Overcoming access control in web APIs

How to address security concerns using Sanic

Adam Hopkins

```python
class Adam:

    def __init__(self):
        self.work = PacketFabric("Sr. Software Engineer")
        self.oss = Sanic("Core Maintainer")
        self.home = Israel("Negev")

    async def run(self, inputs: Union[Pretzels, Coffee]) -> None:
        while True:
            await self.work.do(inputs)
            await self.oss.do(inputs)

    def sleep(self):
        raise NotImplemented
```

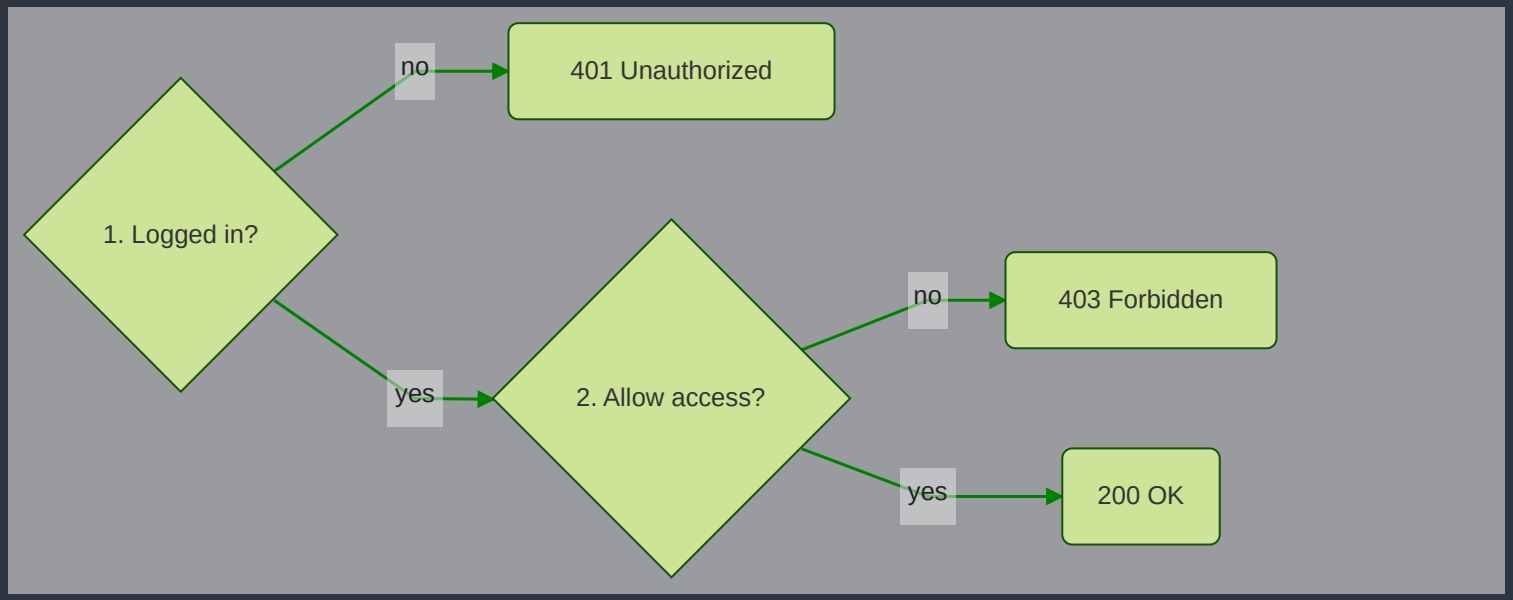
- PacketFabric - Network-as-a-Service platform; private access to the cloud; secure connectivity between data centers
- Sanic Framework - Python 3.6+ `asyncio` enabled framework and server. Build fast. Run fast.
- GitHub - /ahopkins
- Twitter - @admhpkns

What we will **NOT** cover?

- TLS
- Password and other sensitive information storage
- Server security
- SQL injection
- Data validation

1. Authentication - Do I know who this person is?

2. Authorization - Should I let them in?



```python
@app.get("/protected")
async def top_secret(request):
    return json({"foo":"bar"})
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```
curl localhost:8000/protected -i
HTTP/1.1 200 OK
Content-Length: 13
Content-Type: application/json
Connection: keep-alive
Keep-Alive: 5

{"foo":"bar"}
```

```python
async def do_protection(request):
    ...


def protected(wrapped):
    def decorator(handler):
        async def decorated_function(request, *args, **kwargs):

            await do_protection(request)
            return await handler(request, *args, **kwargs)

        return decorated_function

    return decorator(wrapped)


@app.get("/protected")
@protected
async def top_secret(request):
    return json({"foo": "bar"})
```

```
async def do_protection(request):
    ...

@app.middleware('request')
async def global_authentication(request):
    await do_protection(request)
```

Remember!

