Keeping your applications secure by evolving OAuth 2.0 and OpenID Connect

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The Epic Quest of Single Sign On

Share your identity and delegate resource access to selected services.

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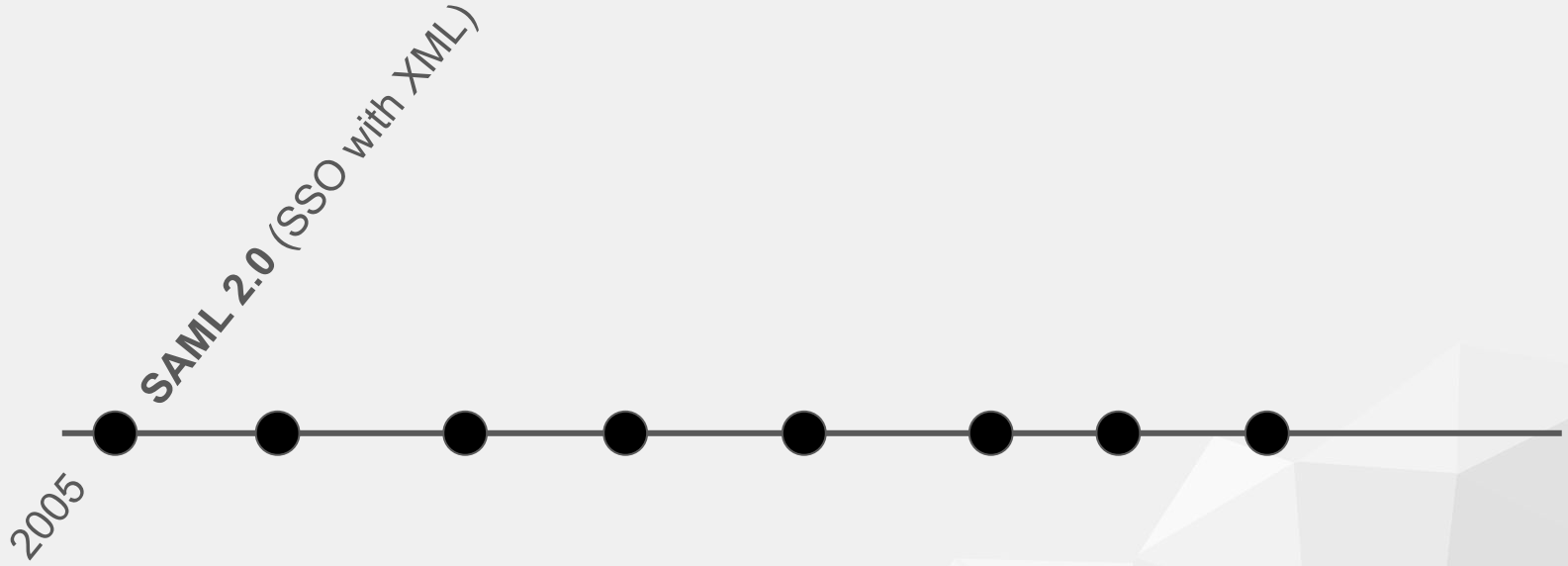
Share your identity and delegate resource access
to selected services.

Keep your credentials secure.
Let applications operate on your data when permitted.

