Securing Your User Authentication Processes

Kevin Dockx
ARCHITECT

@KevinDockx https://www.kevindockx.com

Coming Up

The authorization code flow with PKCE protection

- Logging in and logging out

Best practice for returning identity claims

Comparing the authorization code flow with PKCE protection to the hybrid flow

```
https://idphostaddress/connect/authorize?
client_id=imagegalleryclient
&redirect_uri=https://clientapphostaddress/signin-oidc
&scope=openid profile
&response_type=code
&response_mode=form_post
&nonce=63626...n2eNMxA0
```

The Authorization Code Flow

Authentication request to the authorization endpoint

```
https://idphostaddress/connect/authorize?
client_id=imagegalleryclient
&redirect_uri=https://clientapphostaddress/signin-oidc
&scope=openid profile
&response_type=code
&response_mode=form_post
&nonce=63626...n2eNMxA0
```

The Authorization Code Flow

Authorization endpoint at IDP level

```
https://idphostaddress/connect/authorize?
client_id=imagegalleryclient
&redirect_uri=https://clientapphostaddress/signin-oidc
&scope=openid profile
&response_type=code
&response_mode=form_post
&nonce=63626...n2eNMxA0
```

The Authorization Code Flow

Identifier of the client

```
https://idphostaddress/connect/authorize?
client_id=imagegalleryclient
&redirect_uri=https://clientapphostaddress/signin-oidc
&scope=openid profile
&response_type=code
&response_mode=form_post
&nonce=63626...n2eNMxA0
```

The Authorization Code Flow

Redirection endpoint at client level

```
https://idphostaddress/connect/authorize?
client_id=imagegalleryclient
&redirect_uri=https://clientapphostaddress/signin-oidc
&scope=openid profile
&response_type=code
&response_mode=form_post
&nonce=63626...n2eNMxA0
```

The Authorization Code Flow

Requested scopes by the client application

```
https://idphostaddress/connect/authorize?
client_id=imagegalleryclient
&redirect_uri=https://clientapphostaddress/signin-oidc
&scope=openid profile
&response_type=code
&response_mode=form_post
&nonce=63626...n2eNMxA0
```

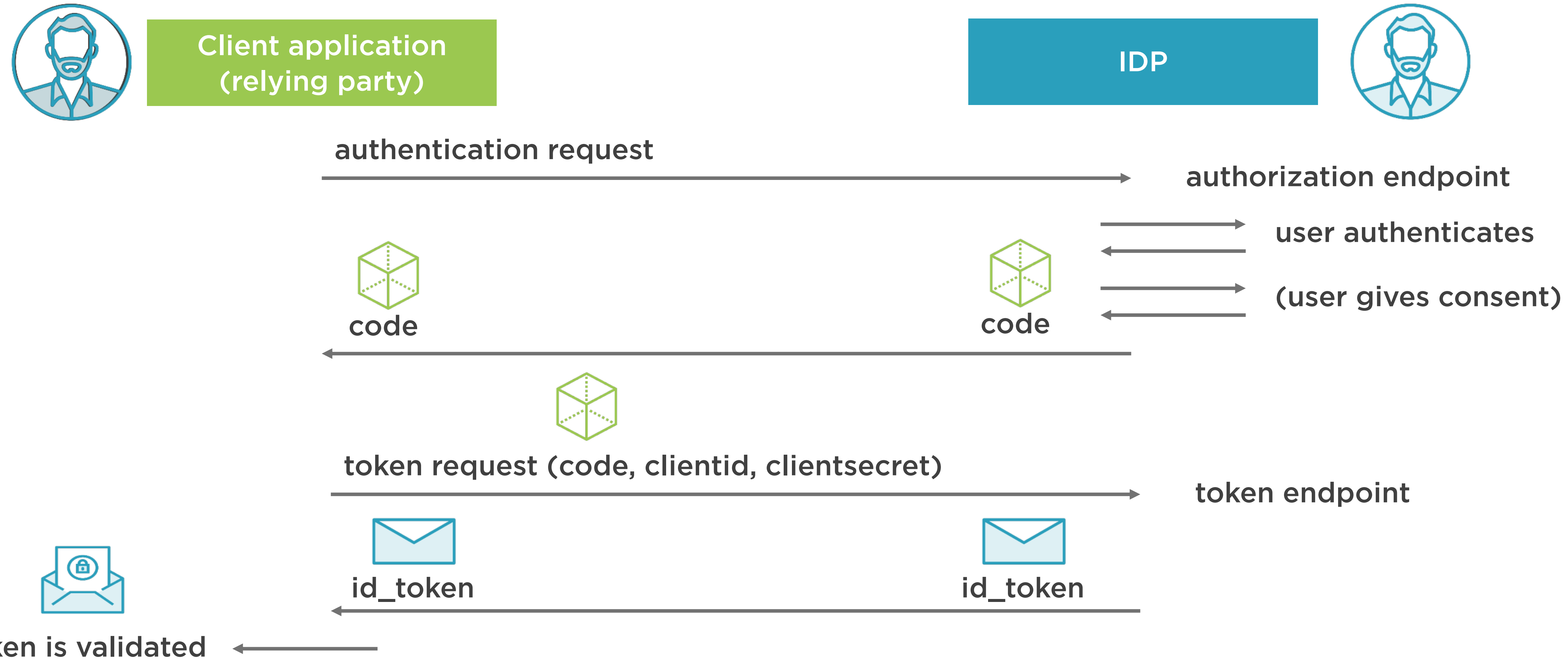
The Authorization Code Flow

The requested response_type determines the flow

Response Type Values

code **Authorization Code**	id_token **Implicit**	id_token token **Implicit**
code id_token **Hybrid**	code token **Hybrid**	code id_token token **Hybrid**

