Web Application Security

Outline

1. Token based Token based Authentication & Authorization (JWT)
2. Authorization for Next.js apps

Web Security Aspects

- **Authentication (Identity verification):**
  - Verify the identity of the user given the credentials received
  - Making sure the user is who he/she claims to be
- **Authorization (Controlling access):**
  - Determine if the user should be granted access to a particular resource/functionality.
- **Confidentiality:**
  - Encrypt sensitive data (e.g., credit card details) to prevent unauthorized access in transit or in storage
- **Data Integrality:**
  - Sign sensitive data (e.g., authentication token) to prevent the content from being tampered (e.g., changed in transit)

Token based Authentication & Authorization

Token based Authentication & Authorization

- After a successful authentication a **JSON Web Token (JWT)** is issued by the server and communicated to the client
- JWT token is a signed json object that contains:
  - Claims (i.e., information about *issuer* and the *user*)
  - Signature (encrypted hash for tamper proof & authenticity)
  - An expiration time
- Client must send JWT in an **HTTP authorization header** with subsequent Web API requests
- Web API (i.e., a resource) **validates** the received token and makes authorization decisions (typically based on the user's **role**)

Web pages Session Management using JWT

- Implements stateless sessions by:
  - Creating utility functions (`createSession`, `verifySession`, `deleteSession`) to manage sessions
  - Using the jose library to create and verify signed/encrypted JWTs containing user object and expiration
  - Storing the JWT in a secure, HttpOnly cookie using `cookies()` from `next/headers`
  - Redirecting users after login/signup or when access is denied using `redirect()` from `next/navigation`

Advantages of Token based Security

- A primary reason for using token-based authentication is that it is **stateless** and **scalable** authentication mechanism
  - It is suitable for SPA, Web APIs, Web pages and mobile apps
  - The token is stored on the client-side
  - The claims in a JWT are encoded as a **JSON** object that contains information that is useful for making authorization decisions
  - JWT is a simple and widely useful security token format with libraries available in most programming languages
- Can be used for **Single Sign-On:**
  - Sharing the JWT between different applications

JWT Structure

HEADER
ALGORITHM & TOKEN TYPE

```
{
  "alg": "HS256",
  "typ": "JWT"
}
```

+

PAYLOAD
DATA

```
{
  "sub": "1234567890",
  "name": "John Doe",
  "admin": true
}
```

+

SIGNATURE
VERIFICATION

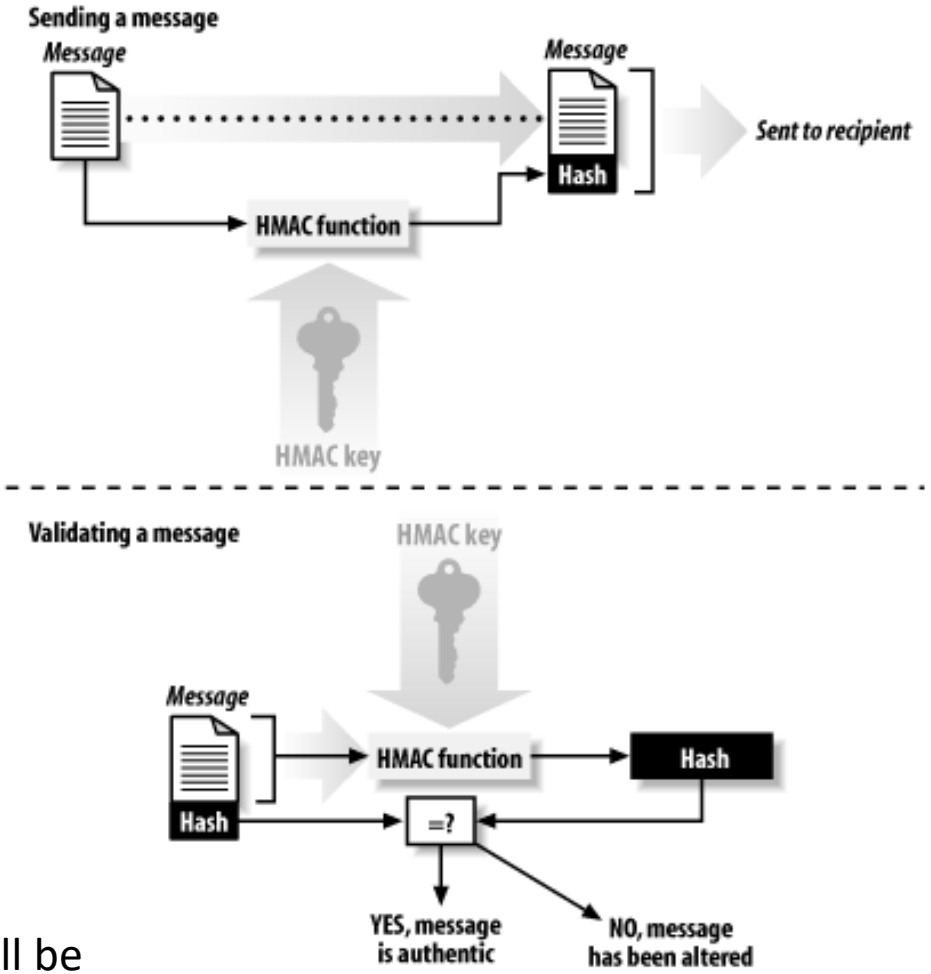
```
HMACSHA256(
  base64UrlEncode(header) + "." +
  base64UrlEncode(payload),secretKey)
```

```
eyJhbGciOiJub25lIn0.eyJpc3MiOiJqb2UiLA0KICJleHAiOjEzMD.4MTkzODAsDQogImh0dHA6Ly9leGFt
```

