Authentication Protocols

Authentication Protocols

Password Authentication

Concerns:

- An eavesdropper might see the password if sent in the clear
- An intruder might read the password file on the sever
- A password might be easy to guess by an attacker who makes several attempts to login
- A password may be crackable with an off-line guessing attack based on some recognizable item that is encrypted with it.
- Administrators tighten the rules for generating passwords to the point where it is too inconvenient to use a system

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At UC you can use bearcat1 as a password but
9W+4-1Bfran may not be allowed

Authentication Protocols

Password Authentication

Possibilities:

- Transmit the password in the clear

- Establish a shared secret with Diffie-Hellman, encrypt the Password (but authentication is not mutual)

- Compute a hash of client password, use that to encrypt in challenge/response handshake

  Client <---------- *R* ---------- Server

  Client ----- *f*(password,*R*) ----> Server

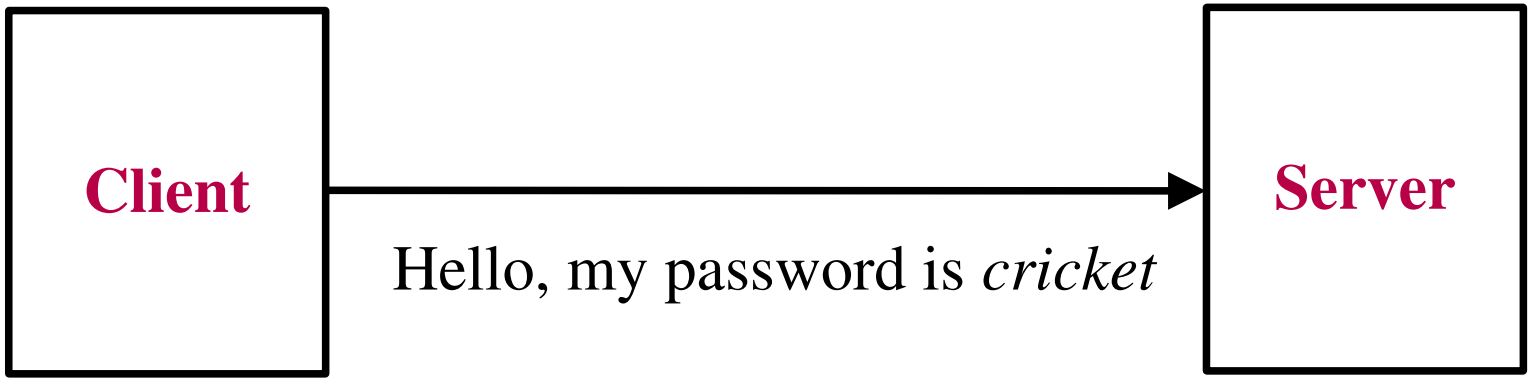
  (dictionary attack on password)

- Use something like Lamport's hash

- Use a strong password protocol

Authentication Protocols

Password Authentication



Authentication Protocols

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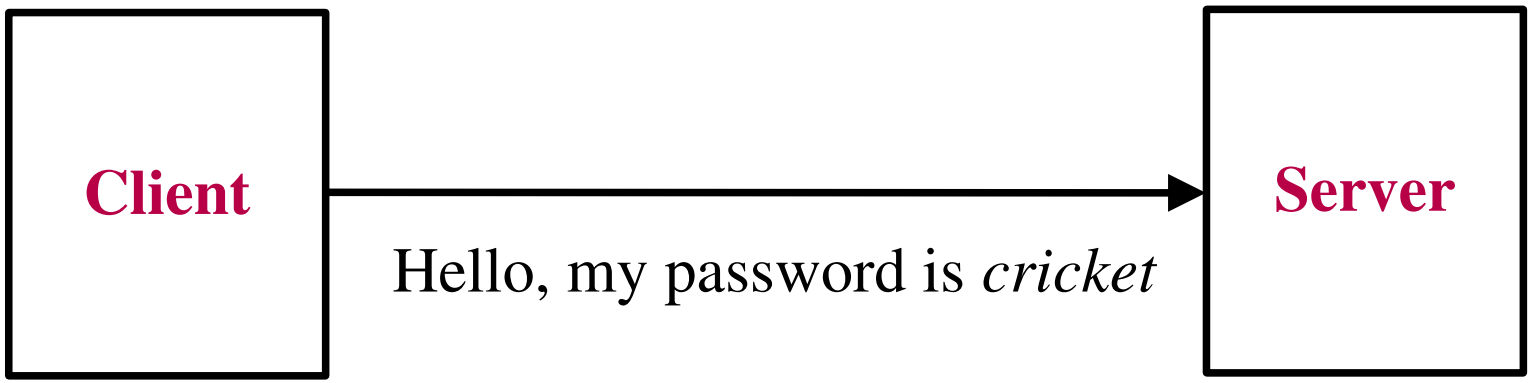

Passwords must be short - imagine a client trying to remember a password like this:

hgsYUW76ewtJHHDKDHJyyeu87362kdfhgodkfhj83hsd838gsb jjhjdj

Passwords must be encrypted - perhaps with RSA which can be used to sign

Authentication Protocols

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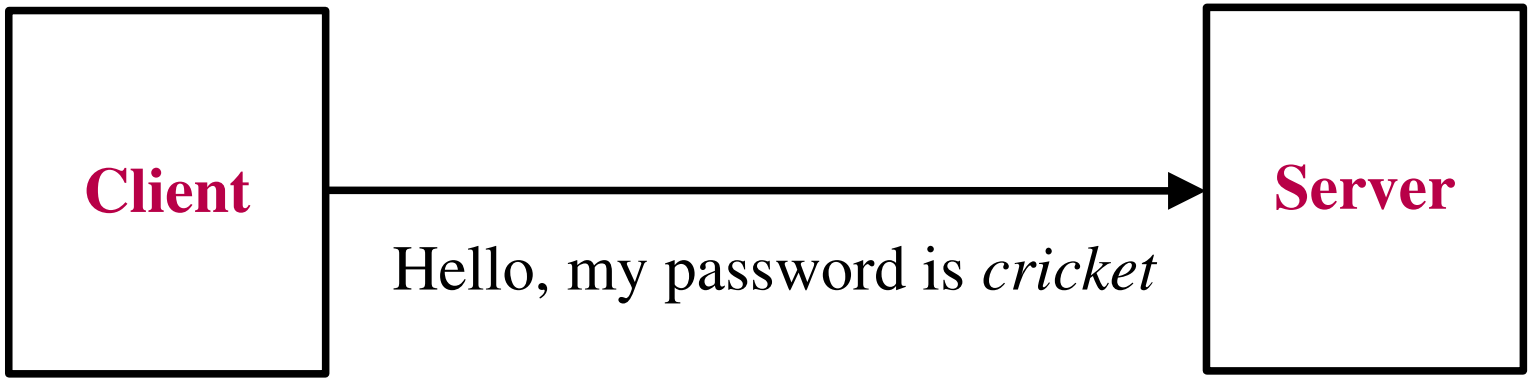

Protection from on-line attack: Server disables client's account after too many password failures.