The Authorization Code Flow



Communication Types

Front channel communication

Information delivered to the browser via URI or Form POST (response_mode)

In our current flow:
authorization endpoint

Back channel communication

Server to server communication

In our current flow:
token endpoint

Defence in Depth

Implement different types of protection against the same vulnerability

- If one mechanism fails, (an)other mechanism(s) is/are still in place

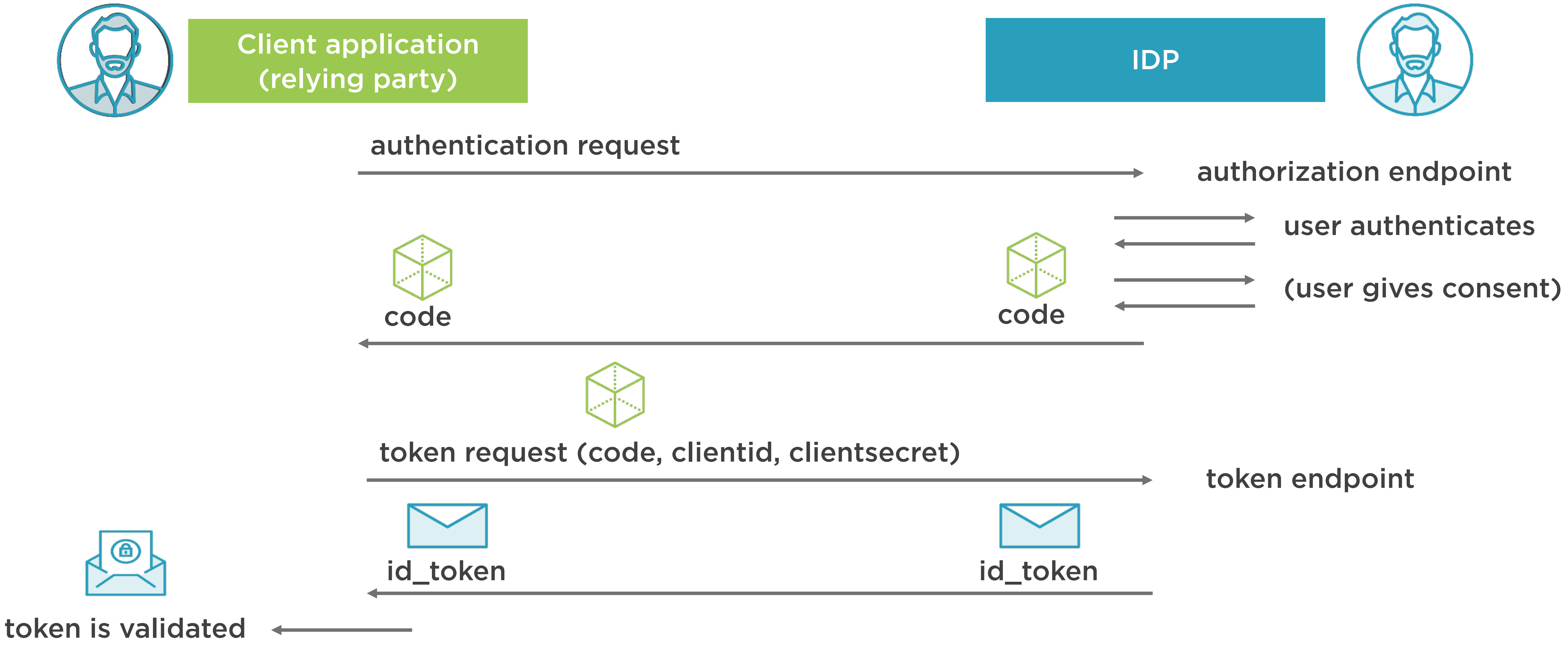
Response Type Values

code **Authorization Code**	id_token **Implicit**	id_token token **Implicit**
code id_token **Hybrid**	code token **Hybrid**	code id_token token **Hybrid**

Response Type Values

code **Authorization Code**	id_token **Implicit**	id_token token **Implicit**
code id_token **Hybrid**	code token **Hybrid**	code id_token token **Hybrid**

The Authorization Code Flow



Demo

Configuring IdentityServer to log in with the authorization code flow

Demo

Logging in with the authorization code flow

Authorization Code Injection Attack

Authorization code grant is vulnerable to authorization code injection attacks

- A leaked authorization code (linked to the victim) is used by the attacker to swap the attackers' session for the victims'
- The attacker now has the privileges of the victim

Authorization Code Injection Attack

Full description of the attack

- https://nat.sakimura.org/2016/01/25/cut-and-pasted-code-attack-in-oauth-2-0-rfc6749/
- https://tools.ietf.org/html/draft-ietf-oauth-security-topics-13#page-19

Proof Key for Code Exchange (PKCE)

