OAuch

Analyzing the Security Best Practices in the OAuth 2.0 Ecosystem

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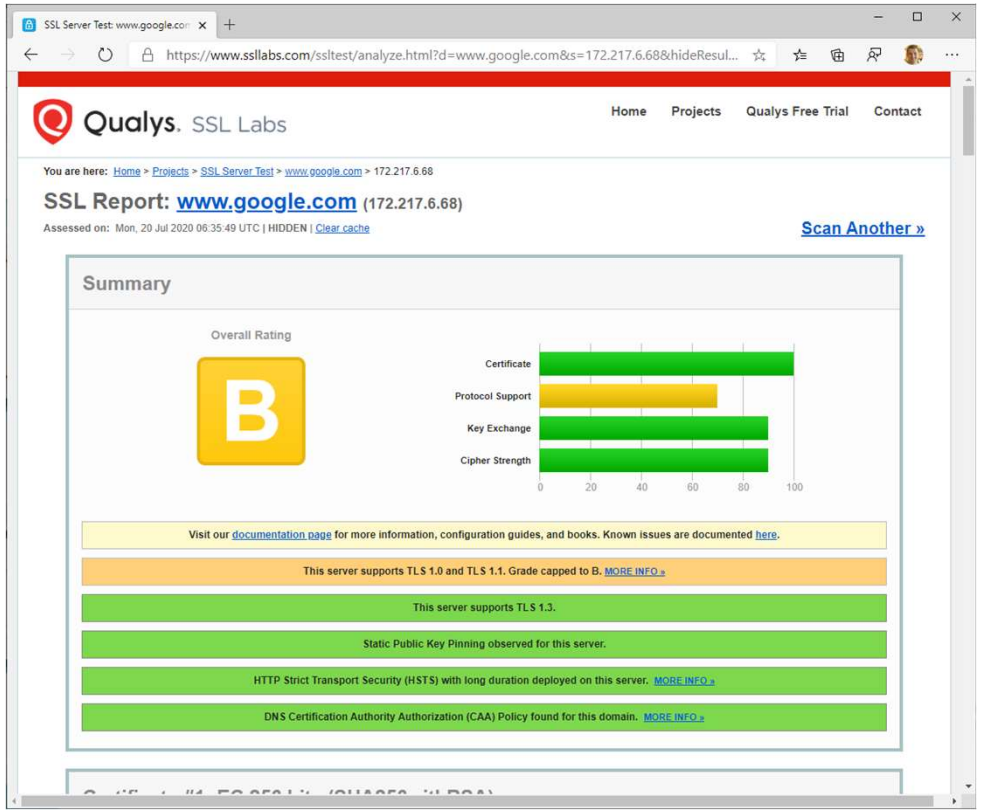
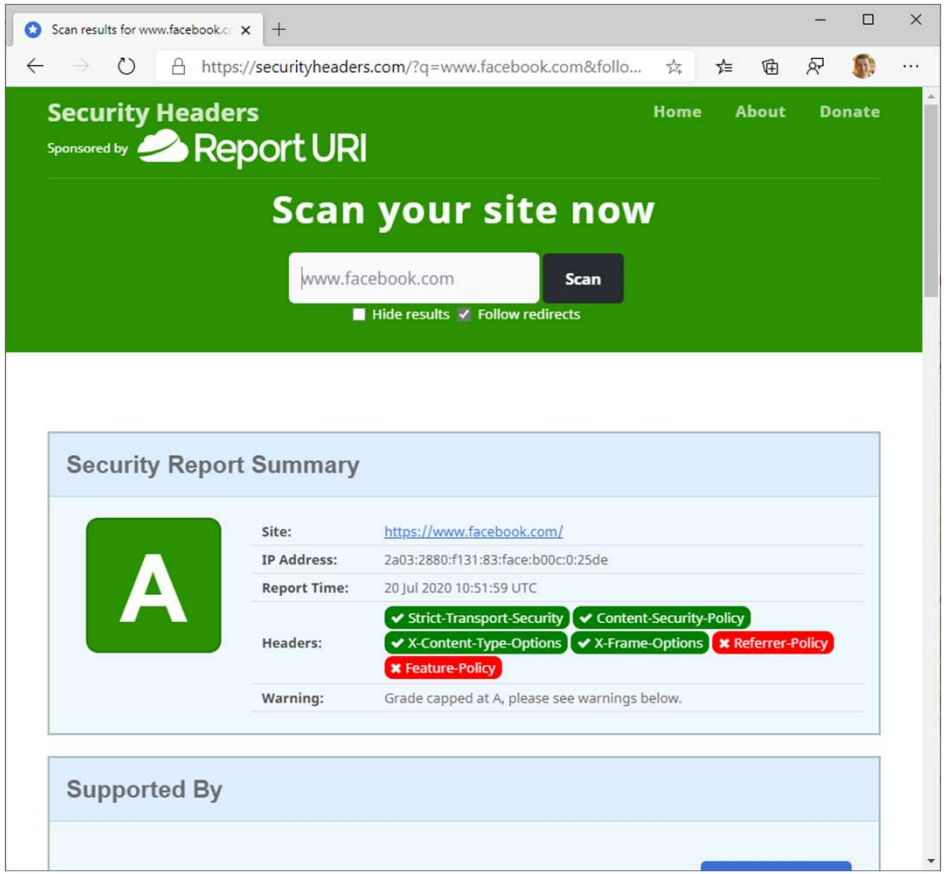
“Once you have implemented OAuth2, how do you know you have implemented it securely?”