Header **Payload** **Signature**

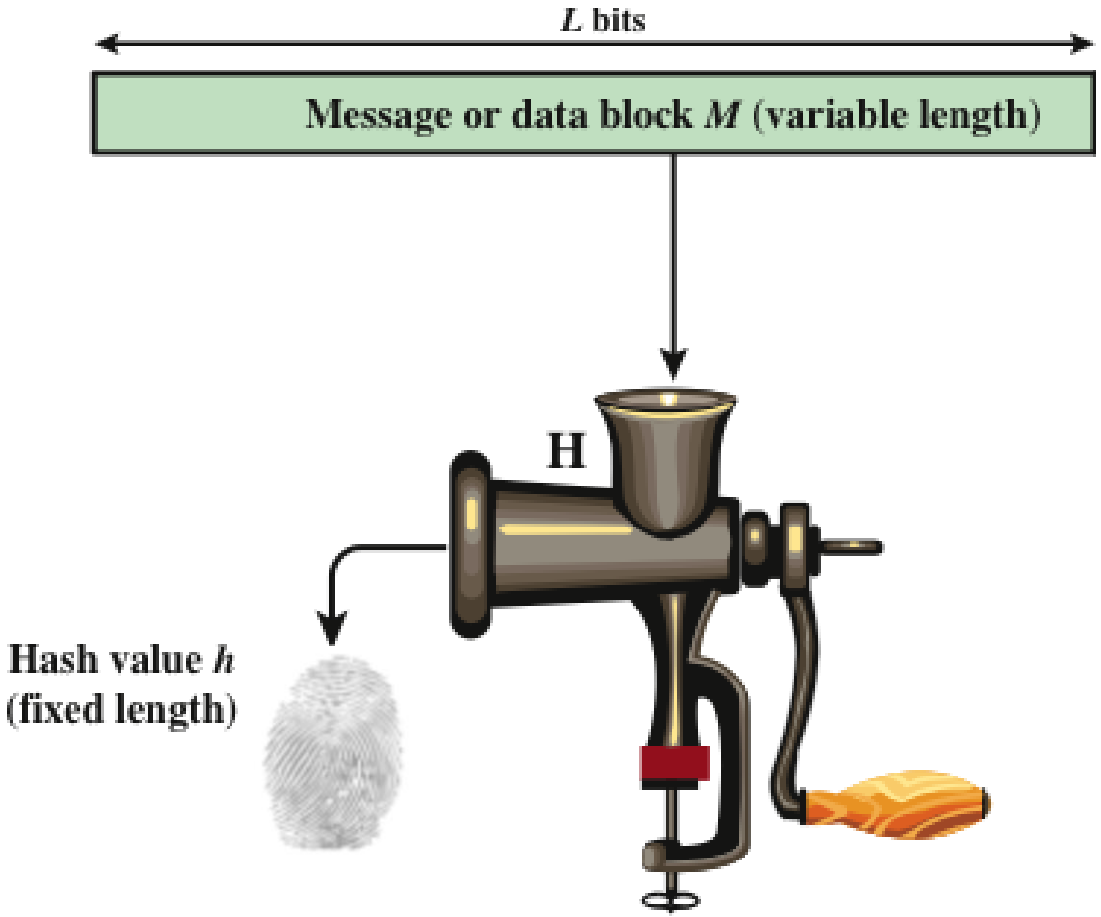
Hash-based Message Authentication Code (HMAC)

