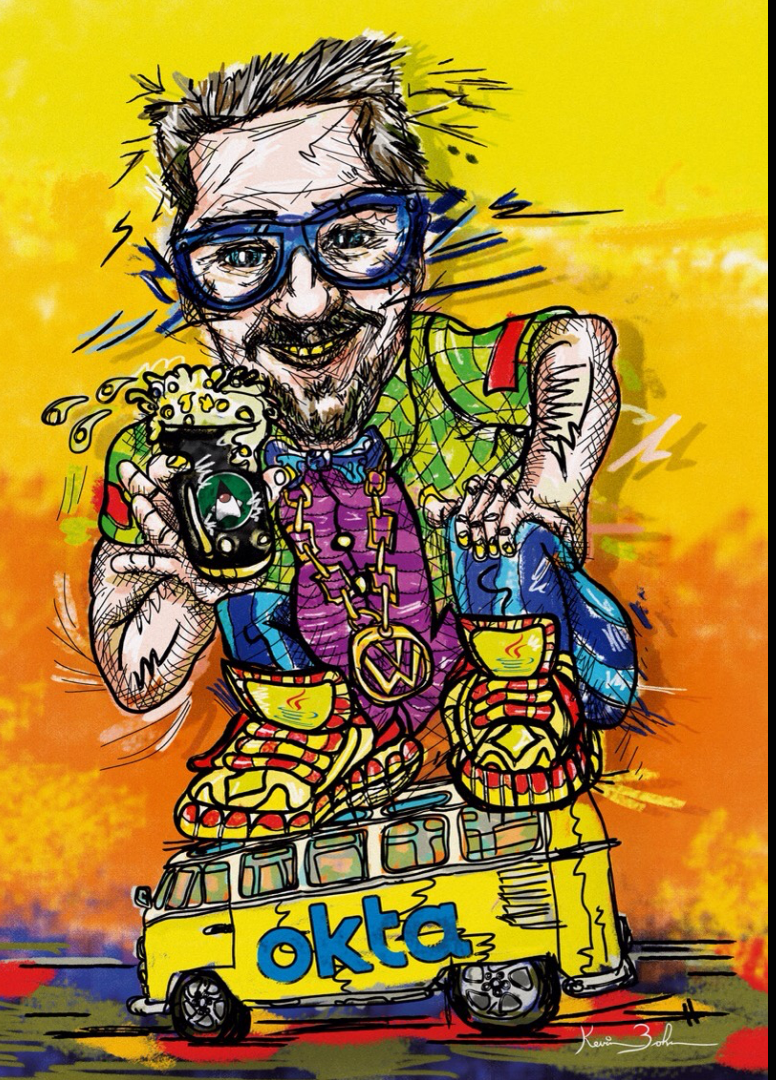
What the Heck is OAuth and OIDC?

Matt Raible | **@mraible**

October 25, 2018

Photo by **L1mey** flickr.com/photos/l1mey/4510426390

okta



Who is Matt Raible?

Father, Skier, Mountain Biker,
Whitewater Rafter

Open Source Connoisseur

Web Developer and Java Champion

Okta Developer Advocate

Bus Lover

Blogger on raibledesigns.com and
developer.okta.com/blog


The UPS Store
perry nails
DUGOUT
DENTIST
PHILLIPS 66

developer.okta.com

Authentication Standards

What about You?

Have you heard of OAuth or OIDC?

Do you consider yourself a developer?

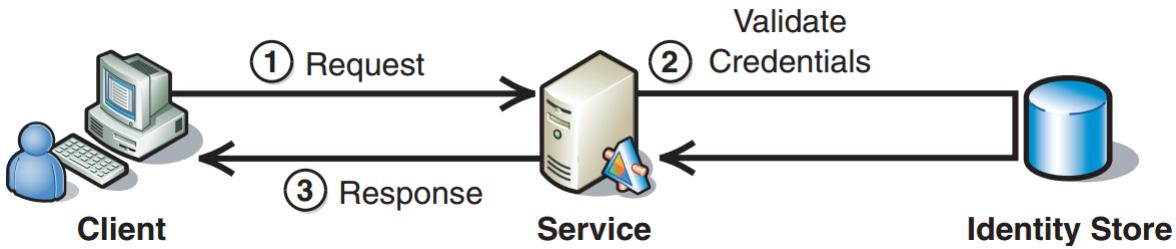
Have you ever written authentication from scratch?

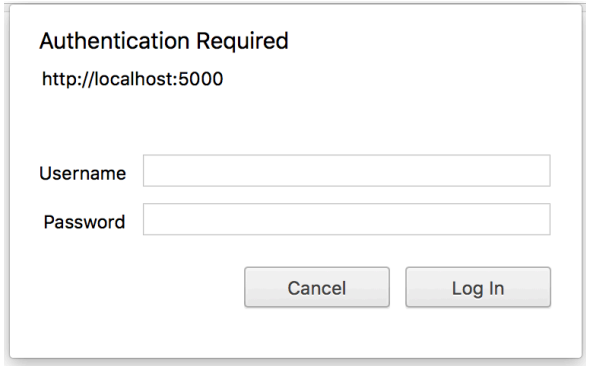
Have you implemented OAuth or OIDC?

Why are you here?

OAuth 2.0 Overview

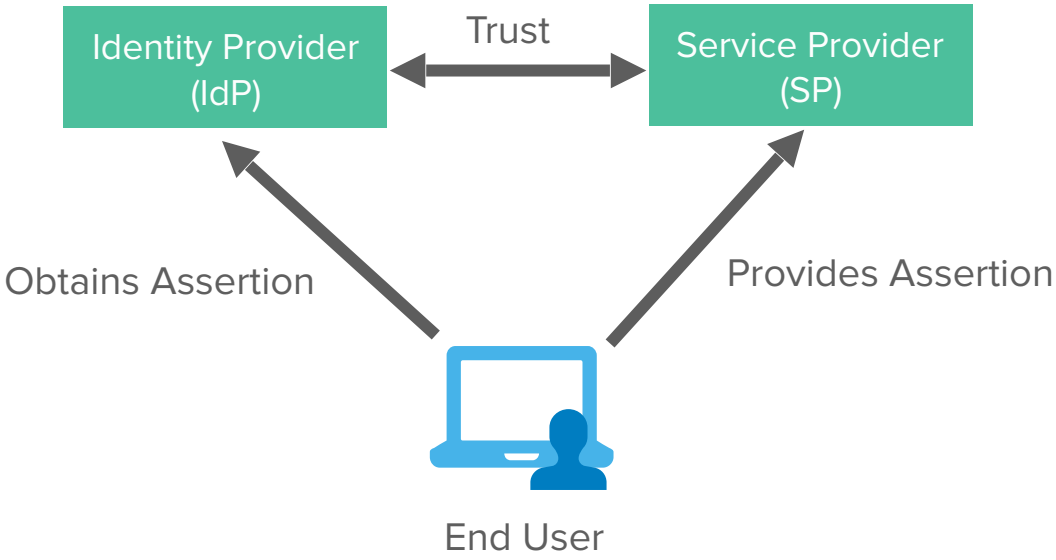
Web Authentication



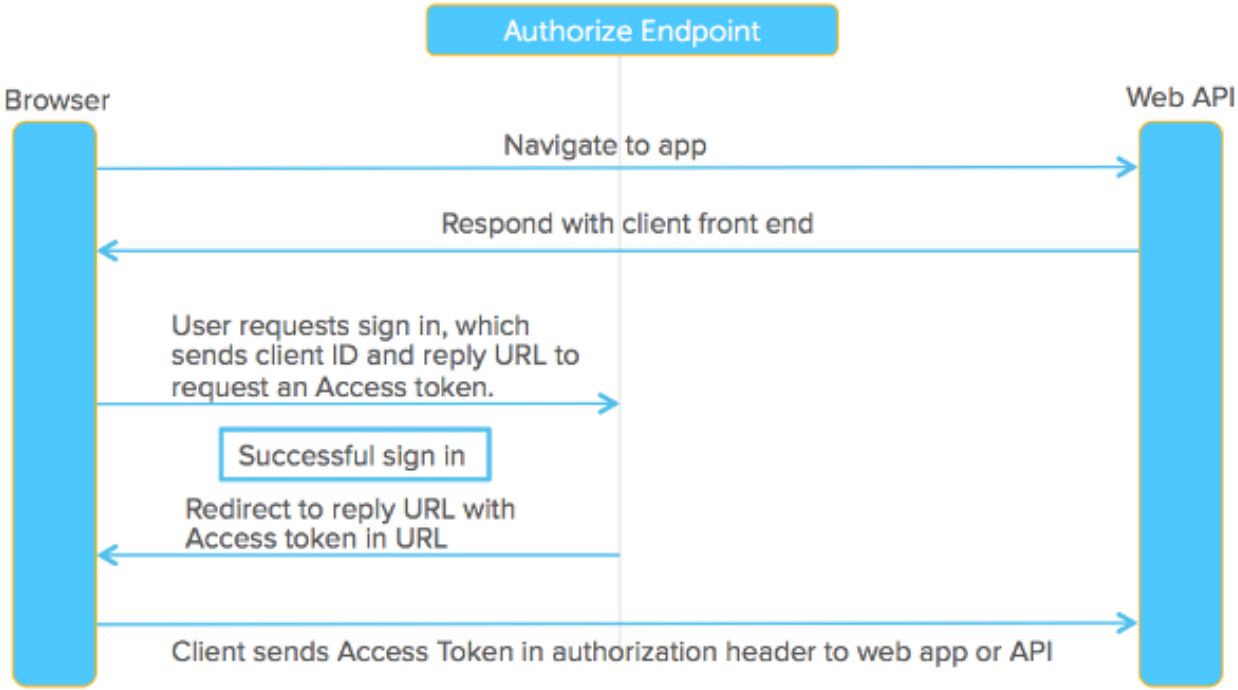


GET **/index.html** HTTP/1.1
Host: www.example.com
Authorization: Basic QWxhZGRpbjpvcGVuIHNlc2FtZQ==

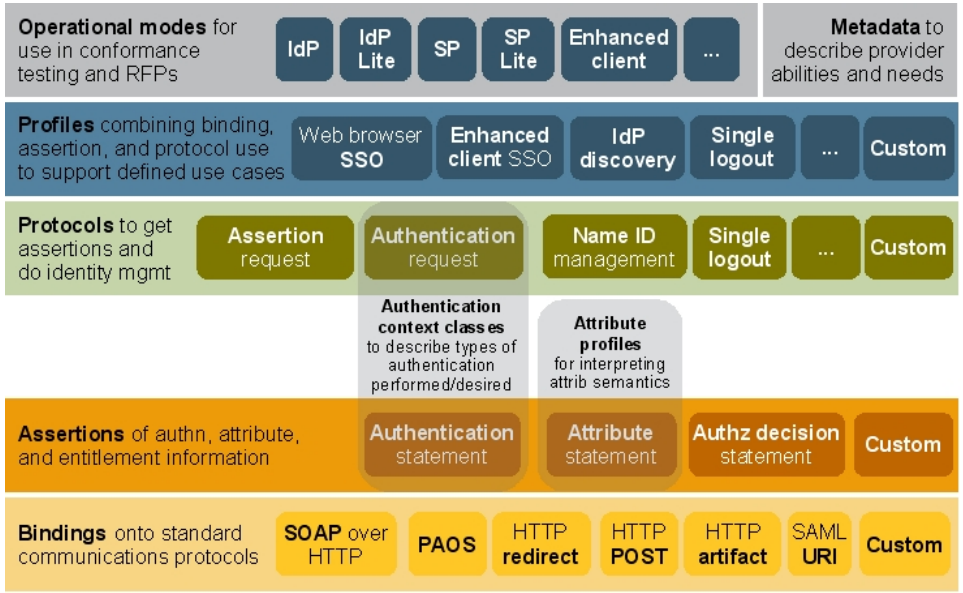
Federated Identity



How Federated Identity Works



SAML 2.0



OASIS Standard, 15 March 2005

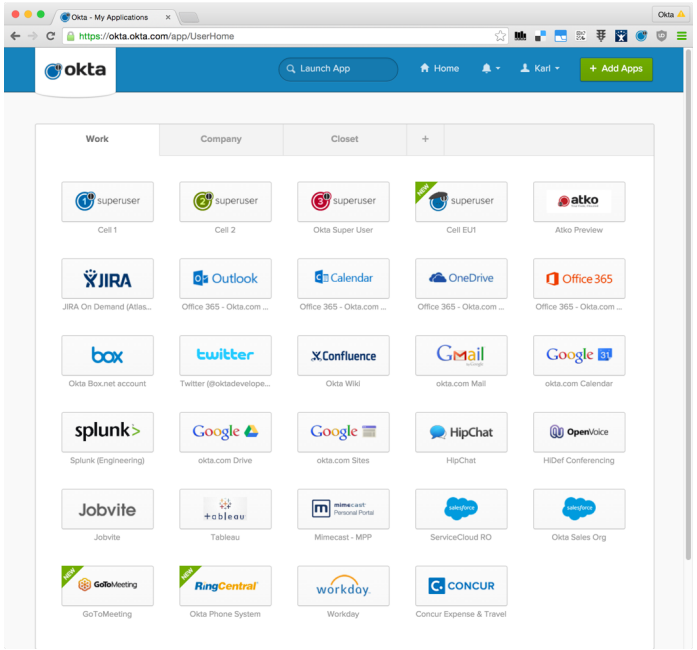
Authentication Request Protocol

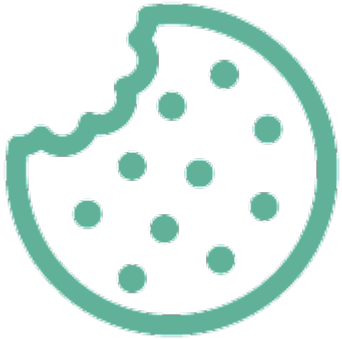
Assertion

SAML 2.0 Assertion

```
<Assertion xmlns="urn:oasis:names:tc:SAML:2.0:assertion" ID="b07b804c-7c29-ea16-7300-4f3d6f7928ac" Version="2.0"
IssueInstant="2004-12-05T09:22:05"
   <Issuer>https://example.okta.com</Issuer>
   <ds:Signature xmlns:ds="http://www.w3.org/2000/09/xmldsig#">...</ds:Signature>
   <Subject>
     <NameID Format="urn:oasis:names:tc:SAML:2.0:nameid-format:unspecified">
       matt@example.com
     </NameID>
     <SubjectConfirmation Method="urn:oasis:names:tc:SAML:2.0:cm:bearer">
     </SubjectConfirmation>
   </Subject>
   <Conditions NotBefore="2004-12-05T09:17:05" NotOnOrAfter="2004-12-05T09:27:05">
     <AudienceRestriction>
       <saml:Audience>https://sp.example.com/saml2/sso</saml:Audience>
     </AudienceRestriction>
   </Conditions>
   <AuthnStatement AuthnInstant="2004-12-05T09:22:00" SessionIndex="b07b804c-7c29-ea16-7300-4f3d6f7928ac">
     <AuthnContext>
       <AuthnContextClassRef>
         urn:oasis:names:tc:SAML:2.0:ac:classes:PasswordProtectedTransport
      </AuthnContextClassRef>
     </AuthnContext>
   </AuthnStatement>
   <AttributeStatement>
     <Attribute Name="displayName">
       <AttributeValue>Matt Raible</AttributeValue>
     </Attribute>
   </AttributeStatement>
 </Assertion>
```