Evolution of Single Sign On and delegation



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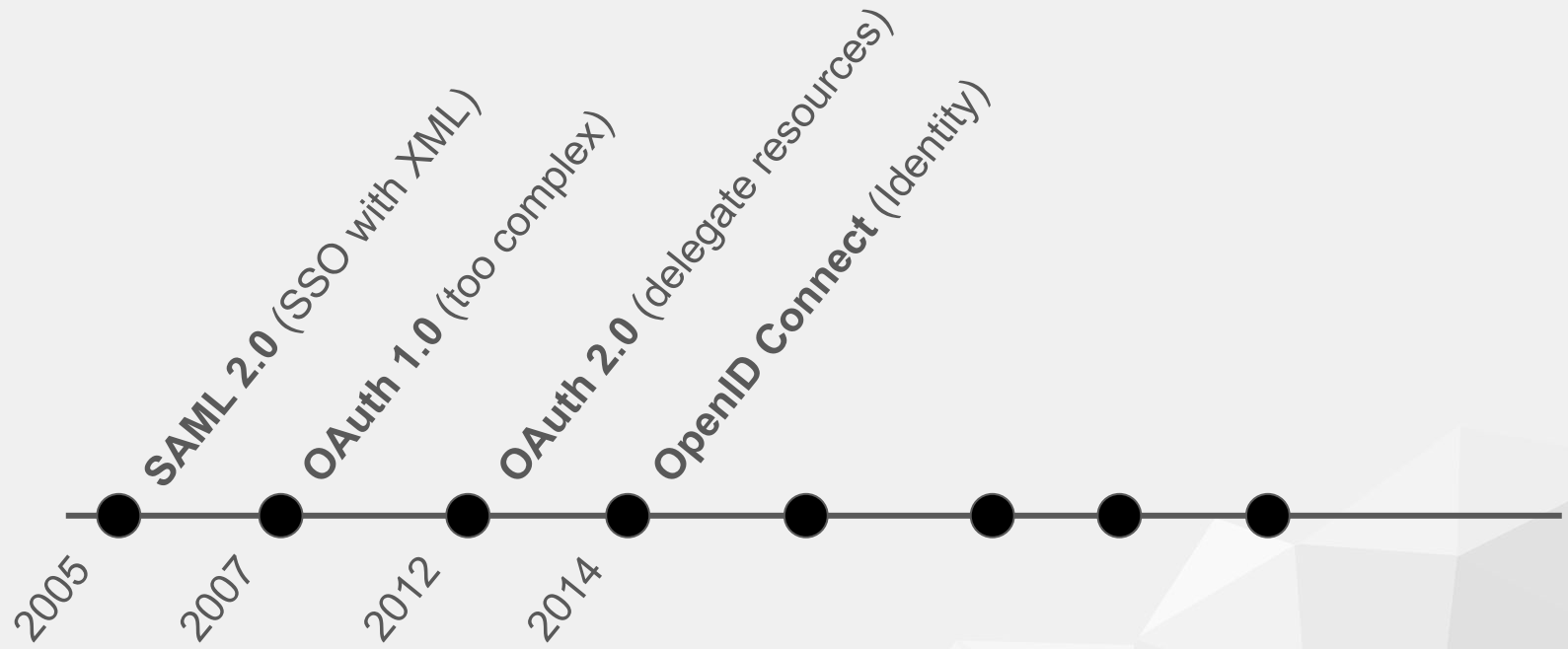

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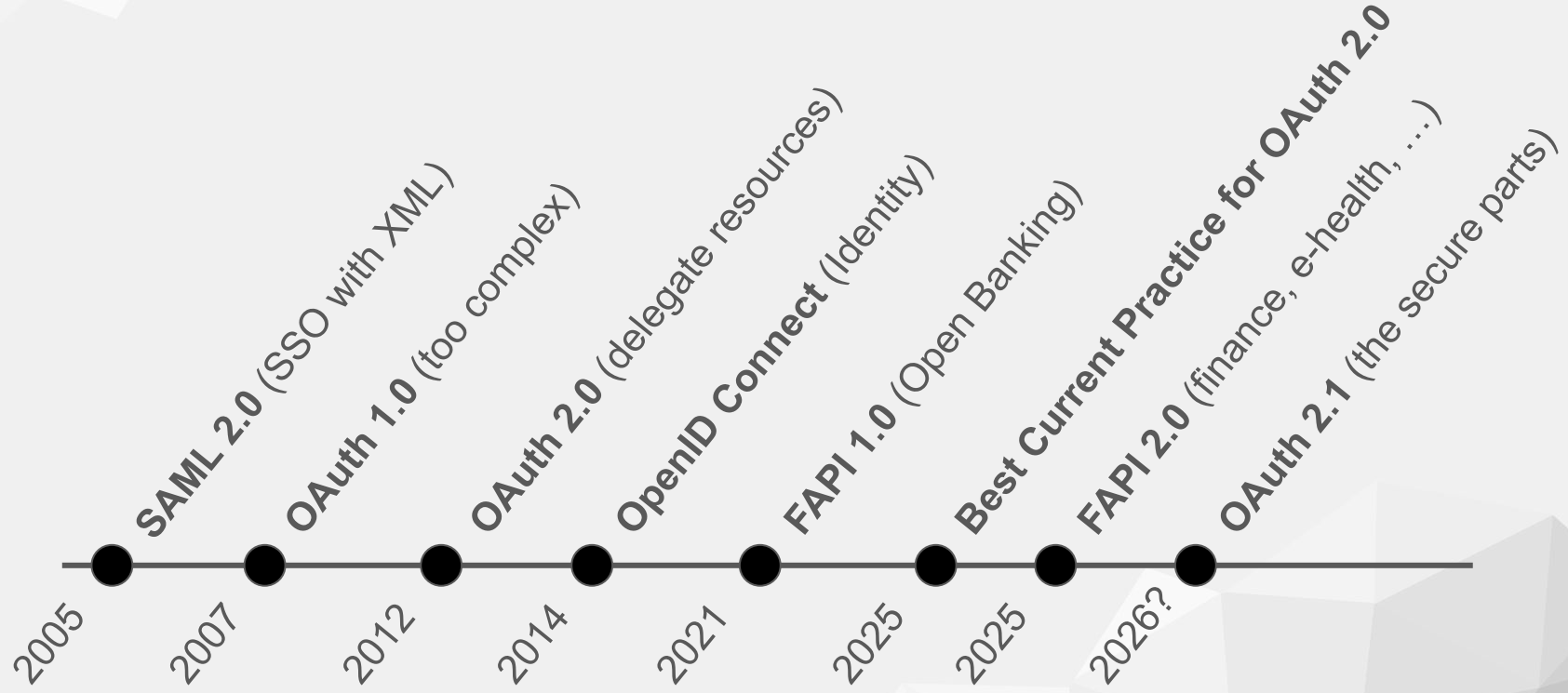