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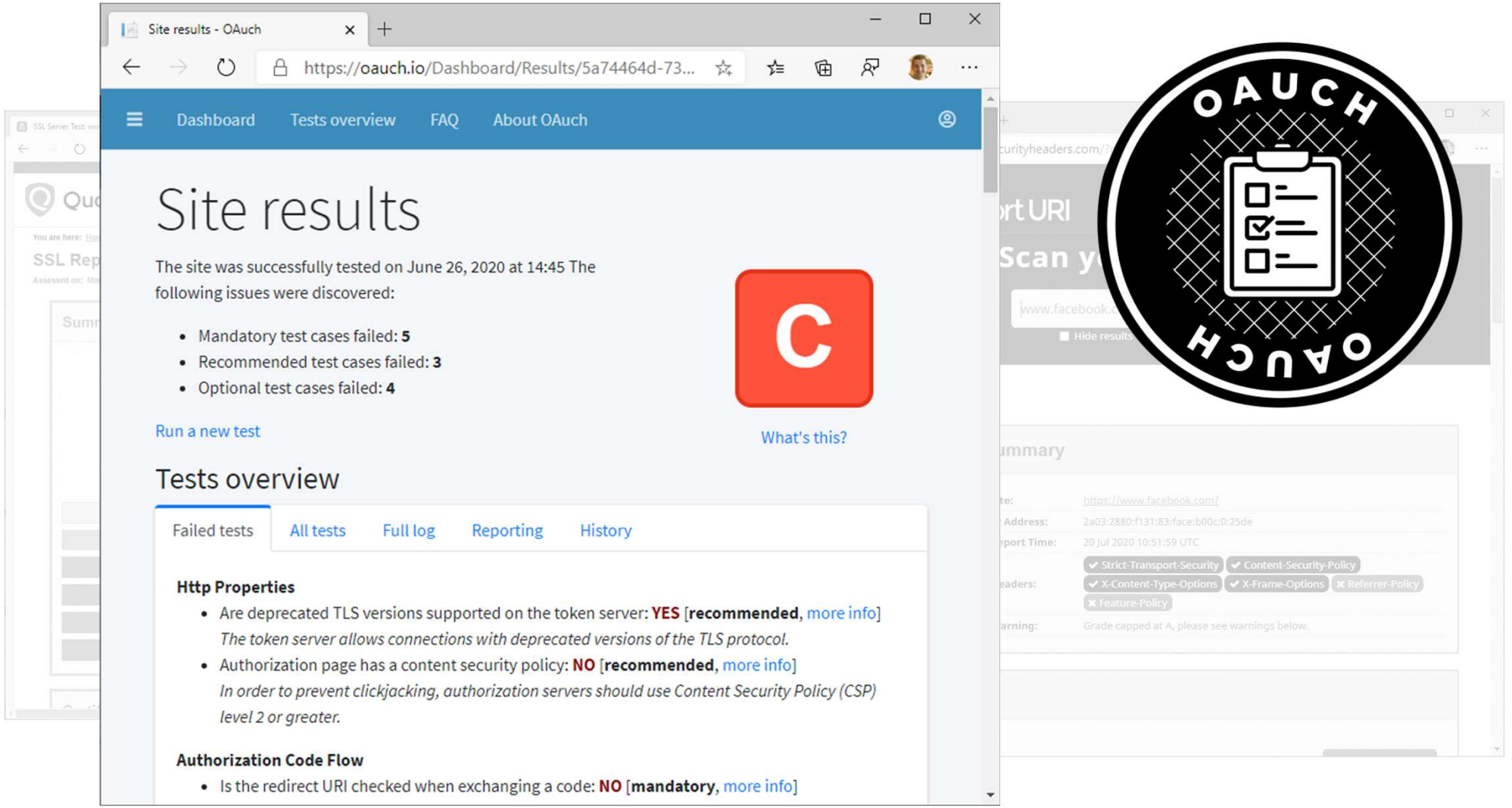

