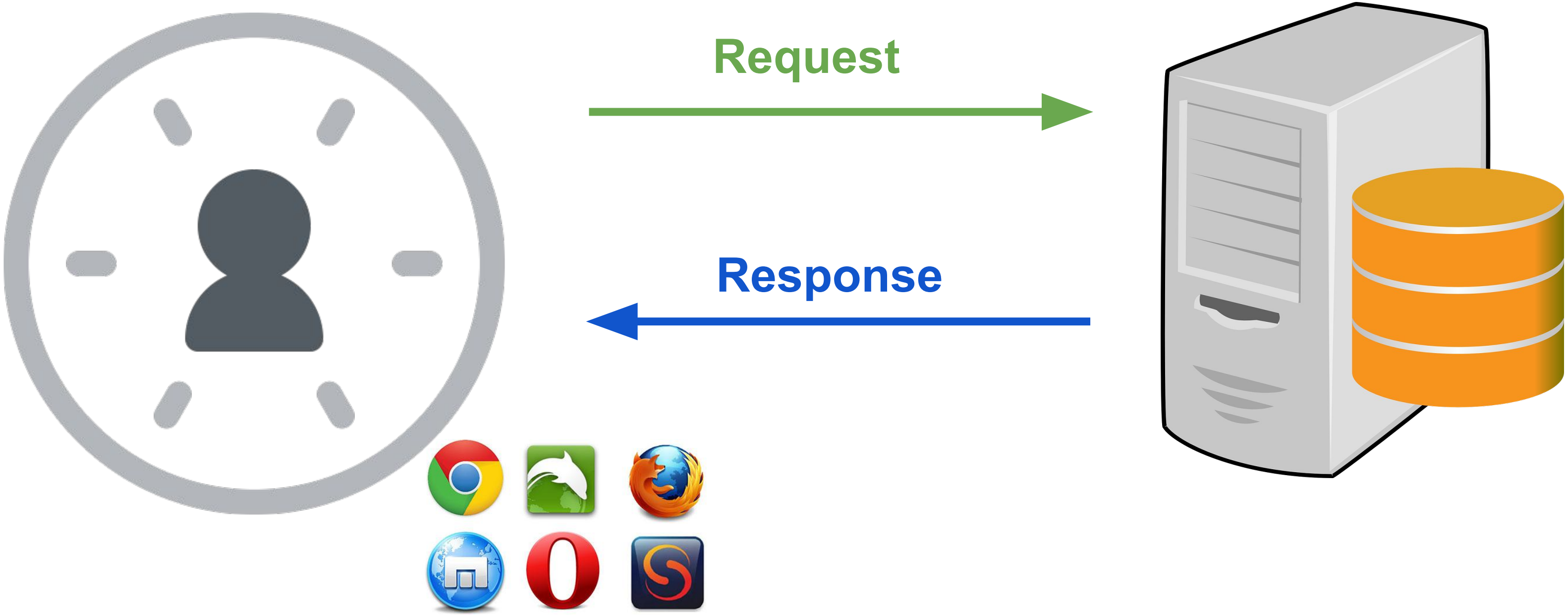
ÉCOLE POLYTECHNIQUE
FÉDÉRALE DE LAUSANNE

HW1-HW2 Overview

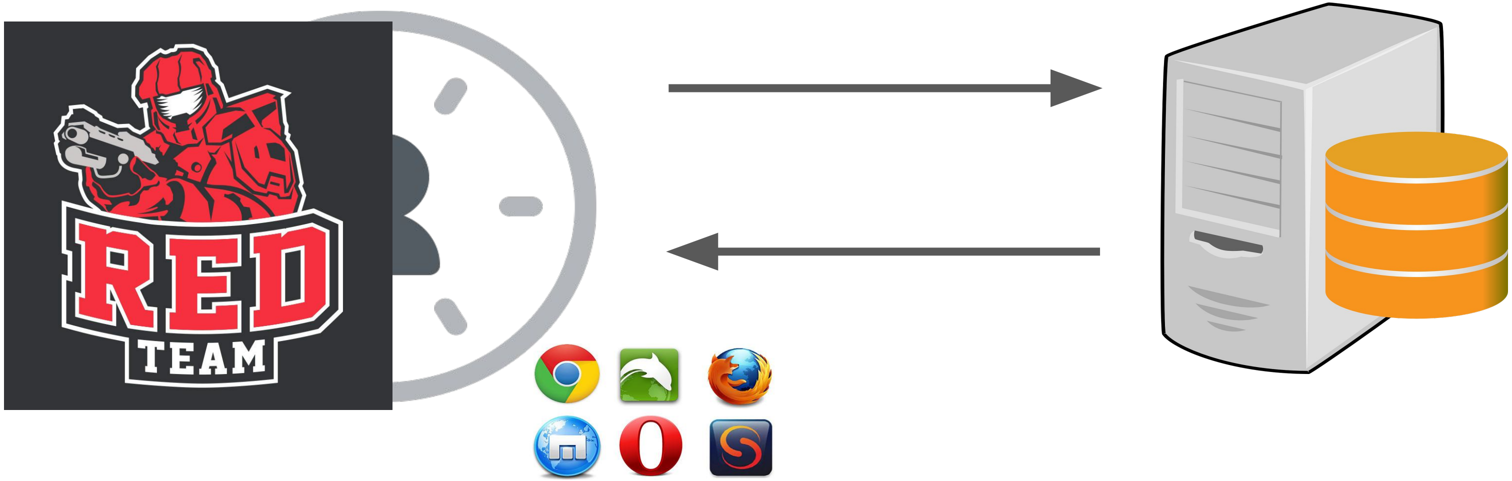
COM-402: Information Security and Privacy

