Smartphone as a security token

Group 18

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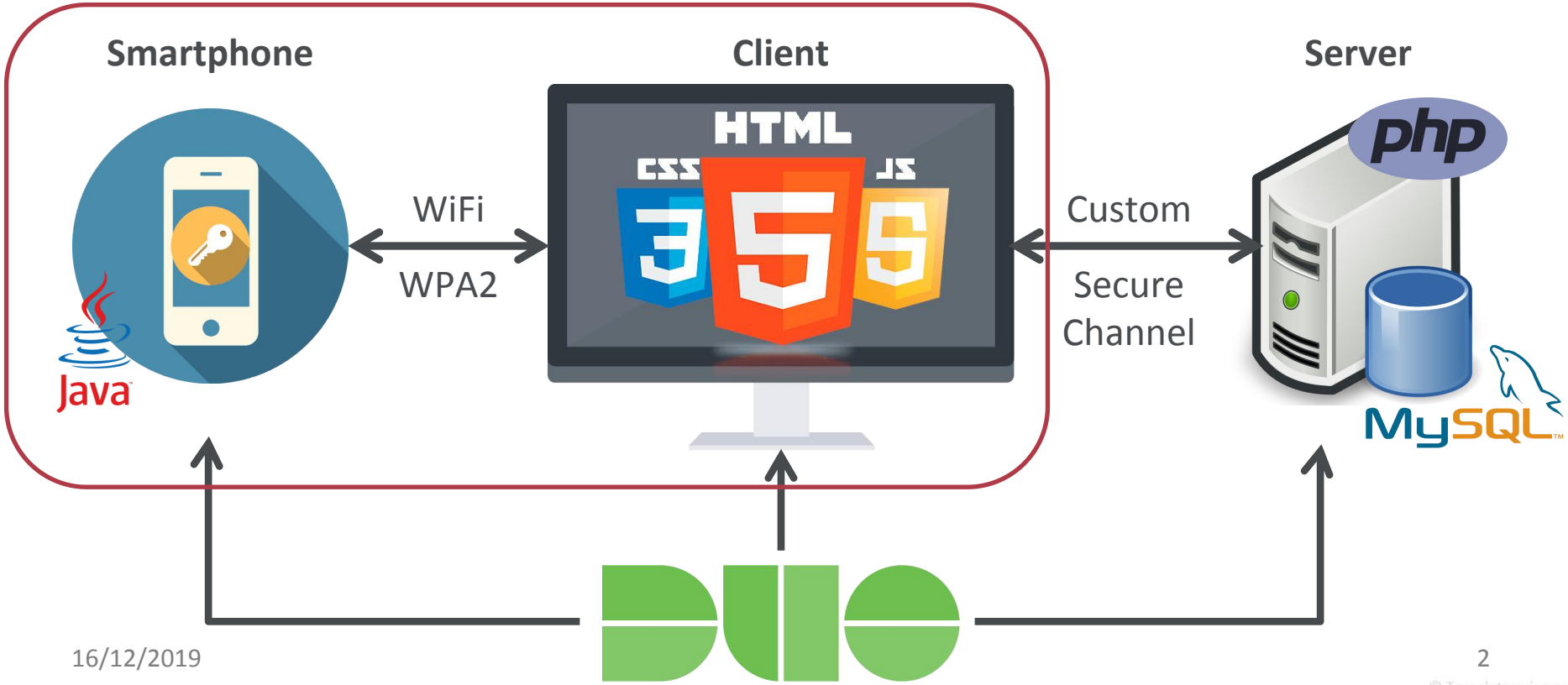
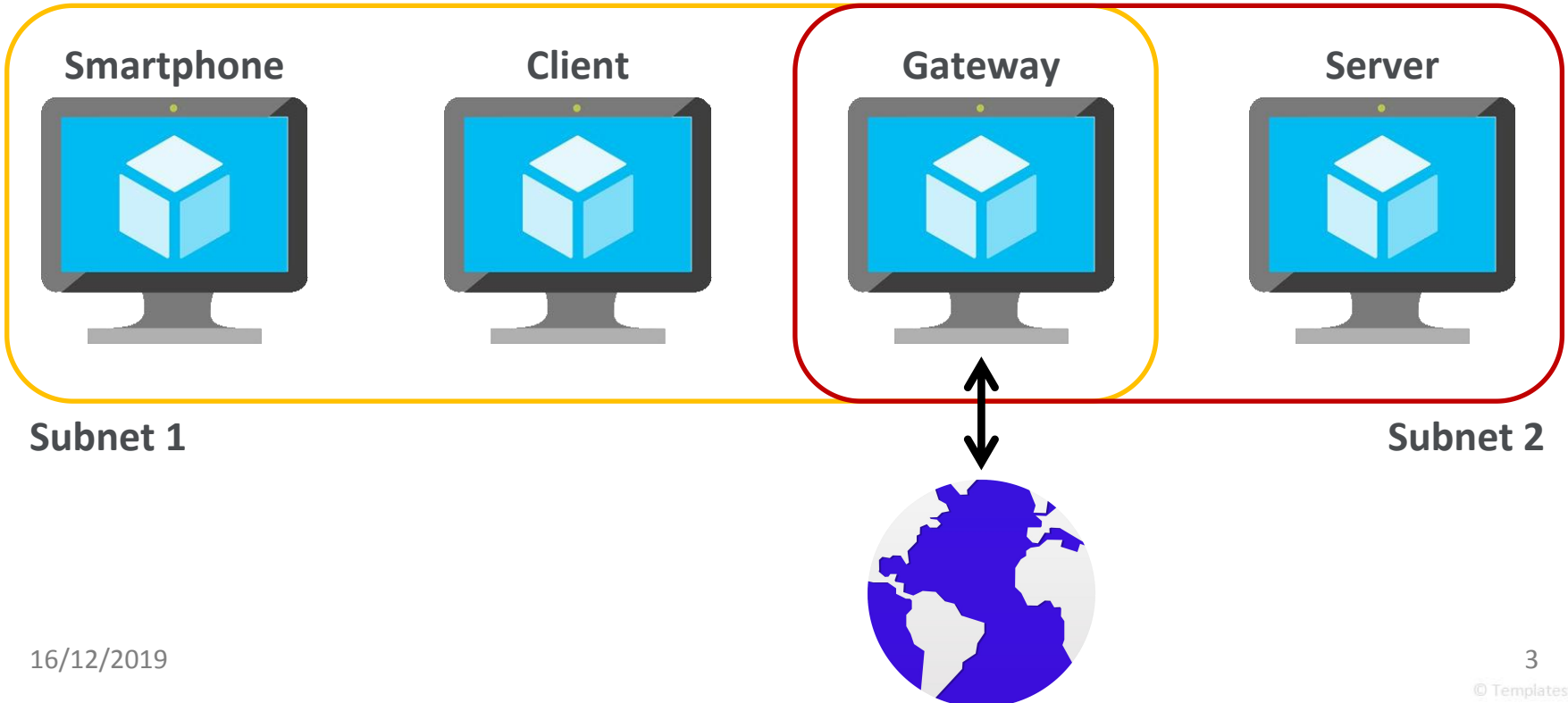
System architecture



