CECS 478

PHASE DESIGN

“DUODOLO”

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1. Assets
    a. User Information
    b. Content of messages
    c. Server
    d. Database
2. Stakeholders
    a. Members of DuoDolo
    b. Users of our messaging app
3. Adversary Models
    a. User Info / DuoDolo & User Info/Users
        i. Active Insider / Passive Insider
            1. Digital Resources
                a. Low/high computational power
                b. Low/high power supply
                c. Might have access to database
                d. Access to our code
            2. Protection Plan
                a. Access Control
                b. Need to implement accountability
                c. Need to implement undeniability

1. logs/transcripts

ii. Active Outsider
    1. Digital Resources
        a. Low/High computational power
        b. Low/High power supply
    2. Protection Plan
        a. Limit number of attempts for login
        b. Hash passwords

iii. Passive Outsider
    1. Digital Resources
        a. Low/High computational power
        b. Low/High power supply
    2. Protection Plan
        a. Hash passwords
        b. Do not store information on server

b. Message Content / DuoDolo & Message Content / User
    i. Active Insider / Passive Insider
        1. Digital Resources
            a. Low/high computational power
            b. Low/high power supply
        2. Protection Plan
            a. Encrypt messages
            b. Encrypt keys
            c. HMAC
    ii. Active Outsider / Passive Outsider
        1. Digital Resources
            a. Low/high computational power

b. Low/high power supply

2. Protection Plan

a. Encrypt messages

b. Encrypt keys

c. HMAC

c. Server / DuoDolo

i. Active Insider / Passive Insider

1. Digital Resources

a. Low/high computational power

b. Low/high power supply

2. Protection Plan

a. AWS shield

b. Accountability

c. Undeniability

i. Logs

d. Access Control

ii. Active Outsider / Passive Outsider

1. Digital Resources

a. Low/high computational power

b. Low/high power supply

2. Protection Plan

a. AWS shield

d. Server / User

i. Active Outsider / Passive Outsider

1. Digital Resources

a. Low/high computational power

b. Low/high power supply

2. Protection Plan
    a. AWS shield

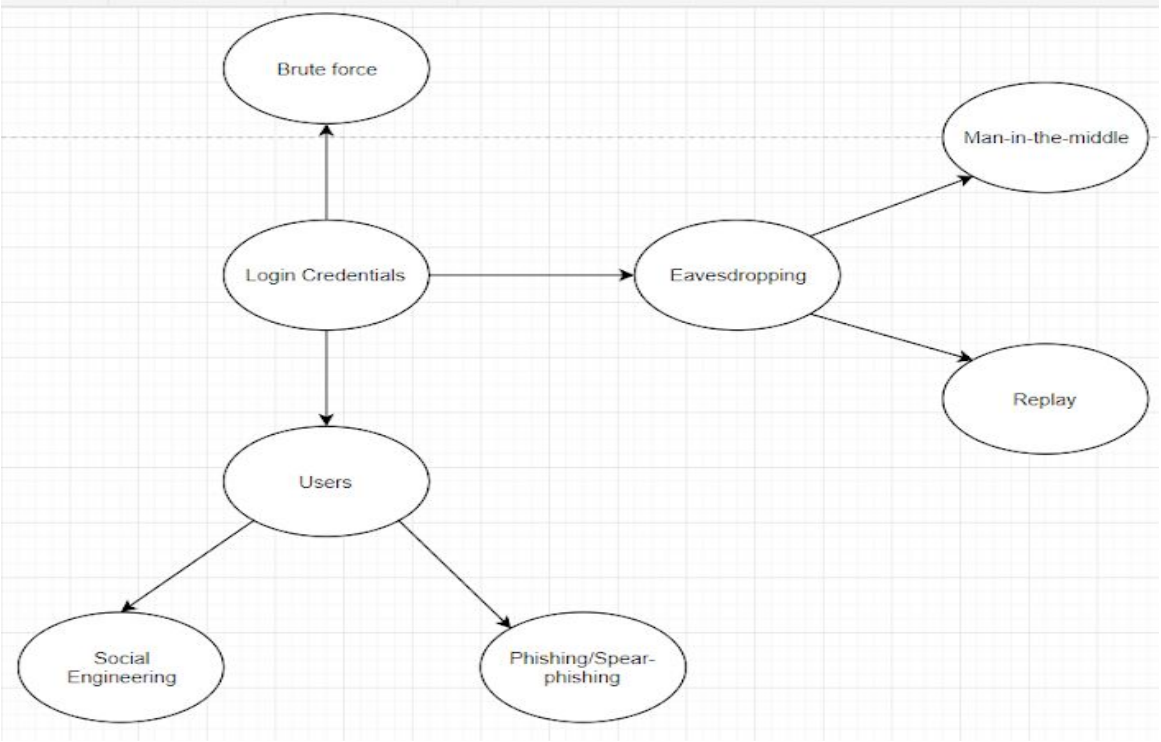
e. Database / DuoDolo
    i. Active Insider / Passive Insider & Active Outsider / Passive Outsider
        1. Digital Resources
            a. Low/high computational power
            b. Low/high power supply
        2. Protection Plan
            a. Accountability
            b. Undeniability
            c. Access Control