Authentication

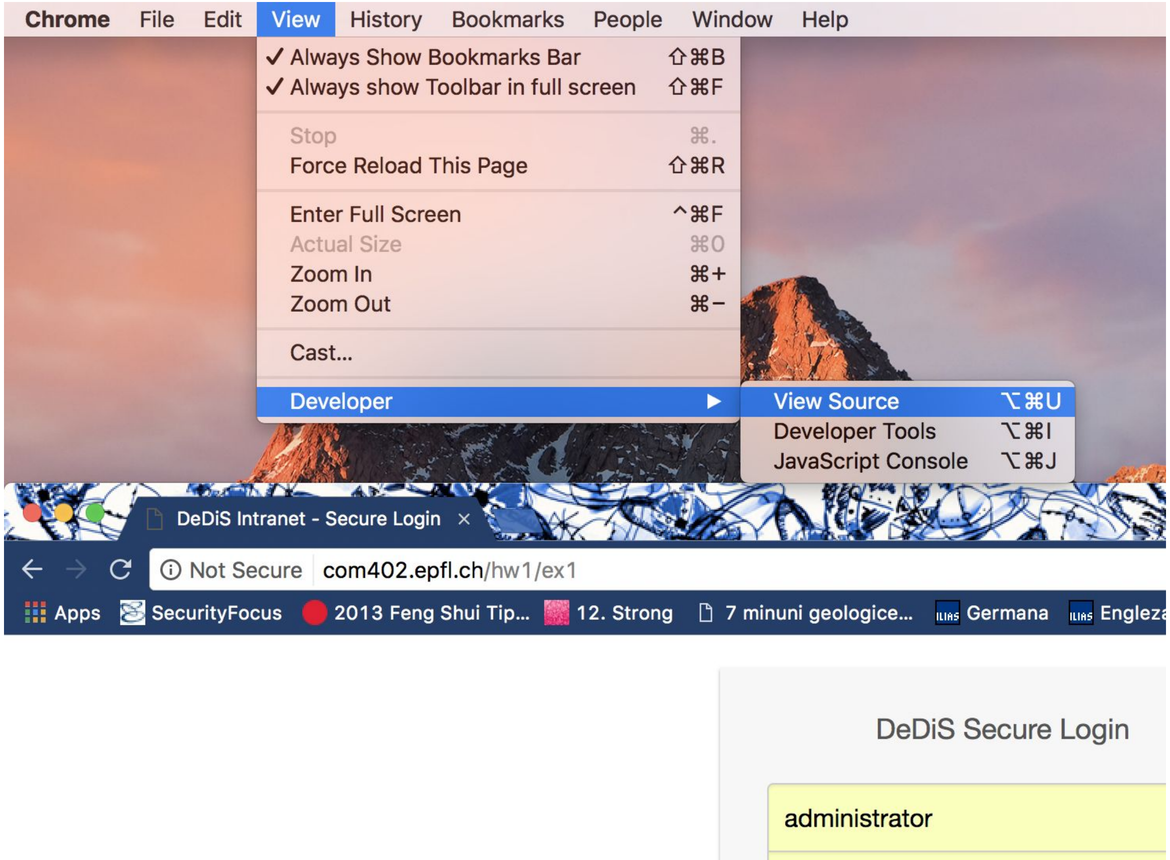


Authentication - hw1 ex1

- **Password check on client side (Javascript!)**
  - Javascript code visible to client



Javascript code (1)



Javascript code (2)

```
var enc = superencryption(username,mySecureOneTimePad) ;
if (enc != password) {
    alert("I didn't say it would be easy, Neo. I just said it would be the truth.");
    return;
}
```

```
function superencryption(msg,key) {
    if (key.length < msg.length) {
        var diff = msg.length - key.length;
        key += key.substring(0,diff);
    }

    var amsg = msg.split("").map(ascii);
    var akey = key.substring(0,msg.length).split("").map(ascii);
    return btoa(amsg.map(function(v,i) {
        return v ^ akey[i];