Security Assumptions FAPI 2.0

Attacker personas: what is assumed to be secure, and what can be compromised.

Assumed to work and not compromised/out of scope:

 Transport layer security (TLS)

 Sharing public keys (JWKS)

 Browsers and Endpoints

 Identities and session management

https://openid.net/specs/fapi-attacker-model-2_0-final.html

Attacker Models FAPI 2.0

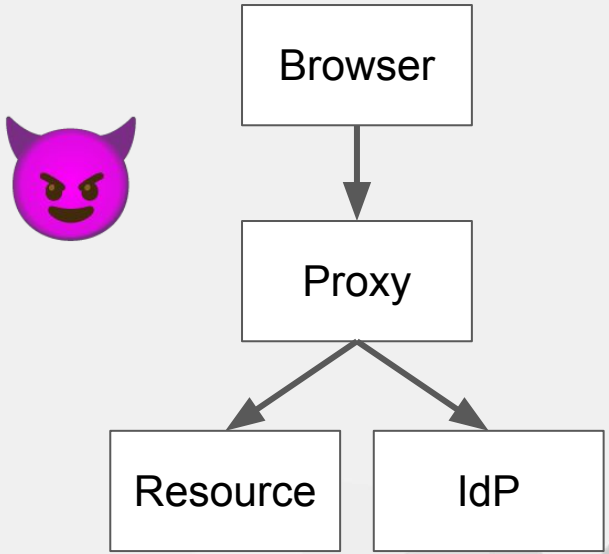
A1: Web attacker: Calls URLs on its own, makes users click links, but can't break encryption.

A2: Spying on the network, but can't break encryption.

A3a: Read authorization requests in the browser.

A5: Read proxy/resource owner request logs, but can't read responses.

…



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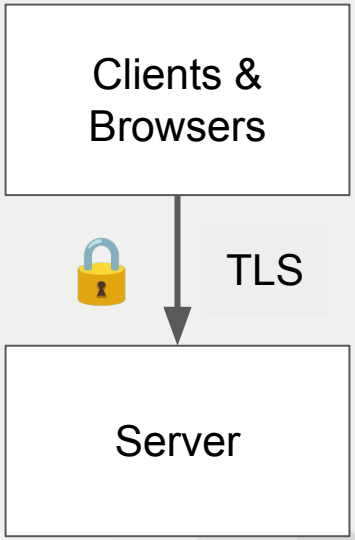
Secure your transport layer

- TLS 1.2+
- TLS certificate checks
- DNSSEC
- Secure TLS ciphers
- HSTS to avoid downgrading
- …

TL;DR: Apply best practices to avoid breaking the out-of-scope assumptions earlier.



https://openid.net/specs/fapi-security-profile-2_0-final.html

Simplified OAuth 2.0 Authorization Code Flow

```
GET authorization_endpoint + ?redirect_uri=...&prompt=login..."
```

```
GET redirect_uri "?...session_state=...code=..."
```

```
POST code and other parameters to token_endpoint
```

```
response with ID token, access token, refresh token, ...
```

Refreshing tokens and calling APIs

```
POST refresh_token to token endpoint
```

```
response with ID token, access token, refresh token, ...
```

