verifier** – The code verifier for the PKCE request, that the app originally generated before the authorization request.

# THANK YOU