System architecture - VMs



Solution

- Password strength, XSS, SQLI
- 2FA
- Custom Secure Channel
- Proximity

Password strength, XSS, SQLI

- Not the focus of our project, but still:
  - we use use PHP's **password_hash** which uses **bcrypt**.
  - we require a minimum of 10 characters with lowercase, uppercase, digit and symbol.
  - we escape HTML characters directly or indirectly provided by a user when output to the screen.
  - we use SQL prepared statements.

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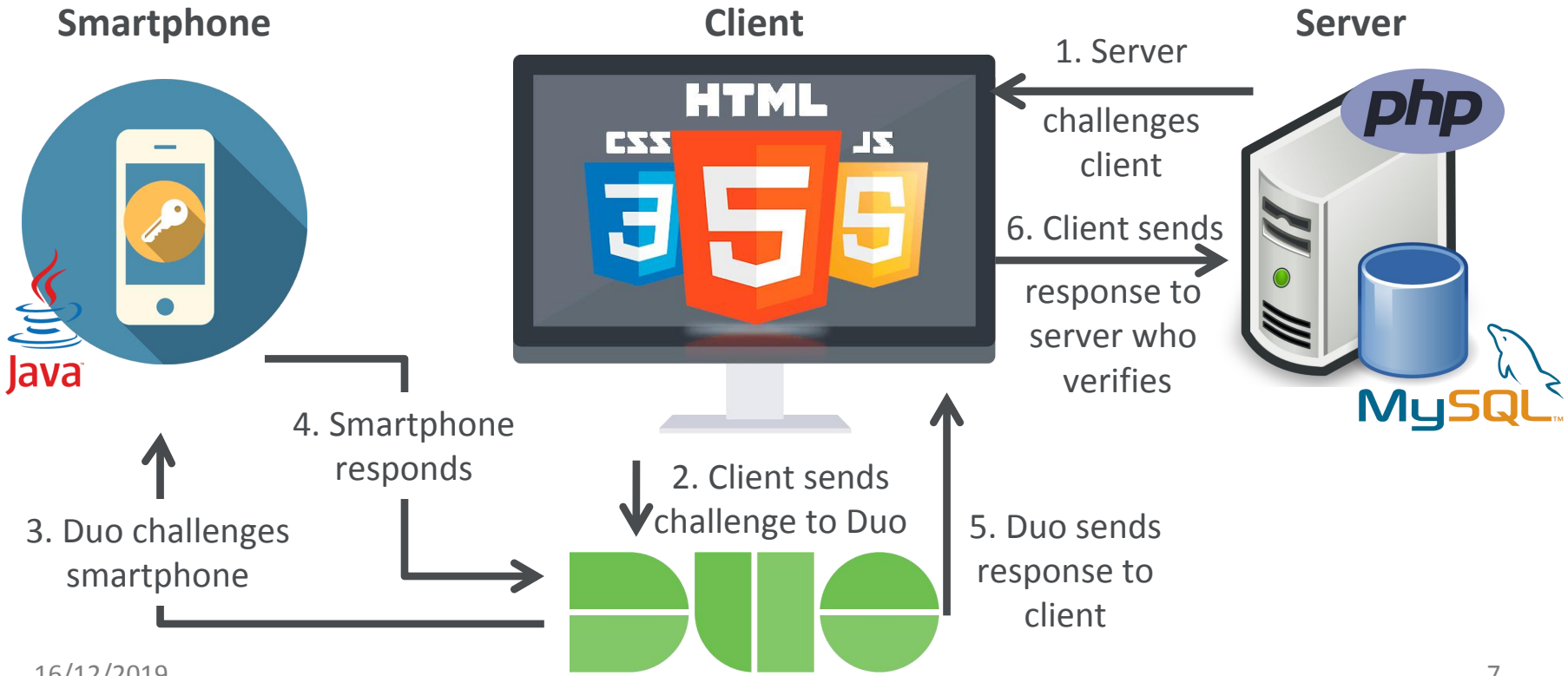
Two-factor authentication



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Diffie-Hellman

Private is large and random

Private = 5

(6^5) MOD 13
(7776) MOD 13
Public = 2

Agree upon two numbers:

P Prime Number 13
G Generator of P 6

P is large, e.g. 2048 bits

Randomly generate a Private Key

G is a primitive root modulo P

Calculate Public Key:
$(G^{Private})$ MOD P

Exchange Public Keys

Calculate the Shared Secret
$(Shared\ Public^{Private})$ MOD P

Private = 4

(6^4) MOD 13
(1296) MOD 13
Public = 9

(9^5) MOD 13
(59049) MOD 13
Shared Secret = 3

(2^4) MOD 13
(16) MOD 13
Shared Secret = 3

Ephemeral Diffie-Hellman (DHE)

- Grants **perfect forward secrecy** by computing new private and public values for each session
  - If a session key is discovered only that session is compromised.
  - If a long-term private key is compromised, past sessions are not compromised.

Ephemeral Diffie-Hellman with RSA (DHE-RSA)

Client acts as middle man due to the lack of JS crypto and smartphone proximity

* clicks Register button *

request DH

login to smartphone

1. Smartphone verifies if RSA pub.'s certificate is signed by a CA. *(not implemented)*
2. Verifies DH pub. key signature
2. Smartphone computes its own DH pub. and shared secret.