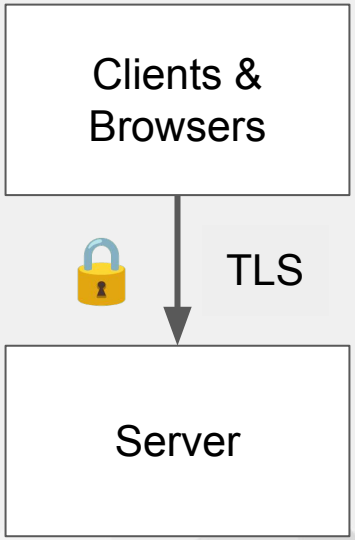
```
Call API endpoint with access token as "Authorization: Bearer ..." header
```

```
Receiving API response
```

Use OAuth best practices

- TLS on all endpoints
- No resource owner password grant
- No wildcards in redirect URIs
- Private Key JWT Client Authentication (= no public clients)

- Pushed Authorization Requests (PAR)
- PKCE with S256
- Sender Constrained Tokens (mTLS or DPoP)

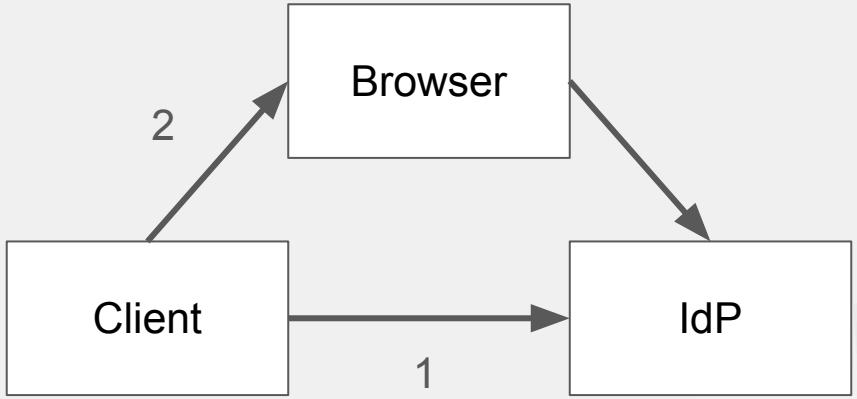


https://openid.net/specs/fapi-security-profile-2_0-final.html

Use PAR for confidential auth flow parameters

Use Pushed Authorization Requests to prevent passing information via the URL to the browser. This ensures confidentiality and integrity. *Works only for confidential clients.*

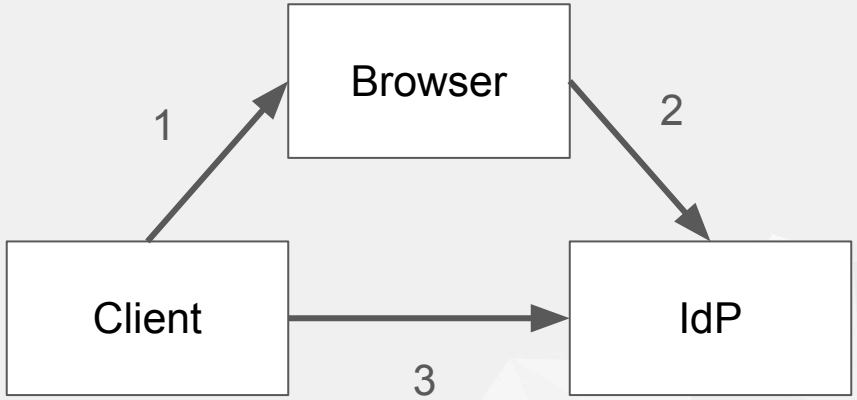
1. Send Information to IdP authenticated with client credentials and receive an ID
2. Forward it to the browser



Use PKCE to secure Authorization Code

Use Proof Key for Code Exchange to prevent others using the authorization code.

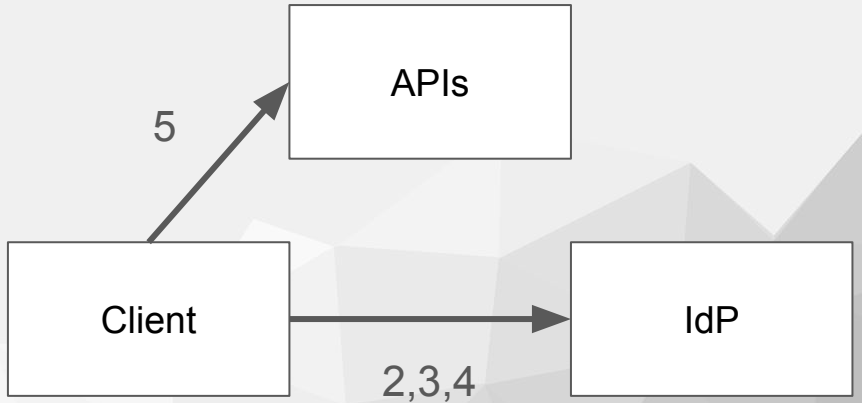
1. Send a code challenge at the start of the authorization code flow
2. Forward challenge to the IdP by the browser
3. Send a code verifier when requesting code-to-token exchange



Sender Constrained Tokens: DPoP

Use Demonstrating Proof-of-Possession (DPoP) with an ephemeral client key pair to secure all steps.