f. Database / User
    i. Active Outsider / Passive Outsider
        1. Digital Resources
            a. Low/high computational power
            b. Low/high power supply
        2. Protection Plan
            a. Encryption
            b. Hash

4. Attack Surfaces
    a. Login Credentials
        i. Brute force attacks
        ii. Social Engineering
        iii. Users
            1. Social Engineering
            2. Phishing / Spear phishing

iv. Eavesdropping

1. Man in the middle attack
2. Replay

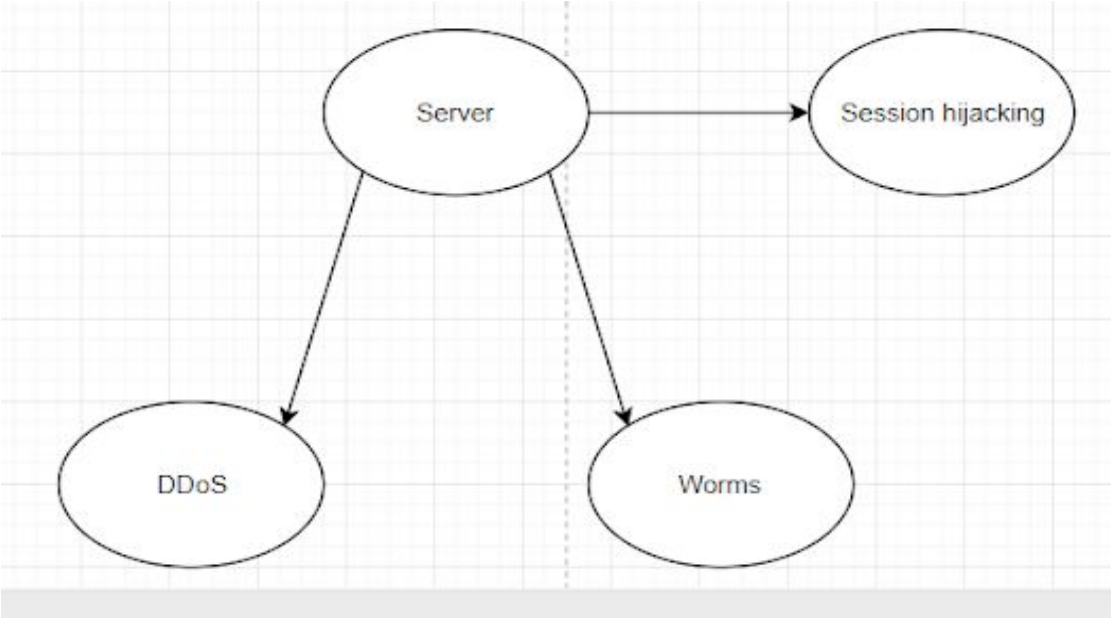


b. Server

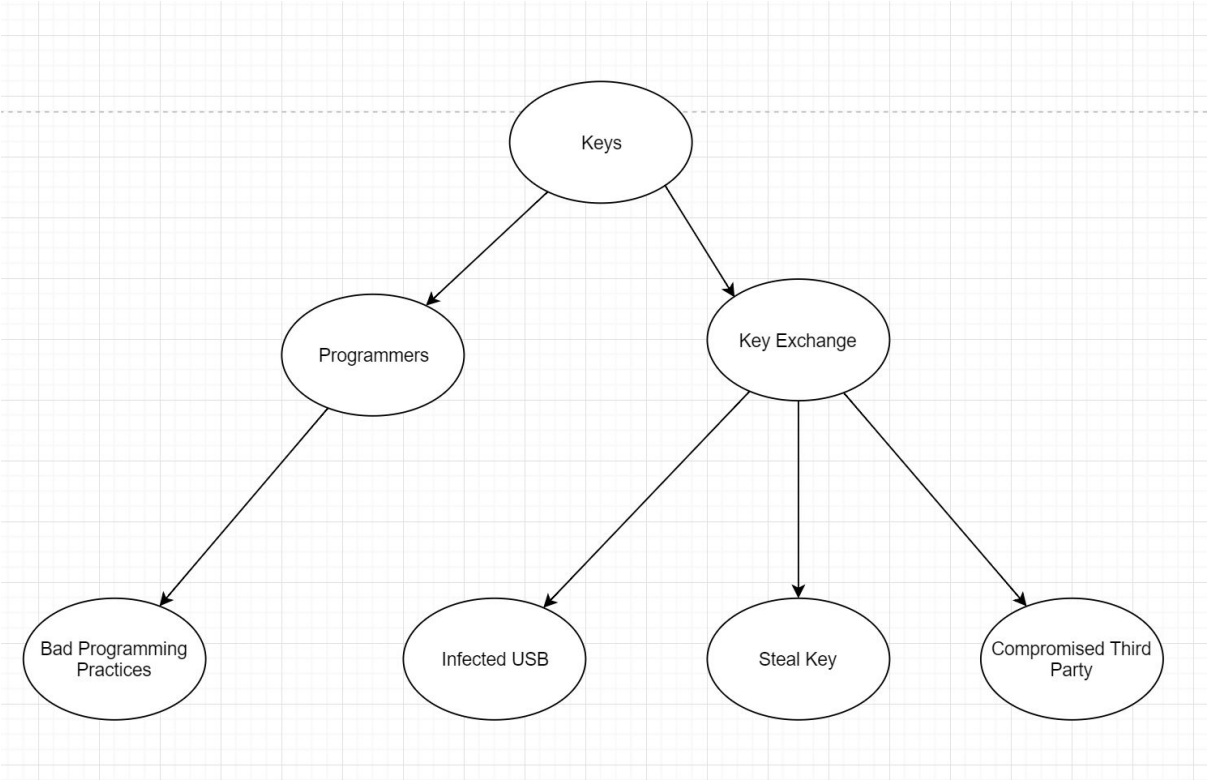
i. Worms

ii. DDoS

iii. Session hijacking



c. Key
    i. Key Exchange
        1. Steal Key
        2. Infected USB
        3. Compromised Third Party
    ii. Programmers
        1. Bad programming practices



5. Solutions
    a. Authentication Methods
        i. JWT tokens verify the identity of the user and gives access to send/receive messages.
        ii. Let's Encrypt
            1. Provides HTTPS domain authentication
    b. Message Integrity Check
        i. Integrity tag is generated by running HMAC on the ciphertext.
        ii. This tag is output to a JSON file with an encrypted concatenation of the HMAC and AES keys.
        iii. On decryption, the encrypted keys are decrypted.
        iv. HMAC is executed with the recovered HMAC key to re-generate the HMAC tag.