SAML = Web SSO


Okta - My Applications
https://okta.okta.com/app/UserHome
okta
Launch App
Home
Karl
+ Add Apps
Work
Company
Closet
+
superuser
Cell 1
superuser
Cell 2
superuser
Okta Super User
superuser
Cell EU1
atko
Atko Preview
JIRA
JIRA On Demand (Atlas...
Outlook
Office 365 - Okta.com ...
Calendar
Office 365 - Okta.com ...
OneDrive
Office 365 - Okta.com ...
Office 365
Office 365 - Okta.com ...
box
Okta Box.net account
twitter
Twitter (@oktadevelope...
Confluence
Okta Wiki
Gmail
okta.com Mail
Google
okta.com Calendar
splunk>
Splunk (Engineering)
Google
okta.com Drive
Google
okta.com Sites
HipChat
HipChat
OpenVoice
HiDef Conferencing
Jobvite
Jobvite
+ableau
Tableau
mimecast
Mimecast - MPP
salesforce
ServiceCloud RO
salesforce
Okta Sales Org
GoToMeeting
GoToMeeting
RingCentral
Okta Phone System
workday.
Workday
CONCUR
Concur Expense & Travel




SOAP


What's
Changed
Since
2005?

Confusion

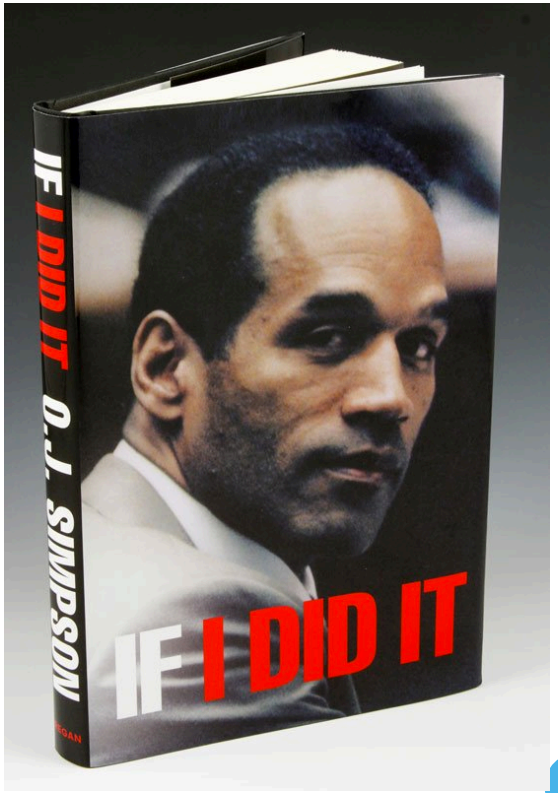
Identity Use Cases (circa 2006)

Simple login — basic, forms, and cookies

Single sign-on across sites — SAML

Mobile app login — N/A

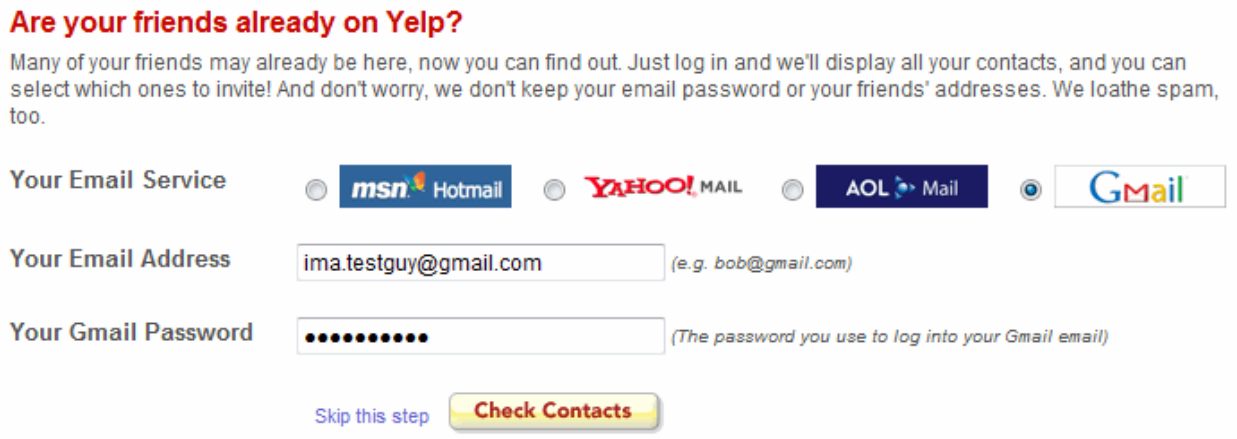
Delegated authorization — N/A



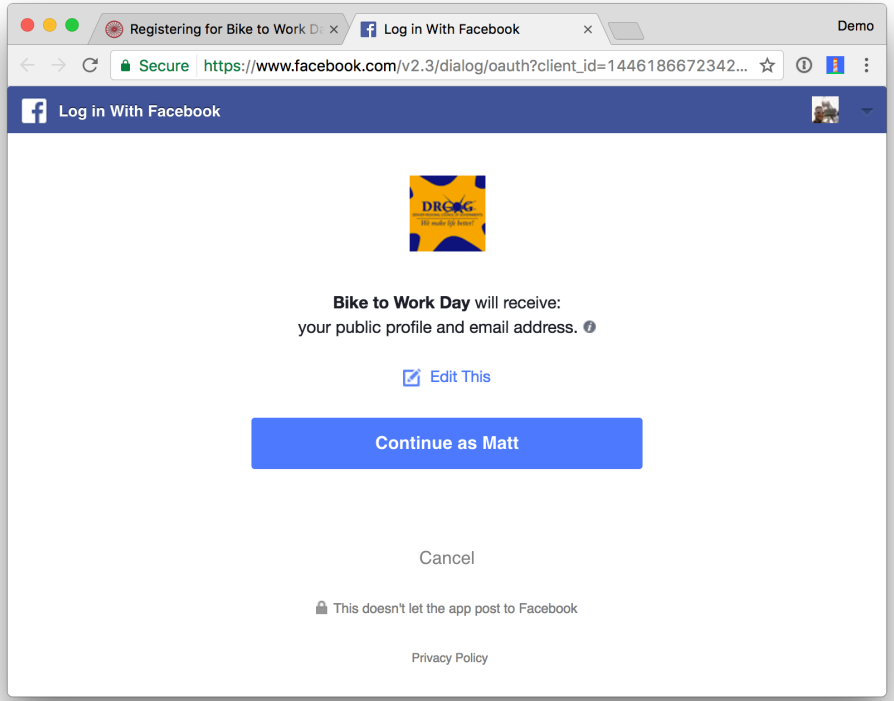
The Delegated Authorization Problem

How can you let a website access your data
(without giving it your password)?

Don’t do it this way!



Have you ever seen one of these?




OAUTH
2
OAUTH

Hotel Key Cards, but for Apps

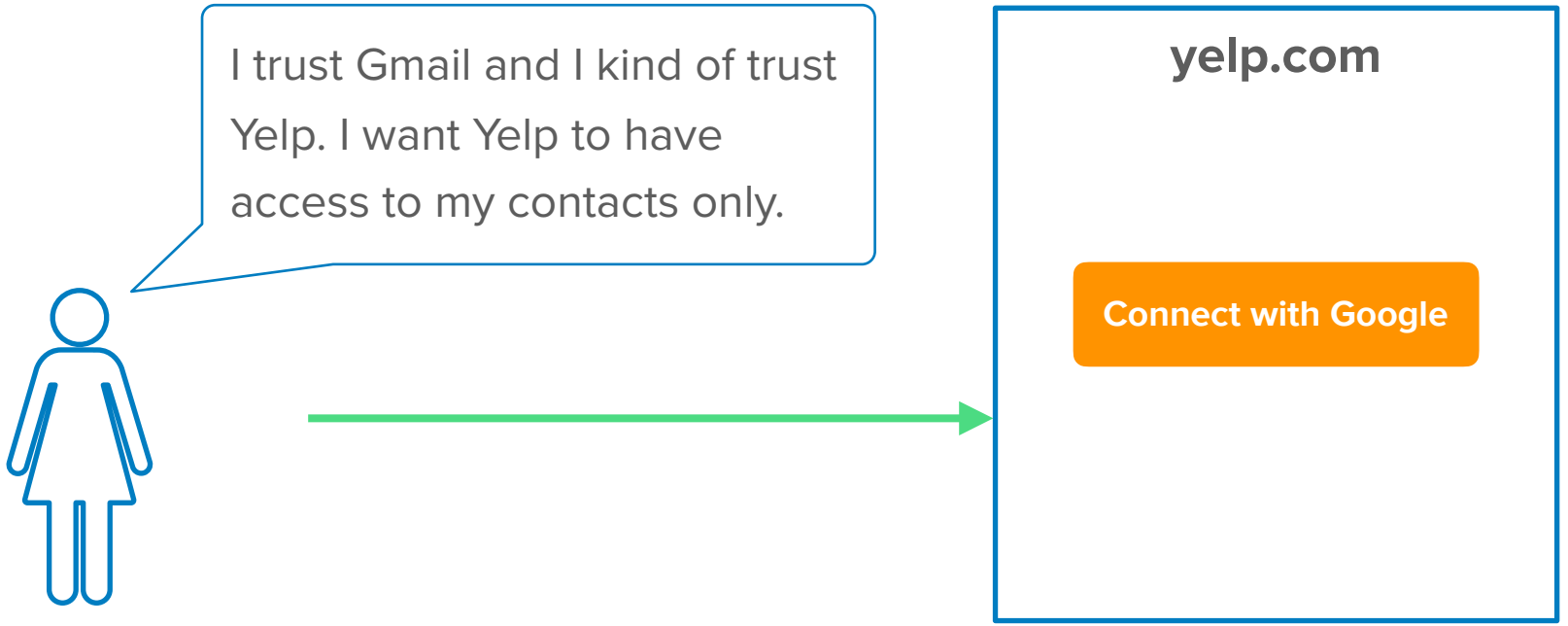
Hotel Key Cards, but for Apps

OAuth Authorization Server

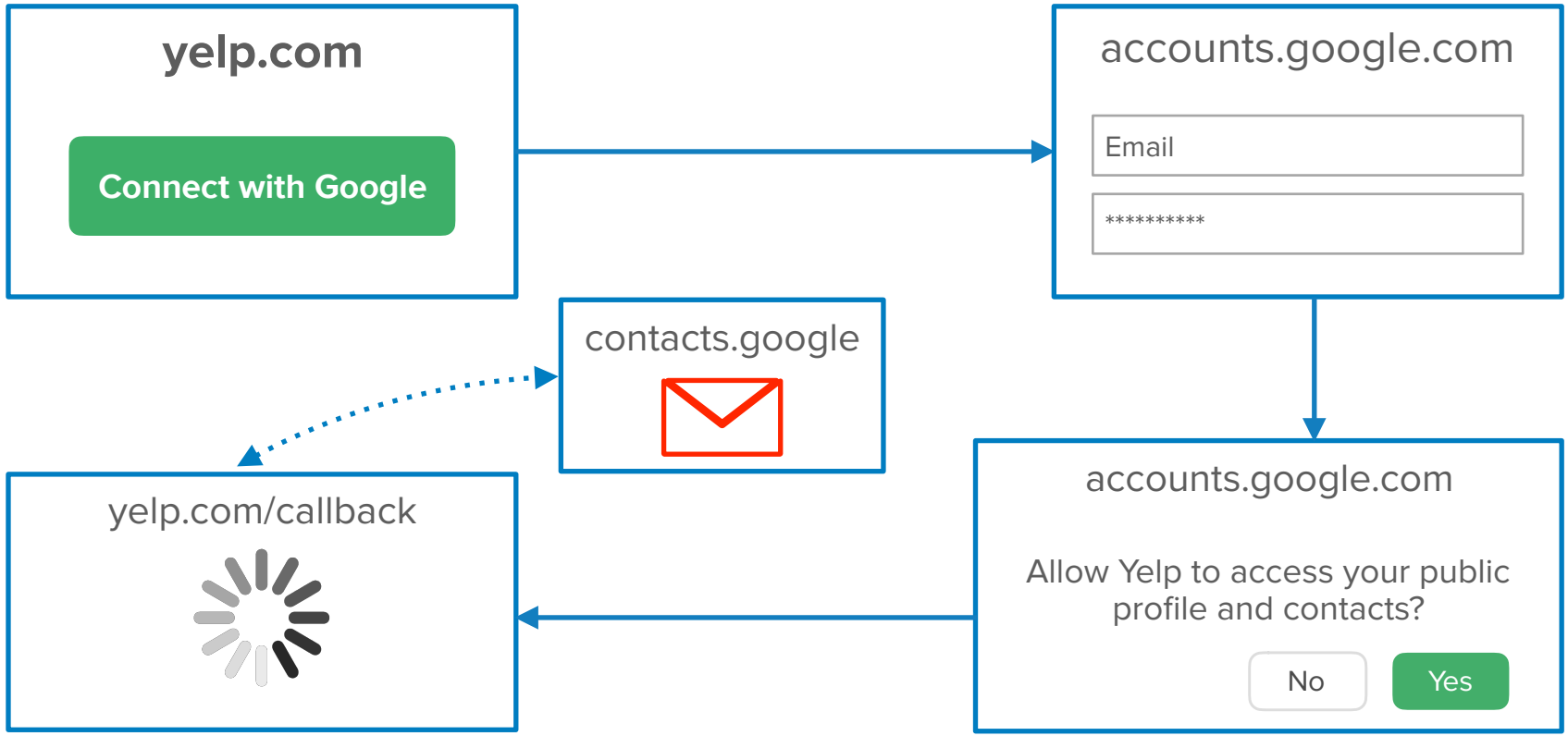
Access Token

Resource (API)