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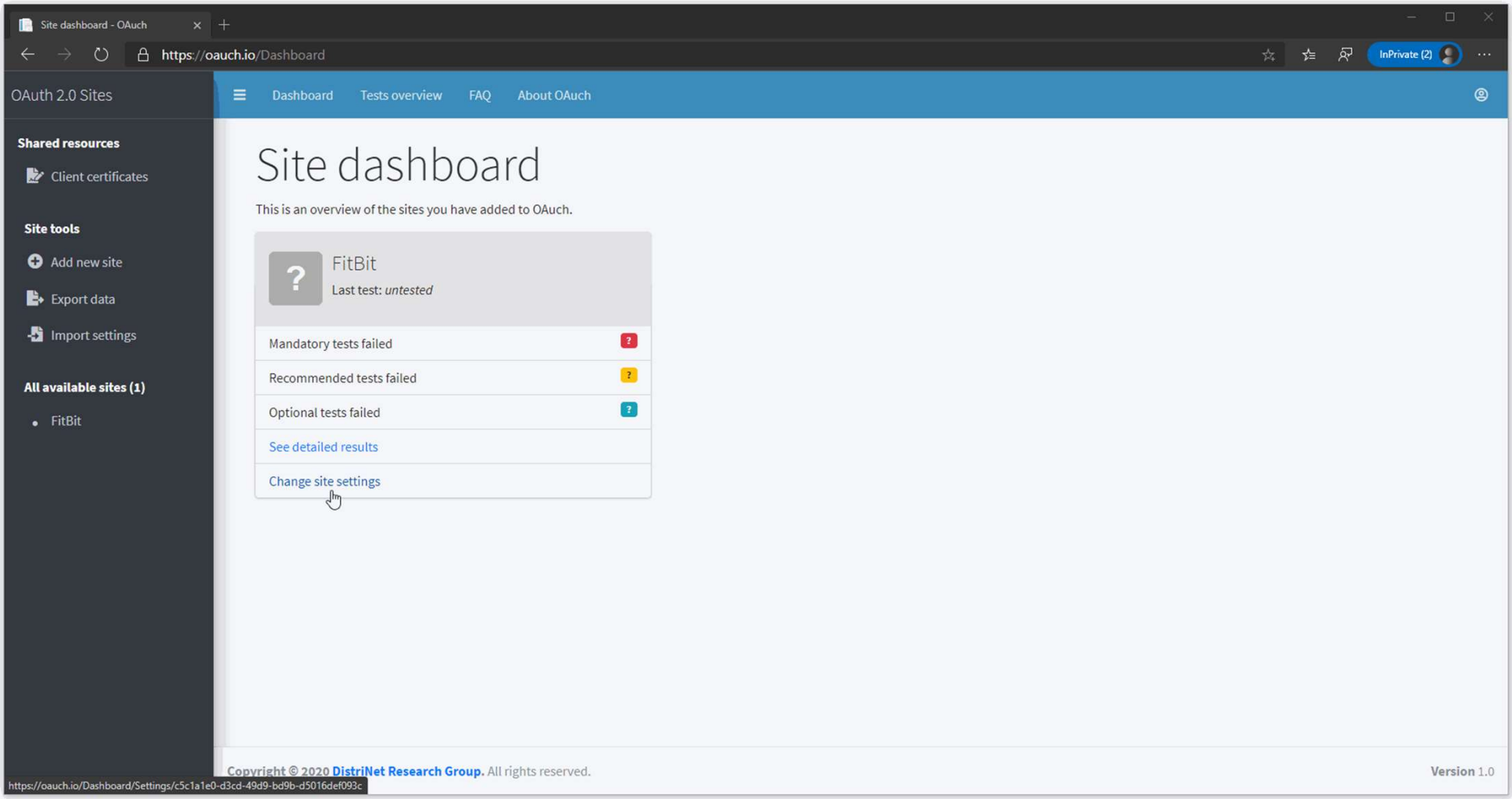