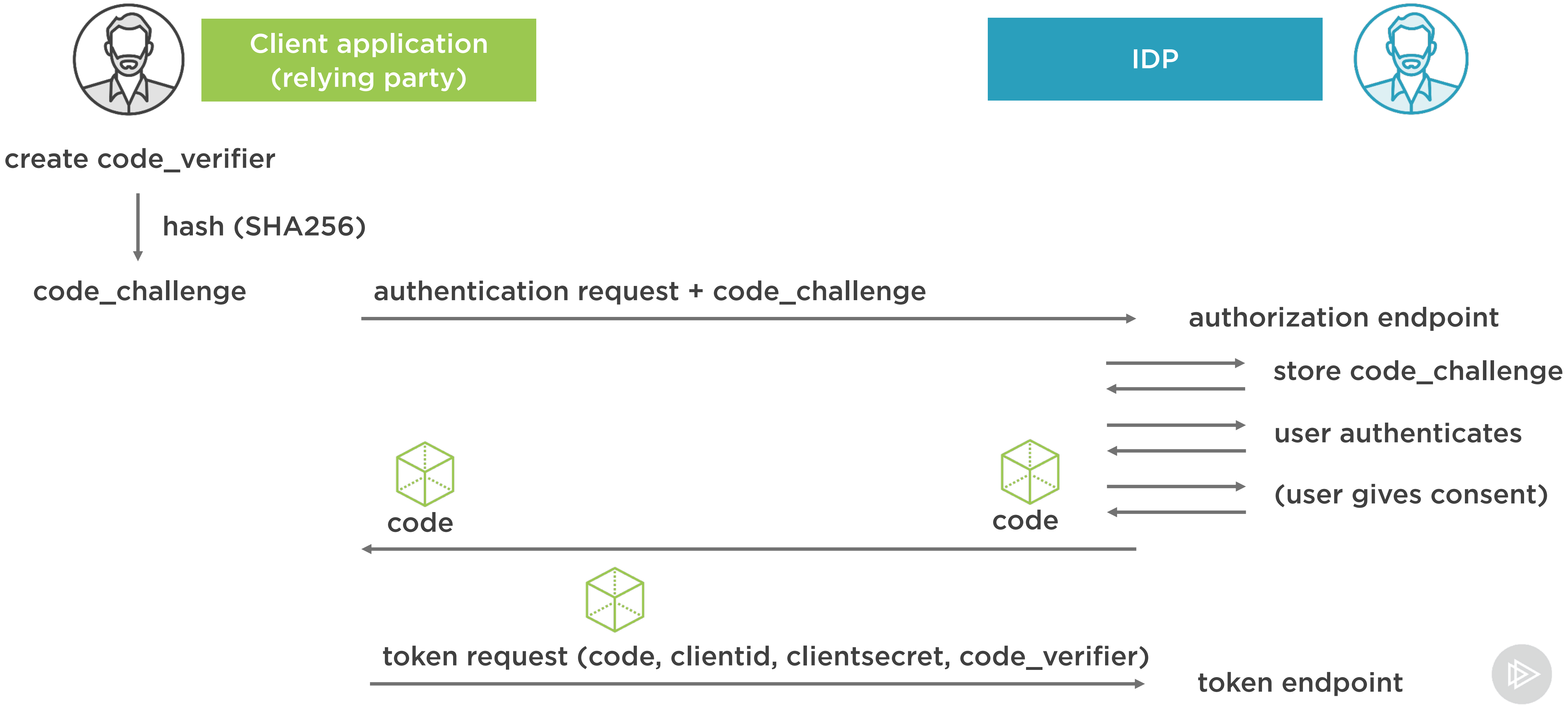
There's multiple ways to mitigate this attack, PKCE (Proof Key for Code Exchange) is currently the advised approach

- https://tools.ietf.org/html/rfc7636
- For each request to the auth endpoint, a secret is created
- When calling the token endpoint, it's verified

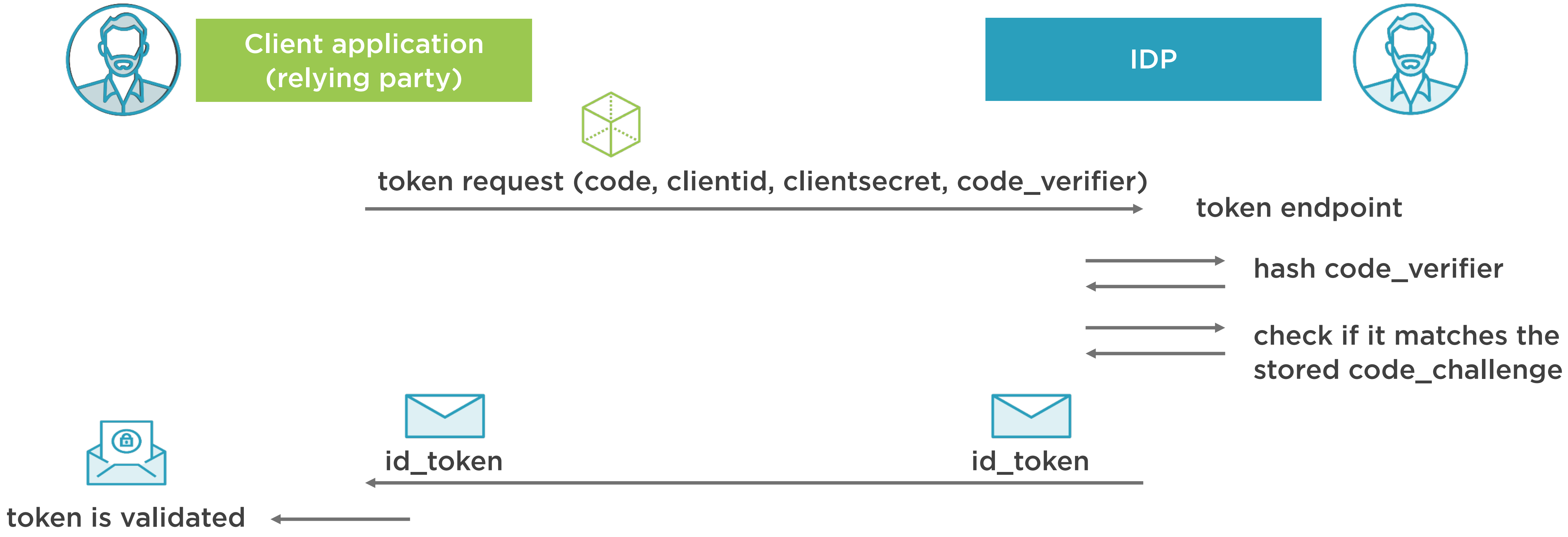
Proof Key for Code Exchange (PKCE)