Delegated Authorization with OAuth 2.0



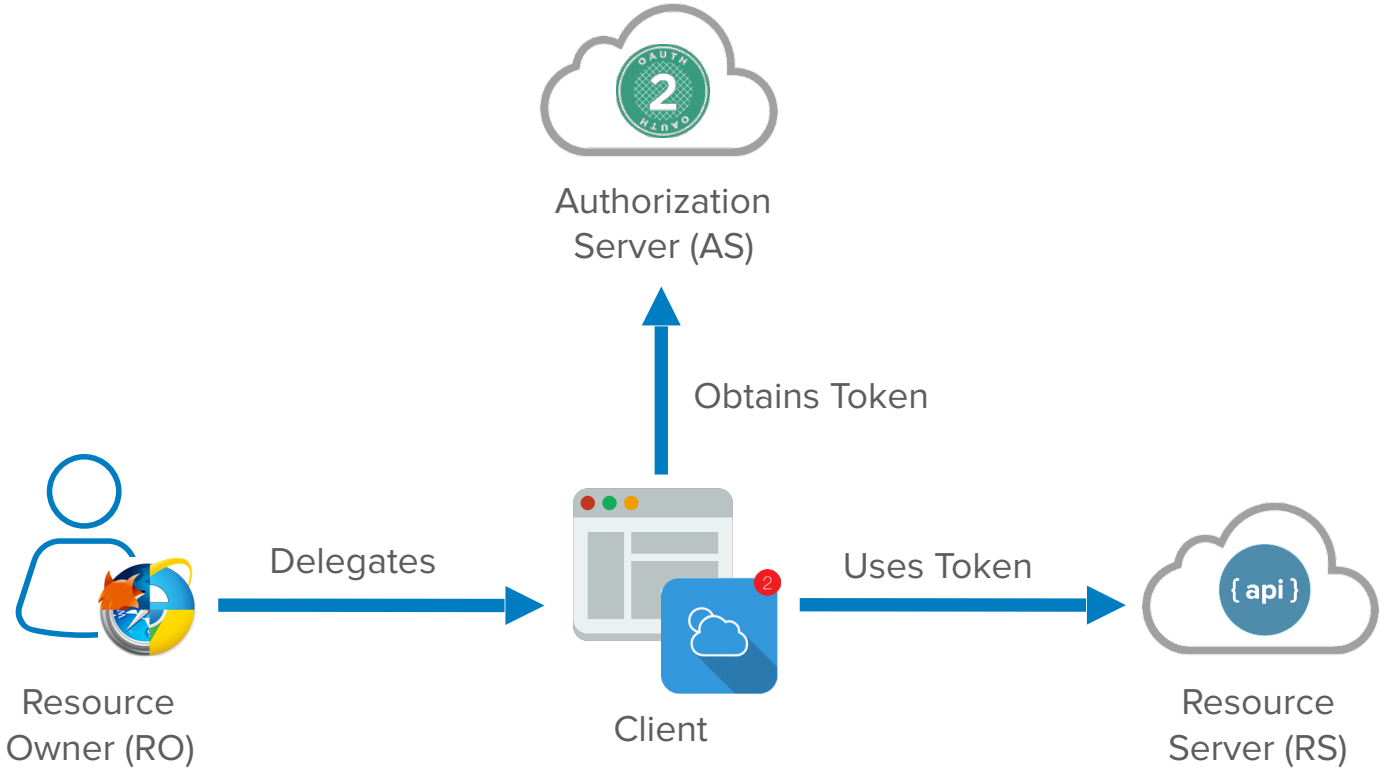
Delegated Authorization with OAuth 2.0



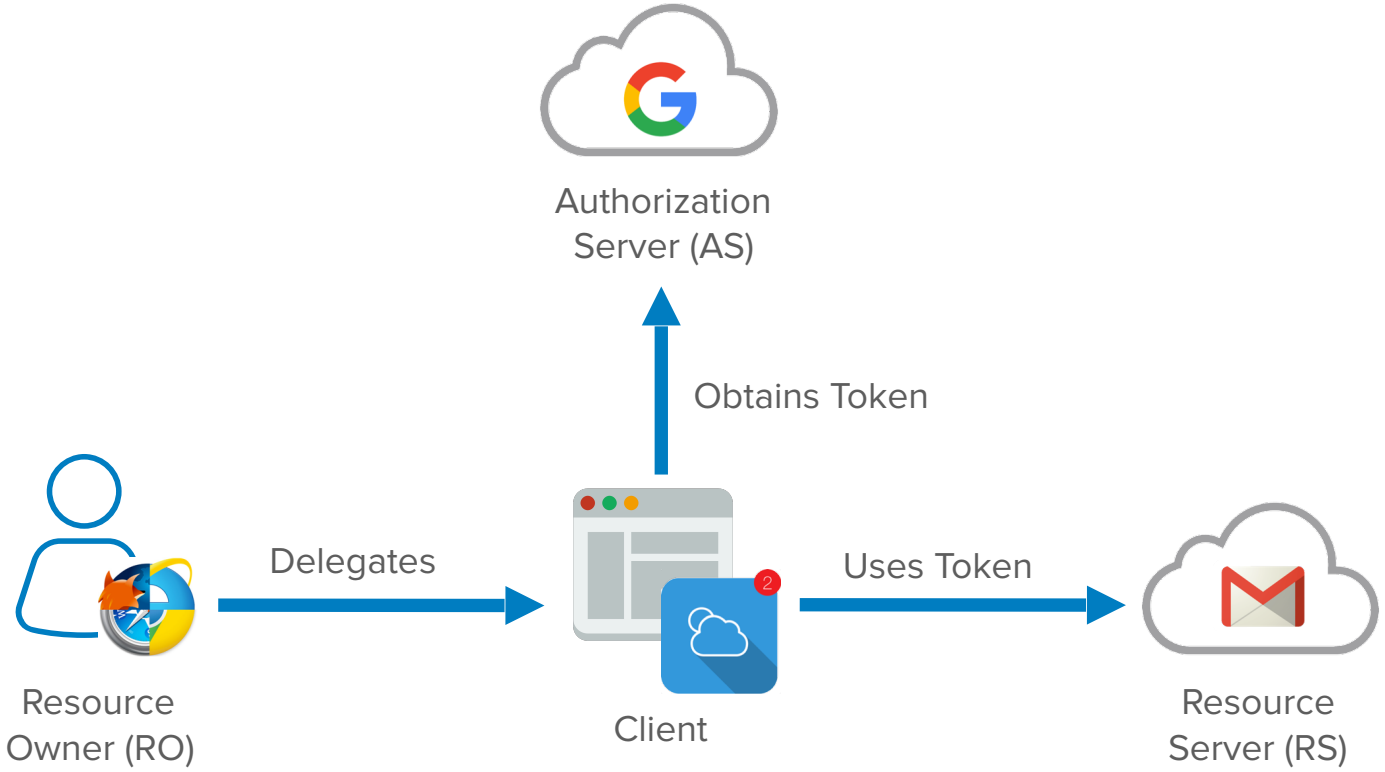
OAuth 2.0 Terminology

- Actors
- Clients
- Authorization Server
- Resource Server
- Access Tokens
- Redirect URI

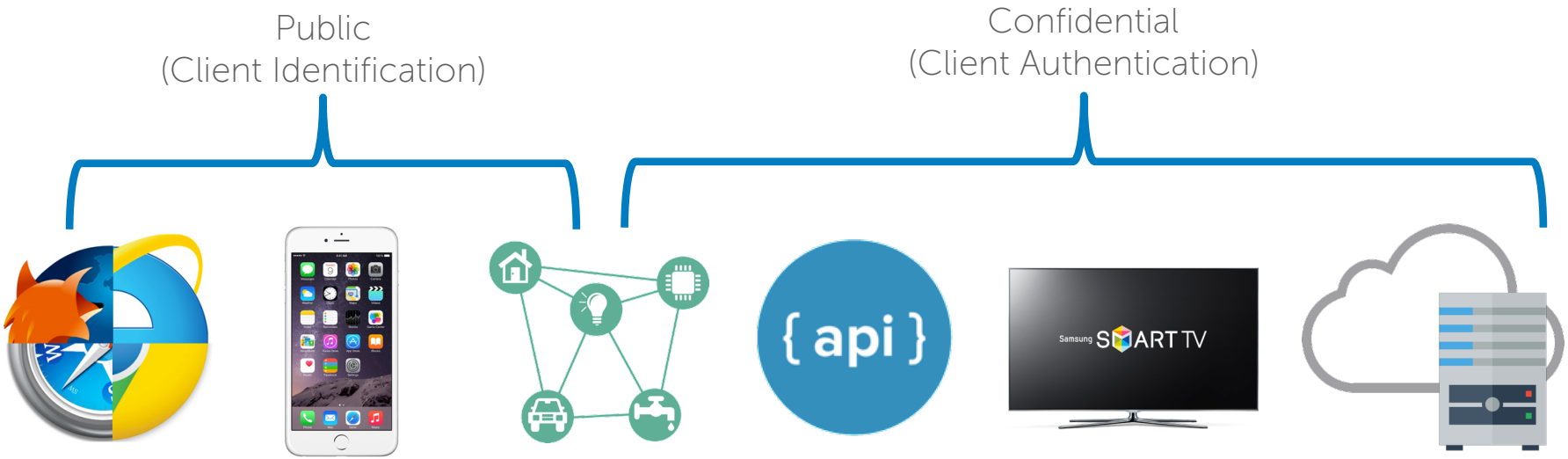
Actors


Authorization Server (AS)
Obtains Token
Delegates
Uses Token
{ api }
Resource Owner (RO)
Client
Resource Server (RS)

Actors


Authorization Server (AS)
Obtains Token
Delegates
Uses Token
Resource Owner (RO)
Client
Resource Server (RS)

Clients


Public
(Client Identification)
Confidential
(Client Authentication)
{ api }
Samsung SMART TV

Clients

Client Registration is the DMV of OAuth

Create client ID

Application type

- (•) Web application
- ( ) Android Learn more
- ( ) Chrome App Learn more
- ( ) iOS Learn more
- ( ) PlayStation 4
- ( ) Other

Name

My Web App

Authorized JavaScript origins

Enter JavaScript origins here or redirect URIs below (or both)

Cannot contain a wildcard (http://*.example.com) or a path (http://example.com/subdir).

http://www.example.com

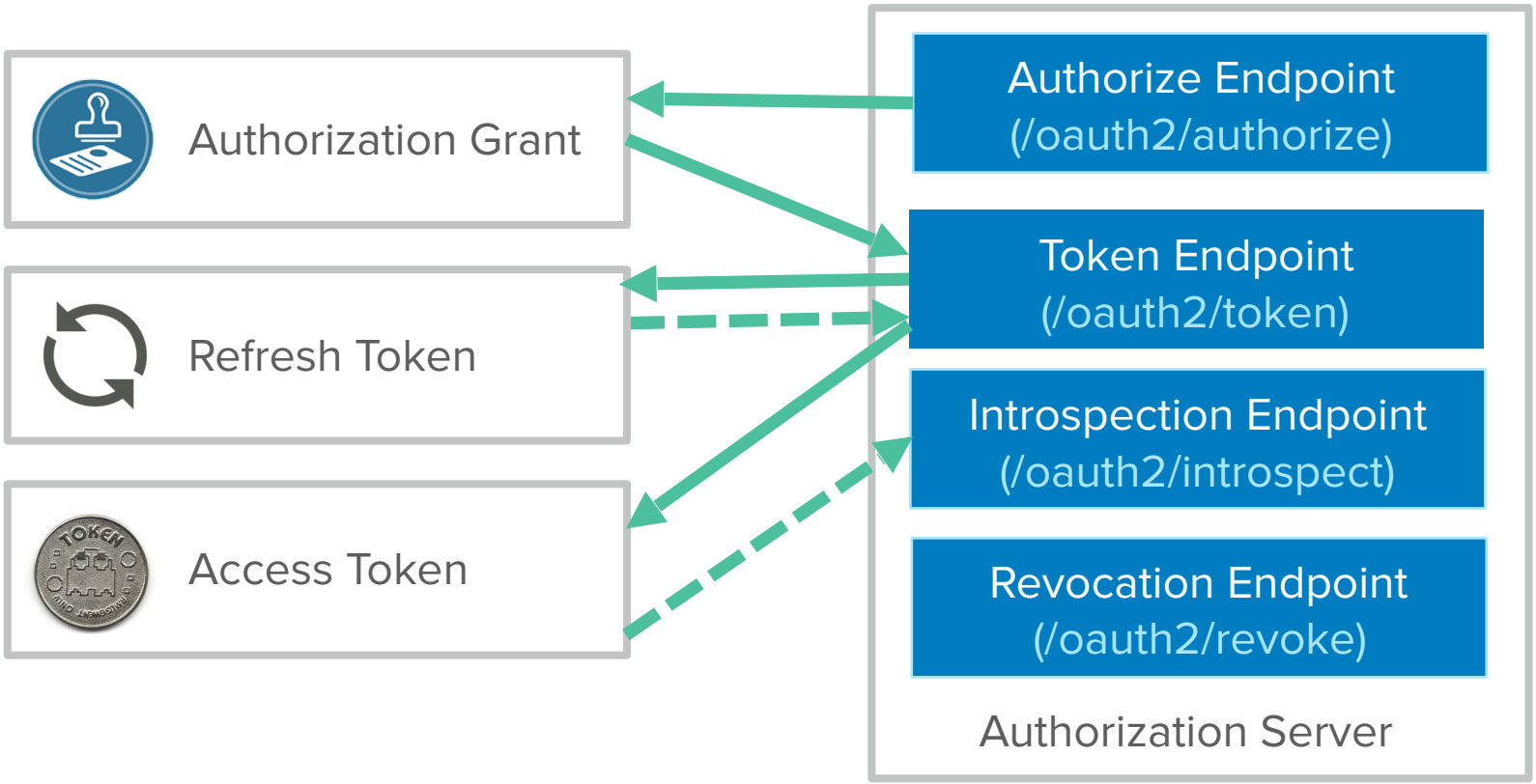
Authorized redirect URIs

Must have a protocol. Cannot contain URL fragments or relative paths. Cannot be a public IP address.

