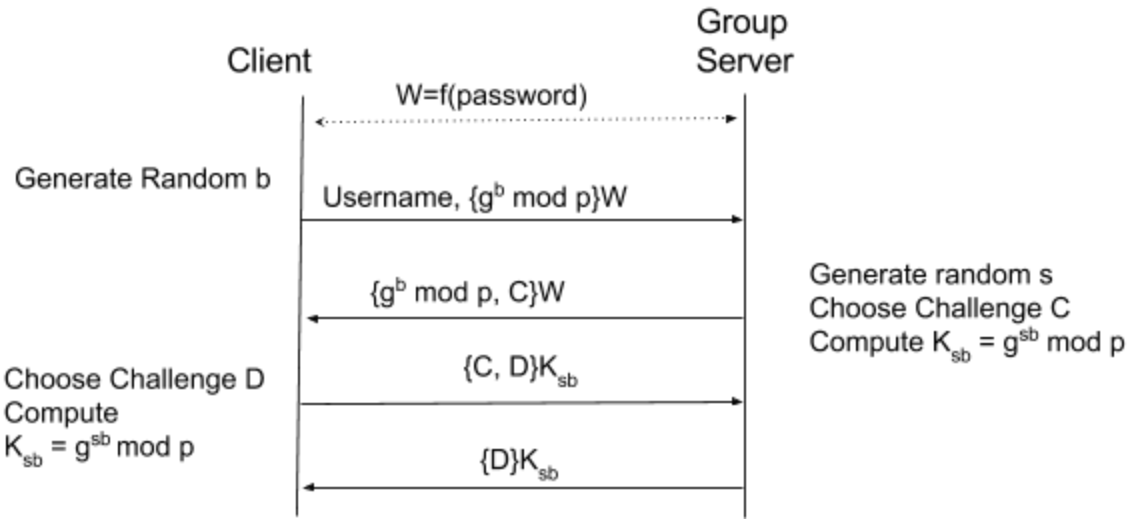
Introduction

Our group used various cryptographic measures to handle each of the threat models. For token issuance we used Encrypted Key Exchange to create a strong key from a weak password entered by the user. Then both the group server and the client will authenticate each other using AES encryption with the key generated from EKE. To handle token modification, we used HMAC-SHA2 to verify that the token isn't going through any unwanted modification. To handle unauthorized file servers, we had the file server send over a fingerprint to the client. The client is then expected to verify if that fingerprint matches the fingerprint that the admin has saved. Finally to handle the passive attacker we encrypt all messages between client and server. We are encrypting everything using AES-128 because in the group server we used EKE to authenticate and generate a symmetric key. This key will be used for the AES encryption. The file server uses Diffie Hellman to generate a shared key that is then used for the AES encryption.

T1 Unauthorized Token Issuance

The issue describes unauthorized clients accessing data they shouldn't be able to see. The best way to prevent this kind of attack is to make sure that every client is an authorized member of the system. To ensure that each member currently using the system is authorized, we just have to make sure they only have access once they provide a password. This will be done prior to any other methods and the user will only be able to use the system when they prove they have the correct password. A clean way to make sure that the password is hidden from passive attackers is to encrypt the messages from both the server and the client. The protocol that will be used is Encrypted Key Exchange. This protocol ensures that a weak password will yield a strong encryption key that will protect all data from passive attackers. The W generated from the password will originally be a symmetric key which will be used for AES encryption in the EKE protocol. EKE was chosen because it provides a shared key and authenticates the user at the same time. EKE was chosen over SRP because we are assume that the group server is trustworthy meaning we can assume it will not be compromised. With this assumption in place, we won't need to protect against compromised servers. The communication between client-server authentication is done through AES-128 using the shared key generated earlier during EKE.