Authentication Protocols

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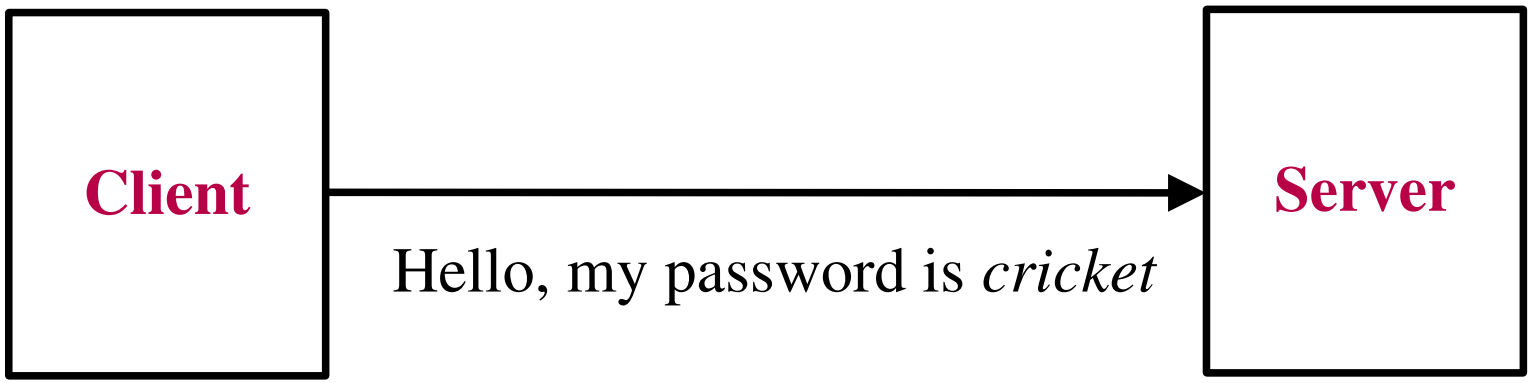
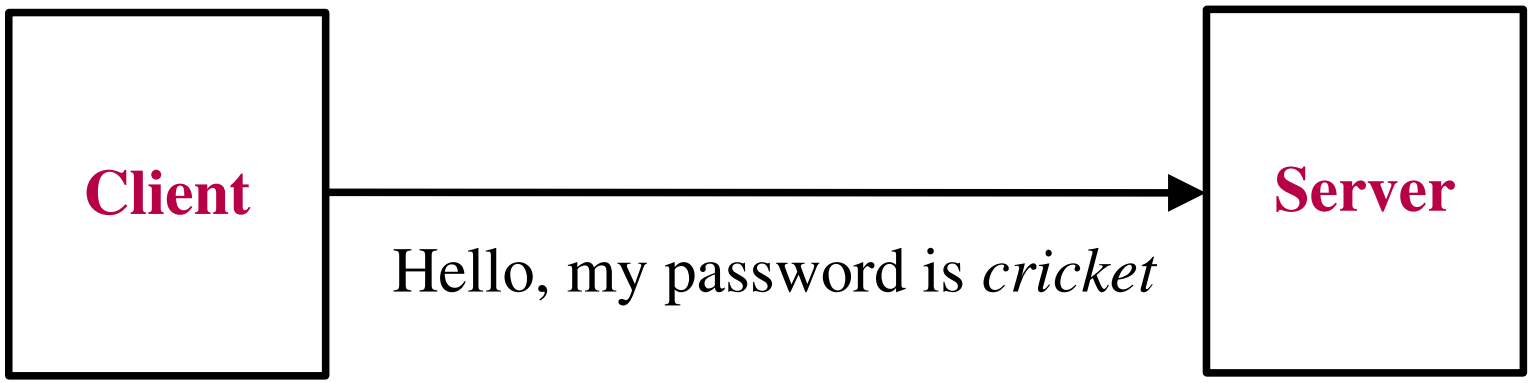


Protection from on-line attack: Server disables client's account after too many password failures.

Harder to protect from off-line attack: Attacker gets some important piece of information which can be used to check the password against. Attacker can repeatedly try passwords until agreement with info is reached.

Authentication Protocols

Password Authentication



How to store password information: Cannot just store the password as that is too vulnerable.

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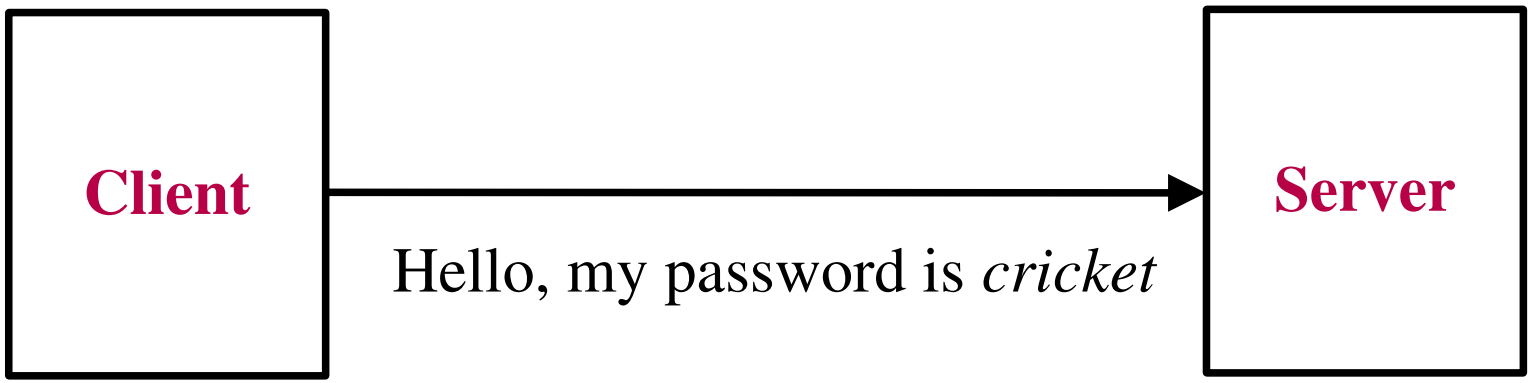