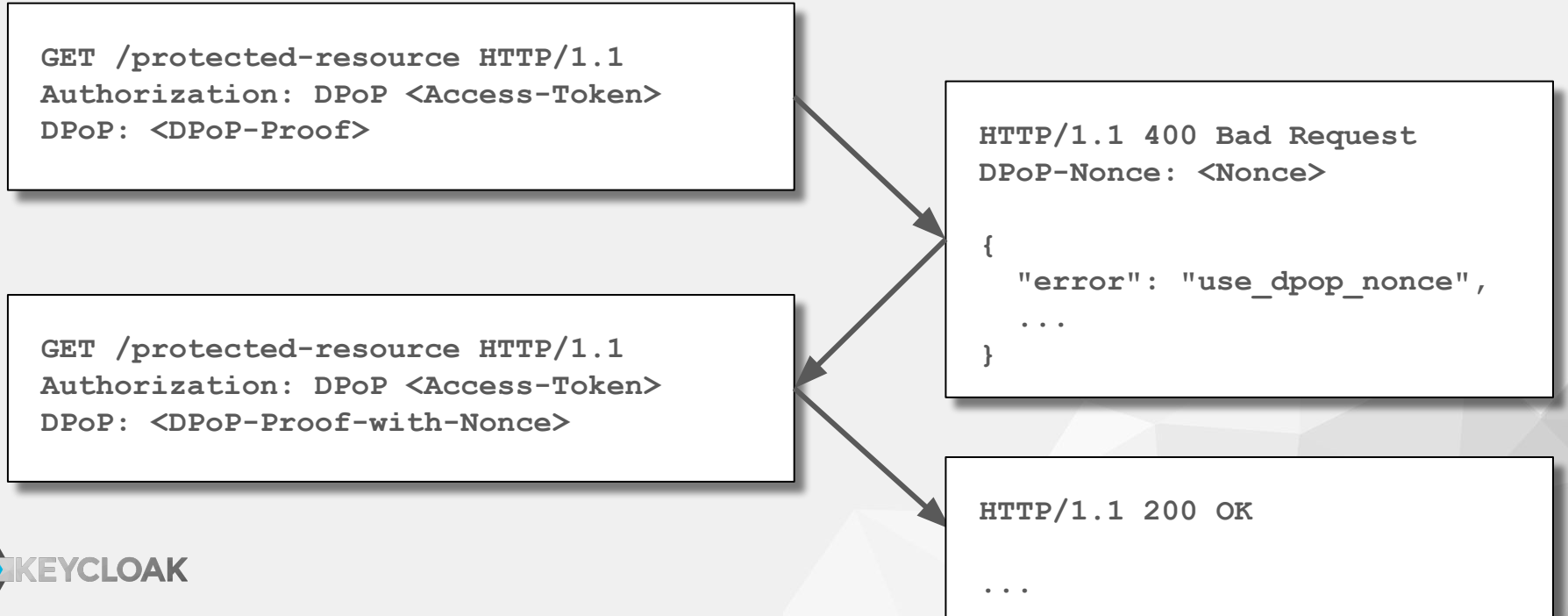
1. Create an ephemeral key pair (for SPAs use the WebCrypto API)
2. Use the authorization code flow with PKCE or DPoP to prevent spoofing
3. Use the DPoP key pair for the code-to-token flow to bind the access token (all clients) and refresh token (public clients) to the keypair to prevent misuse of stolen tokens
4. Use DPoP for all future token refreshes
5. Optional: Use DPoP for APIs (with “Authorization: DPoP …”)



KEYCLOAK https://www.keycloak.org/nightly/securing-apps/dpop

Sender Constrained Tokens: DPoP

HTTP method, URI, DPoP proof, access token and optional nonce need to align!



Sender Constrained Tokens: mTLS

Bind all issued tokens to the the TLS client certificate.

1. Client connects to the IdP to acquire tokens. Tokens contain a hash of the client's certificate
2. All consumers of the access tokens can validate the hash as it is stored as a claim in the token.