- **HMAC-SHA256** is often used for **signing JWT** to ensure its integrity
- HMAC-SHA256 is a *cryptographic hash function* that uses SHA256 hashing and **a *secret key*** *to generate a MAC (i.e., JWT signature)*
- The MAC is appended to the message sent
- MAC provides **message integrity**: Any manipulations of the message during transit will be detected by the receiver



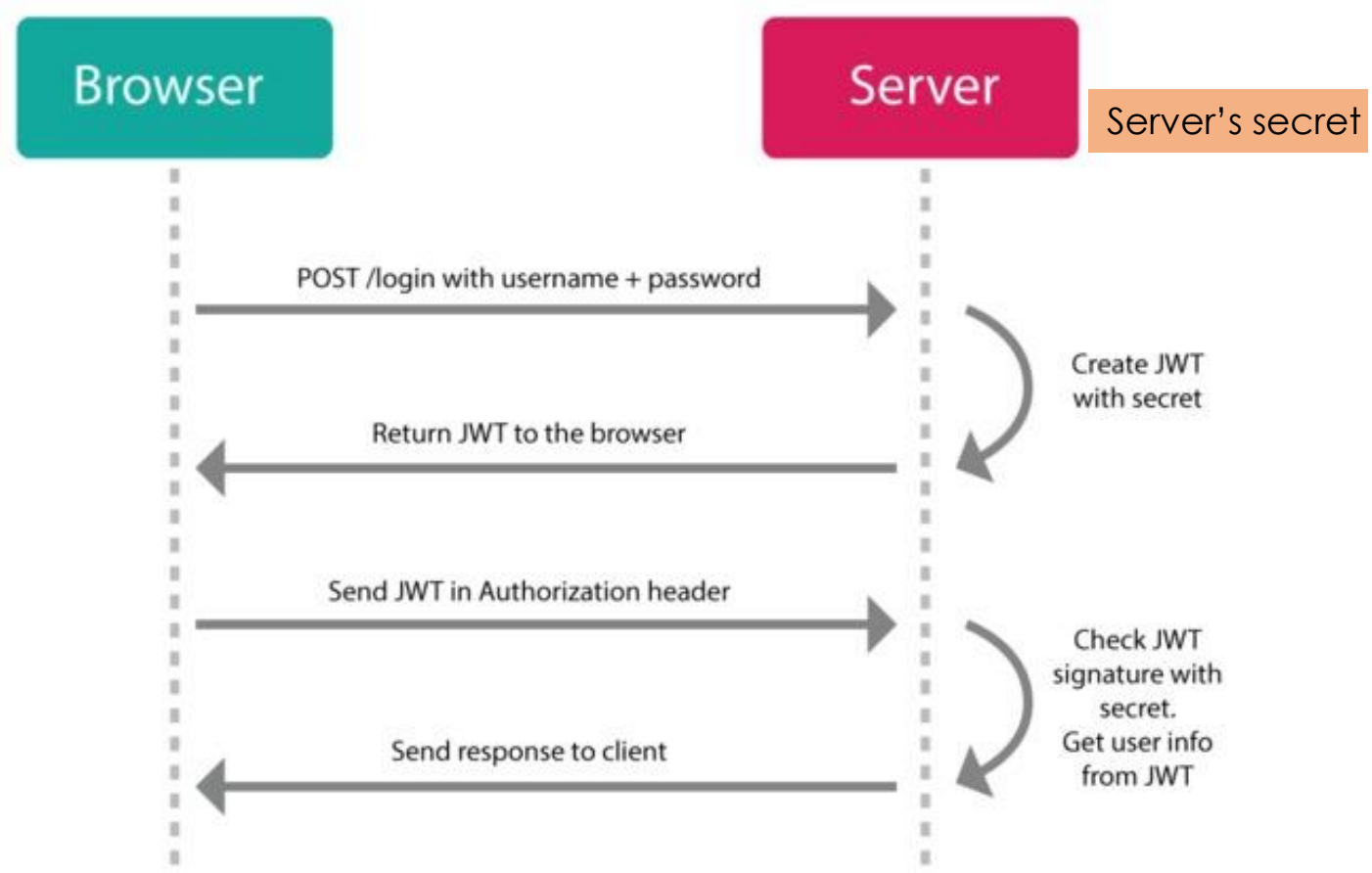
An attacker who alters the message will be **unable** to alter the associated MAC value without knowledge of the secret key

Hashing



Hash functions are used to compute a digest of a message. It takes a variable size input, produce fixed size pseudorandom output