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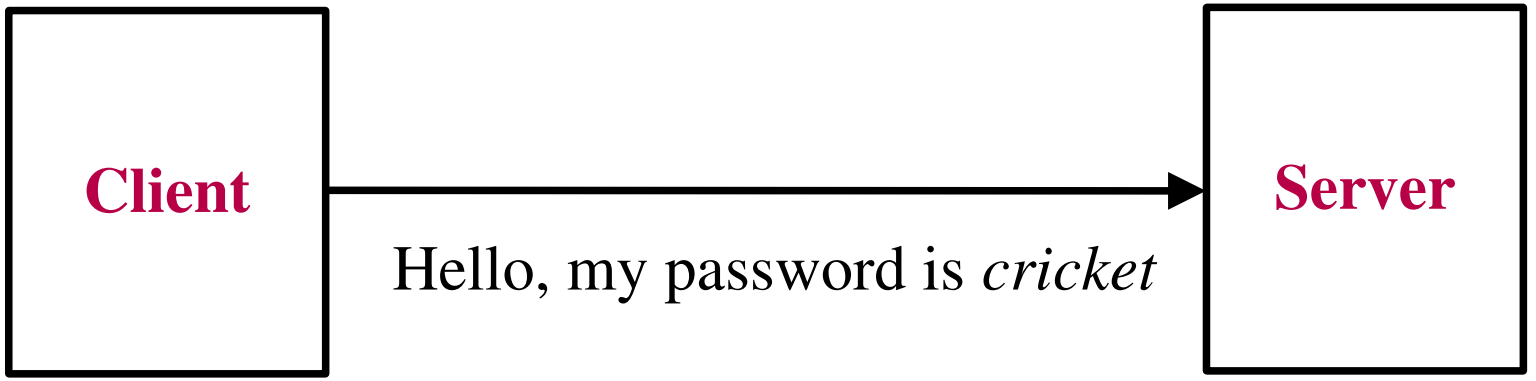

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Should the hash be on every machine client accesses or on one?

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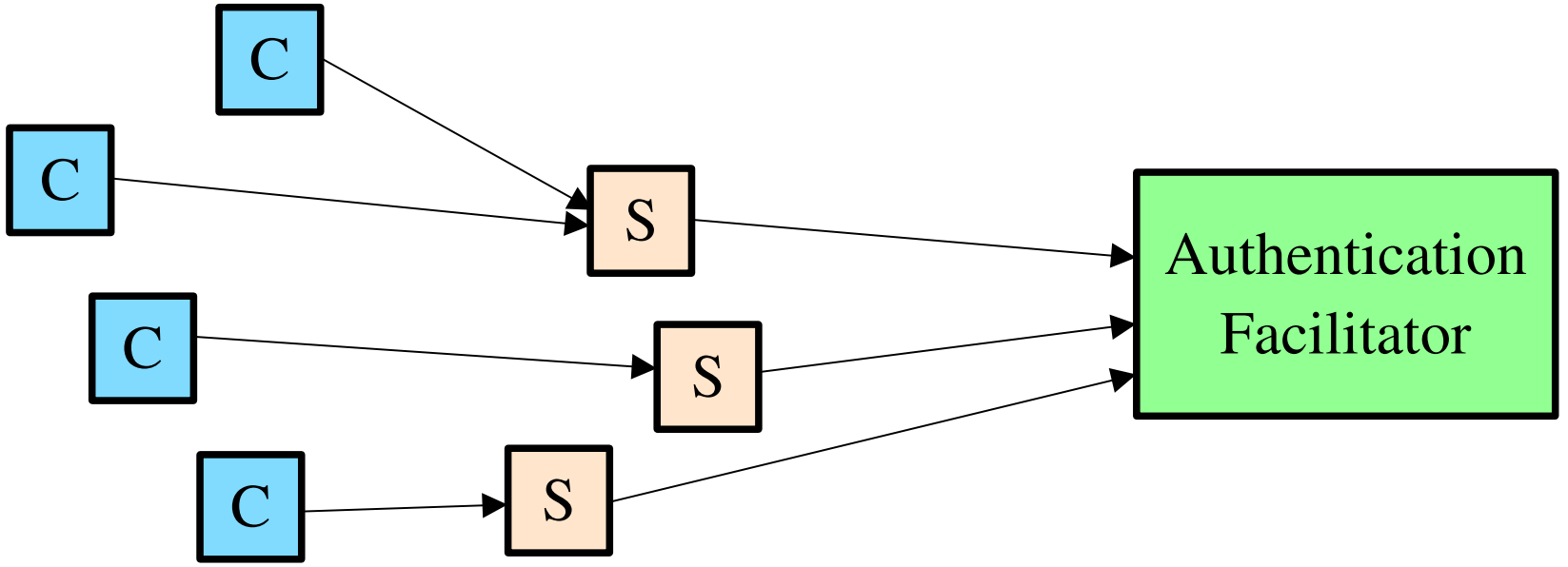

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If on one machine, should servers retrieve that info when needed or should the authentication be passed onto the ***authentication facilitator***?