    }).map(toChar).join(""));
}
```

Javascript code (3)


```
var enc = superencryption(username,mySecureOneTimePad) ;
if (enc != password) {
    alert("I didn't say it would be easy, Neo. I just said it would be the truth.");
    return;
}
```

```
var mySecureOneTimePad = "Never send a human to do a machine's job";
```

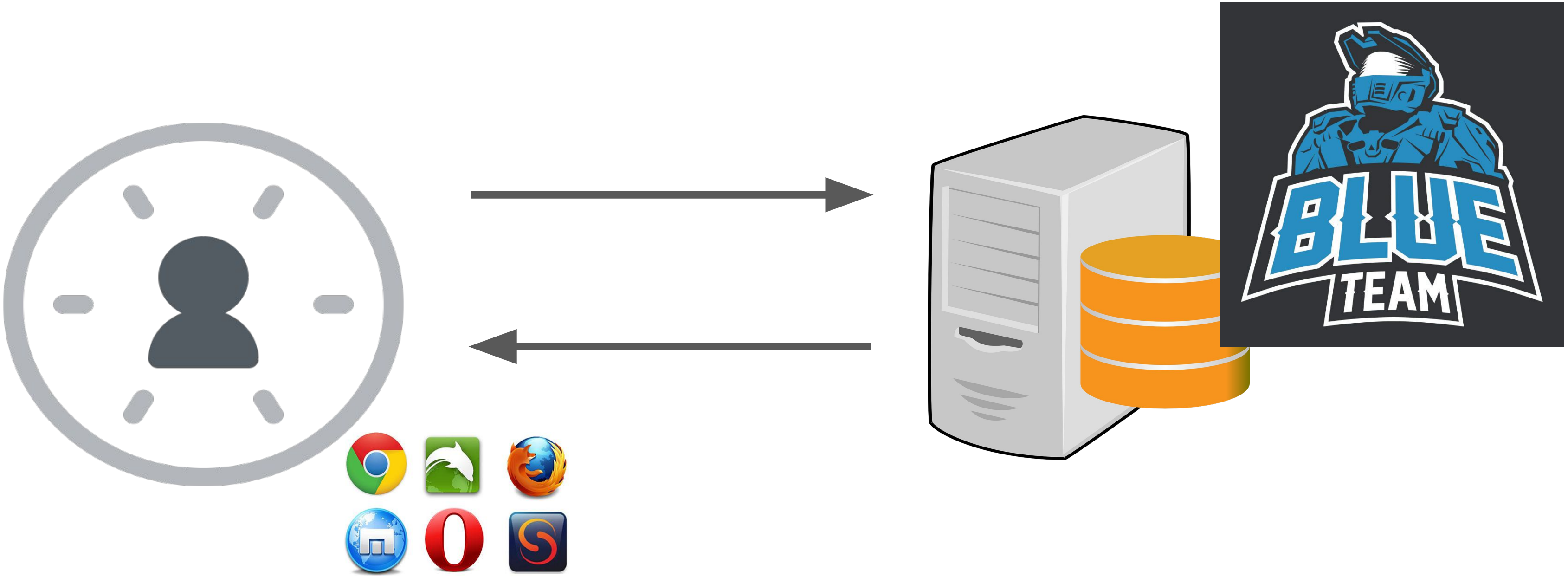
```
function superencryption(msg,key) {
    if (key.length < msg.length) {
        var diff = msg.length - key.length;
        key += key.substring(0,diff);
    }

    var amsg = msg.split("").map(ascii);
    var akey = key.substring(0,msg.length).split("").map(ascii);
    return btoa(amsg.map(function(v,i) {
        return v ^ akey[i];
    }).map(toChar).join(""));
}
```