Code injection is mitigated because the attacker doesn’t have access to the per-request secret

The Authorization Code Flow + PKCE



The Authorization Code Flow + PKCE


Client application (relying party)
IDP
token request (code, clientid, clientsecret, code_verifier)
token endpoint
hash code_verifier
check if it matches the stored code_challenge
id_token
id_token
token is validated

Demo

Enabling PKCE protection

Demo

Logging out of our web application

Demo

Logging out of the identity provider

Demo

Redirecting after logging out

```
new Client {
    ClientId = "imagegalleryclient",
    AlwaysIncludeUserClaimsInIdToken = true,
    …
}
```

The UserInfo Endpoint

IdentityServer doesn't include identity claims (except sub) in the identity token, unless we specifically ask for this

The UserInfo Endpoint

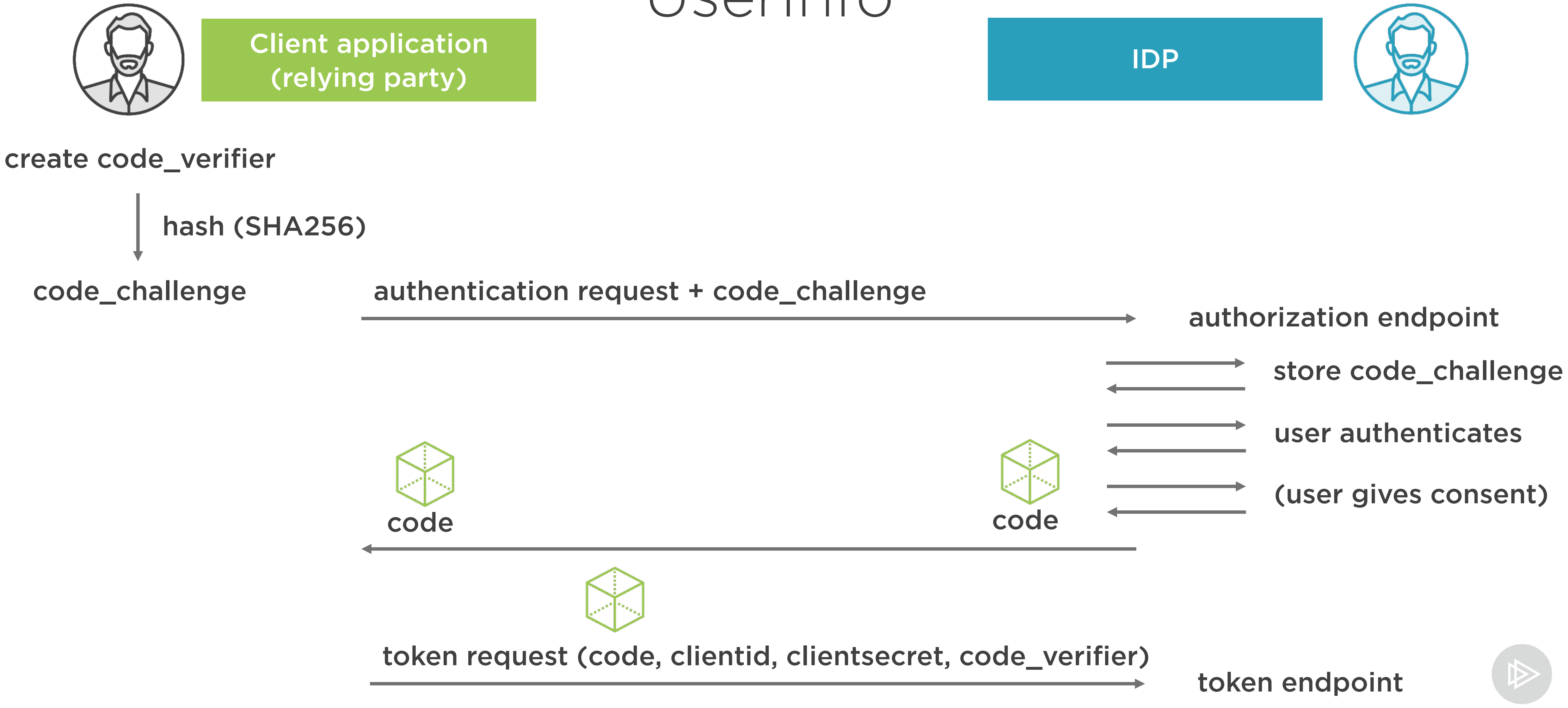
Not including the claims in the id_token keeps the token smaller, avoiding URI length restrictions