http://www.example.com/oauth2callback

Create Cancel

Authorization Server



Tokens

Access Token (Required)

- Short-lived token used by Client to access Resource Server (API)
- Opaque to the Client
- **No client authentication required (Public Clients)**
- Optimized for scale and performance
- Revocation is dependent on implementation

Refresh Token (Optional)

- Long-lived token that is used by Client to obtain new access tokens from Authorization Server
- **Usually requires Confidential Clients with authentication**
- Forces client to rotate secrets
- Can usually be revoked

OAuth doesn't define the format of a token!

Access Token Types

Self-encoded tokens

Protected, time-limited data structure agreed upon between Authorization Server and Resource Server that contains metadata and claims about the identity of the user or client over the wire.

Resource Server can validate the token locally by checking the signature, expected issuer name and expected audience or scope.

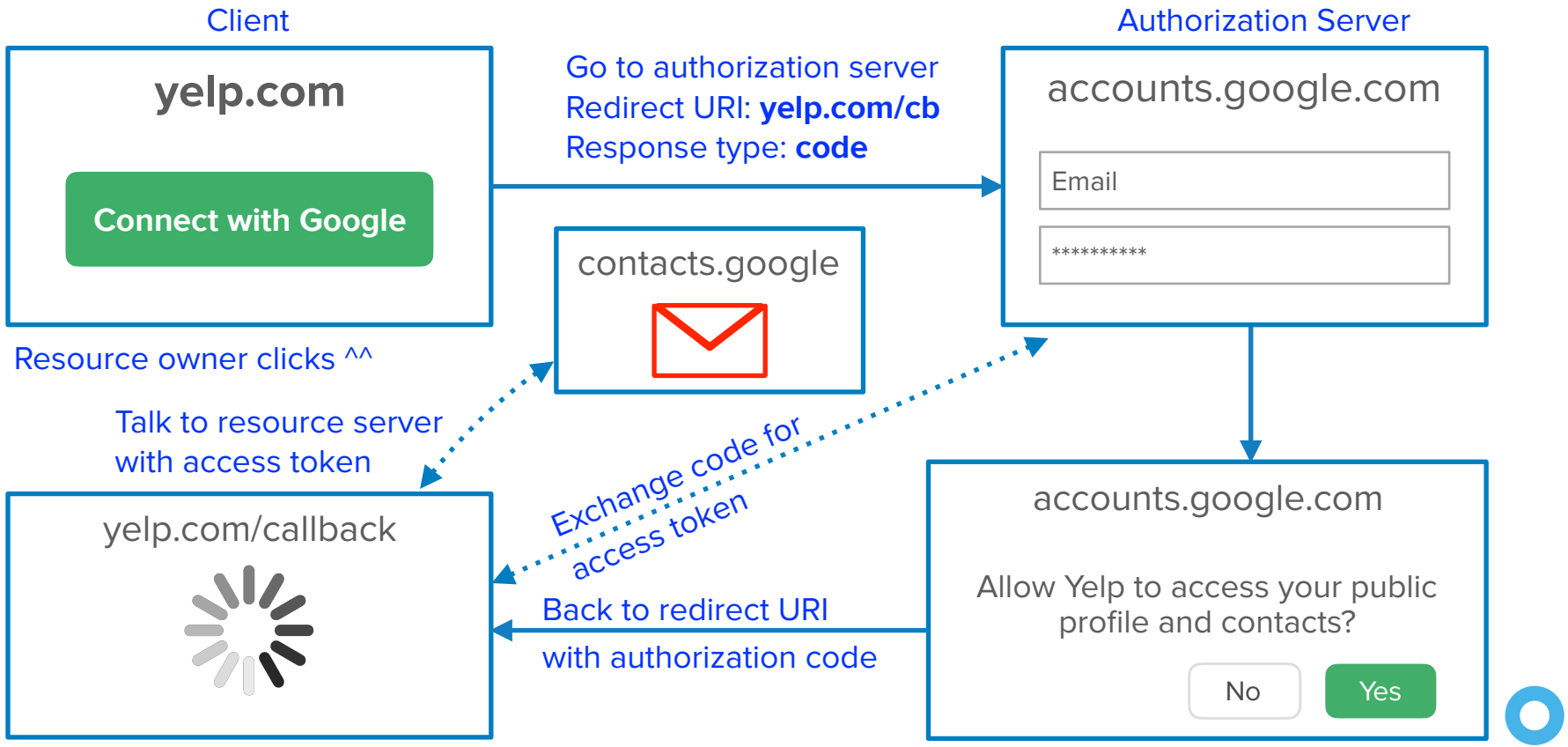
Commonly implemented as a signed JSON Web Tokens (JWT)

Reference tokens (aka opaque tokens)

Infeasible-to-guess (secure-random) identifier for a token issued and stored by the OAuth 2.0 Authorization Server

Resource Server must send the identifier via back-channel to the OAuth 2.0 Authorization Server's token introspection endpoint to determine if the token is valid and obtain claims/scopes

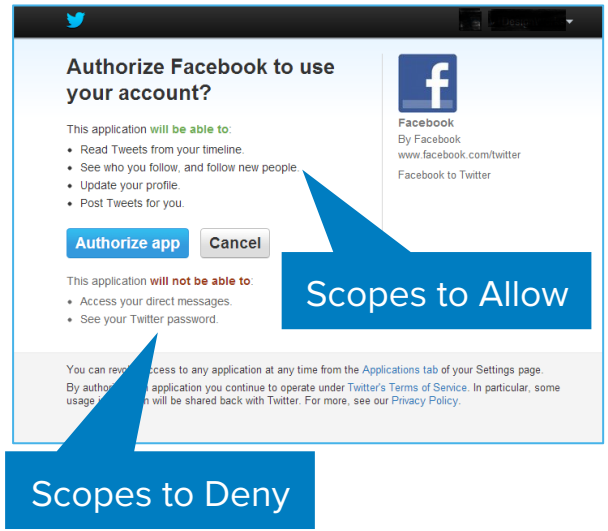
OAuth 2.0 Authorization Code Flow



More OAuth 2.0 Terminology

- Scopes
- Consent
- Grants

Scopes



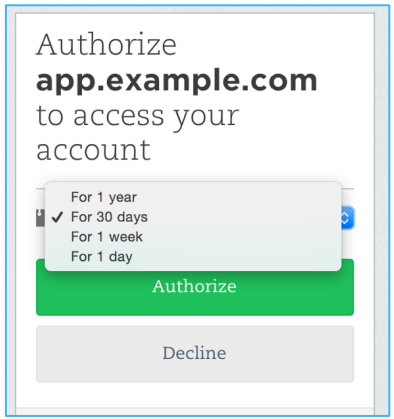
Additive bundles of permissions asked by client when requesting a token

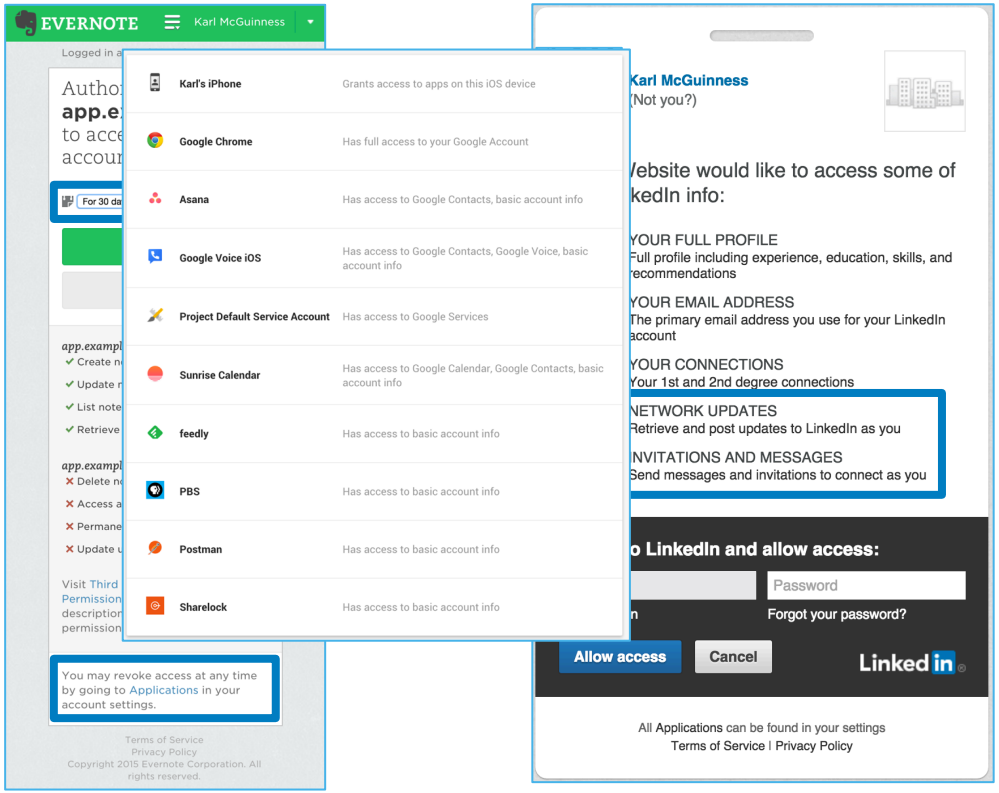
Decouples authorization policy decisions from enforcement

- Who owns the data? End user or the target service
- Who gets to specify the authorization policy? End user or application owner

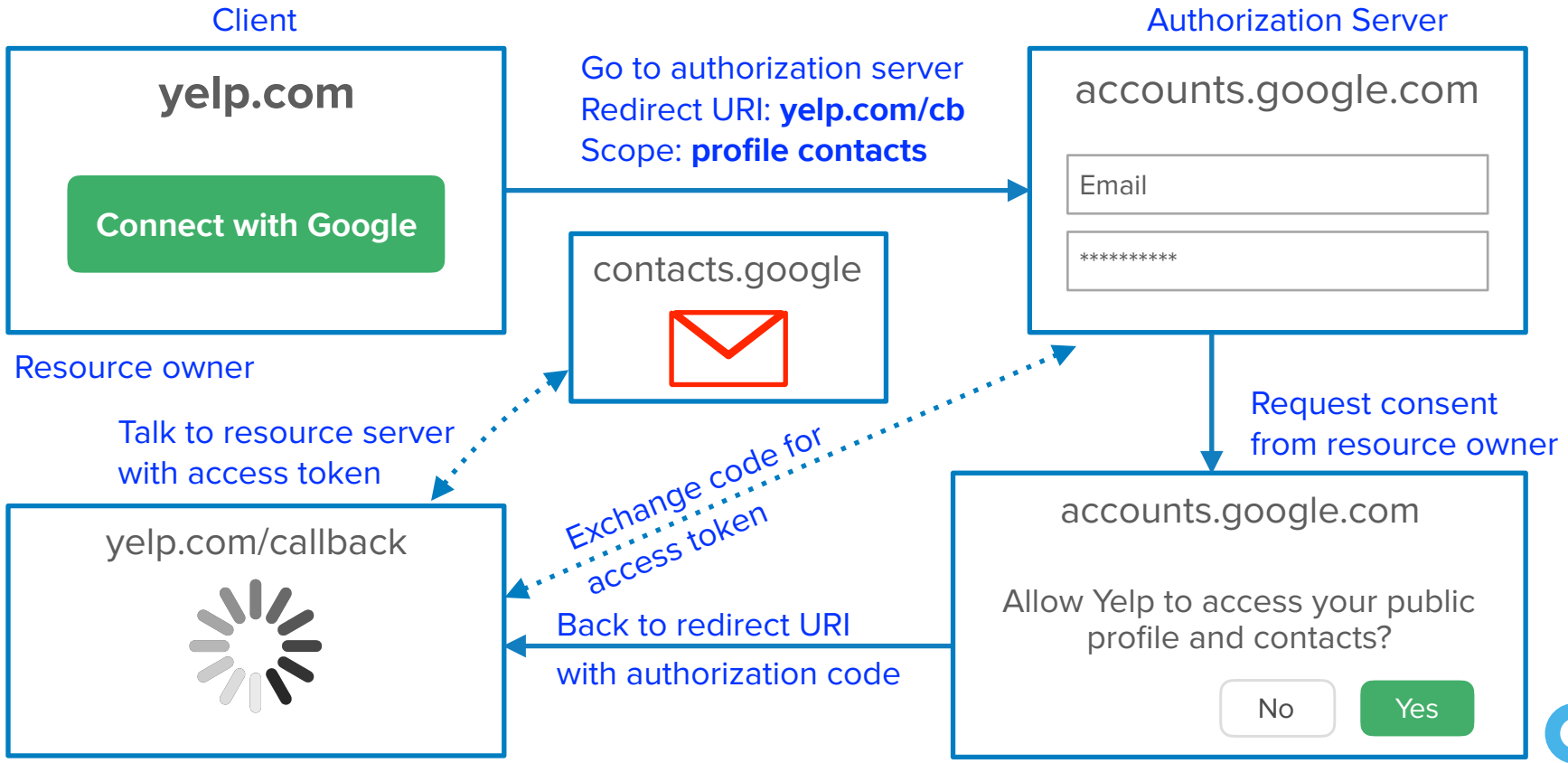
Capturing User Consent

Authorization Grant (Trust of First Use)