JWT for Web API

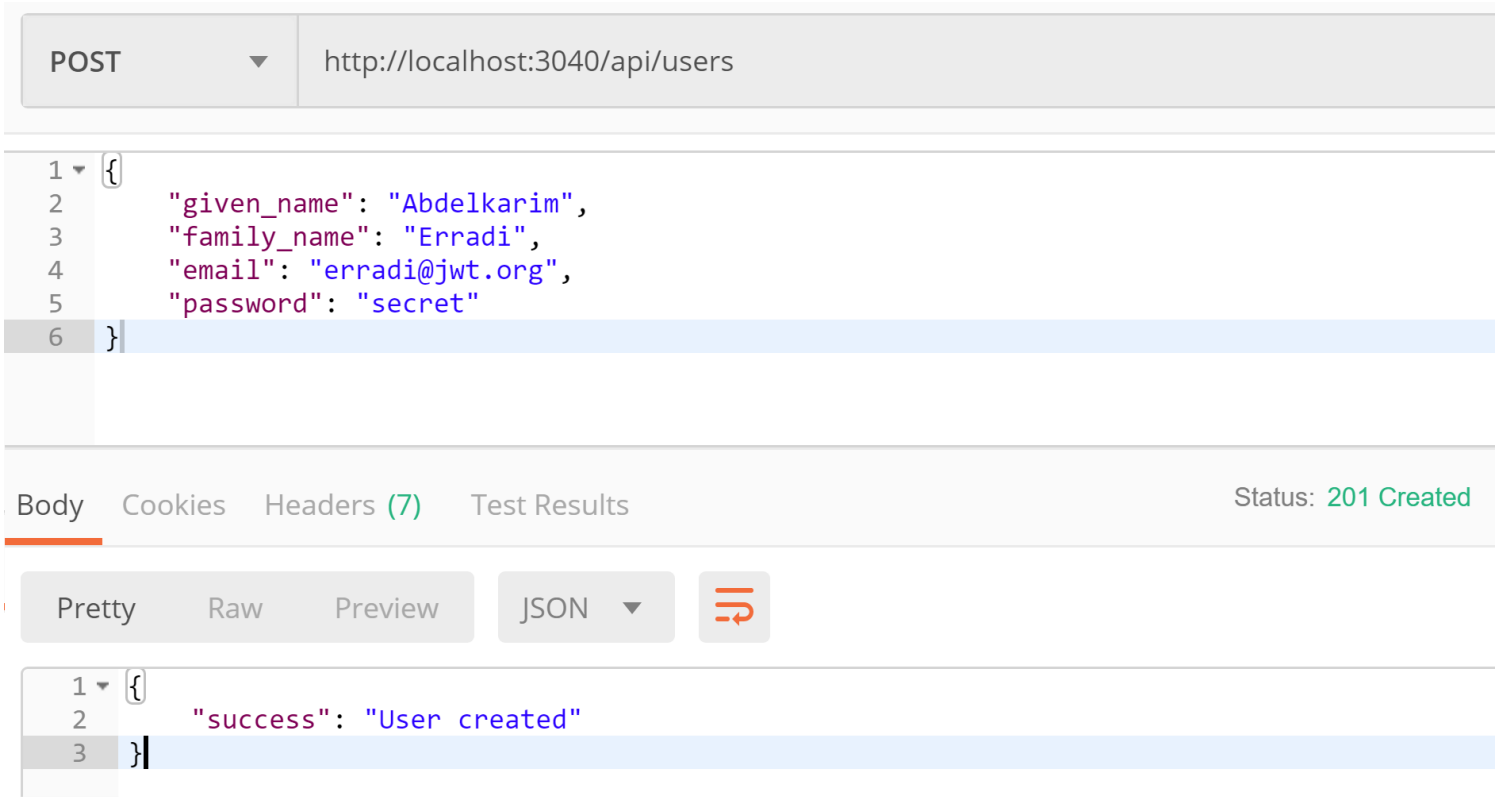


- Every request to a Web API must include a **JWT** in the Authorization header
- Web API checks that the JWT token is valid
- Web API uses info in the token (e.g., **role**) to make authorization decisions