	Status Code	Status Text
Authentication	401	Unauthorized
Authorization	403	Forbidden

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Authentication	401	Unauthorized
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```
from sanic.exceptions import Forbidden, Unauthorized

async def do_protection(request):
    if not await is_authenticated(request):
        raise Unauthorized("Who are you?")

    if not await is_authorized(request):
        raise Forbidden("You are not allowed")
```

```
curl localhost:8000/protected -i
HTTP/1.1 401 Unauthorized
Content-Length: 49
Content-Type: application/json
Connection: keep-alive
Keep-Alive: 5

{"error":"Unauthorized","message":"Who are you?"}
```

```python
async def is_authenticated(request):
    """How are we going to authenticate requests?"""
```

Common authentication strategies

- Basic
- Digest
- Bearer
- OAuth
- Session

Common authentication strategies

- ~~Basic~~
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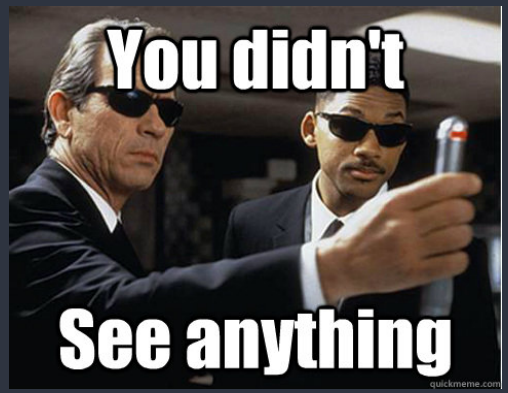
- ~~OAuth~~
- Session

Forget what you know!



Train pass

Session based

Single Ride

Point A to Point B

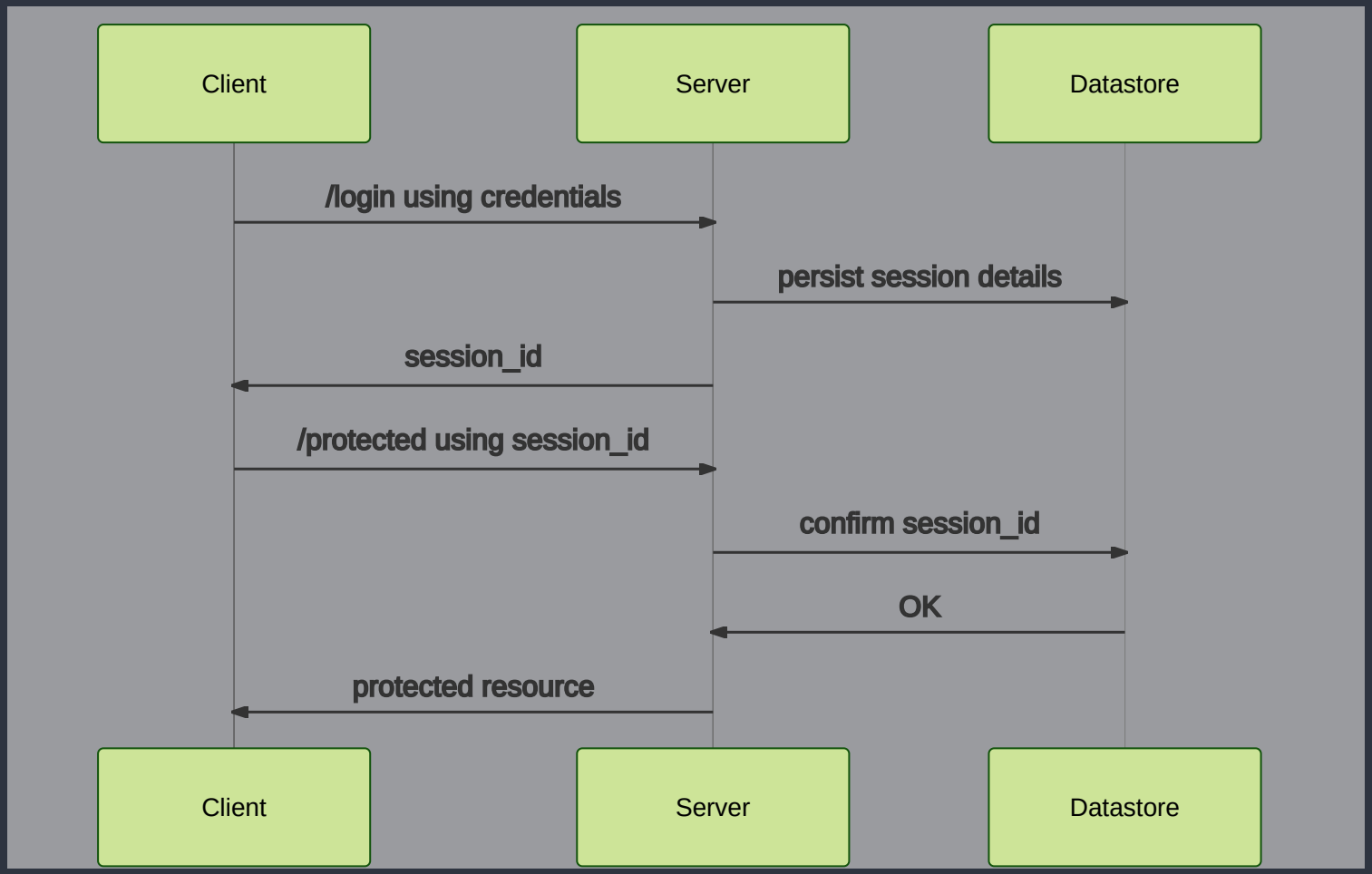
~~**Bearer**~~ **Non-session** based

All day pass

Off and on at any stop

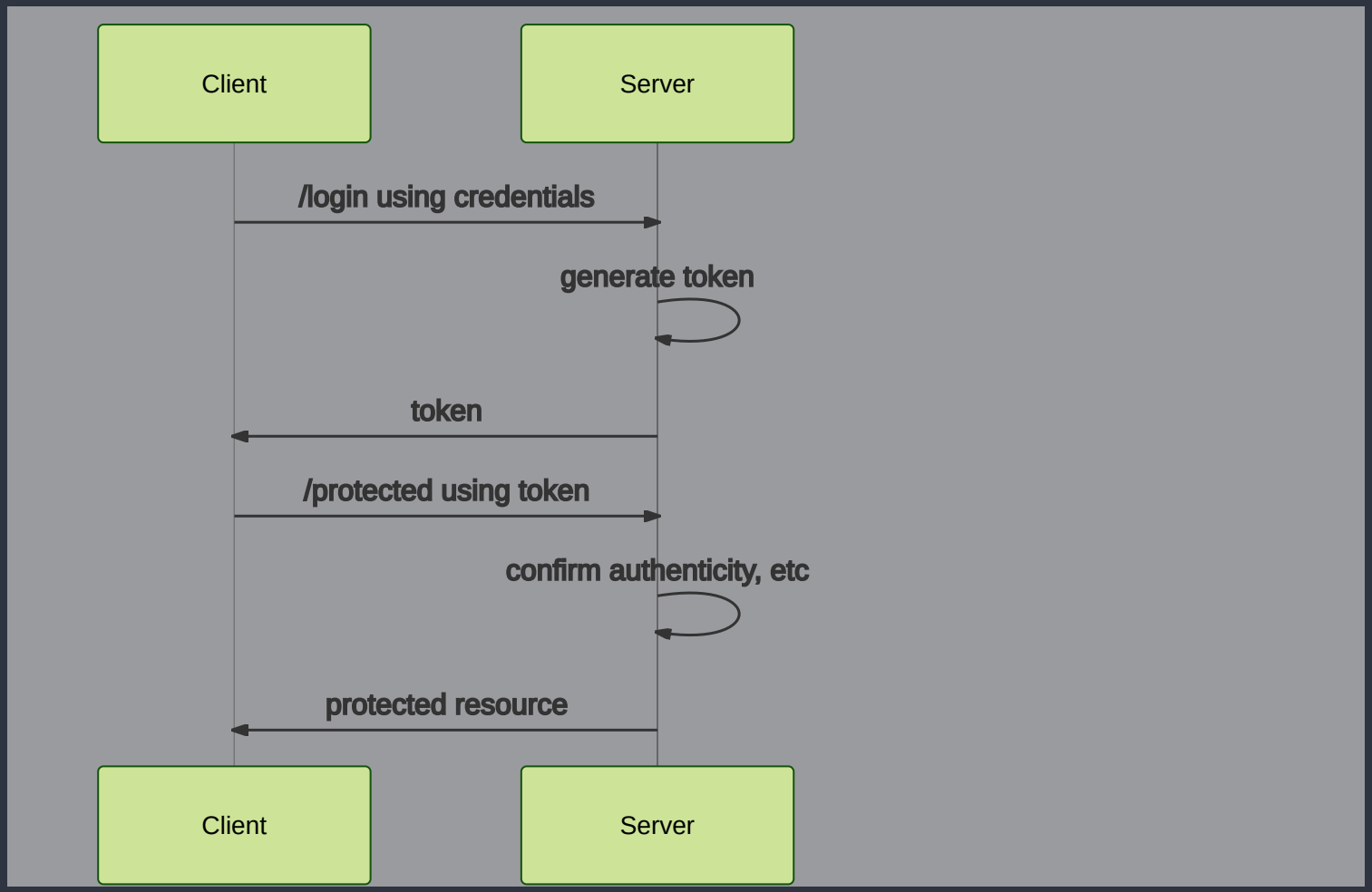
Session based

aka Single Ride



~~Bearer~~ Non-session based

All day pass



Hold that thought …

Let's decide on an auth strategy...

1. Who will consume the API?

   Applications? Scripts? People?
2. Do you have control over the client?
3. Will this power a web browser frontend application?

What we really want to know is...

Direct API v. **Browser** Based API (or both)

Direct API

- Fewer security concerns
- Scripts, mobile apps, non-browser clients
- More techinically sophisticated users
- API key or JWT