Authentication Protocols

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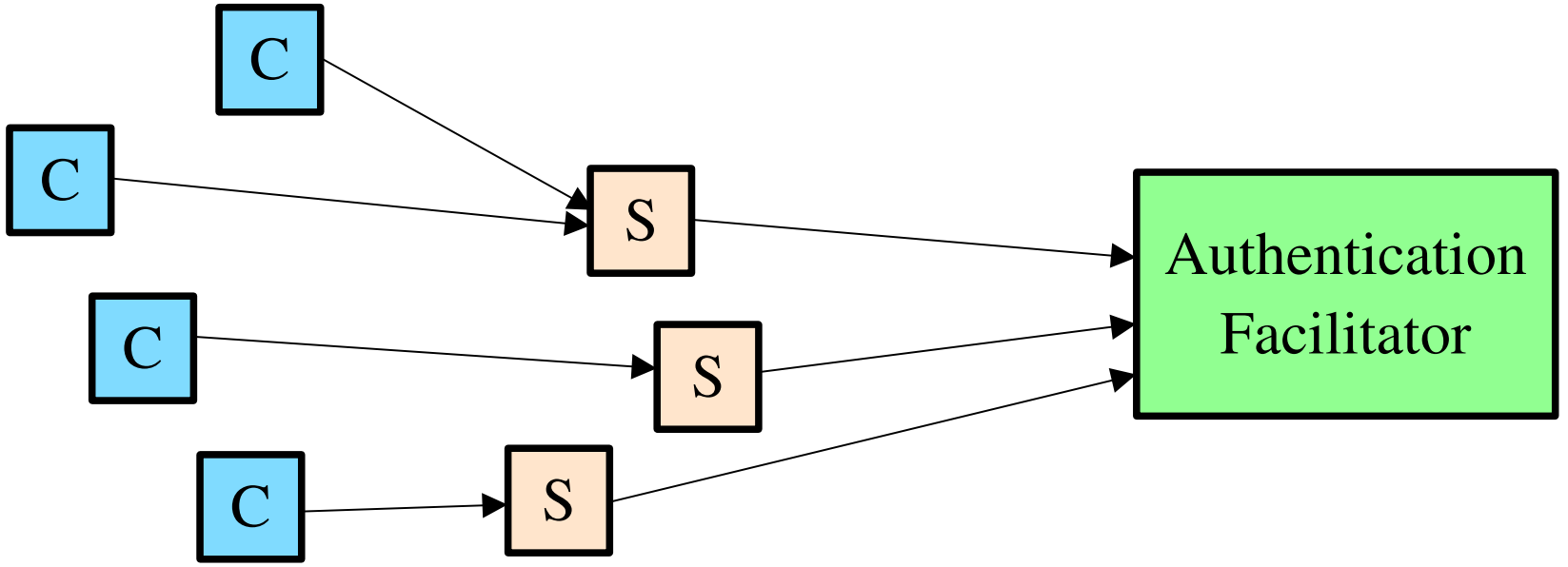

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If on one, server authenticates the storage node or authentication facilitator

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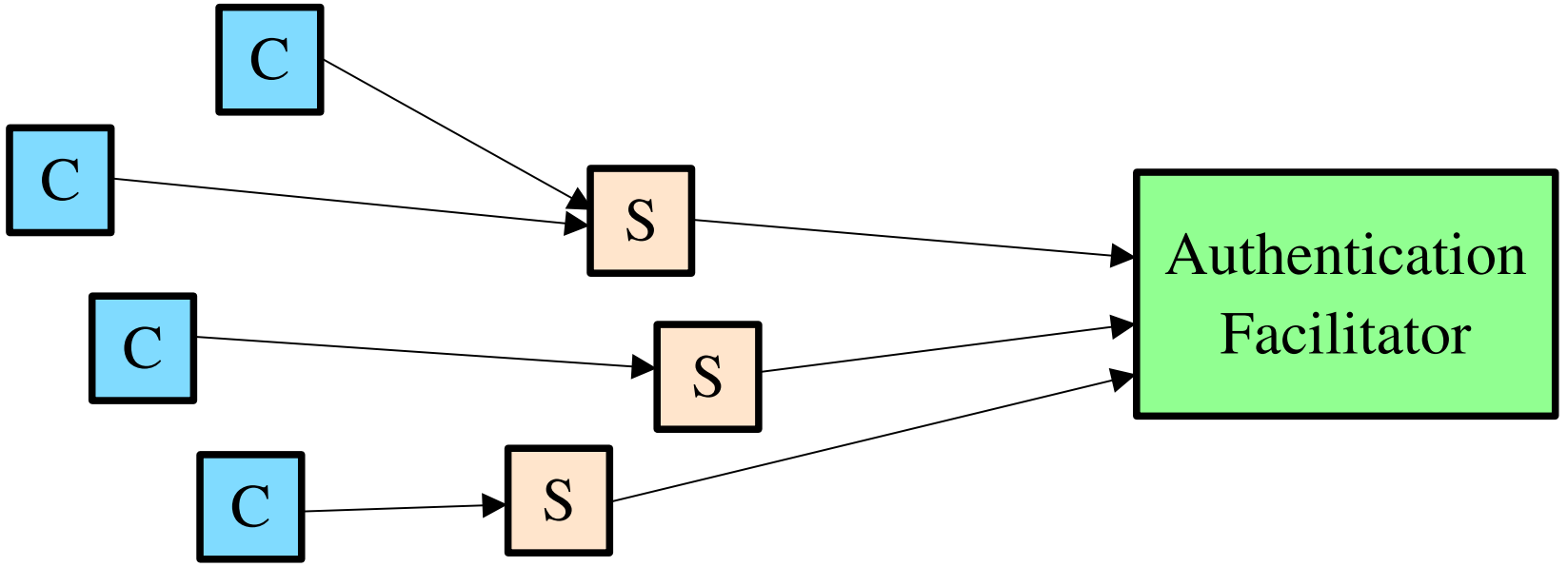

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If on every server, if passwords are not encrypted then capturing a server's database enables impersonation of all users on that system - maybe on other systems as well if users have the same passwords there