Expand key if needed

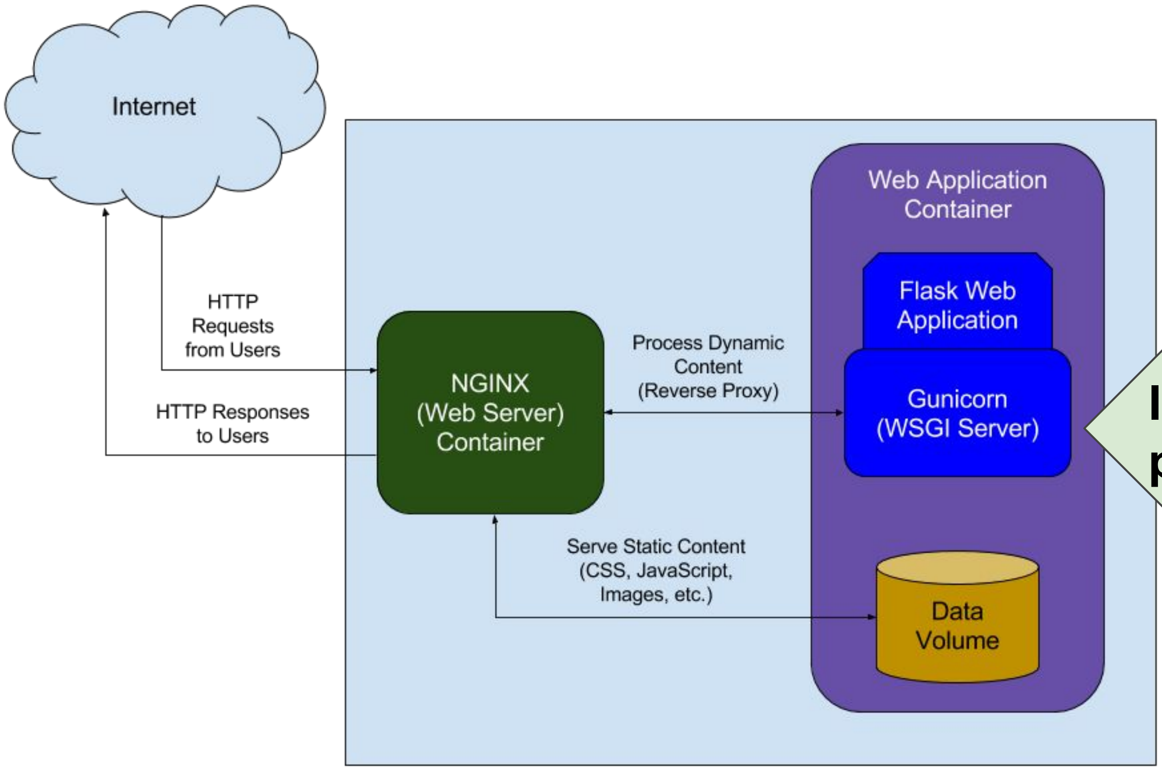
Bitwise xor each character of key and username. Btoa encodes string in base64.