Challenges:

- Only works for confidential clients
- Connecting to the IdP with mTLS
- All APIs that the client calls need to support mTLS

Keycloak is an Open Source Identity und Access Management System

- 🎂 First Commit 2013-07-02
- 🏆 Cloud Native Computing Foundation Incubating project since April 2023
- 📜 Apache License, Version 2.0
- ⭐ 33k GitHub stars

Keycloak supports several standards

OpenID Connect, OAuth, SAML, …

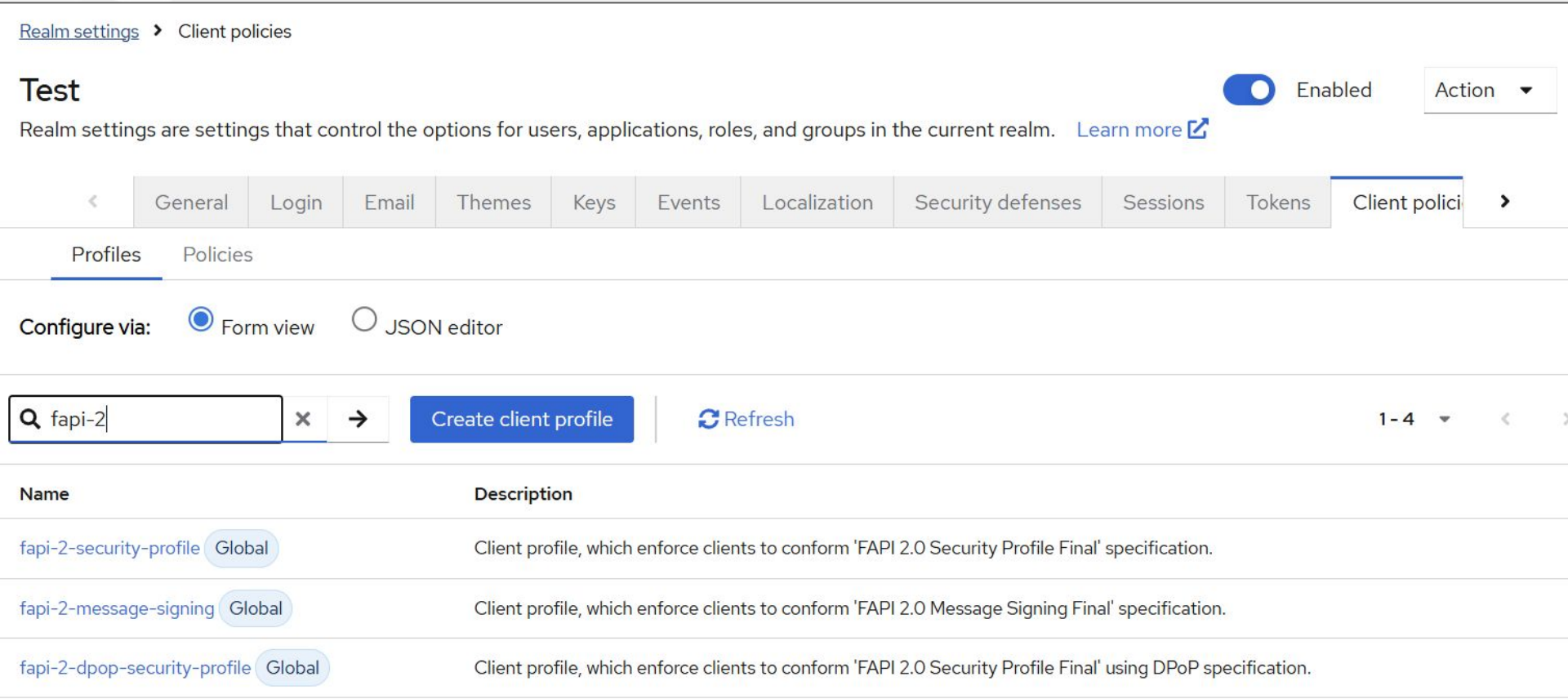
Including:

- **FAPI 2.0 Security Profile**
- **The OAuth 2.1 Authorization Framework (Draft)**

Demo: Let's enforce the FAPI 2.0 Security Profile

https://www.keycloak.org/securing-apps/specifications

Keycloak Client Profiles



Keycloak Adding a client policy

Realm settings > Client policies > Policy details

My secure clients

Enabled

Action

Name *

My secure clients

Description

Apply FAPI 2.0 security profile to all clients that have a client-role "secure".