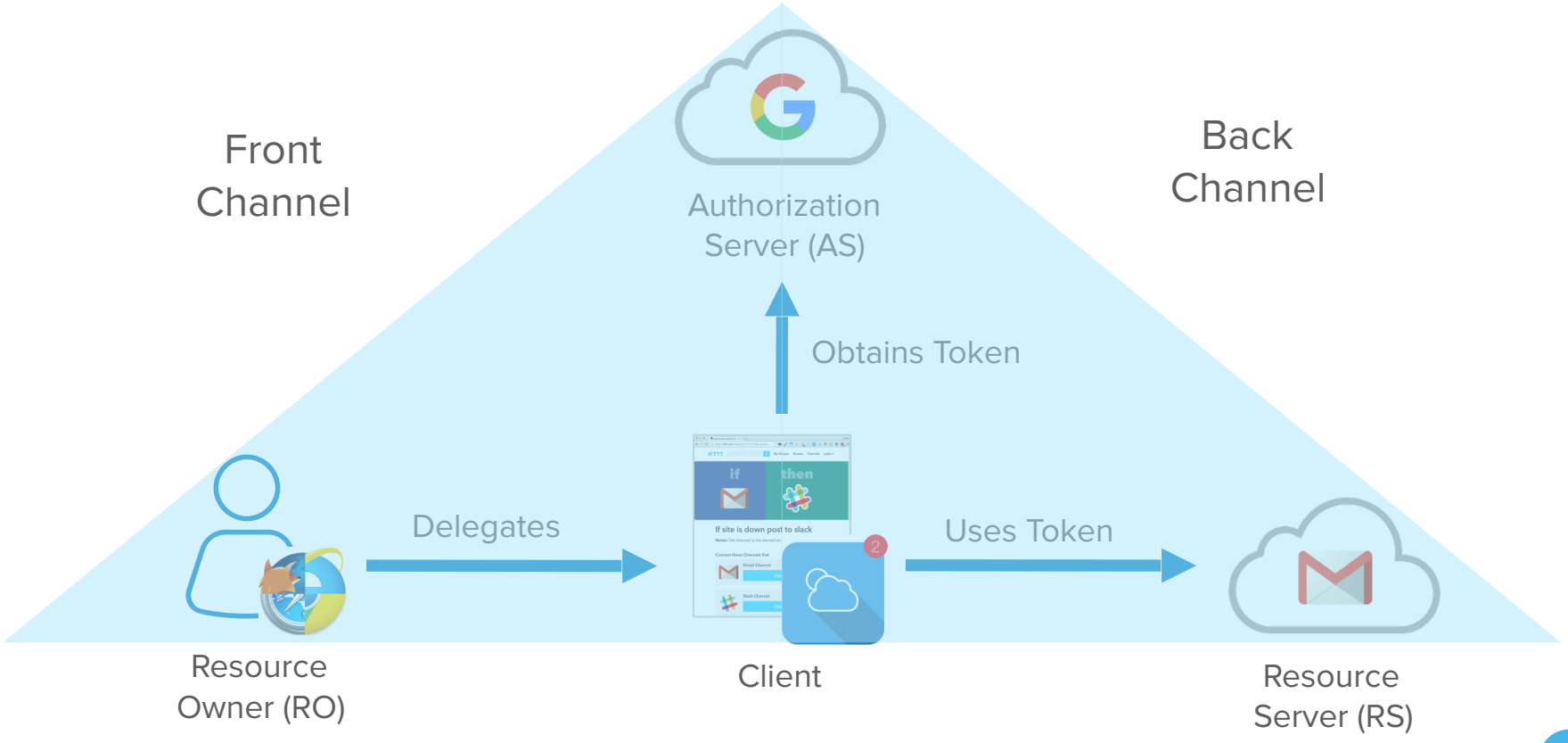




OAuth 2.0 Authorization Code Flow



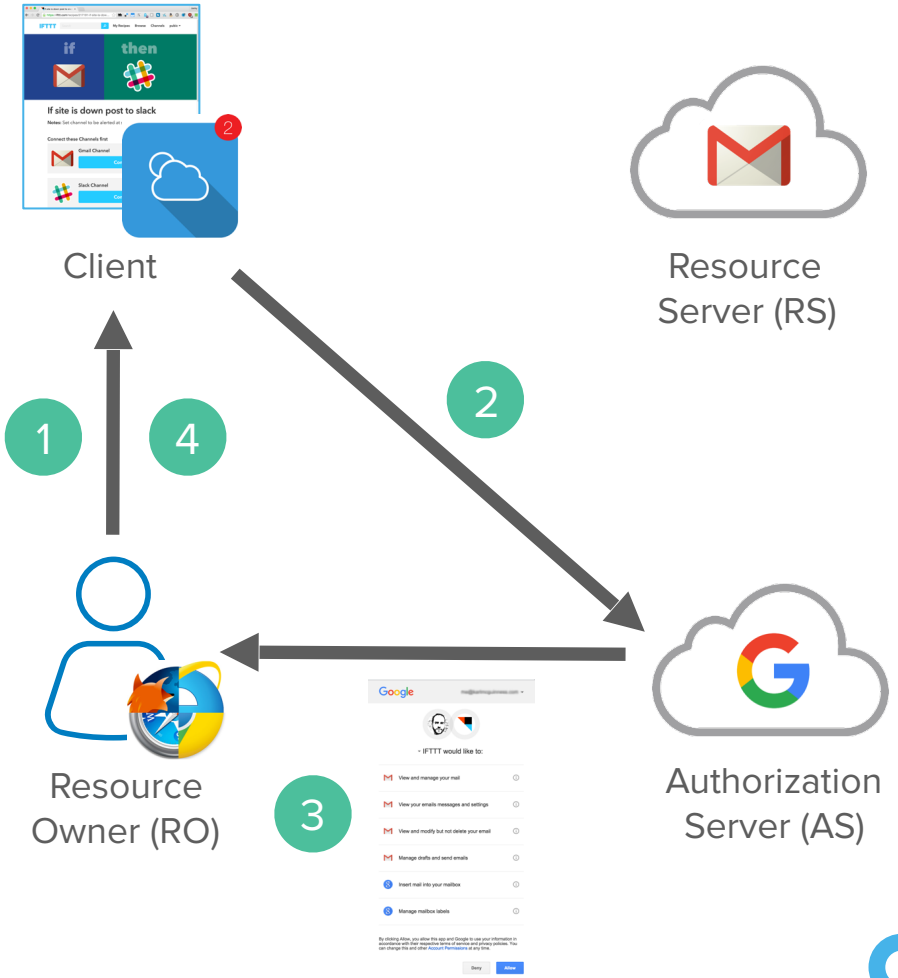
Flow Channels



Front Channel Flow

Authorize via User Agent

1. Resource Owner starts flow to delegate access to protected resource
2. Client sends authorization request with desired scopes via browser redirect to Authorize Endpoint on Authorization Server
3. User authenticates and consents to Delegated Access (Grant)
4. **Authorization Code Grant** or **Access Token** is returned to Client via browser redirect



Authorization Request

Request

```
GET https://accounts.google.com/o/oauth2/auth?
    scope=gmail.insert gmail.send&
    redirect_uri=https://app.example.com/oauth2/callback&
    response_type=code&
    client_id=812741506391&
    state=af0ifjsldkj
```

Response

```
HTTP/1.1 302 Found
Location: https://app.example.com/oauth2/callback?
    code=MsCeLvIaQm6bTrgtp7&
    state=af0ifjsldkj
```

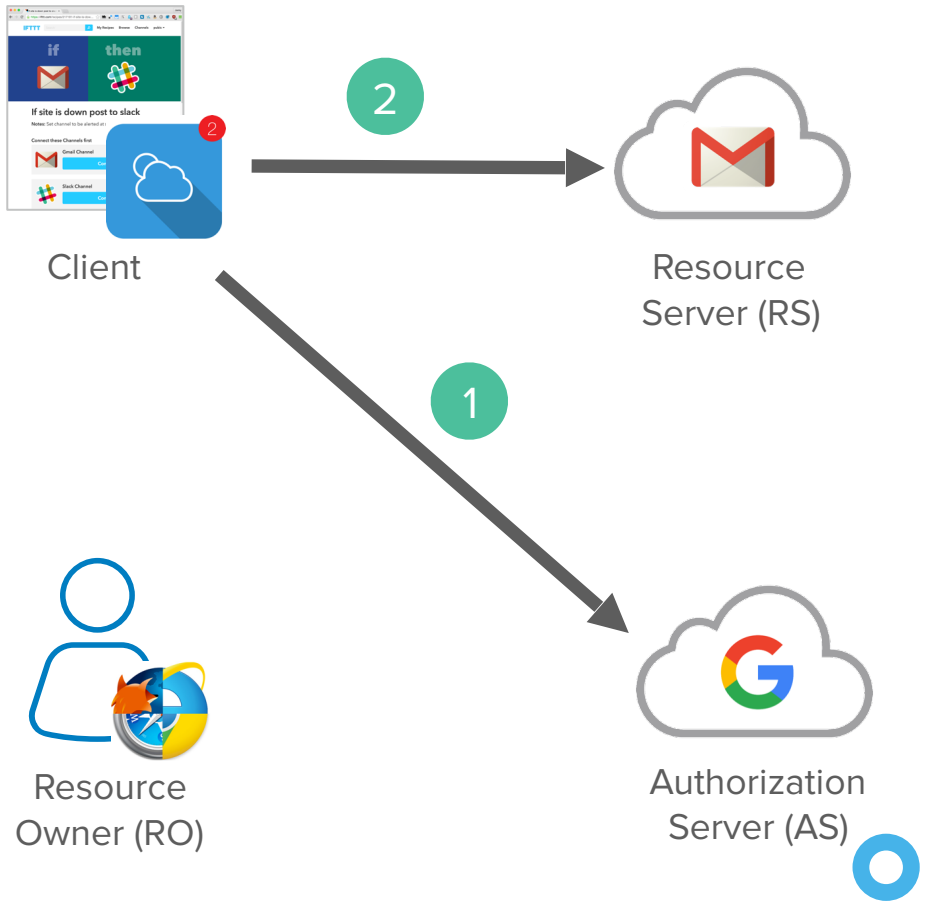
Note: Parameters are not URL-encoded for example purposes

Back Channel Flow

Exchange Grants for Tokens

1. Client exchanges **Authorization Code Grant** with token endpoint on Authorization Server for an **Access Token** and optionally **Refresh Token**

2. Client accesses protected resource with **Access Token**



Token Request

```
POST /oauth2/v3/token HTTP/1.1
Host: www.googleapis.com
Content-Type: application/x-www-form-urlencoded

code=MsCeLvIaQm6bTrgtp7&
client_id=812741506391&
client_secret={client_secret}&
redirect_uri=https://app.example.com/oauth2/callback&
grant_type=authorization_code
```