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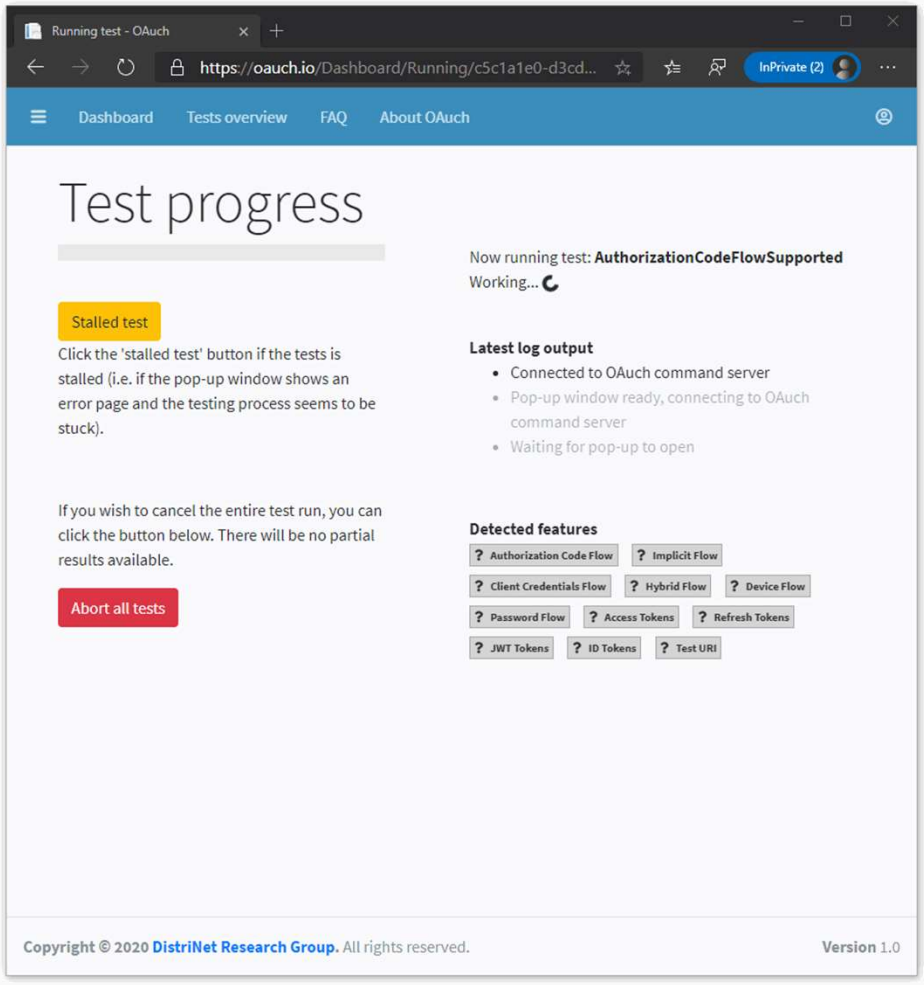
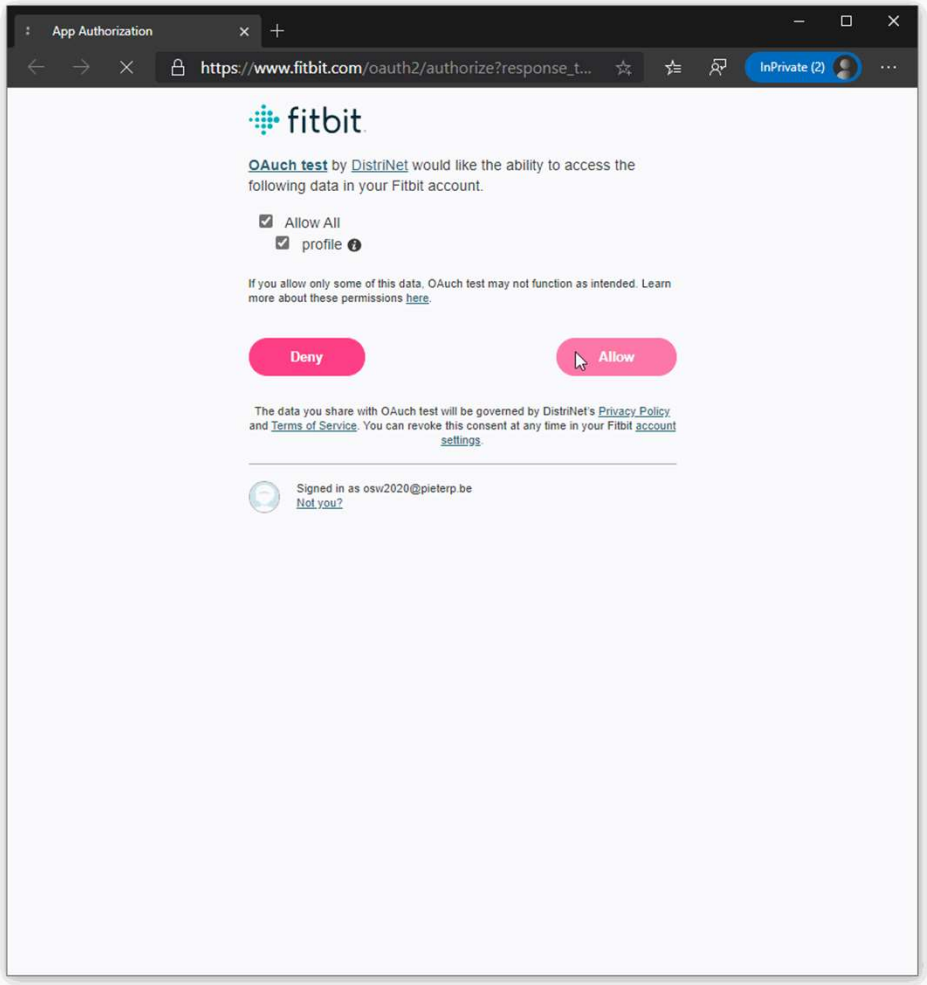