Save

Reload

Conditions

Add condition

client-roles

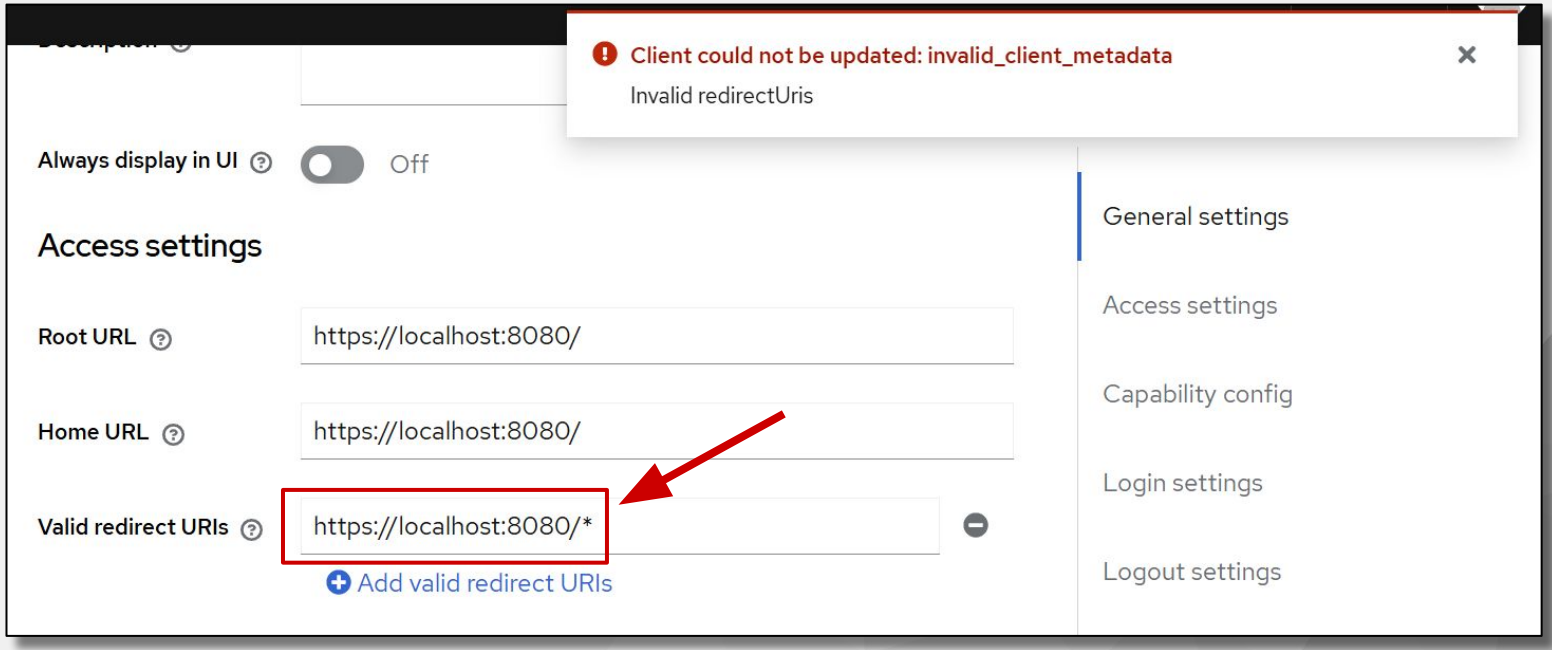
Client profiles

Add client profile

fapi-2-security-profile

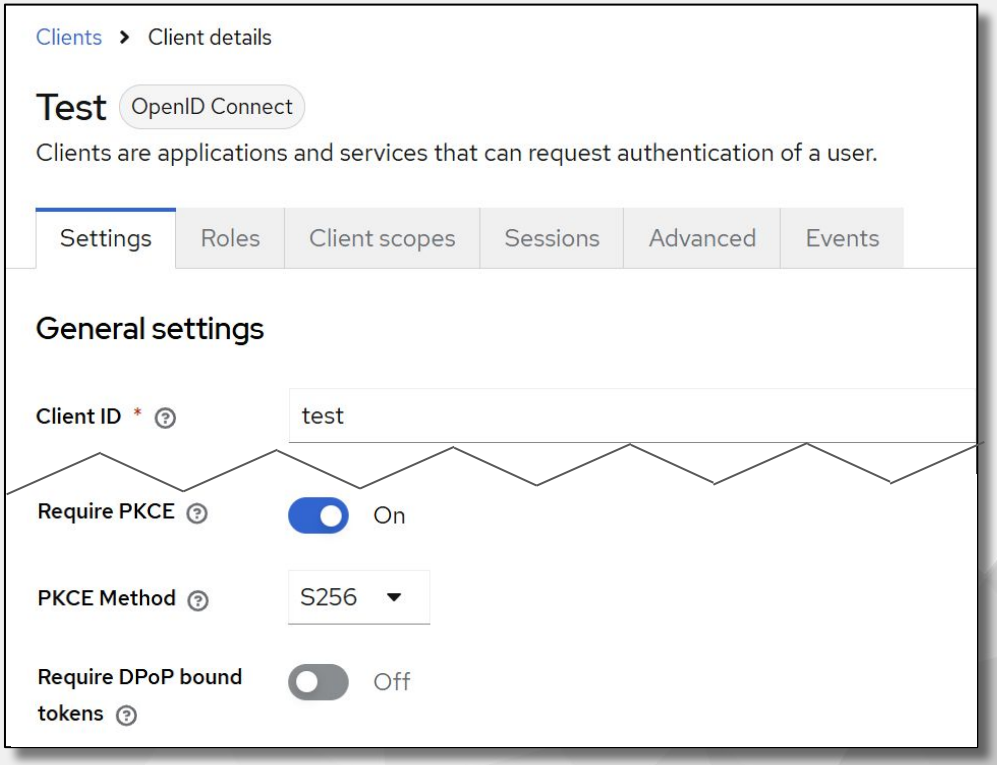
Validation of the policy in all actions

Policy is checked on client update, login, token issuing. See an example for client update below where a wildcard redirect URI is not allowed.



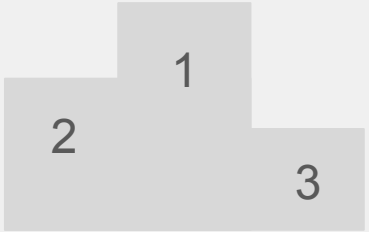
Client-specific configurations

Some settings are also available on a per-client level.



OAuth 2.1 (draft) vs. OAuth 2.0

- No wildcard redirect URLs or URL fragments.
- No localhost and loopback addresses.
- Must use PKCE.
- No implicit grant.
- No Resource Owner Password Grant.
- No Bearer token in query parameters.
- …



➡️ Moving target as it is not released yet, but very much aligned with FAPI 2.0 and “Best Current Practice for OAuth 2.0 Security” (RFC 9700)

Tools to help you

- **mod_auth_openidc** / OAuth 2 and OpenID Connect for Apache 2.x httpd server
  Supports FAPI 2.x (including DPoP)
  https://github.com/OpenIDC/mod_auth_openidc
- **openid-client** / OAuth 2 and OpenID Connect Client API for JavaScript Runtimes
  https://github.com/panva/openid-client
  Certified for FAPI 2.0 (including DPoP)
- **Nimbus OAuth SDK** / Framework-agnostic OAuth 2 and OpenID Connect for Java
  https://connect2id.com/products/nimbus-oauth-openid-connect-sdk

How to evolve OAuth security in your setup

1. Pick one security feature to enforce and educate developers (for example PKCE)