Fixing hw1 ex1 in hw2 ex1

- **Implement password check on server side**



Password check on server side (1)



Interface for running python web applications

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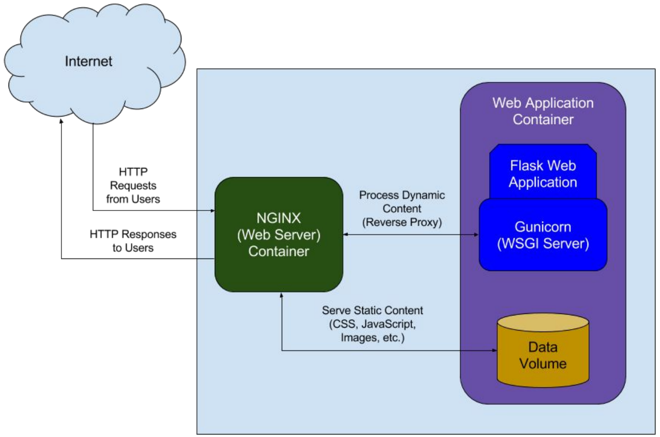
Password check on server side (2)

- **Use POST HTTP method**
  - Submits data to be processed to a specific resource
- **Here the resource is /hw2/ex1**
- **Steps**
  - Key at least as long as e-mail
  - Bitwise xor e-mail with key
  - Convert result of xor to bytes (characters)
  - Base64 encode the bytes



Cookies - Kirill

Cookies

- For storing info across user's sessions (HTTP is stateless)
- Stored on client machines
- Used for
  - Authentication
  - Personalization
  - Tracking

Credit: Wikipedia. [HTTP cookie]

Cookies

- Usually include
  - Name
  - Domain and Path
  - Expiration date
- But may also include browsing activity, account information, state, etc.

Cookies - Storing state in browser

Dansie Shopping Cart (2006)

```
<FORM METHOD=POST
 ACTION="http://www.dansie.net/cgi-bin/scripts/cart.pl">

  Black Leather purse with leather straps<

  <INPUT TYPE=HIDDEN NAME=name      VALUE="Black leather purse">
  <INPUT TYPE=HIDDEN NAME=price     VALUE="20.00">
  <INPUT TYPE=HIDDEN NAME=sh        VALUE="1">
  <INPUT TYPE=HIDDEN NAME=img       VALUE="p
  <INPUT TYPE=HIDDEN NAME=custom1   VALUE="B
       with leather straps">

  <INPUT TYPE=SUBMIT NAME="add" VALUE="Put in Shopping Cart">

</FORM>
```

Change this to 2.00

Bargain shopping!