Note: Parameters are not URL-encoded for example purposes

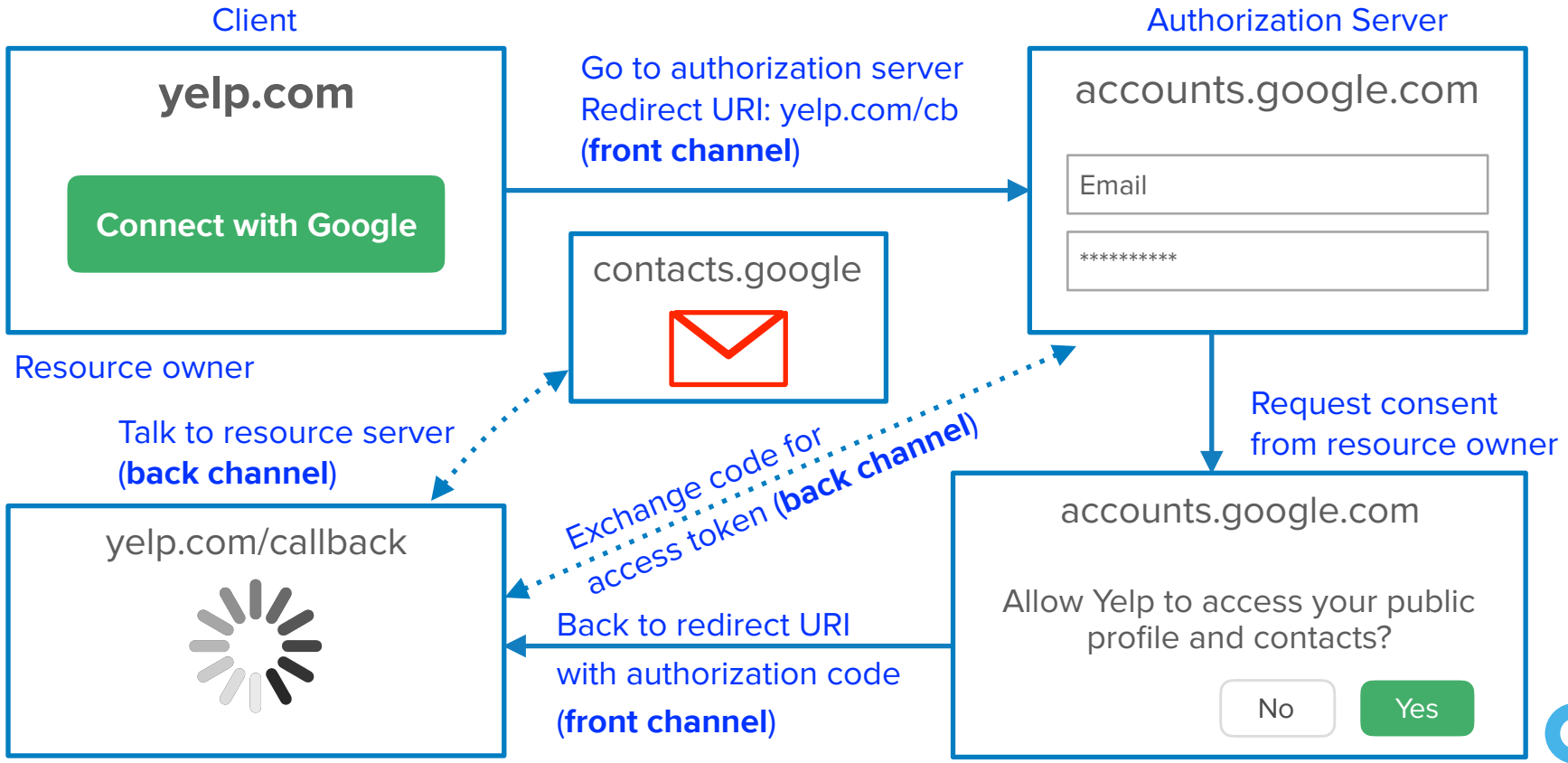
Token Response


```
{
  "access_token": "2YotnFZFEjr1zCsicMWpAA",
  "token_type": "Bearer",
  "expires_in": 3600,
  "refresh_token": "tGzv3JOkF0XG5Qx2TlKWIA"
}
```


Making Protected Resource Requests

```
curl -H "Authorization: Bearer 2YotnFZFEjr1zCsicMWpAA" \
https://www.googleapis.com/gmail/v1/users/1444587525/messages
```

OAuth 2.0 Authorization Code Flow



OAuth 2.0 Grant Types (Flows)

Implicit (2 Legged)

- Optimized for browser-only Public Clients
- **Access token** returned directly from authorization request (Front-channel only)
- *Does not support* ***refresh tokens***
- Assumes Resource Owner and Public Client are on the same device
- Most vulnerable to security threats

Authorization Code (3 Legged)

- Front channel flow used by Client to obtain authorization code grant
- Back channel flow used by Client to exchange **authorization code grant** for **access token** and optionally **refresh token**
- Assumes Resource Owner and Client are on separate devices
- Most secure flow as tokens never passes through user-agent

Client Credential

- Optimized for server-only Confidential Clients acting on behalf of itself or a user
- Back-channel only flow to obtain an **access token** using the Client's credentials
- Supports shared secrets or assertions as Client credentials signed with either symmetric or asymmetric keys

OAuth 2.0 Grant Types (Flows)

Resource Owner Password

- Legacy grant type for native username/password apps such as desktop apps
- Username/password is **authorization grant** to obtain **access token** from Authorization Server
- *Does not support **refresh tokens***
- Assumes Resource Owner and Public Client or on the same device

Assertion

- Allows Authorization Server to trust **authorization grants** from third party such as SAML IdP (Federation)
- **Assertion** is used to obtain **access token** with token request
- *Does not support **refresh tokens***

Device

- Optimized for devices that do not have access to web-browsers
- **User code** is returned from authorization request that must be redeemed by visiting a URL on a device with a browser to authorize
- Back channel flow used by Client to poll for authorization approval for **access token** and optionally **refresh token**

OAuth Flows

Six different flows

Necessary because of:

- How you get consent from client?
- Who is making consent?

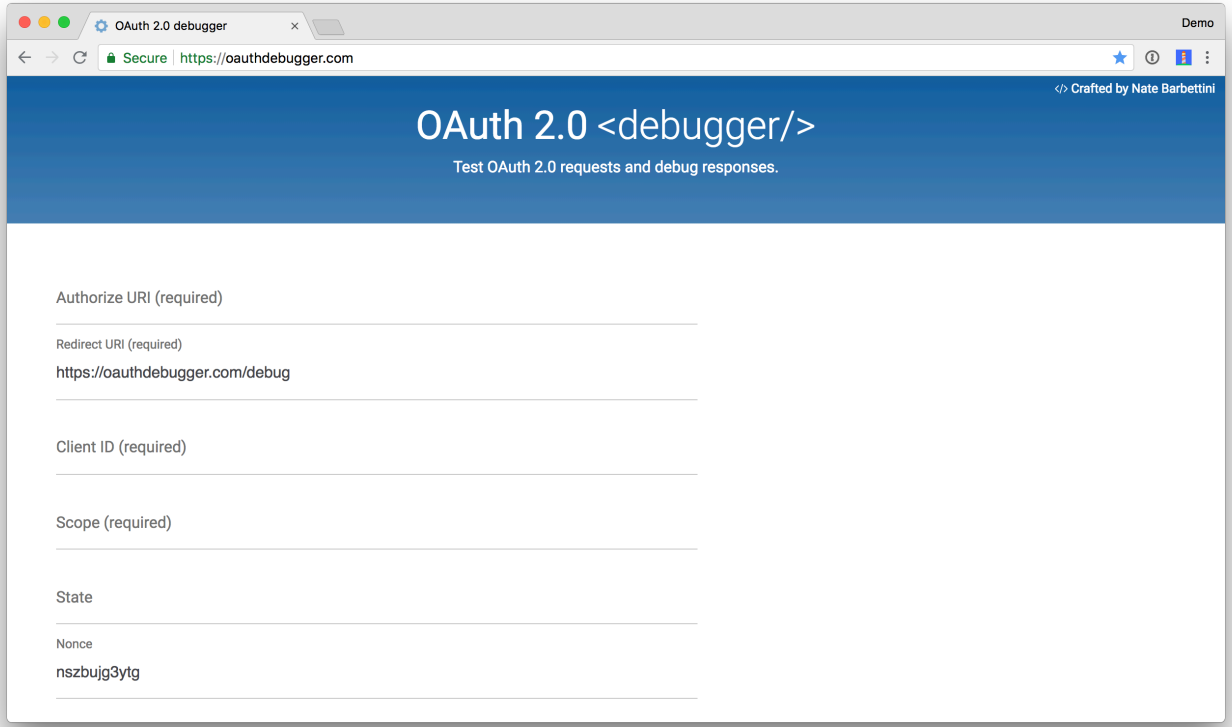
Adds a lot of complexity to OAuth

When people ask if you support OAuth, are they asking for all six?

Image: Ian Sane, Spring Runoff
https://www.flickr.com/photos/31246066@N04/4620052369

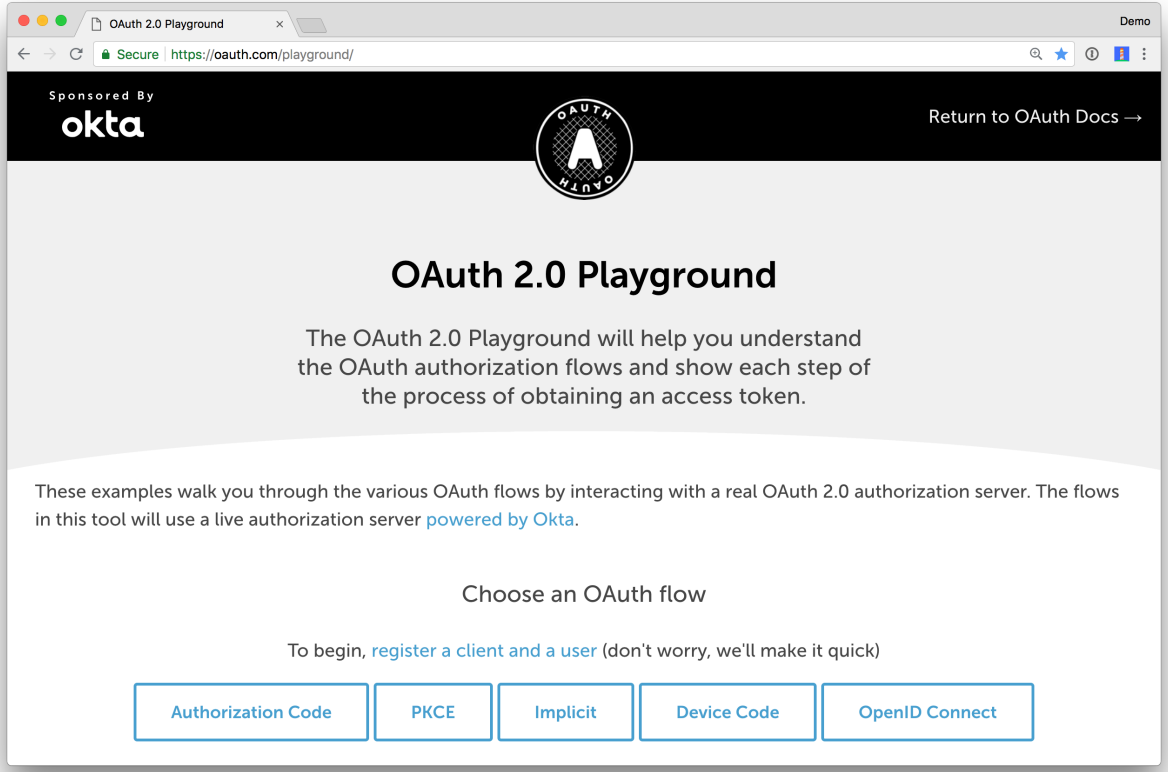
OAuth 2.0 Debugger

https://oauthdebugger.com



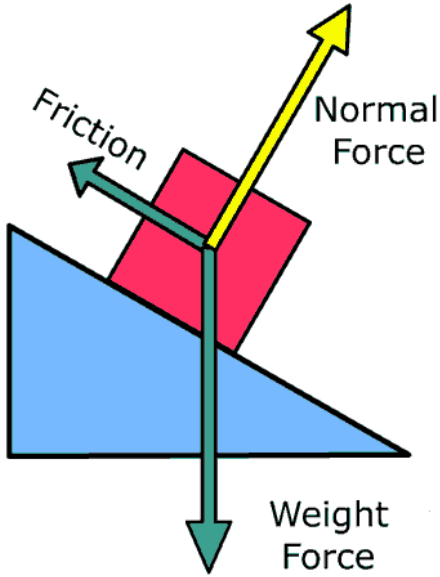
OAuth 2.0 Playground

https://oauth.com/playground



Token State Management

Developer Friction



Common OAuth 2.0 Security Issues

Too many inputs that need validation

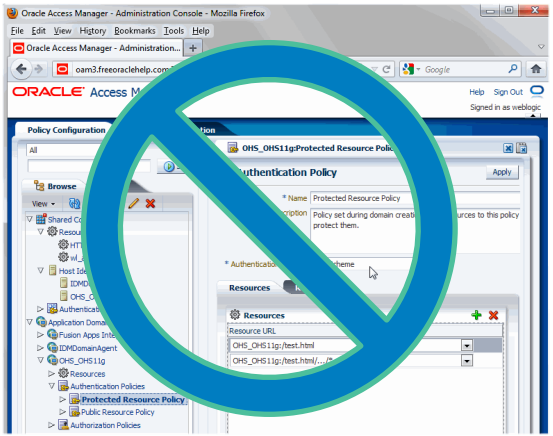
- Token hijacking with CSRF
  - Always use CSRF token with state parameter to ensure OAuth flow integrity
- Leaking authorization codes or tokens through redirects
  - Always whitelist redirect URIs and ensure proper URI validations
- Token hijacking by switching clients
  - Bind the same client to authorization grants and token requests

Leaking client secrets

Unbounded & Bearer Tokens

- See draft specification of OAuth Proof-of-Possession Token Extension

Key Enterprise OAuth 2.0 Use Cases



- Decouples authorization policy decisions from enforcement
  - Enables the right blend of fine & coarse grained authorization
  - Replaces traditional Web Access management (WAM) Policies
- Restrict and revoke which apps can access specific APIs
- Ensure only managed and/or complaint devices can access specific APIs
- Deep integration with identity deprovisioning workflow to revoke all tokens for a user and device
- Federation with an IdP

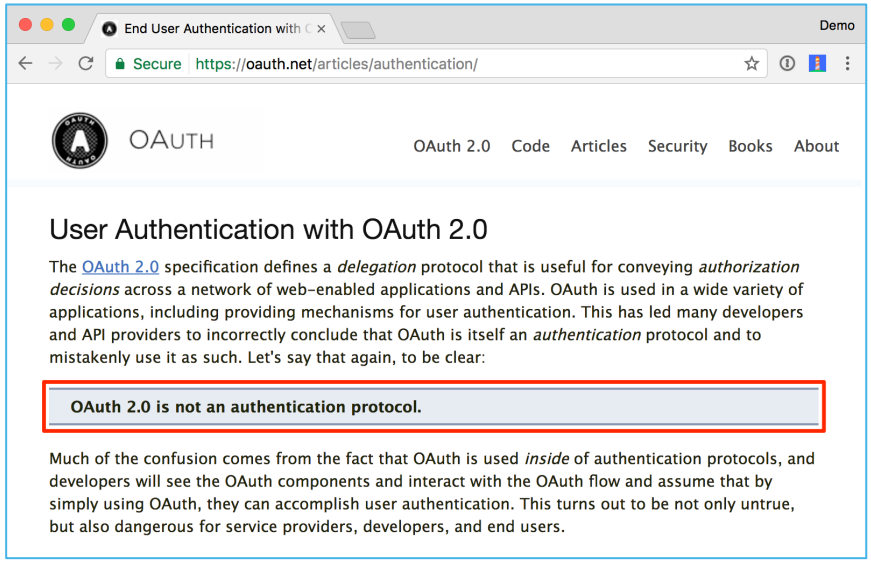
OAuth 2.0 Facts

Not backward compatible with OAuth 1.0

Interoperability issues exists as its not a protocol but rather an authorization framework

OAuth 2.0 is not an authentication protocol

OAuth 2.0 alone says absolutely nothing about the user



Identity Use Cases (circa 2012)

Simple login — OAuth 2.0

Single sign-on across sites — OAuth 2.0

Mobile app login — OAuth 2.0

Delegated authorization — OAuth 2.0

Not an Authentication Protocol?