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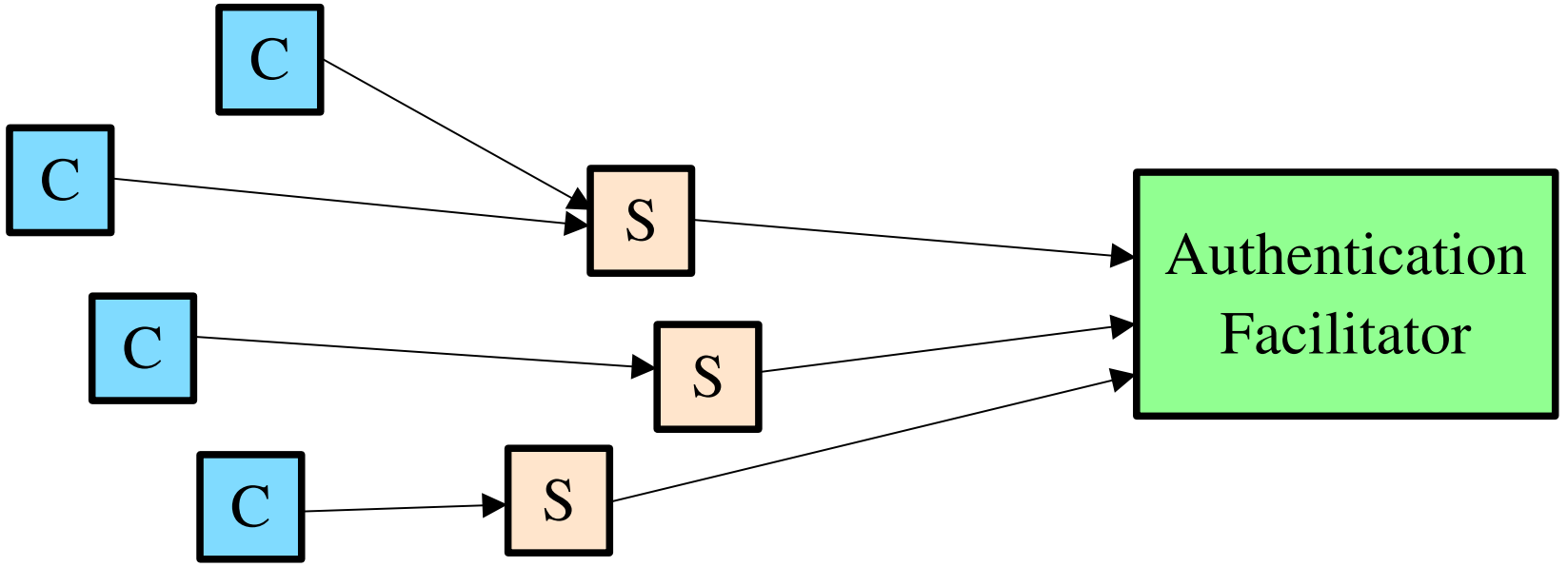

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Same argument applies to authentication facilitator but it is much easier to protect one machine than all the servers

Authentication Protocols

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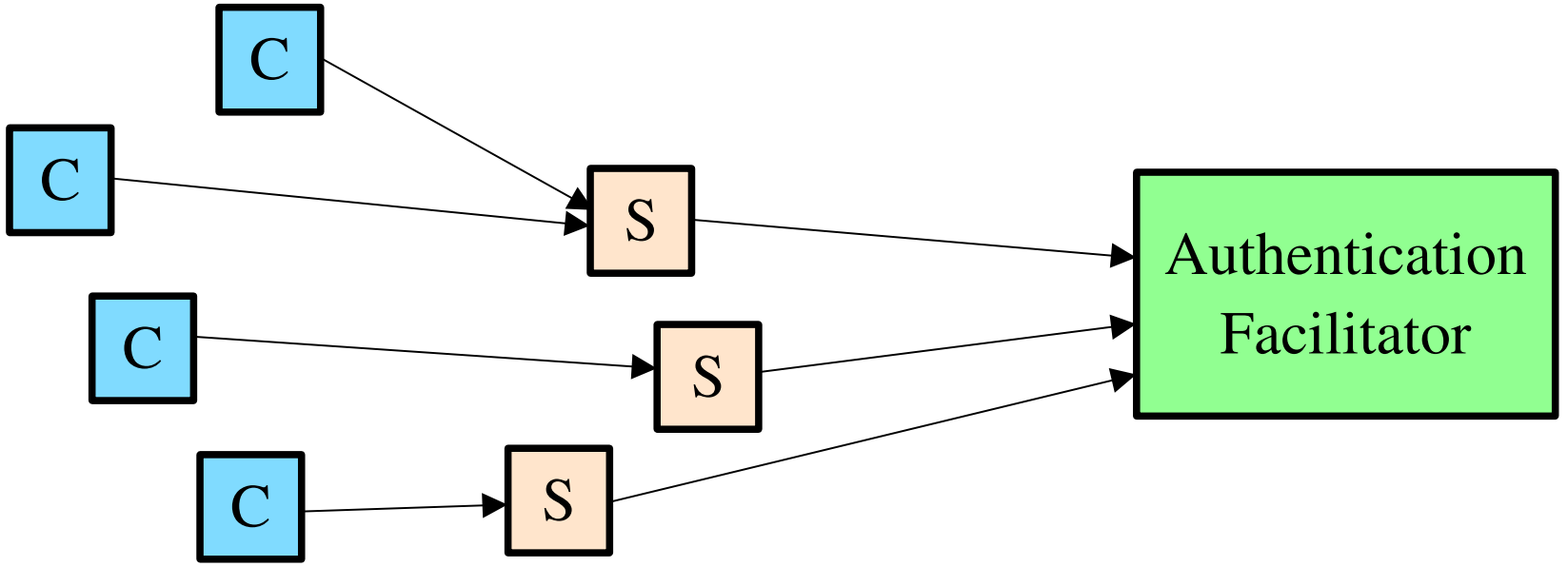

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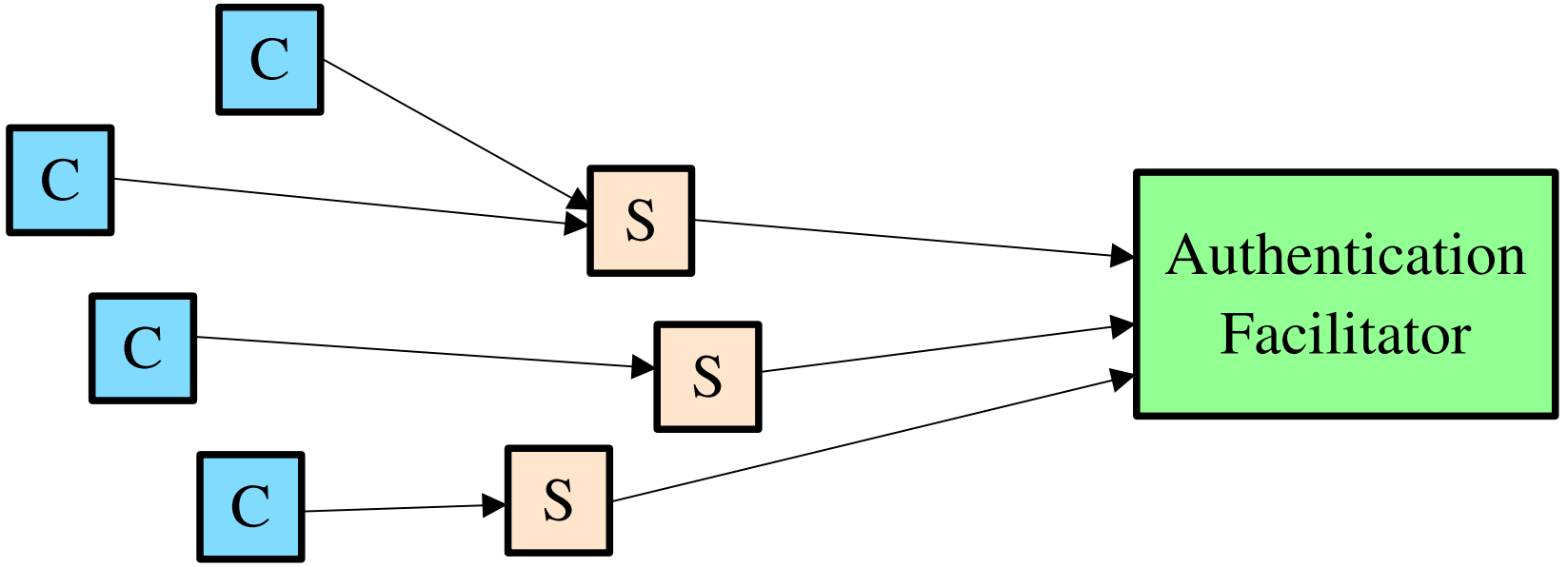