The UserInfo Endpoint

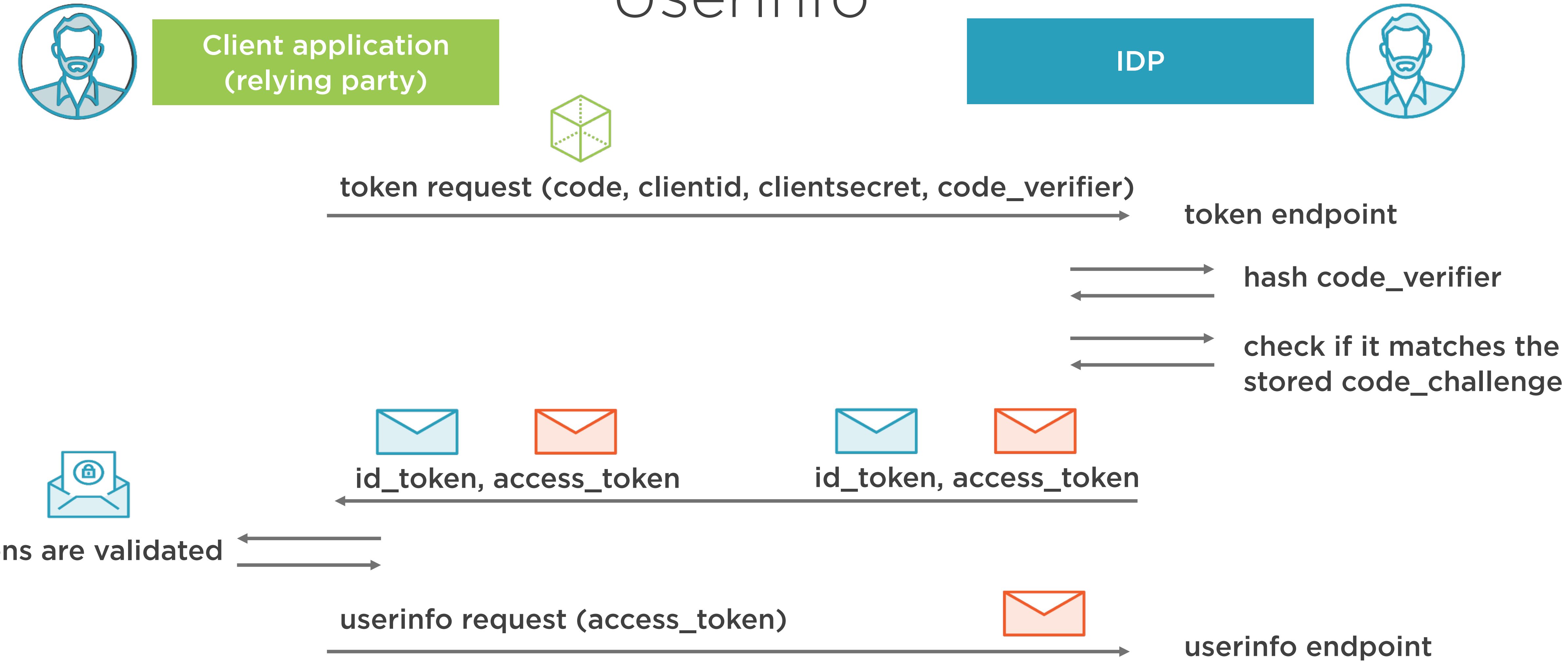
UserInfo endpoint (IDP level)

- Used by the client application to request additional user claims
- Requires an access token with scopes related to the claims that have to be returned

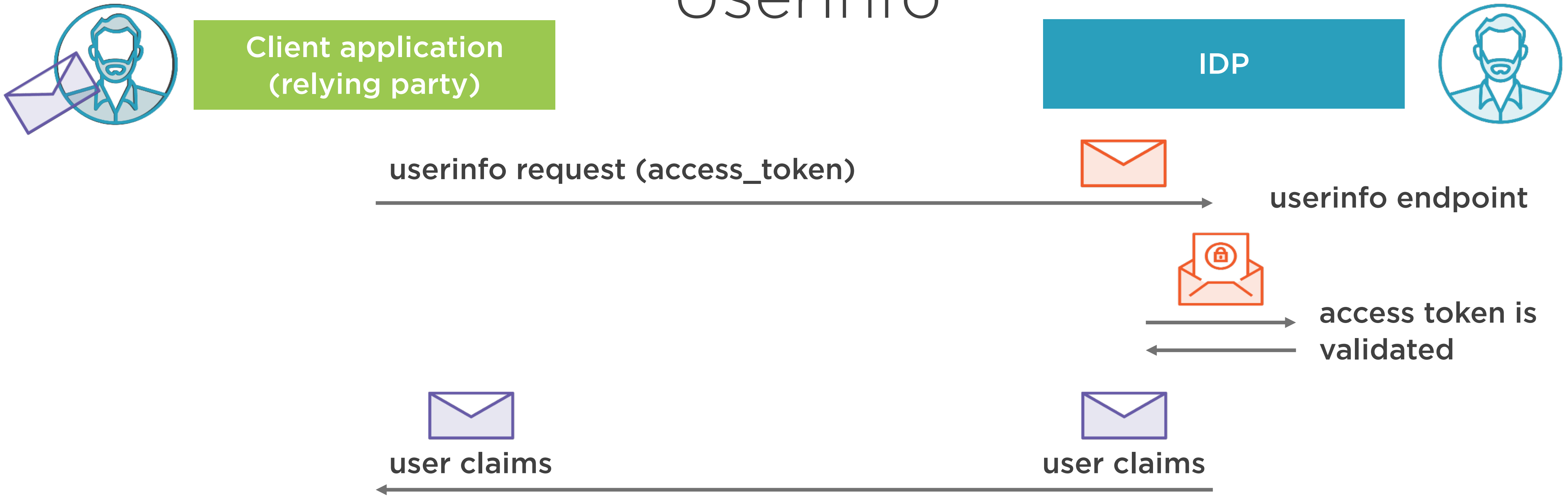
The Authorization Code Flow + PKCE + UserInfo