OAuth 2.0 as Pseudo-Authentication

As made famous by Facebook Connect and Twitter

Client accessing a https://api.example.com/me resource with an access token is not authenticating the user

Access tokens just prove the Client was authorized, are opaque, and intended to only be consumed by the Resource Server

Who is the user (claims)?

When did the user authenticate?

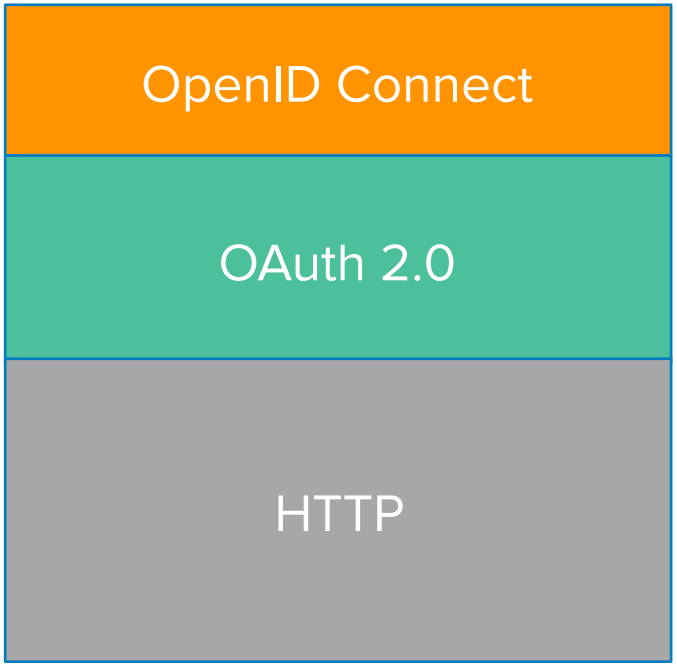
Does the user still have an active or expired session?

How did the user authenticate?

Just password or password + second factor

OpenID Connect

OAuth 2.0 and OpenID Connect

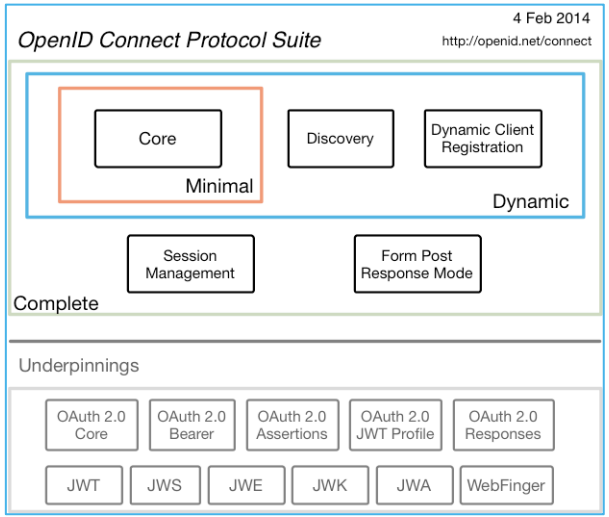


OpenID Connect is for **authentication**

OAuth 2.0 is for **authorization**

OpenID Connect

OAuth 2.0 + Facebook Connect + SAML 2.0 (good parts)



Google Microsoft okta

- Extends OAuth 2.0 with new signed id_token for the Client and UserInfo endpoint to fetch user attributes
- Provides a standard set of scopes and claims for identities
  - profile
  - email
  - address
  - phone
- Built-in registration, discovery & metadata for dynamic federations
  - Bring Your Own Identity (BYOI)
- Supports high assurance levels and key SAML use cases (enterprise)

Authorization Request

Request

```
GET https://accounts.google.com/o/oauth2/auth?
    scope=openid email&
    redirect_uri=https://app.example.com/oauth2/callback&
    response_type=code&
    client_id=812741506391&
    state=af0ifjsldkj
```

Response

```
HTTP/1.1 302 Found
Location: https://app.example.com/oauth2/callback?
    code=MsCeLvIaQm6bTrgtp7&
    state=af0ifjsldkj
```

Note: Parameters are not URL-encoded for example purposes

Token Request

```
POST /oauth2/v3/token HTTP/1.1
Host: www.googleapis.com
Content-Type: application/x-www-form-urlencoded

code=MsCeLvIaQm6bTrgtp7&
client_id=812741506391&
client_secret={client_secret}&
redirect_uri=https://app.example.com/oauth2/callback&
grant_type=authorization_code
```

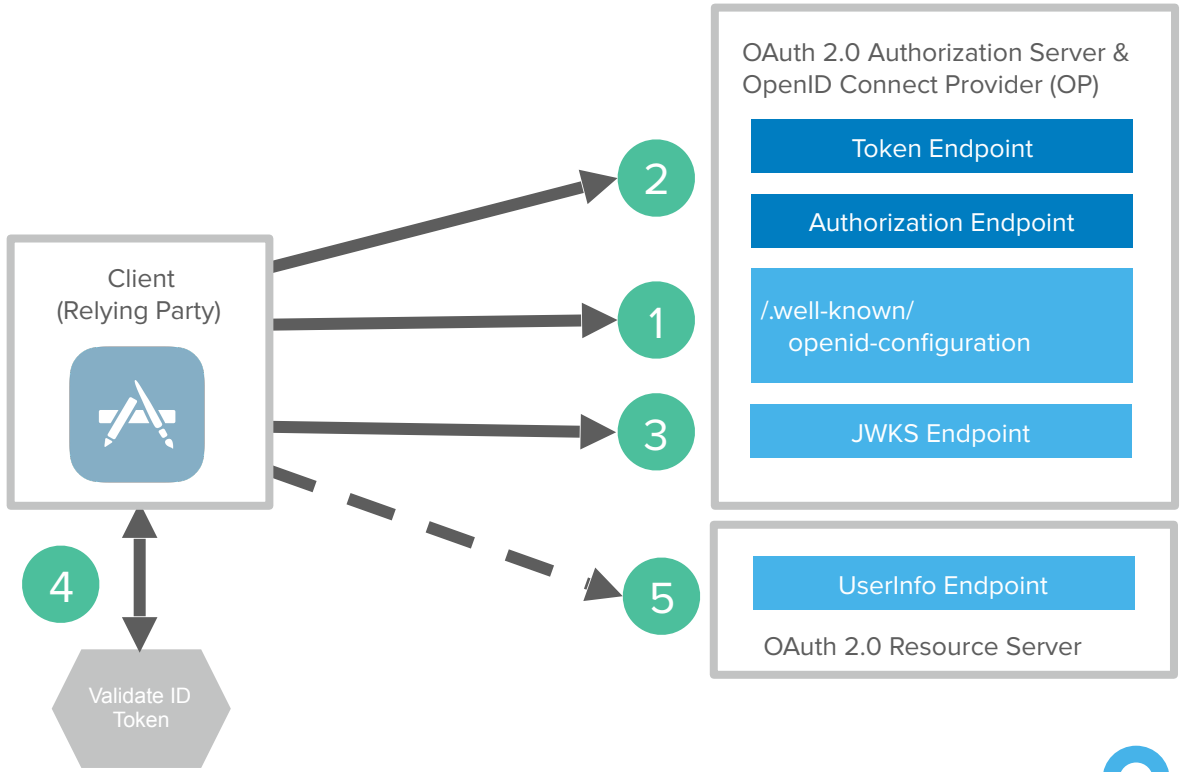
Note: Parameters are not URL-encoded for example purposes

Token Response

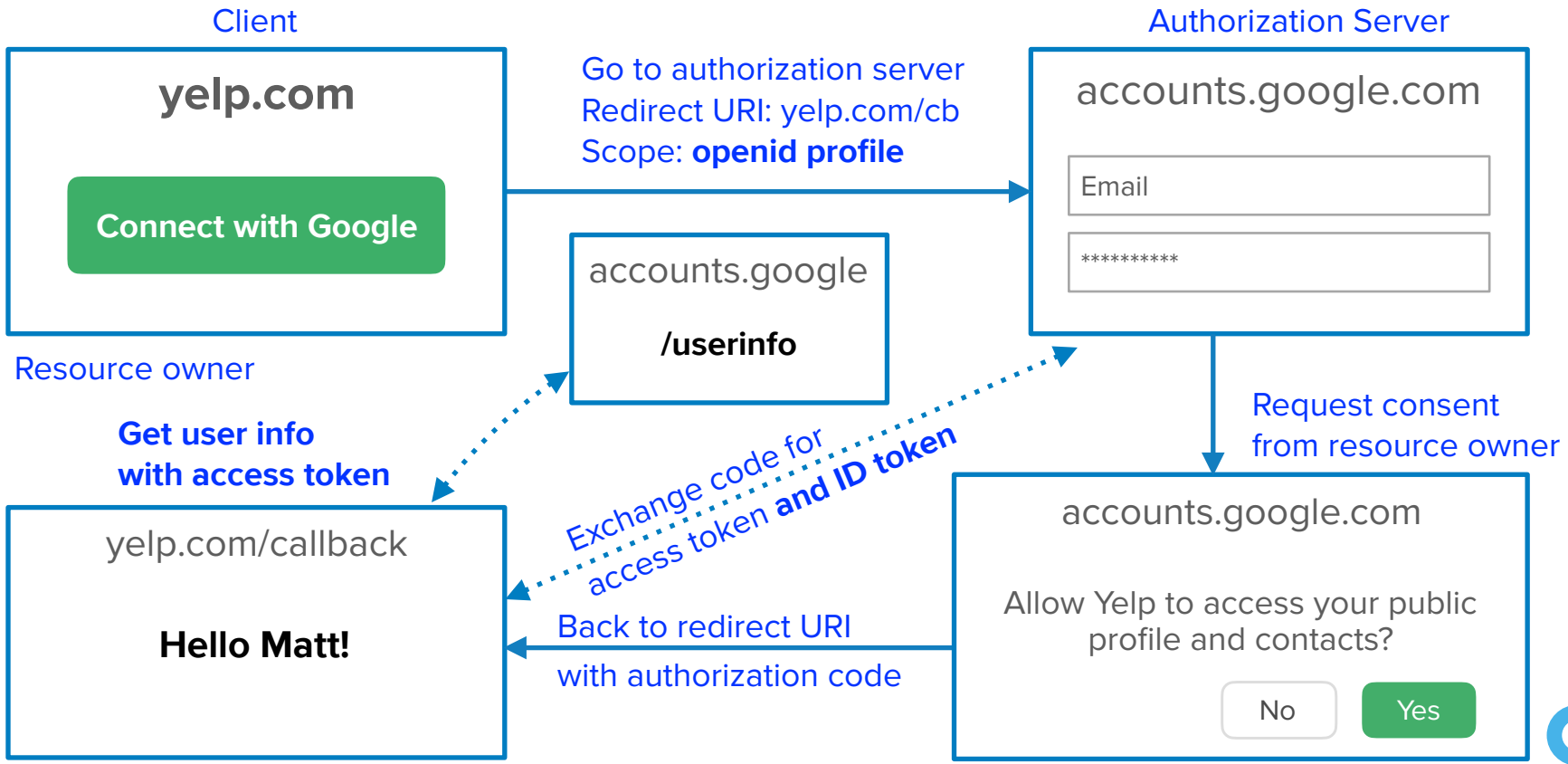

```
{
  "access_token": "2YotnFZFEjr1zCsicMWpAA",
  "token_type": "Bearer",
  "expires_in": 3600,
  "refresh_token": "tGzv3JOkF0XG5Qx2TlKWIA",
  "id_token": "eyJhbGciOiJSUzI1NiIsImtpZCI6IjFlOWdkazcifQ..."
}
```


OpenID Connect

1. Discover OpenID Provider Metadata
2. Perform OAuth flow to obtain a **ID token** and/or **access token**
3. Get JSON Web Key Set (JWKS) for signature keys
4. Validate **ID token** (JSON Web Token)
5. Get additional user attributes with **access token** from UserInfo endpoint



OIDC Authorization Code Flow



JSON Web Token (JWT)

base64url(Header) + “.” + base64url(Claims) + “.” + base64url(Signature)

Header **Claims**

```
eyJhbGciOiJSUzI1NiJ9.eyJpc3MiOiJodHRwczovL2
V4YW1wbGUub2t0YS5jb20iLCJzdWIiOiIwMHVncmVuT
WVxdllsYTRIVzBnMyIsImF1ZCI6IncyNTVIRVdpU1U0
QXVOeEVqZWlqIiwiaWF0IjoxNDQ2MzA1MjgyLCJleHA
iOjE0NDYzMDg4ODIsImFtciI6WyJwd2QiXSwiYXV0aF
90aW1lIjoxNDQ2MzA1MjgyLCJlbWFpbCI6ImthcmxAZ
XhhbXBsZS5jb20iLCJlbWFpbF92ZXJpZmllZCI6dHJ1
ZX0.XcNXs4C7DqpR22LLti777AMMVCxM7FjEPKZQnd-
AS_Cc6R54wuQ5EApuY6GVFCkIlnfbNmYSbHMkO4H-
L3uoeXVOPQmcqhNPDLLEChj00jQwZDjhPD9uBoNwGyi
Z9_YKwsRpzbg9NEeY8xEwXJFIdk6SRktTFrVNHAOIhE
Qsgm8
```