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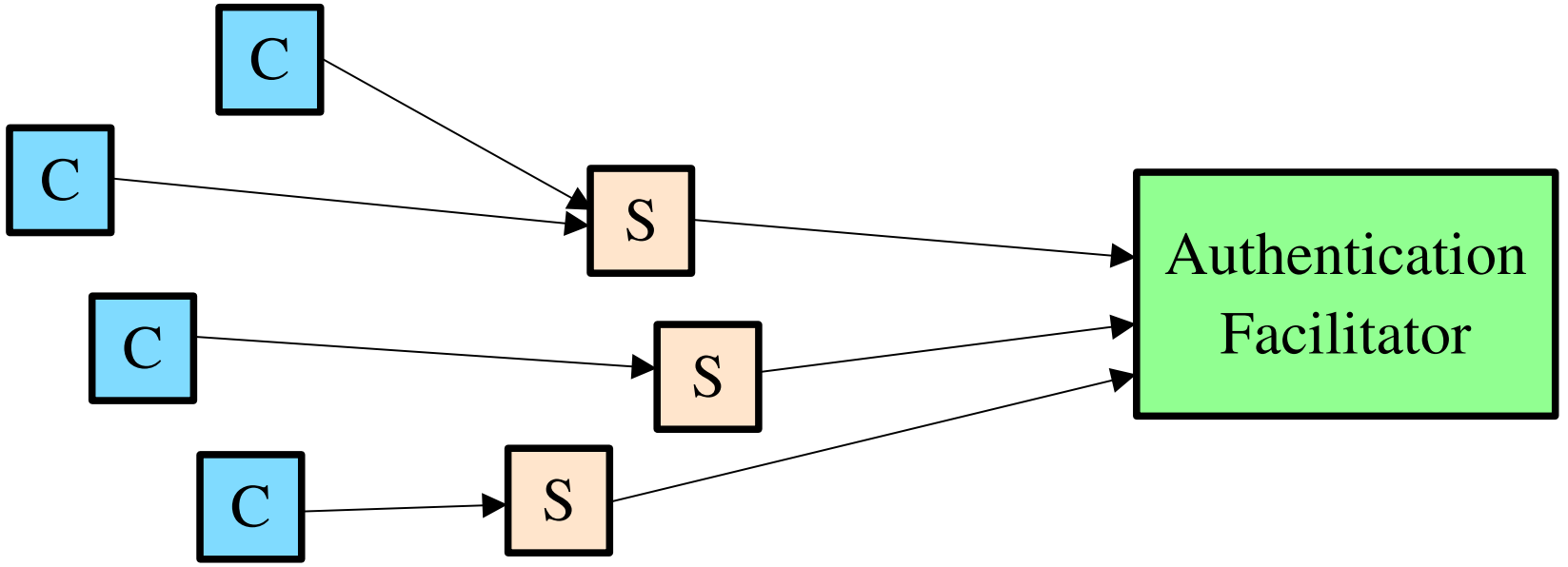

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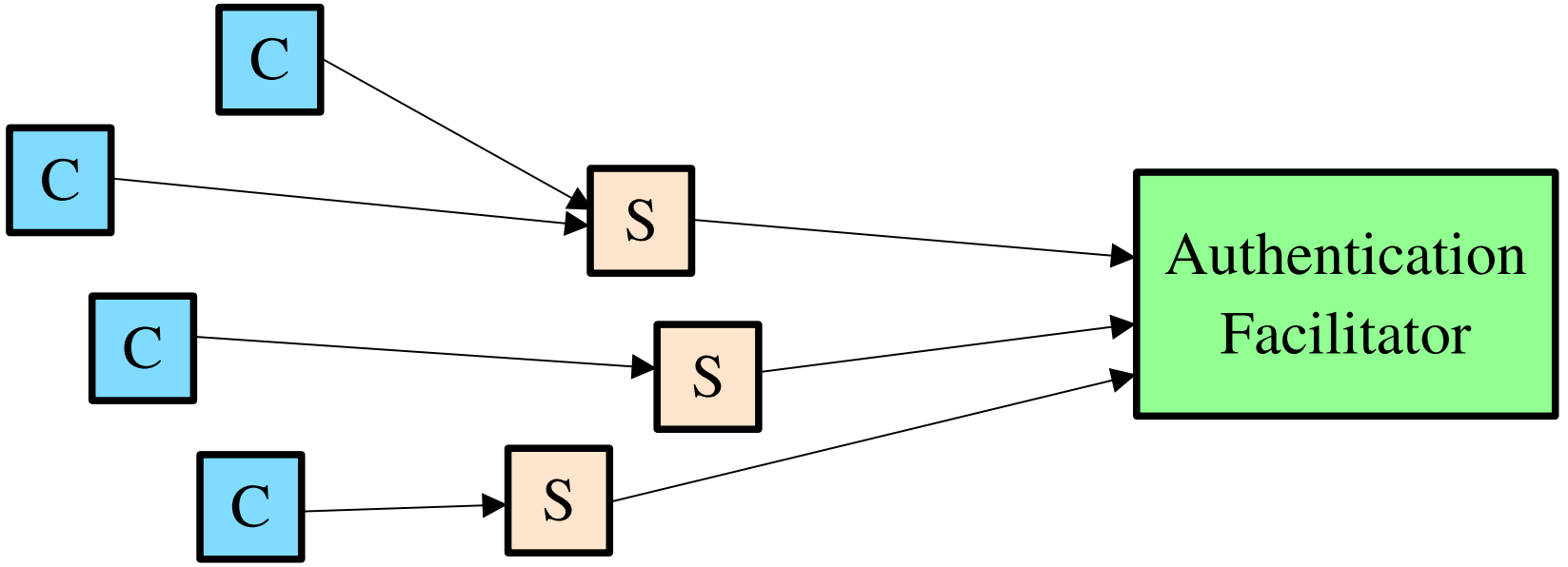

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But if the key is found by attacker, then everyone's account is at risk.
If the key is lost then clean-up could be really difficult.