The Authorization Code Flow + PKCE + UserInfo


Client application (relying party)
IDP
token request (code, clientid, clientsecret, code_verifier)
token endpoint
hash code_verifier
check if it matches the stored code_challenge
id_token, access_token
id_token, access_token
tokens are validated
userinfo request (access_token)
userinfo endpoint

The Authorization Code Flow + PKCE + UserInfo


Client application (relying party)
IDP
userinfo request (access_token)
userinfo endpoint
access token is validated
user claims
user claims

Demo

Returning additional claims from the UserInfo endpoint

```
{
  "sub": "b7539694-97e7-4dfe-84da-b4256e1ff5c7",
  "given_name": "Claire",
  "iss": "https://localhost:44303",
  "aud": "imagegalleryclient",
  …
}
```

Inspecting an Identity Token

Identity tokens are JWTs (Json Web Token)

```
{
  "sub": "b7539694-97e7-4dfe-84da-b4256e1ff5c7",
  "given_name": "Claire",
  "iss": "https://localhost:44303",
  "aud": "imagegalleryclient",
  …
}
```

Inspecting an Identity Token

Subject: the user’s identifier

```
{
  "sub": "b7539694-97e7-4dfe-84da-b4256e1ff5c7",
  "given_name": "Claire",
  "iss": "https://localhost:44303",
  "aud": "imagegalleryclient",
  …
}
```

Inspecting an Identity Token

Optional user claims related to the requested scopes

```
{
  "sub": "b7539694-97e7-4dfe-84da-b4256e1ff5c7",
  "given_name": "Claire",
  "iss": "https://localhost:44303",
  "aud": "imagegalleryclient",
  …
}
```

Inspecting an Identity Token

Issuer: the issuer of the identity token

```
{
  "sub": "b7539694-97e7-4dfe-84da-b4256e1ff5c7",
  "given_name": "Claire",
  "iss": "https://localhost:44303",
  "aud": "imagegalleryclient",
  …
}
```

Inspecting an Identity Token

Audience: the intended audience for this token

```
{ …
  "iat": 1490970940,
  "exp": 1490971240,
  "nbf": 1490970940,
  "auth_time": 1490970937,
  …
}
```

Inspecting an Identity Token

Issued at: the time at which the JWT was issued

```
{ …
  "iat": 1490970940,
  "exp": 1490971240,
  "nbf": 1490970940,
  "auth_time": 1490970937,
  …
}
```

Inspecting an Identity Token

Expiration: the expiration time on or after which the identity token must not be accepted for processing

```
{ …
  "iat": 1490970940,
  "exp": 1490971240,
  "nbf": 1490970940,
  "auth_time": 1490970937,
  …
}
```

Inspecting an Identity Token

Not before: the time before which the identity token must not be accepted for processing

```
{ …
  "iat": 1490970940,
  "exp": 1490971240,
  "nbf": 1490970940,
  "auth_time": 1490970937,
  …
}
```

Inspecting an Identity Token

Authentication time: the time of the original authentication

```
{ …
  "amr": ["pwd"],
  "nonce": "63…200.ZjMzZ…5YzFlNWNiN2Mw…AtNGYyZi00MzYzNmZh",
  "at_hash": "90V_c-PO0kdoP-IOERlkdi"
}
```

Inspecting an Identity Token

Authentication methods references: identifiers for authentication methods

```
{ …
  "amr": ["pwd"],
  "nonce": "63…200.ZjMzZ…5YzFlNWNiN2Mw…AtNGYyZi00MzYzNmZh",
  "at_hash": "90V_c-PO0kdoP-IOERlkdi"
}
```

Inspecting an Identity Token

Number only to be used once

```
{ …
  "amr": ["pwd"],
  "nonce": "63…200.ZjMzZ…5YzFlNWNiN2Mw…AtNGYyZi00MzYzNmZh",
  "at_hash": "90V_c-PO0kdoP-lOERlkdi"
}
```