P, G, nº bits of P, server DH pub. key (plain and signed), RSA pub. key

P, G, nº bits of P, server DH pub. key (plain and signed), RSA pub. key

Smartphone's DH pub. key (plain and signed)

Smartphone's DH pub. key (plain and signed)

Request encrypt [username, password]

Ek[username, password, RSA public key]

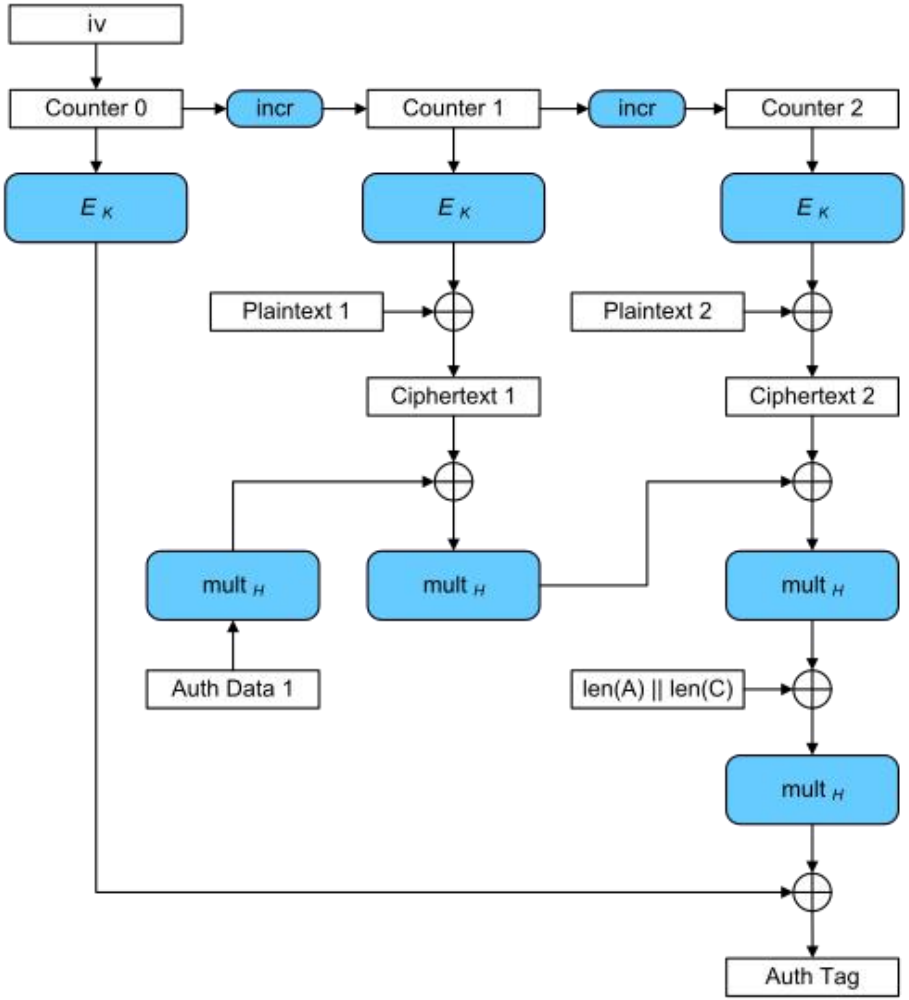
Ek[username, password, RSA public key]

1. Server verifies DH pub. key signature except on registration
2. Server computes shared secret.

AES Galois/Counter Mode (AES-GCM)

- DH only finds a shared secret that can be used as a symmetric key, it is not an encryption algorithm.

- GCM is an authentication encryption mode of operation, it is composed by two separate functions: one for encryption (AES-CTR) and one for integrity and authentication (GMAC).



Solution

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Proximity

- The client can only communicate with the server with the smartphone close by.
  - Smartphone contains RSA private key and all cryptographic methods.
- Client application logs out as soon as connection with the smartphone is lost.
- Encrypted .txt files are decrypted to volatile memory only (garbage collected as soon as smartphone connection is lost). *(not implemented)*
- Decrypted binary files are encrypted again as soon as smartphone connection is lost. *(not implemented)*

Conclusion

Aside from:

1. Not verifying if the server's RSA public key is inside a certificate signed by a Certification Authority;
2. Not having implemented file encryption / decryption in time;
3. Not associating the user's account with Duo at registration;

We have also not encrypted the HTTP headers including the session cookie!

But otherwise we consider our implementation to be a start and our design logic robust.