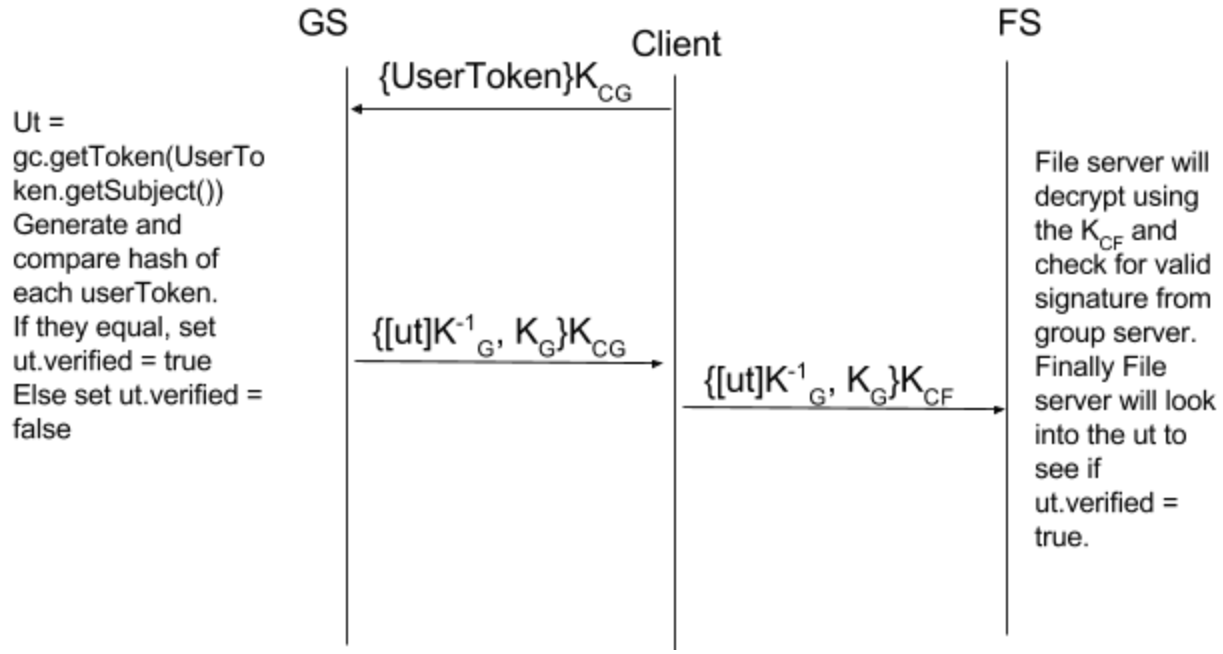


T2 Token Modification/Forgery

Token modification is taken as a client attempting to modify the group list within their token in order to gain access to more groups. Our current implementation doesn't use token class to check for ownership or admin so that's not the concern of this problem. In order to verify that the token isn't changed, we create a method in the UserToken interface that will return true if the UserToken has been verified. To verify the usertoken, before connecting to the file server we connect to the group server and send the UserToken to the group server. The group server will create a new token from the user's name. The group server will then generate the hash of both the sent usertoken and the generated usertoken and compare the results of the hash. Should the hashes equal each other, the usertoken will set a variable called 'verified' to true. If they don't, the UserToken sets 'verified' to false. The group server will then sign the UserToken and send it back to the client. This signature will be encrypted with the symmetric key shared between the client and the group server. Once the client receives the encrypted message, he will decrypt it with the shared key K_{CG}. Now he sees a UserToken signed by the group server. Client will encrypt the signature using the symmetric key between the client and the file server. Once the file server receives the encrypted message, it will decrypt using the symmetric key, K_{CF}, and decrypt the signature using the group server's public key. This assures the file server that the group server was the one who verified the token. The file server will then call a method inside UserToken to see if 'verified' is true. File server will only continue if 'verified' is true. If it isn't, the file server will end the connection. Although the client saw the signature and could get to the token, File server will not accept any modifications because it's looking for the group server's signature. In other words, if the client attempts to decrypt the group server's signature to modify the UserToken, the file server will immediately know when it goes to look for the group server's signature. In the event that the client is malicious and attempts to modify the UserToken by

decrypting the signature, taking and modifying the UserToken, and attempts to get the group server to sign it again before sending it to the file server, the group server will know that the client's UserToken was tampered with when the group server goes to generate its own UserToken to compare it with the client's modified UserToken. Therefore the group server won't grant the client its signed UserToken, leaving the client unable to access the file server.