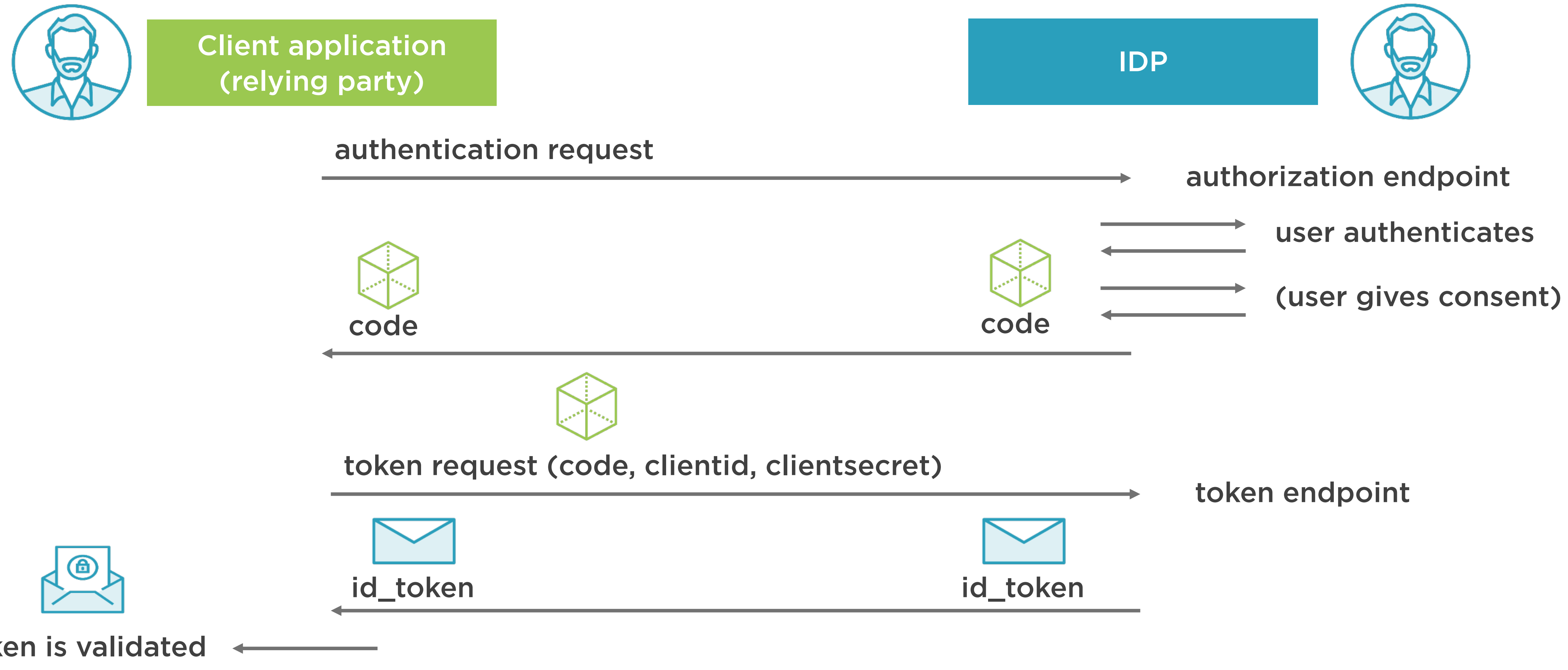
Inspecting an Identity Token

Access token hash: Base64 encoded value of the left-most half of the hash of the octets of the ASCII representation of the access token

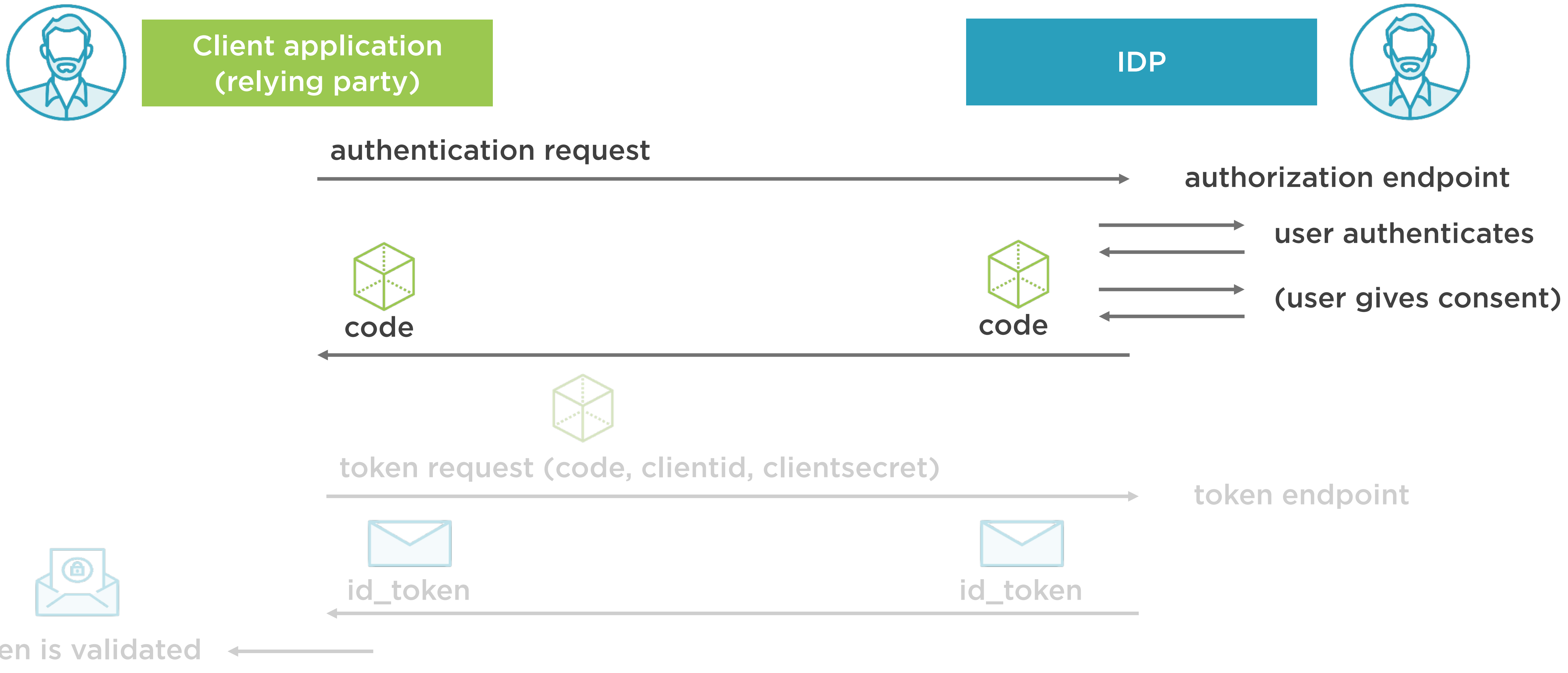
Authorization Code vs. Hybrid Flow

code **Authorization Code**	id_token **Implicit**	id_token token **Implicit**
code id_token **Hybrid**	code token **Hybrid**	code id_token token **Hybrid**