```
$ curl https://foo.bar/protected
```

Solved

Browser Based API

- More security concerns (CSRF, XSS)
- Web applications
- Lesser techinically sophisticated users
- Session ID or JWT

```
fetch('https://foo.bar/protected').then(r => {
    console.log(response)
})
```

Unsolved

Browser Based API Concerns

1. How should the browser store the token? (XSS)

   Cookie, localStorage, sessionStorage, in memory

2. How should the browser send the token? (CSRF)

   Cookie, Authentication header

Typical recommendations

Session based

- Stored: `Set-Cookie: token=<TOKEN>`
- Sent: `Cookie: token=<TOKEN>`
- Subject to **CSRF**
- Fixed with: `X-XSRF-TOKEN: <CSRFTOKEN>`

Solved

Non-session based

- Stored: JS accessible
- Sent: `Authorization: Bearer <TOKEN>`
- Subject to **XSS**

Unsolved

How do we authenticate?

- Session based v. Non-session based
- Direct API v. Browser Based API (or both)
- API key v. Session ID v. JWT

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Solutions:

Direct API using API key in `Authorization` header

Browser Based API using session ID in cookies

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But what about:

- Both Direct API and Browser Based API?

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- API key v. Session ID v. JWT

Solutions:

Direct API using API key in `Authorization` header

Browser Based API using session ID in cookies

But what about:

- Both Direct API and Browser Based API?
- Browser Based API using non-session tokens, aka JWTs?


WHAT IF I TOLD YOU WE CAN SECURE
JWT FROM BOTH CSRF AND XSS?
imgflip.com

Anatomy of a JWT

eyJhbGciOiJIUzI1NiIsInR5cCI6IkpXVCJ9.eyJzdWIiOiIxMjM0NTY3ODkwIiwibm
FtZSI6IkpvaG4gRG9lIiwiaWF0IjoxNTE2MjM5MDIyfQ.SflKxwRJSMeKKF2QT4f
wpMeJf36POk6yJV_adQssw5c

Anatomy of a JWT

eyJhbGciOiJIUzI1NiIsInR5cCI6IkpXVCJ9

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

eyJzdWIiOiIxMjM0NTY3ODkwIiwibmFtZSI6IkpvaG4gRG9lIiwiaWF0IjoxNTE2MjM5MDIyfQ

```
{
    "sub": "1234567890",
    "name": "John Doe",
    "iat": 1516239022
}
```

SflKxwRJSMeKKF2QT4fwpMeJf36POk6yJV_adQssw5c