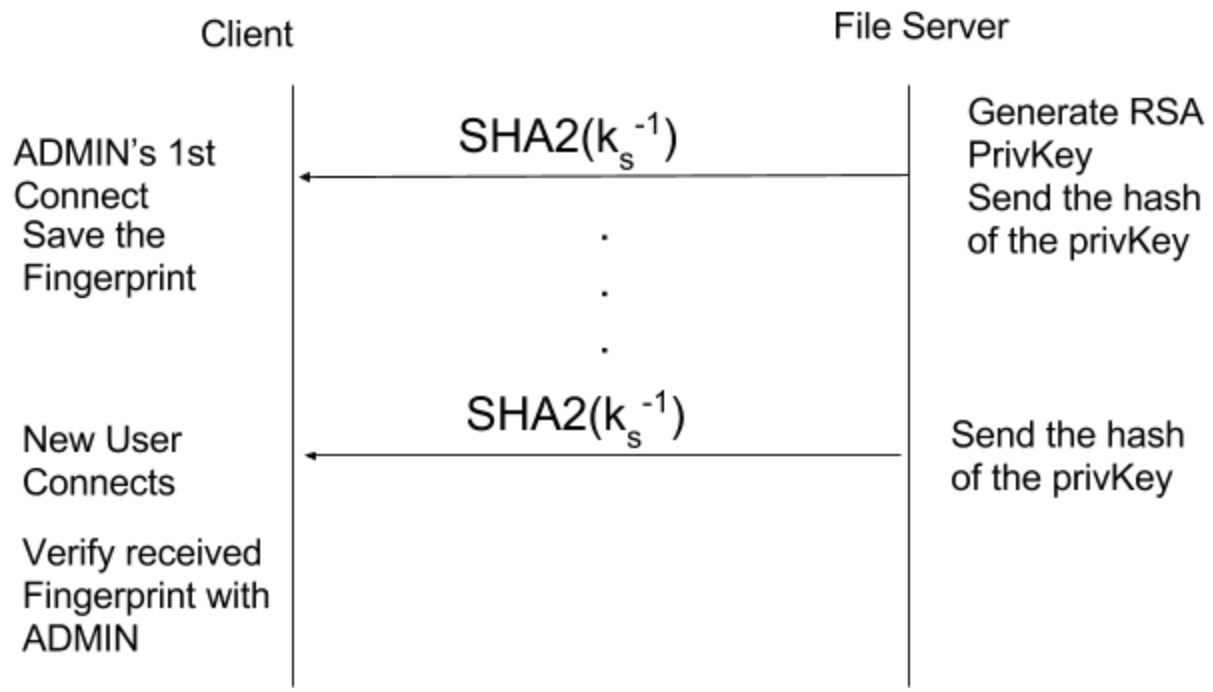
First of all hashing is used because of its property whereby a small change in the object usually has a large change in the hash value. Therefore, if the client was able to modify the token, this modification will noticeably change the hash generated. The hash function we will use is HMAC-SHA2 because it gives us the benefits of preimage, second preimage, collision resistance and protects against length extension attacks.



T3 Unauthorized File Servers

This problem focuses on the client being trustworthy and testing the server to see if it's also trustworthy. In other word we have a trusted client trying to see if the server can be trusted or not. Initially when a file server is up and running for the first time, a fingerprint will be generated. In the project implementation, the fingerprint would be printed on the terminal running the file server. Every user is assumed to have the fingerprint(s) because they can ask their boss or check the fingerprints copied down somewhere in the work building. The file server will send the fingerprint over to the client when the client connects. The client is to verify if the