Sign-Up Example

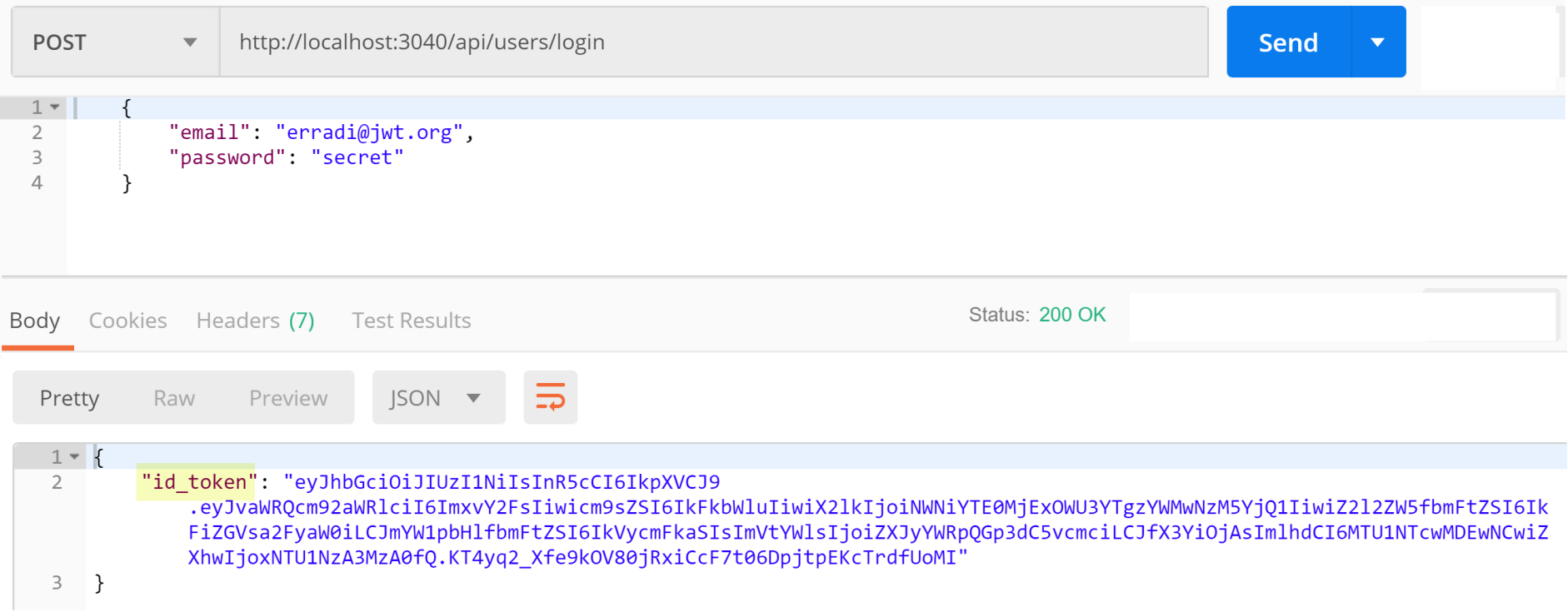
- Sign up @ http://localhost:3040/api/users