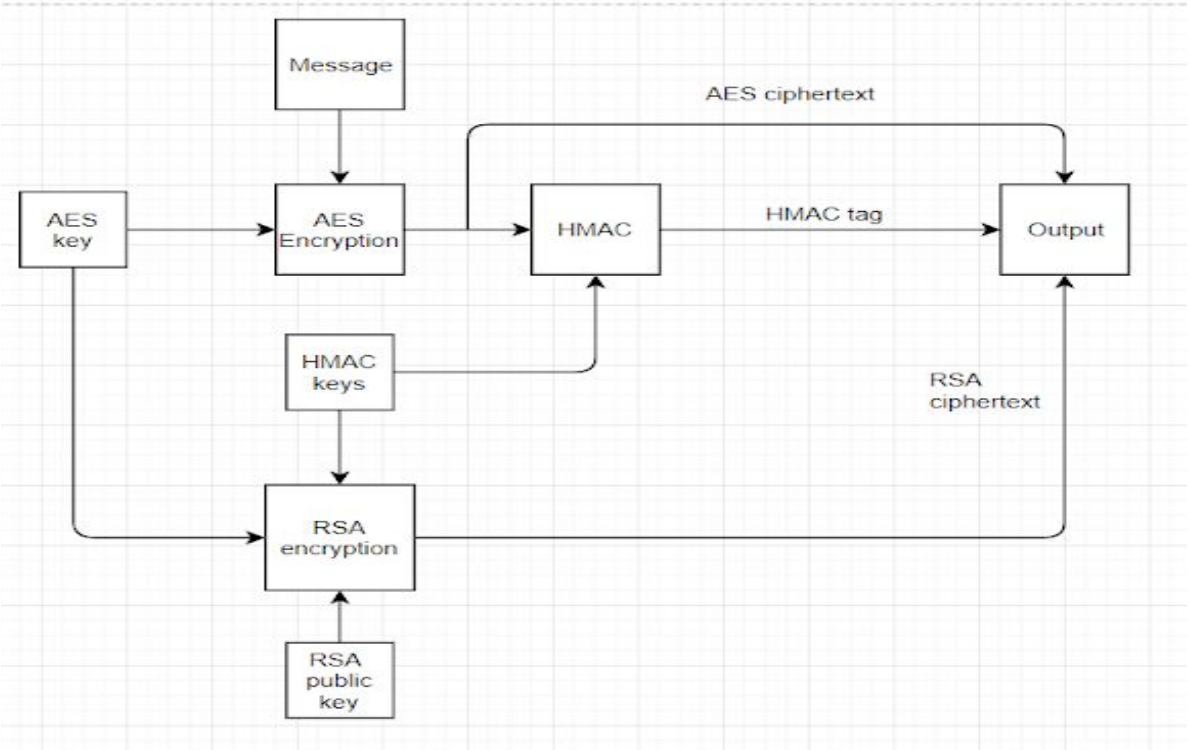
v. This regenerated tag is compared with the recovered tag from the JSON.
vi. If they match, then integrity is achieved.

c. Preservation of confidentiality
    i. Integrity checks
    ii. Authentication
    iii. Hashed passwords
    iv. Encrypted messages
        1. A 256-bit AES key is used to encrypt the users message, which is followed up by an HMAC with a 256-bit HMAC key.
        2. The two keys, AES and HMAC, are then encrypted with an RSA public key provided by the user.