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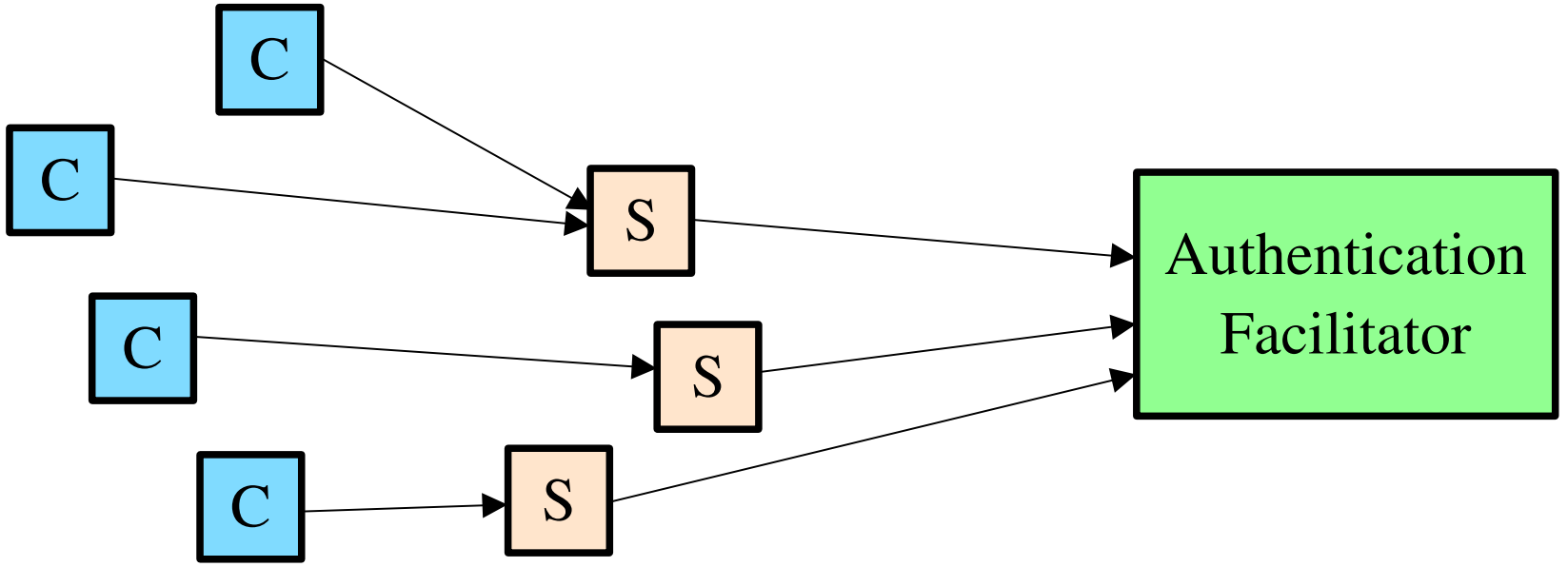

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Obvious solution: encrypt a database of hashed passwords.

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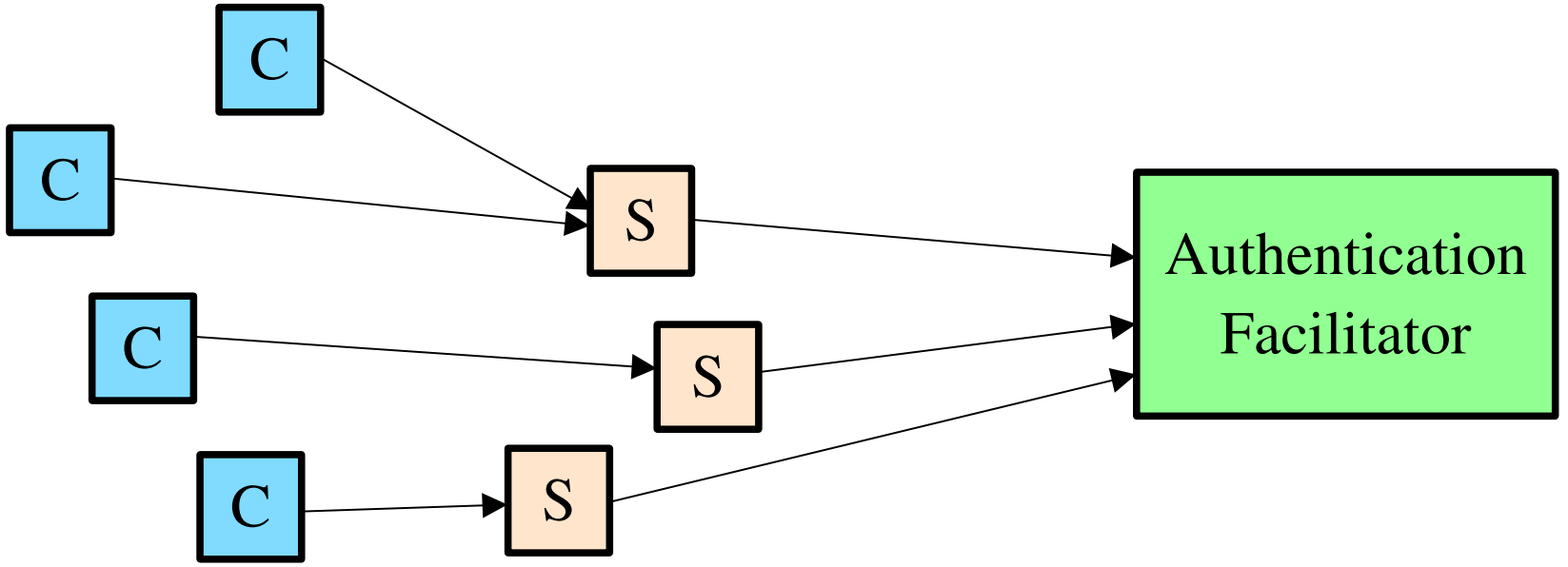

Address-based Authentication

Uses the network address of originator, not a password, to infer the identity.