Try it with Postman



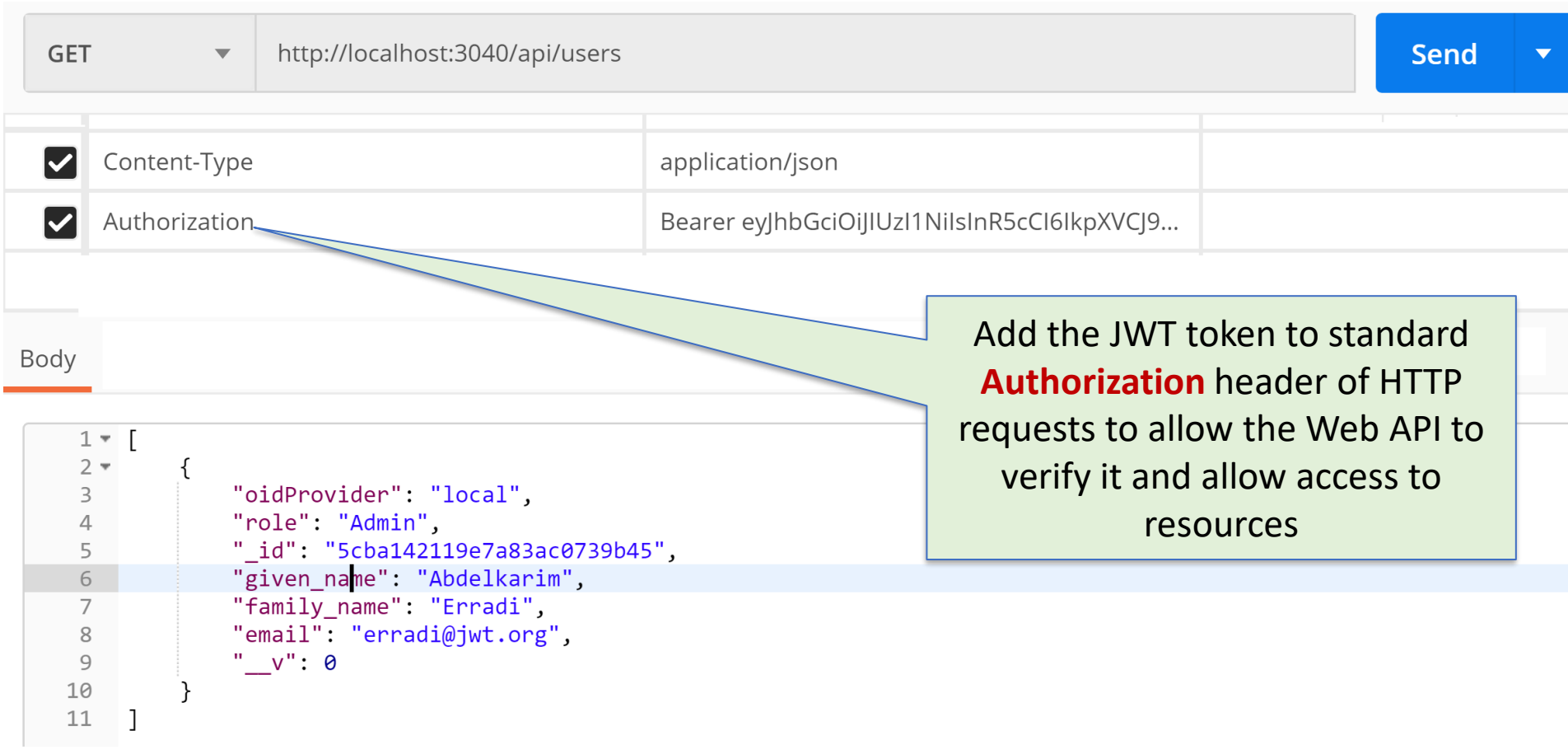
Successful Login to get JWT

- Sign in @ http://localhost:3040/api/users/login



Use JWT to Access Protected Resource

- Get users http://localhost:3040/api/users



Storing JWT in Browser Local Storage

Local Storage allows storing a set of name value pairs directly accessible with **client-side** JavaScript