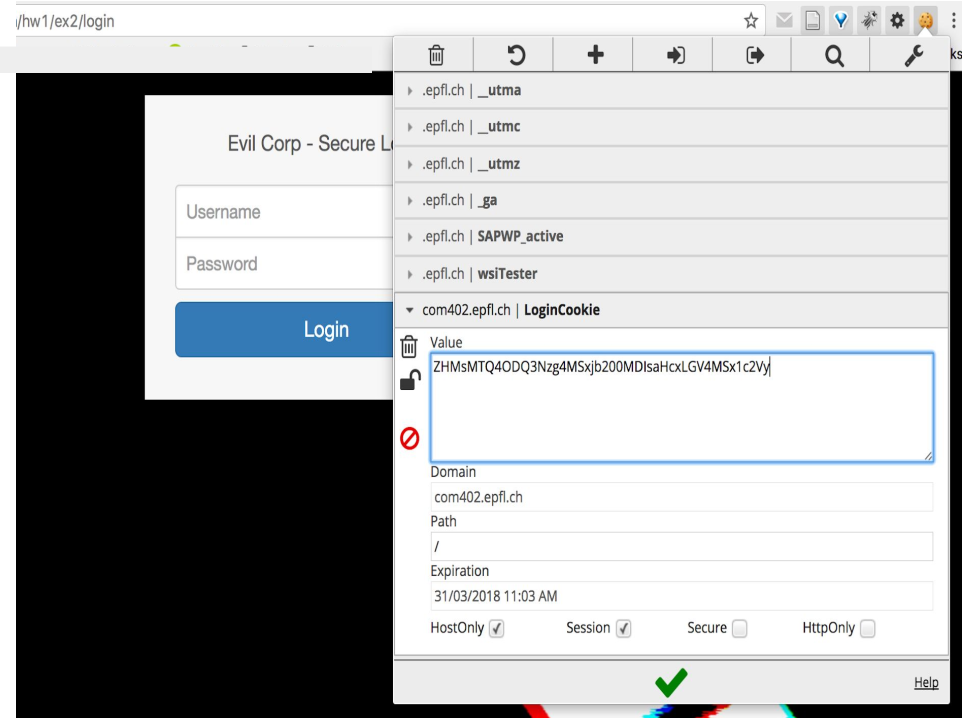
HW1 - ex2

Steps to solve:

- Decode from base64
- You obtain smth like:

'hero@epfl.ch,1488477881,com402,
hw1,ex1,*user*'

- Substitute ‘*user*’ by ‘*administrator*’
- Encode back into base64 and paste into your browser state
- Go to /hw1/ex2/list
- Hack & Spy



HW2 - ex3

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- When having received a POST request at “/ex3/login”, check “user” and “pass” and prepare an appropriate string:
  - administrator,*timestamp*,com402,hw2,ex3,administrator or
  - *name*,*timestamp*,com402,hw2,ex3,user
- Compute HMAC of the prepared string with your password of hw1/ex1 encoded in utf-8 as a secret key *K* (use python3 module `hmac`)

$$HMAC(K,m) = H\Big((K' \oplus opad) \,||\, H\big((K' \oplus ipad) \,||\, m\big)\Big)$$

- Send a response with a cookie <*your_string*, *HMAC*>.
- Expect a POST request to "/ex3/list" with the cookie. Upon reception, check whether HMAC is correct and return a corresponding status code.

Key Agreement Protocols

- Key agreement protocol - parties agree on a shared key in such a way that both parties influence the key
  - Example: Diffie-Hellman key exchange
  - Alice and Bob have g and p
  - Alice: A = g^a mod p, send A to Bob
  - Bob: B = g^b mod p, send B to Alice
  - Shared key K = A^b mod p = B^a mod p = g^(ab) mod p
  - Problem - No authentication -> vulnerable to MiTM attacks
- Potential solutions:
  - Public-key crypto: digitally signed keys (Certificate authorities, TLS, HTTPS,...)
  - Password authenticated key exchange protocols (PAKE)

PAKE

- PAKE - two parties establish a shared key based on their knowledge of a password in such a way that MiTM attacker can’t participate in the method
- Two main purposes of PAKE:
  - Generate a cryptographically secure shared key from a low-entropy password
  - Prove the knowledge of a password without sending the actual password

SRP

- Secure remote password protocol (SRP)
  - Augmented PAKE - server doesn’t store password-equivalent data
- Client and server have an established shared password
  - Goal: User wants to prove to the server that it knows the password without sending it