Signature

Header

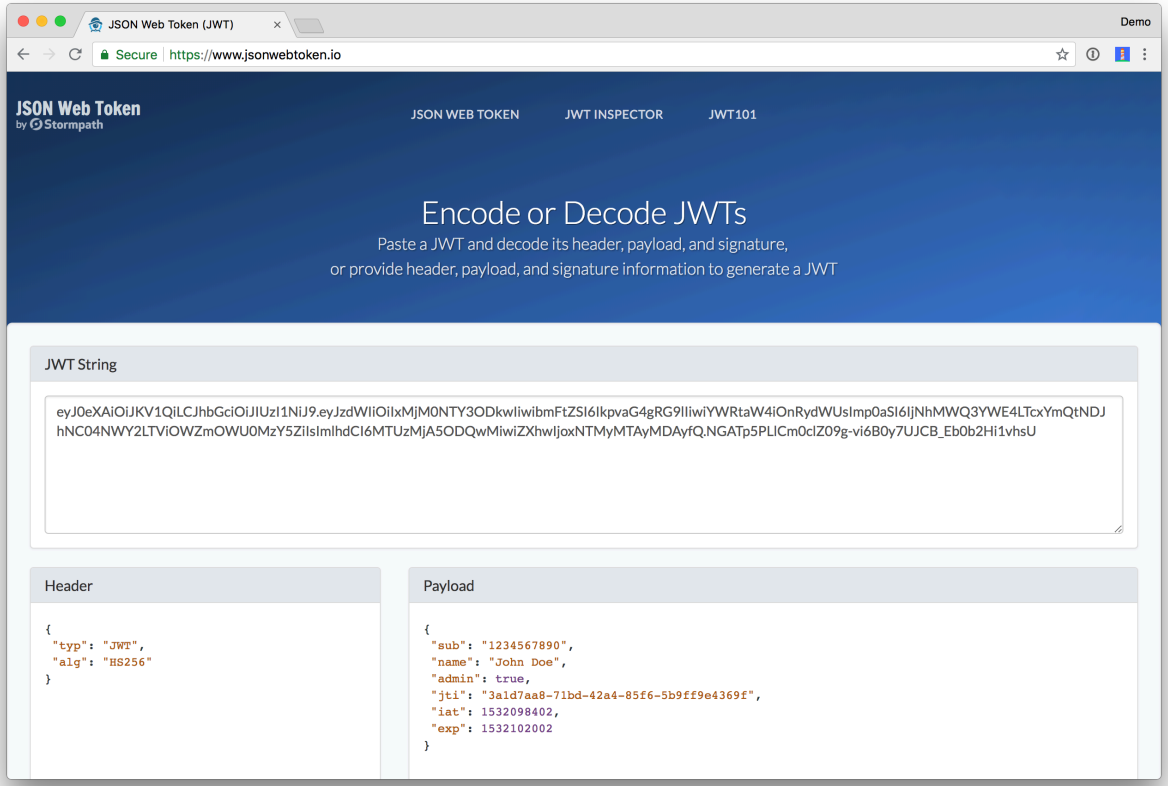
```
{
  "alg": "RS256”
  "kid": "123456789"
}
```

Claims

```
{
  "iss": "https://example.okta.com",
  "sub": "00ugrenMeqvYla4HW0g3",
  "aud": "w255HEWiSU4AuNxEjeij",
  "iat": 1446305282,
  "exp": 1446308882,
  "amr": [
    "pwd"
  ],
  "auth_time": 1446305282,
  "email": "matt@example.com",
  "email_verified": true
}
```

jsonwebtoken.io

https://www.jsonwebtoken.io

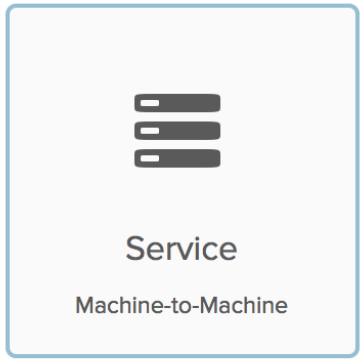


Which grant type is right for you?

Authorization Code

Implicit

Authorization Code



Client Credentials

Native App Best Practices

Do not use an embedded web views for authenticating users!

- App (or 3rd party library/script) can directly obtain the user's credentials which goes against OAuth's raison d'être
- Users can't reuse their existing session with their IdP (SSO) increasing friction for sign-in/sign-up
- IdPs can't implement new authentication methods

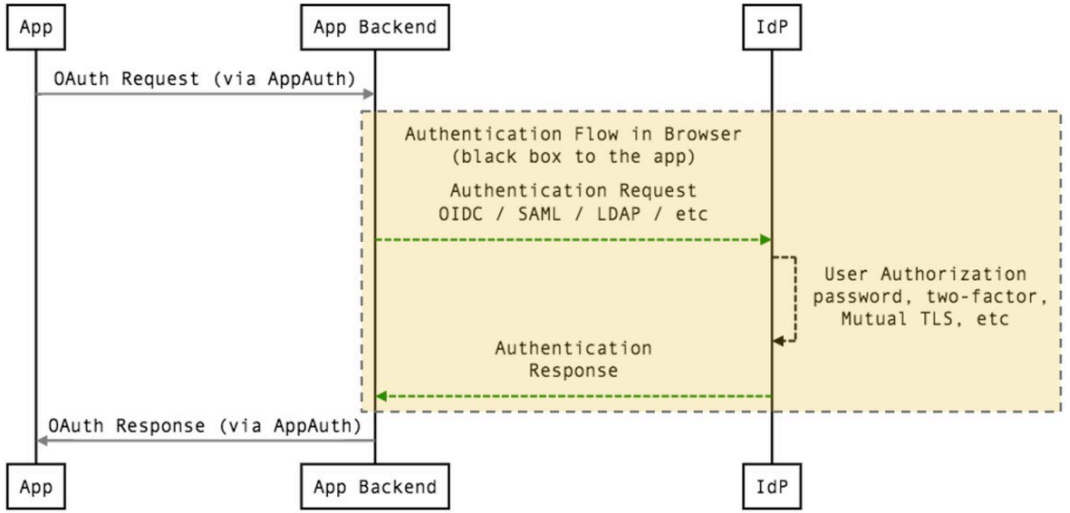
Do not store client secrets in apps that are distributed via App Stores!

Use PKCE (RFC 7636) to protect authorization code from interception

Follow guidelines outlined in **OAuth 2.0 for Native Apps** Best Current Practice
https://tools.ietf.org/html/draft-ietf-oauth-native-apps-12

Just Use AppAuth!

https://appauth.io

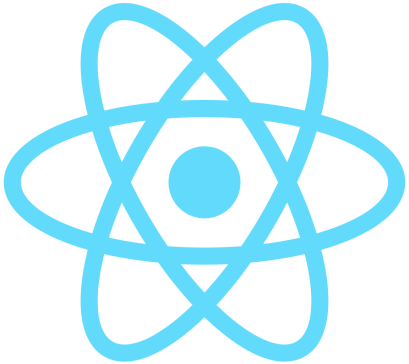


JS iOS macOS ANDROID

Implements **OAuth 2.0 for Native Apps** Best Current Practice

OAuth and OIDC Demos

github.com/oktadeveloper



OAuth and OIDC Libraries

Google OAuth Client Library

ScribeJava

Spring Security OAuth

Nimbus OAuth SDK

List of client and server libraries for many languages:

https://oauth.net/code/

Open Source OAuth and OIDC Servers

ORY Hydra

https://github.com/ory/hydra

Apereo CAS

https://github.com/apereo/cas

Keycloak

https://github.com/keycloak/keycloak

JHipster UAA

https://jhipster.github.io/using-uaa/

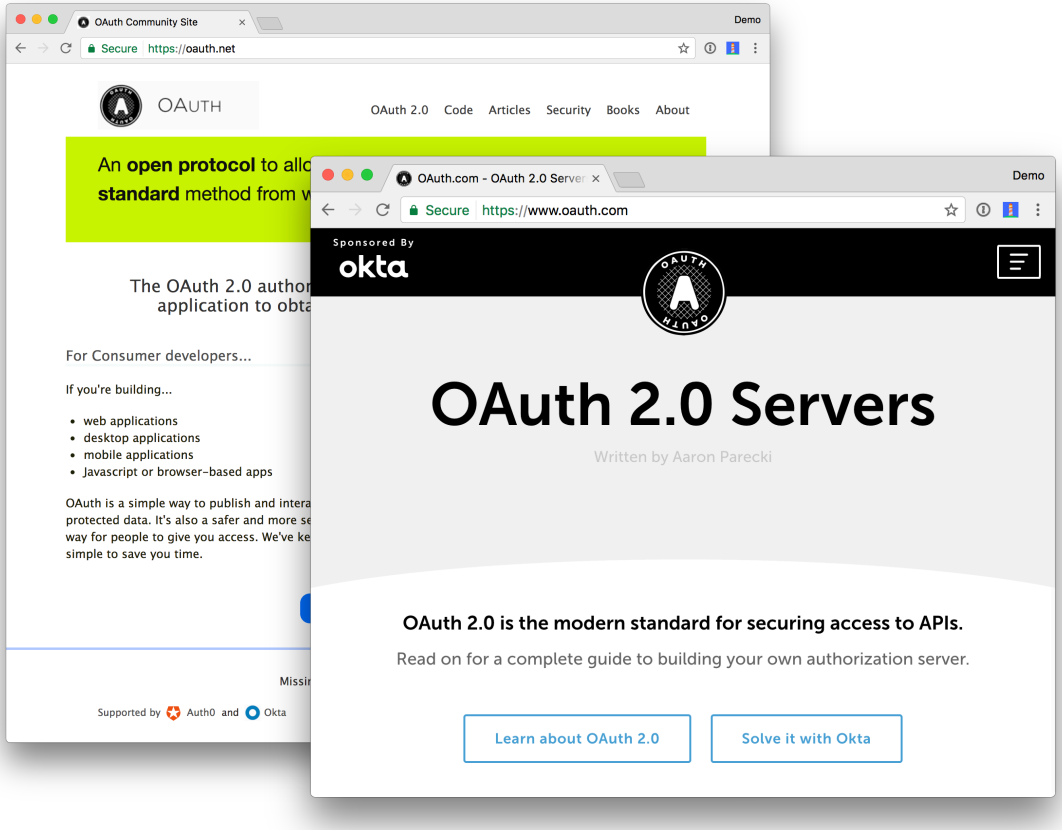
Additional Resources

OAuth Specification

oauth.net

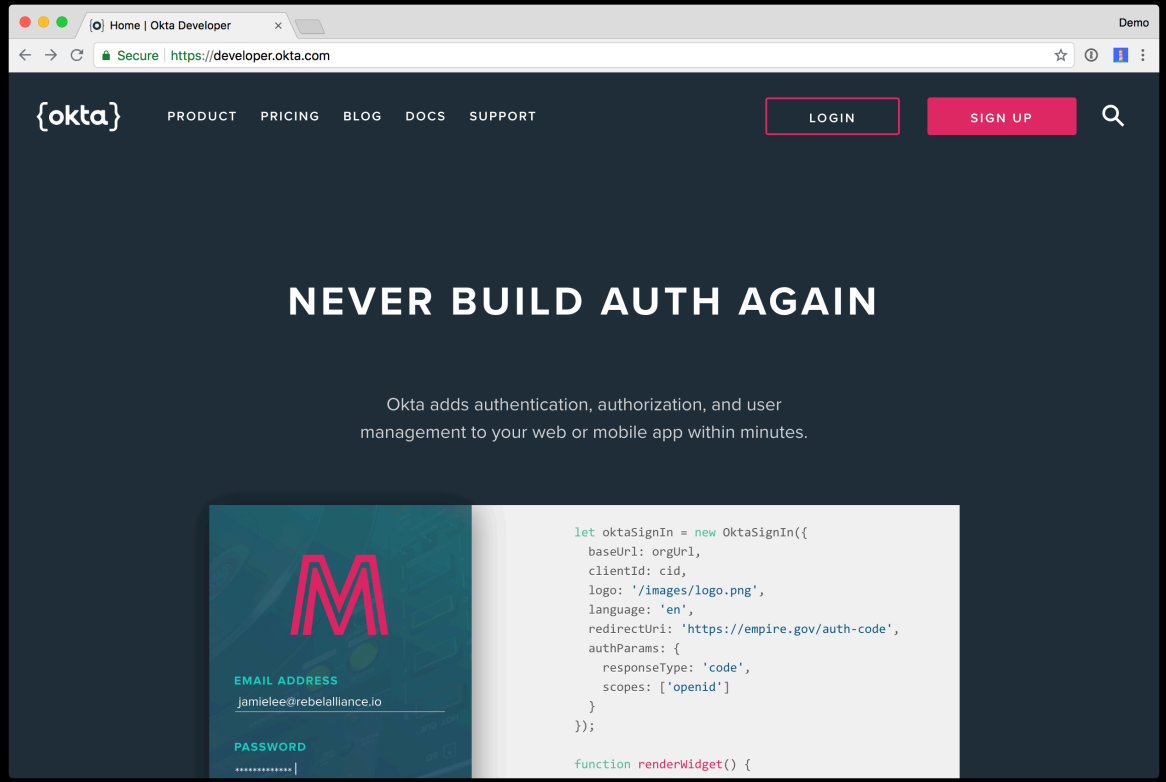
OAuth 2.0 Servers

oauth.com




developer.okta.com/blog
@oktadev

Play with OAuth 2.0 and OIDC



YouTube: OAuth 2.0 in plain English

https://youtu.be/996OiexHze0

Questions?

Keep in touch!

raibledesigns.com

@mraible

Presentations

speakerdeck.com/mraible

Code

github.com/oktadeveloper

@oktadev