- **Store**

```
localStorage.id_token = "eyJhbnR5cCI…."
```

- **Retrieve**

```
Console.log(localStorage.id_token)
```

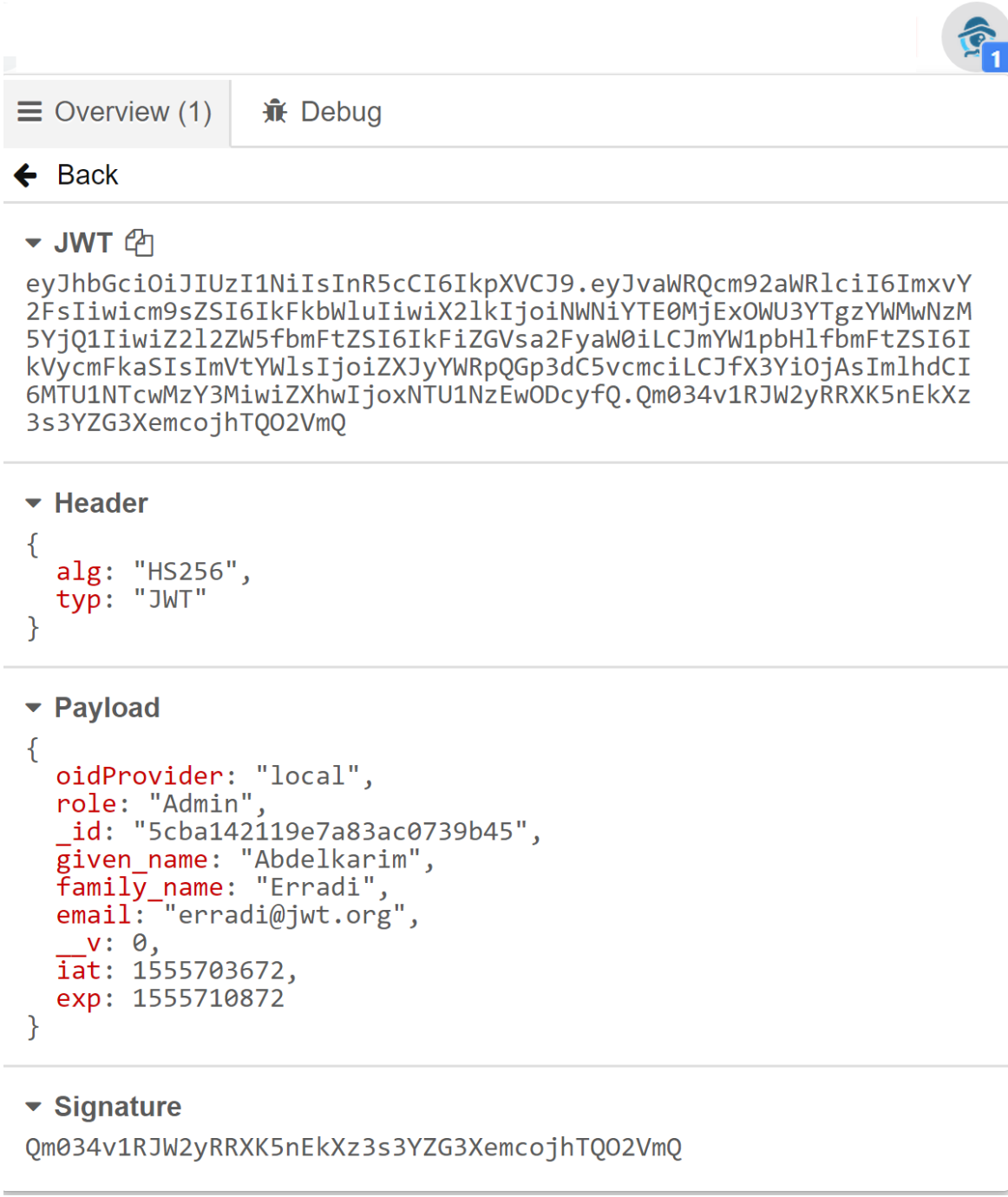
- **Remove**

```
delete localStorage.id_token
```

- **Remove all saved data**

```
localStorage.clear();
```

JWT Inspector is a chrome extension that lets you **decode** and **inspect** JWT in requests, and local storage



401 vs. 403

- ***401 Unauthorized***

- Should be returned in case of failed authentication

- ***403 Forbidden***

- Should be returned in case of failed authorization

- The user is authenticated but not authorized to perform the requested operation on the given resource


Auth.js

NextAuth.js

- **Auth.js** is a flexible, easy to use and open-source authentication library for Web applications
  - Support multiple providers such as Facebook, Google, Twitter, Github, … and the traditional email/password authentication
  - Supports passwordless sign in
- A working Next.js example is available at this link

NextAuth.js Programming Steps (1 of 2)

1. Install NextAuth.js **`npm install next-auth@beta`**
2. Configure the Authentication Providers to be used such as GitHub, Google (more info):

- Create `./app/api/auth/[...nextauth]/route.js`

- Creating a new auth. js file at the root of your app and configure the desired auth provider such as Github provider with the **clientId** and the **secret.** Get them from https://github.com/settings/applications/new

Enter them in the **`.env`** file in the root of the project

```
import GithubProvider from "next-
auth/providers/github"
import NextAuth from "next-auth"

const authOptions = {
  providers: [
    GithubProvider({
      clientId: process.env.GITHUB_ID,
      clientSecret: process.env.GITHUB_SECRET,
    }) ] }
export default NextAuth(authOptions)
```

Auth Web API

- Well, the magic has happened already. If we navigate to http://localhost:3000/api/auth/signin and you should see this