2. Wait for developers to complete their tests.
3. Update clients configurations in the IdP one-by-one.
4. Repeat for other features (like implicit grant, DPoP, etc.).

Brownouts to speed up the process

“deliberate introduction of temporary outages to a system, API or feature that is being phased out.”

1. Explain a set of best practices to your engineers and how to test them in staging.
2. Let IdP enforce best practices Monday between 9 and 10.
3. Set a deadline to enforce them permanently.
4. Repeat with the next set.

https://en.wikipedia.org/wiki/Brownout_(software_engineering)

Keeping applications secure

 Level up clients, IdPs and and APIs.

 Enforce policies to keep your organization aligned.

 Share your successes and lessons learned with the community.

Case Studies

Hitachi Ltd. used Keycloak to make financial grade security easier

OpenTalk achieves versatile and compliant user authentication with Keycloak

BRZ migrated the Austrian Business Service Portal with 2M+ users to Keycloak

https://www.keycloak.org/case-studies

Links

Slides:

- **Keycloak**
  https://www.keycloak.org/
- **Case Studies**
  https://www.keycloak.org/case-studies
- **KeycloakCon @ KubeCon EU**
  https://events.linuxfoundation.org/kubecon-cloudnativecon-europe/
- **Using DPoP to use access tokens securely in your Single Page Applications @ FOSDEM 2025**
  https://archive.fosdem.org/2025/schedule/event/fosdem-2025-5370-using-dpop-to-use-access-tokens-securely-in-your-single-page-applications/

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