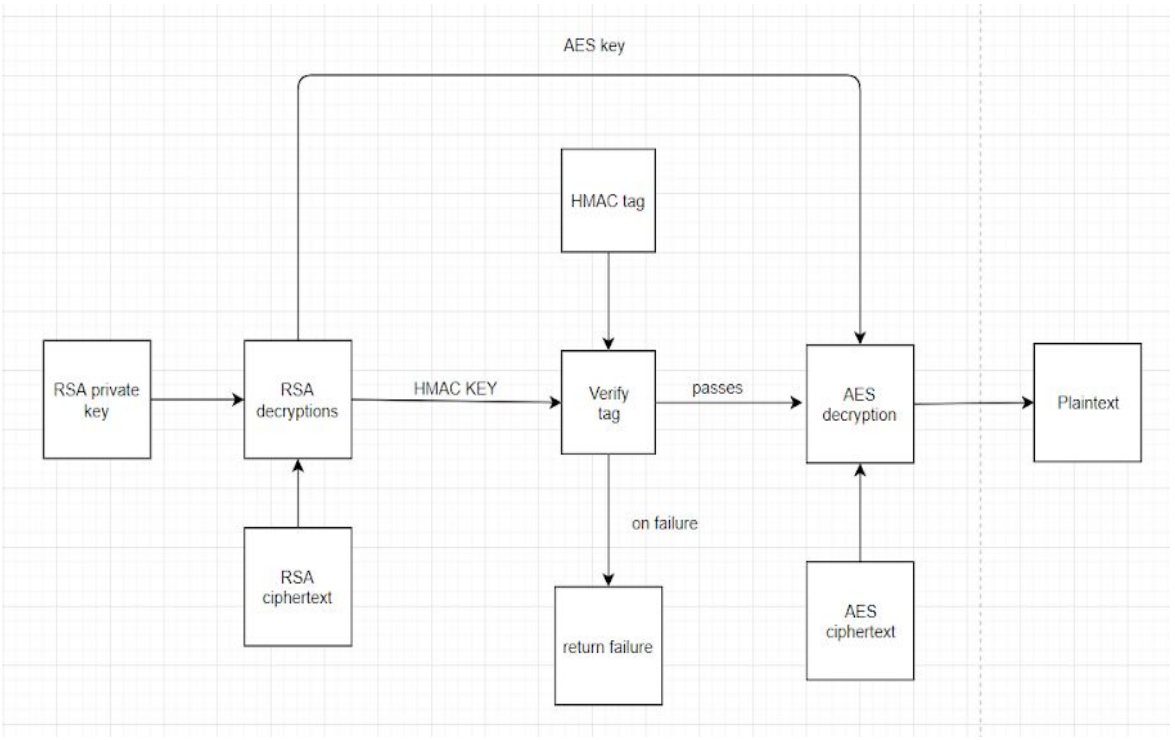
6. Analysis
    a. Pros
        i. Provided PGP for messages.
        ii. Only those communicating can read the messages as long as keys aren't compromised
            1. Server can't read messages
        iii. RSA Keys are never passed through the server
        iv. Deletes messages after reading them
            1. Adversaries cannot read messages that have already been read
        v. Professor Aliasgari designed most of the project.
    b. Cons
        i. Inconvenient way of exchanging keys
            1. In person