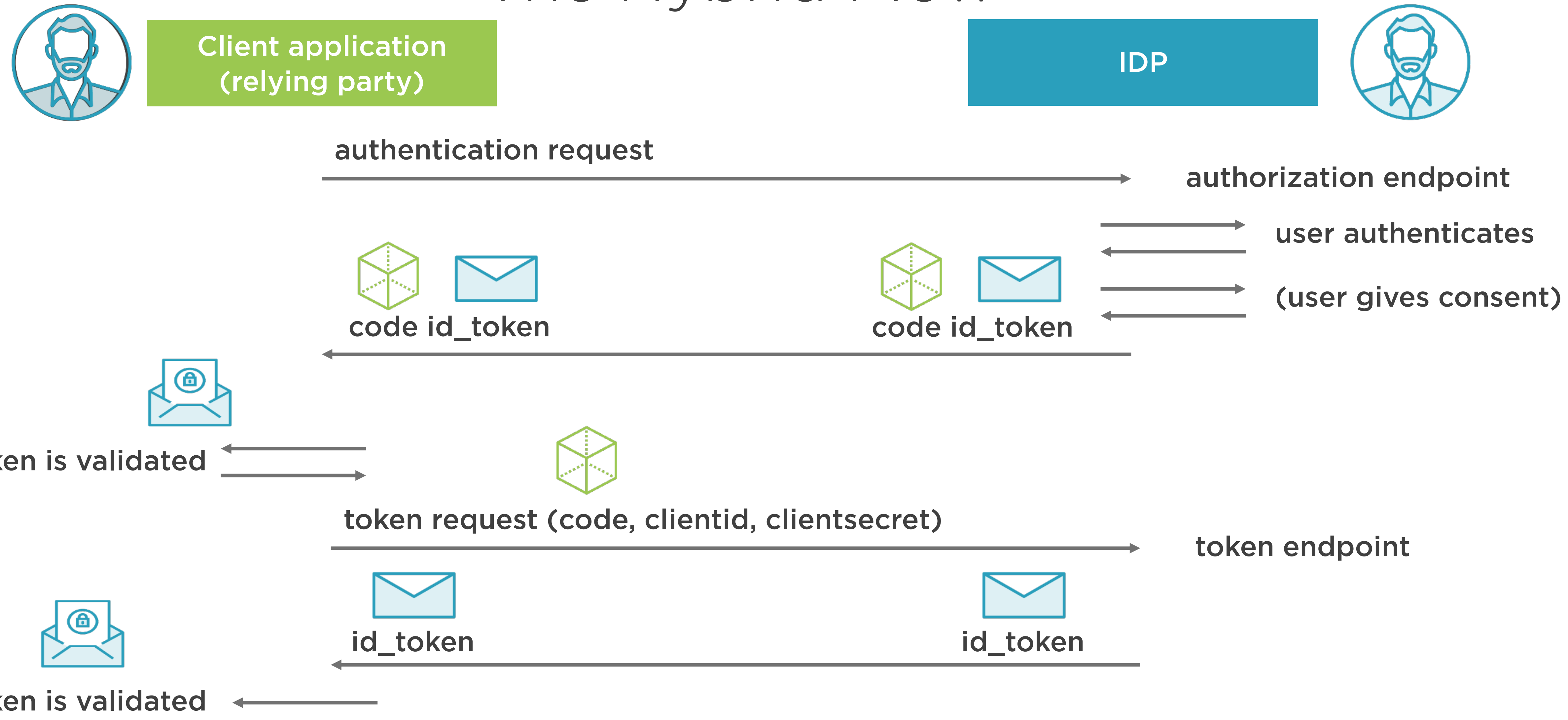
The Authorization Code Flow



The Authorization Code Flow



The Hybrid Flow



Authorization Code vs. Hybrid Flow

The authorization code flow requires PKCE to protect against code injection attacks

- Code injection is mitigated by PKCE because the attacker doesn’t have access to the per-request secret (= code_verifier)

Authorization Code vs. Hybrid Flow

When using the hybrid flow

- The id_token is protected against substitution via the nonce
- The code is linked to the id_token with the c_hash value

```
{ …
  "amr": ["pwd"],
  "nonce": "63…200.ZjMzZ…5YzFlNWNiN2Mw…AtNGYyZi00MzYzNmZh",
  "c_hash": "v1A_h-VQgAvB0-pthVCjJQ",
  "at_hash": "90V_c-PO0kdoP-lOERlkdi"
}
```

Authorization Code vs. Hybrid Flow

Code hash: Base64 encoded value of the left-most half of the hash of the octets of the ASCII representation of the authorization code

Authorization Code vs. Hybrid Flow

When using the hybrid flow

- The id_token is protected against substitution via the nonce
- The code is linked to the id_token with the c_hash value
    - This mitigates the code injection/substitution attack

Authorization Code vs. Hybrid Flow

Hybrid	Authorization code + PKCE
Client-side mitigation of the code substitution attack is more difficult to implement	Client-side mitigation on the code substitution attack only requires the client to generate a random string and hash it
Potentially leak personally identifiable information via the front-channel identity token	

Summary

Current best practice: authorization code flow with PKCE protection

Flow has a front channel and back channel part

- Front channel communication goes via the browser
- Back channel communication is server to server communication

Summary

ClaimsIdentity is created from a validated id_token

Claims can be returned from the UserInfo endpoint to avoid issues with URL length restrictions

When logging out, remember to log out of the IDP if required

The hybrid flow is still a secure alternative