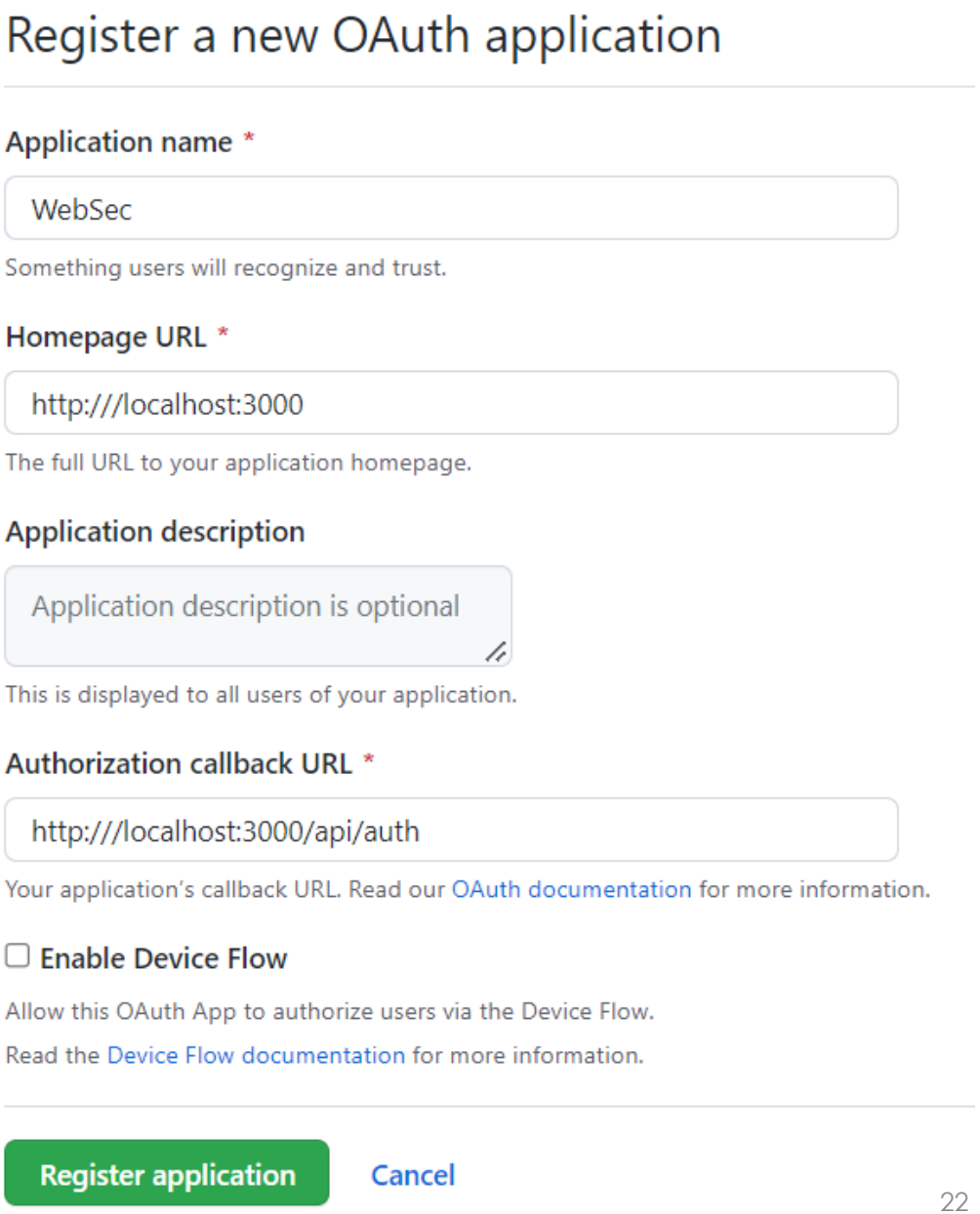
Create and Configure OAuth Client

- Add/Update GitHub OAuth Client https://github.com/settings/developers

- Add/Update Google OAuth Client

https://console.developers.google.com/apis/credentials

- Other Auth Providers provide similar UI to add and configure an OAuth Client (more info)



Auth.js API

- creating a new auth.js file at the root of your app with the following content:

```
import NextAuth from "next-auth"

export const { handlers, signIn, signOut, auth } = NextAuth({
  providers: [],
})
```

- **`signIn`** and **`signOut`** functions can be used to perform the login and logout
- **`auth`** can be used to check the user login status and return the user's details

Authorization for Next.js Apps

Middleware.js to Check Authentication

- Use middleware.js to check if the user is **authenticated** and **authorized** before handling their request

```
const protectedRoutes = ["/", "/assessments", "/comments", "/workload-
report"];

export function middleware(req) {
  const token = req.cookies.get("auth_token")?.value;
  const path = req.nextUrl.pathname;

  console.log("Middleware - Request Path:", path);
  // Check if the current path is a protected route
  const isProtectedRoute = protectedRoutes.some(
    (route) => path === route || (route !== "/" && path.startsWith(route))
  );
  // Redirect to login if accessing a protected route without a token
  if (isProtectedRoute && !token) {
    return NextResponse.redirect(new URL("/login", req.url));
  }
  // Continue if authenticated or accessing public route
  return NextResponse.next();
}
```

Resources

- Good resource to learn about JWT

https://jwt.io/

- JWT Handbook

https://auth0.com/resources/ebooks

- OAuth 2

https://www.oauth.com/