SRP

- Server stores users passwords as:
  {username, pass_verifier, salt}
  pass_verifier = *v* in the diagram

```
Client                                              Server
-------                                             ---------

U = email
sends U
                  --------- >
                                              salt = random(32)
                                                     sends salt
                 < ---------
a = random(32)
A = g^a % N
sends A
                 ---------->
                          x= H(salt || H(U || ":" || password))
                                                   v = g^x % N
                                                b = random(32)
                                            B = (v + g^b) % N
                                                       sends B
                  < ---------
p = password
u = H(A || B)
x = H(salt || H(U || ":" || password))
S = (B - g^x) ^ (a + u * x) % N
                                                 u = H(A || B)
                                          S = (A * v^u) ^ b % N
```

SRP

- Authentication is usually initiated by the user

```
 Client                                  Host
--------                                ------
 U = <username>                 -->
                                   <--     s = <salt from passwd file>
```

SRP

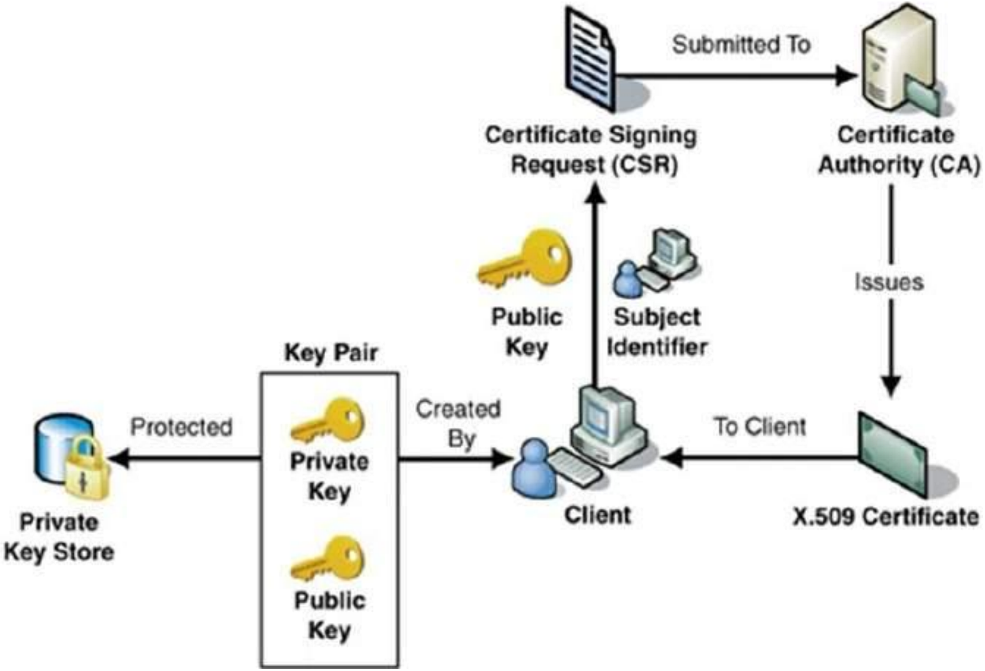
```
a = random()
A = g^a % N                   -->
                                   v = <stored password verifier>
                                   b = random()
                              <--  B = (v + g^b) % N

p = <raw password>
x = SHA(s | SHA(U | ":" | p))

S = (B - g^x) ^ (a + u * x) % N    S = (A * v^u) ^ b % N
```

- After this exchange the user and the server should have the same secret session key *S*
- To finish authentication they need to prove to each other that they indeed have the same key

PKI - Ceyhun

- For PAKE you trust the server and authenticate yourself
  - But do you always know who you talk with?
- Sending password in plain-text is not secure
  - Hey man, can you hack my girlfriends Facebook password?
  - Used to be easy, shouldn't be easy
- First step self-signed certificate
  - A website signs a certificate proving that it holds the key
  - MITM?
  - TOFU?

PKI Infrastructure



Is it secure?

- Better than nothing for sure
- Kind of works
- What If a CA’s signing key is compromised (DigiNotar)
- What if A CA is coerced to sign something for _ _ _

Decentralization