Test Overview



Authorization and Callback Window

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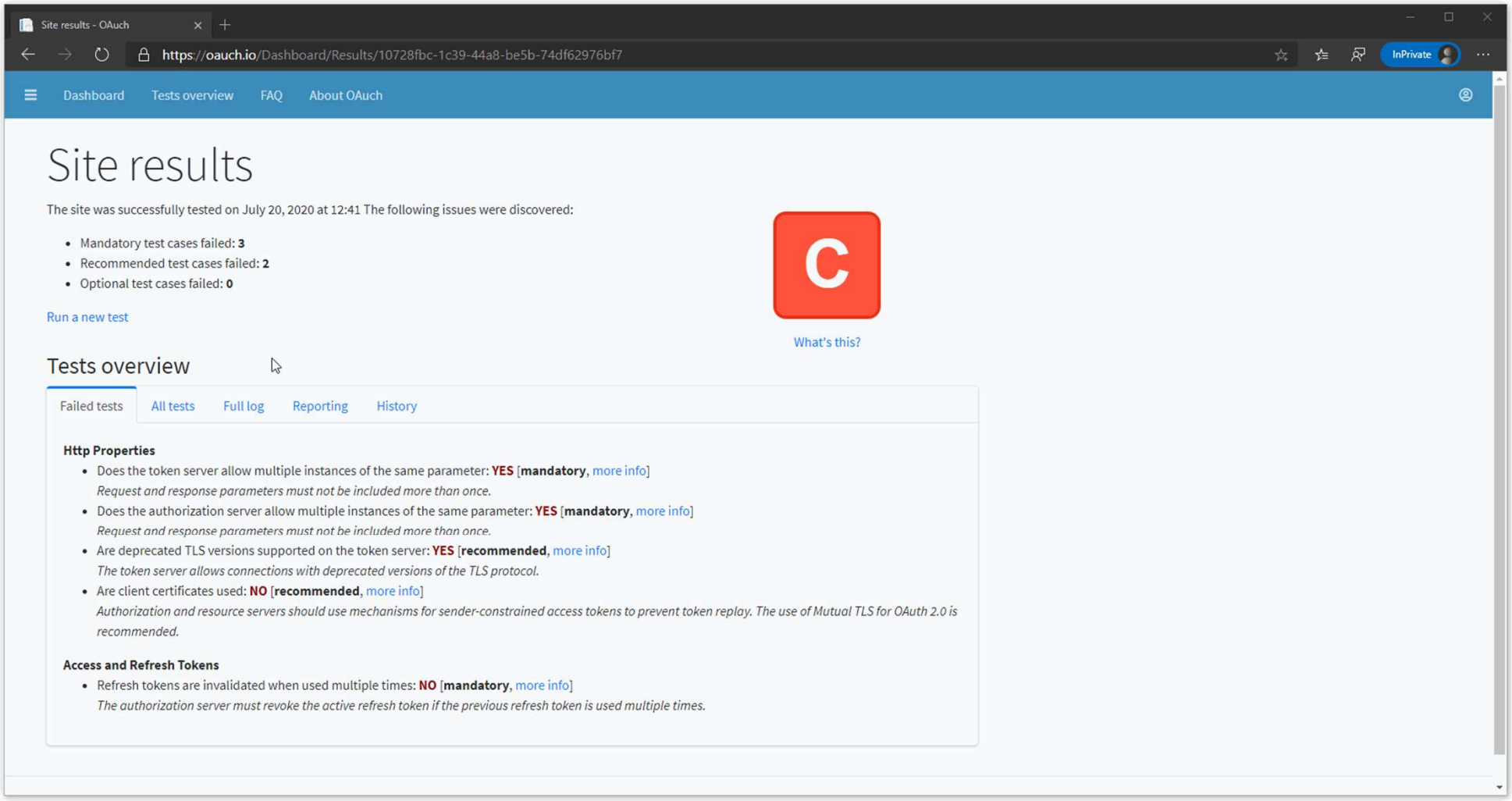