```
signature
```

Anatomy of a JWT

`Set-Cookie access_token=`

eyJhbGciOiJIUzI1NiIsInR5cCI6IkpXVCJ9.eyJzdWIiOiIxMjM0NTY3ODkwIiwibm
FtZSI6IkpvaG4gRG9lIiwiaWF0IjoxNTE2MjM5MDIyfQ; `Secure`

`Set-Cookie access_token_signature=`

SflKxwRJSMeKKF2QT4fwpMeJf36POk6yJV_adQssw5c; `Secure; HttpOnly`

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eyJhbGciOiJIUzI1NiIsInR5cCI6IkpXVCJ9.eyJzdWIiOiIxMjM0NTY3ODkwIiwibm
FtZSI6IkpvaG4gRG9lIiwiaWF0IjoxNTE2MjM5MDIyfQ; `Secure`

`Set-Cookie access_token_signature=`

SflKxwRJSMeKKF2QT4fwpMeJf36POk6yJV_adQssw5c; `Secure; HttpOnly`

Split JWT cookies

```
header_payload, signature = access_token.rsplit(".", maxsplit=1)

set_cookie(
    response, "access_token", header_payload, httponly=False
)

set_cookie(
    response, "access_token_signature", signature, httponly=True,
)

set_cookie(
    response, "csrf_token", generate_csrf_token(), httponly=False,
)  # Do we even need this? Perhaps not!

def set_cookie(response, key, value, config, httponly=None):
    response.cookies[key] = value
    response.cookies[key]["httponly"] = httponly
    response.cookies[key]["path"] = "/"
    response.cookies[key]["domain"] = "foo.bar"
    response.cookies[key]["expires"] = datetime(...)
    response.cookies[key]["secure"] = True
```

We found a winner

~~Non session~~ Stateless JWT based

- Stored: ~~JS accessible~~ 2 cookies
- Sent: ~~Authorization: Bearer <TOKEN>~~ 2 cookies
  Also, 1 token via Header for CSRF protection
- ~~Subject to~~ Secured from **XSS**

Solved

```python
def extract_token(request):
    access_token = request.cookies.get("access_token")
    access_token_signature = request.cookies.get("access_token_signature")

    return f"{access_token}.{access_token_signature}"

def is_authenticated(request):
    token = extract_token(request)

    try:
        jwt.decode(token, ...)
    except Exception:
        return False
    else:
        return True
```

```
def do_protection(request):
    if not is_authenticated(request):
        raise Unauthorized("Who are you?")

    if not is_authorized(request):
        raise Forbidden("You are not allowed")

    if not is_pass_csrf(request):
        raise Forbidden("You CSRF thief!")
```

```
def is_authorized(request):
    """How shall we do this?"""
```

Structured Scopes

user:read:write

namespace:action(s)

Structured Scopes

user:read:write

namespace:action(s)

user:read

Structured Scopes

user:read:write

namespace:action(s)

user:read

Pass

```python
from sscopes import validate

is_valid = validate("user:read:write", "user:read")
print(is_valid)
# True
```

```
def is_authorized(request, base_scope):
    if base_scope:
        token = extract_token(request)
        payload = token.decode(token, ...)

        return validate(base_scope, payload.get("scopes"))
    return True
```

```python
@app.get("/protected")
@protected("user:read")
async def top_secret(request):
    return json({"foo":"bar"})
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```python
@app.get("/protected")
@protected("user:read")
async def top_secret(request):
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```

```javascript
fetch('https://foo.bar/protected').then(async response => {
    console.log(await response.json())
})
```

There must be a better way

There must be a better way

```
pip install sanic-jwt
```

```python
from sanic_jwt import Initialize, decorators

async def authenticate(request):
    """Check that username and password are valid"""

async def retrieve_user(request):
    """Get a user object from DB storage"""

async def my_scope_extender(user):
    return user.scopes

app = Sanic()
Initialize(
    app,
    authenticate=authenticate,                # sanic-jwt required handler
    retrieve_user=retrieve_user,
    add_scopes_to_payload=my_scope_extender,
    cookie_set=True,                          # Set and accept JWTs in cookies
    cookie_split=True,                        # Expect split JWT cookies
    cookie_strict=False,                      # Allow fallback to Authorization header
)

@app.get("/protected")
@decorators.scoped("user:read")
async def top_secret(request):
    ...
```

```
https://foo.bar/auth            # Login with username/password
https://foo.bar/auth/verify     # Verify a valid JWT was passed
https://foo.bar/auth/me         # View details of current user
https://foo.bar/protected       # Must have user:read access
```

Presentation Repo - /ahopkins/europython2020-overcoming-access-control

PacketFabric - https://packetfabric.com

Sanic Repo - /huge-success/sanic

Sanic Community - Forums

sanic-jwt - /ahopkins/sanic-jwt

sscopes - Docs