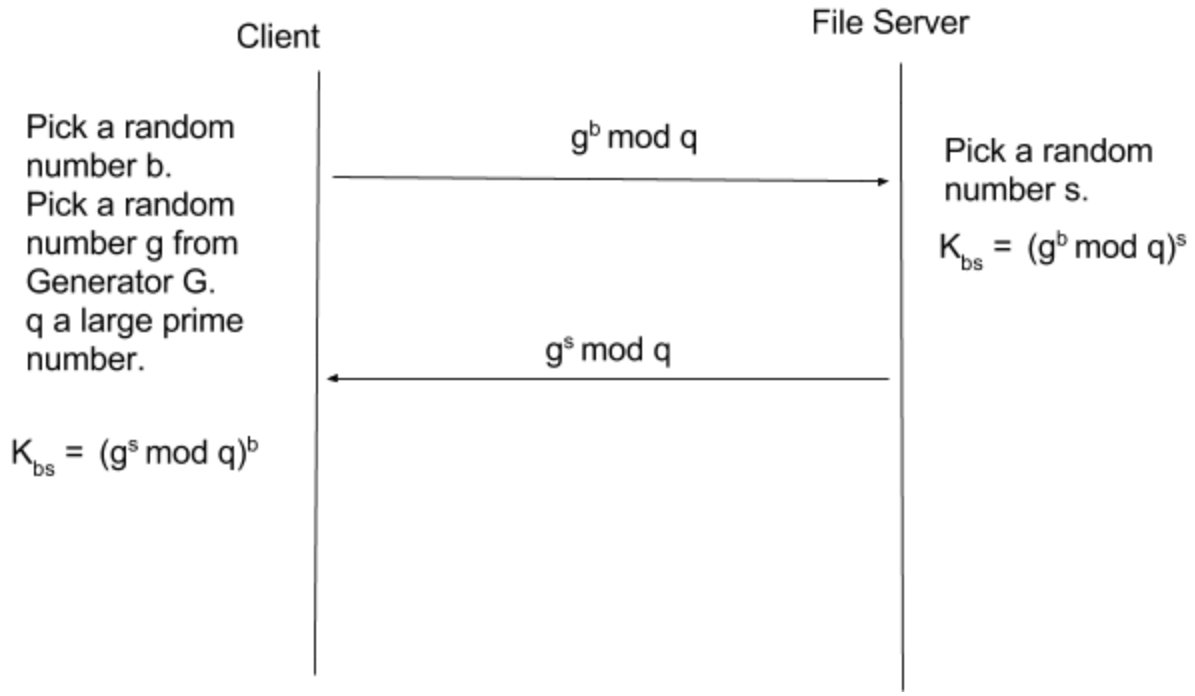
received fingerprint matches the saved fingerprint. To reiterate, the client is assumed to not be lazy with the authentication. The fingerprint will be a hash of an RSA private key of length 128 bits. The hash function that will be used is SHA2 because any hashing algorithm will work but SHA2 is picked for its quick performance. We are using an RSA private key because if a public key was used then anyone can just look up the server's public resulting in any malicious intent by just copying the public key. RSA key is used because SSH commonly uses an RSA key gen. Finally 128 bits because that is a commonly used fingerprint size for SSH. Too large of a bit size could complicate storing for the admin and could result in a lot of traffic. Too small and we risk replay attacks by attackers brute forcing the fingerprint.



T4: Information Leakage via Passive Monitoring

The problem is that passive monitoring allows for attackers to see messages between client and servers. In order to prevent this, we make sure messages are encrypted when sent through transit, then decrypted when the recipient receives the message. We will use a single encryption scheme (AES) for both Group and File servers. For the Group server, we use the Encrypted Key Exchange protocol to create a shared, symmetric key between the client and server since access to the Group server requires a password, which can potentially be weak. EKE allows us to generate a strong key out of that password. For the File server, we use Diffie Hellman to generate a shared key between the client and server instead of EKE because the File

server doesn't require/have access to the client's password. All passwords are stored and restricted to the Group server, and the File server cannot directly communicate with the Group server. Since both the Group and File servers generate a shared key, the best encryption algorithm that makes sense to use is a symmetric crypto algorithm. The reason for AES over other symmetric algorithms is because currently AES is one of the strongest, recommended crypto symmetric key algorithms to date. Specifically we will use AES-128 since AES-256 may be overkill in our context. As mentioned above, we briefly use RSA to authenticate the client and File server, and the rest of the communication will be encrypted in AES-128.



Conclusion

In conclusion, our system used various algorithm to implement a strong file sharing. The main flow between each mechanism is that the protocols used for authentication generated a strong key which can be used for encryption. In the group server we used a protocol that generated a strong, shared key from a password required in T1 and we used that key in the AES encryption for T4. Initially to authenticate the server to the client we tried to use the SSH key protocol. Our group created a simplified version of the SSH key protocol but it failed. The reason it failed was because we didn't develop a secret that the client and the requested server shared to correctly authenticate the requested server. In other words, a malicious server posing as the file server doesn't actually have proof that it's authentic. We ended up misunderstanding the SSH key protocol and forgot about the fingerprinting aspect of it. That is when we incorporated

fingerprinting to do remote host authentication. Our version of fingerprinting basically replicated the process of how it would work in an SSH connection by hashing a key (in our case, a private RSA key) and taking advantage of its preimage resistance.

References

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