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Analyzing the OAuth 2.0 Ecosystem

What we did

- We tested 100+ OAuth implementations
  - 94 deployed and publicly available services
  - 17 OIDC providers, 77 OAuth 2.0 API providers
- We drew statistics over the sites and over the individual countermeasures

Supported Flows

API Providers

- 94% support Authorization Code flow
- 44% support Implicit flow
- 30% support Client Credentials flow
- 3% support Password flow

OIDC Providers

- 100% support Authorization Code flow
- 35% support Client Credentials flow
- 24% support Implicit flow
- 24% support Hybrid flow
- 6% support Device flow

Failure Rates

API Providers

- 38.0% average failure rate (±6.9%)
  - 31% *must* failures
  - 40% *should* failures
  - 85% *may* failures

OIDC Providers

- 28.0% average failure rate (±7.0%)
  - 22% *must* failures

Client Authentication

Client Type

- 1% support only public clients
- 1% support confidential clients (crypto key)
- 98% support confidential client (password)
  - However, 12% do not use/require the password

Client Authentication

Authorization servers must support the *Authorization* header

- Support is mandatory, but only 69% support it
- Other sites use form POST

Proof Key for Code Exchange

Authorization servers must support PKCE

- Only 12% of API providers support PKCE
  - Mostly ignored
  - Sometimes disallowed

Proof Key for Code Exchange

For the API providers supporting PKCE:

- None required PKCE
- 33% supported *plain* PKCE
- 44% allowed very short verifiers
- 56% were vulnerable to PKCE sidestep attack[1]

[1] https://mailarchive.ietf.org/arch/msg/oauth/qrLAf3nWRt8HAFkO49qGrPRuelo/

Redirect URI Matching

Callback URIs must be precisely matched

- Only 48% of sites do this

Token endpoint must compare the callback URI with the one received in the authorization request

- Only 43% of sites do this

Authorization Codes

Authorization codes must only be used once

- 76% disallow code exchange
- 12% disallow code exchange and revoke previously granted access tokens
- 12% allow multiple code exchanges

Access Tokens

- Are mostly opaque (only 15% JWT)
- Are long (85% over 128 bits of entropy)
- Can often be used as URI query parameter (44%)

Refresh Tokens

- Are used by 66% of sites

- When *refresh token rotation* is used, refresh tokens must be single use
  - Of these sites, only 34% prohibited exchanging the same refresh token multiple times
  - Active refresh tokens were never revoked

Access Tokens and Refresh Tokens

If refresh tokens are used, access token lifetime should be short

- < 1 hour: 36%
- < 8 hours and > 1 hour: 27%
- < 24 hours and > 8 hours: 10%
- > 24 hours: 27%

Some of the other results

- 26% allow authorization pages to be framed *(mandatory)*
- 29% allow the caching of sensitive values *(mandatory)*
- 70% do not suppress the referrer header *(optional)*
- 94% do not support *form post response mode* *(optional)*
- 85% allow parameters to be included multiple times *(mandatory)*
- 60% of OIDC servers do not support POST authorization requests *(mandatory)*
- 50% of OIDC servers did not require a *nonce* for the implicit flow *(mandatory)*
- 83% do not support token revocation *(optional)*
  - Of those that did, 42% accept revoked refresh tokens *(mandatory)*
- …

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Work in progress…

- These results are a work-in-progress
  - The full analysis will hopefully be published soon

- The OAuch tool will be available at https://oauch.io/ (early September)
  - Offline download by the end of the year

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Conclusions

- Having a formal verification of the OAuth2 protocol is great (and necessary)!
  - … but we also need tools to verify practical implementations
- A lot of sites can benefit from implementing missing countermeasures

Thank you!

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