ii. **Not true end to end encryption**
    1. No forward secrecy
    2. Needs better method of key exchange
iii. Requires user to provide path for public/private keys
iv. Didn't implement a maximum number of password attempts to prevent brute forcing.
v. Didn't use new keys every session (elliptic curve)
vi. Unable to get the code fully functional on the server.
    1. Worked on a localhost but not on the server.
vii. No GUI
viii. Deletes messages after reading them
    1. Users might want to keep previous messages

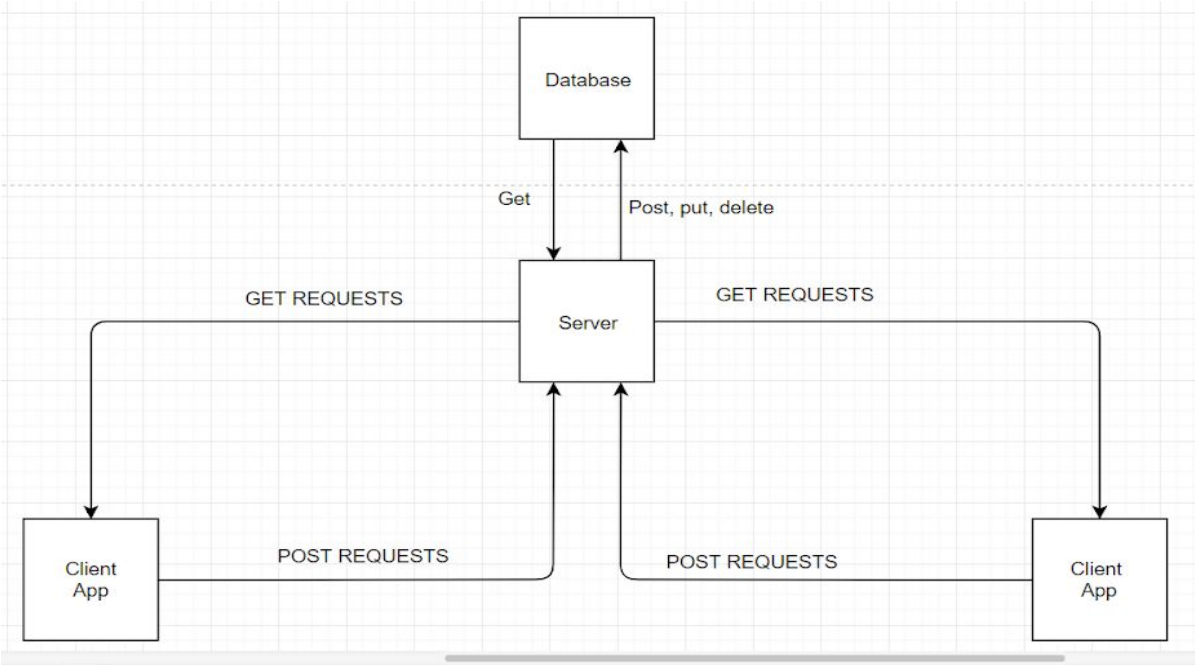
7. System Diagrams
    a. Encrypting Messages



b. Decrypting messages



c. Overview



8. Future implementation
    a. Keep reusing jwt till it expires
        i. Then require another login

b. Time stamp
c. GUI
    i. Electron rather than a python terminal
d. App key
    i. Server only listens to the app we developed
e. Ephemeral Keys
    i. Key derivation functions
    ii. Double-Ratchet algorithm
f. Max number of password attempts to help deter brute forcing
g. Auto generate key pair if not given by the user.
h. Implement a way to not require the user to provide the path to a key file