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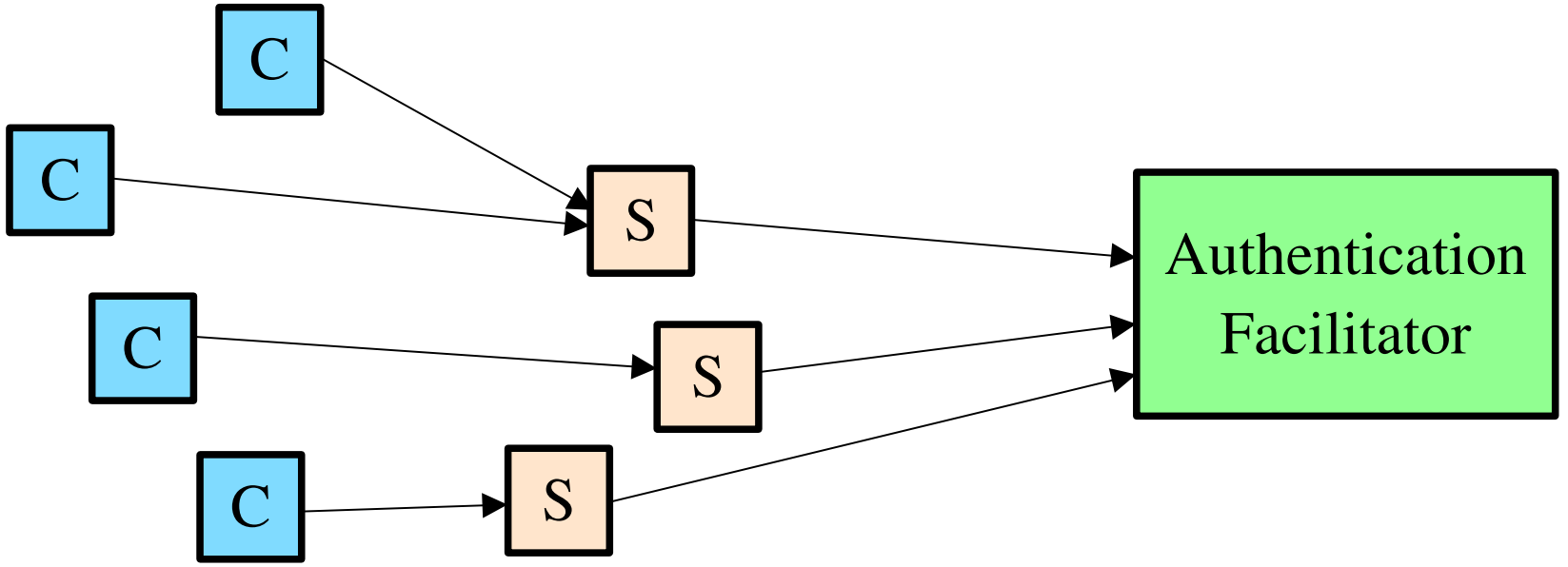

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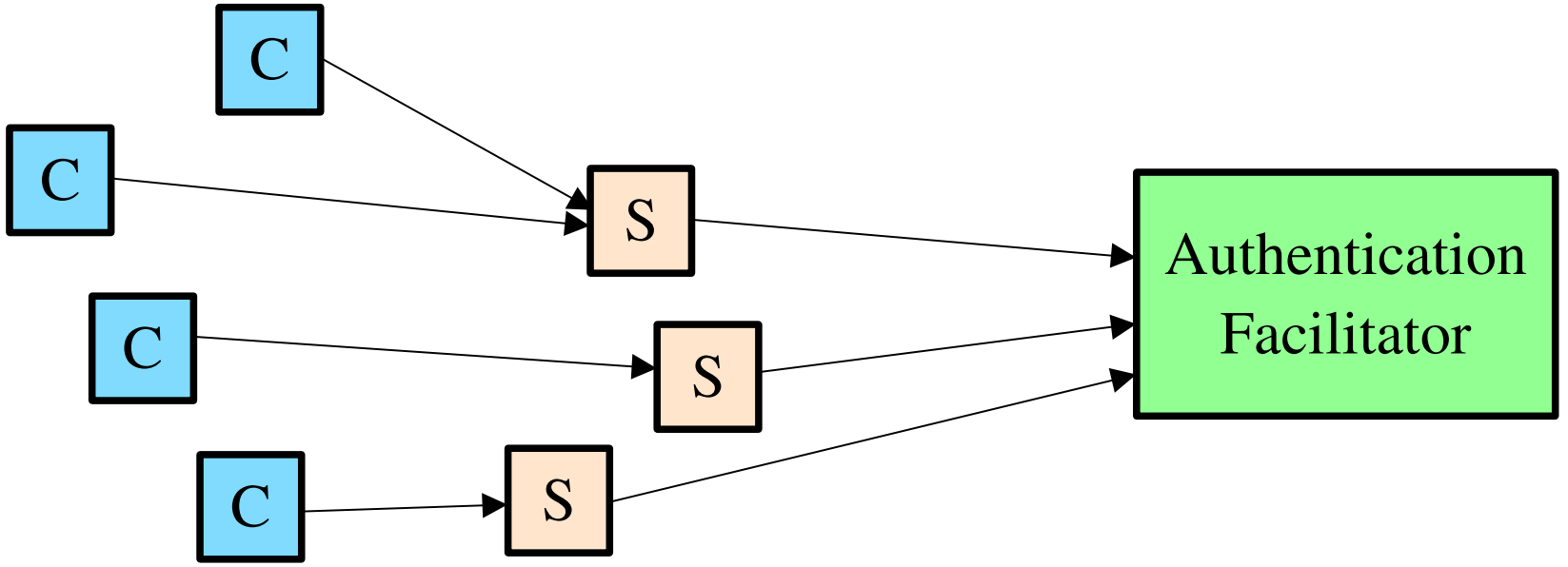

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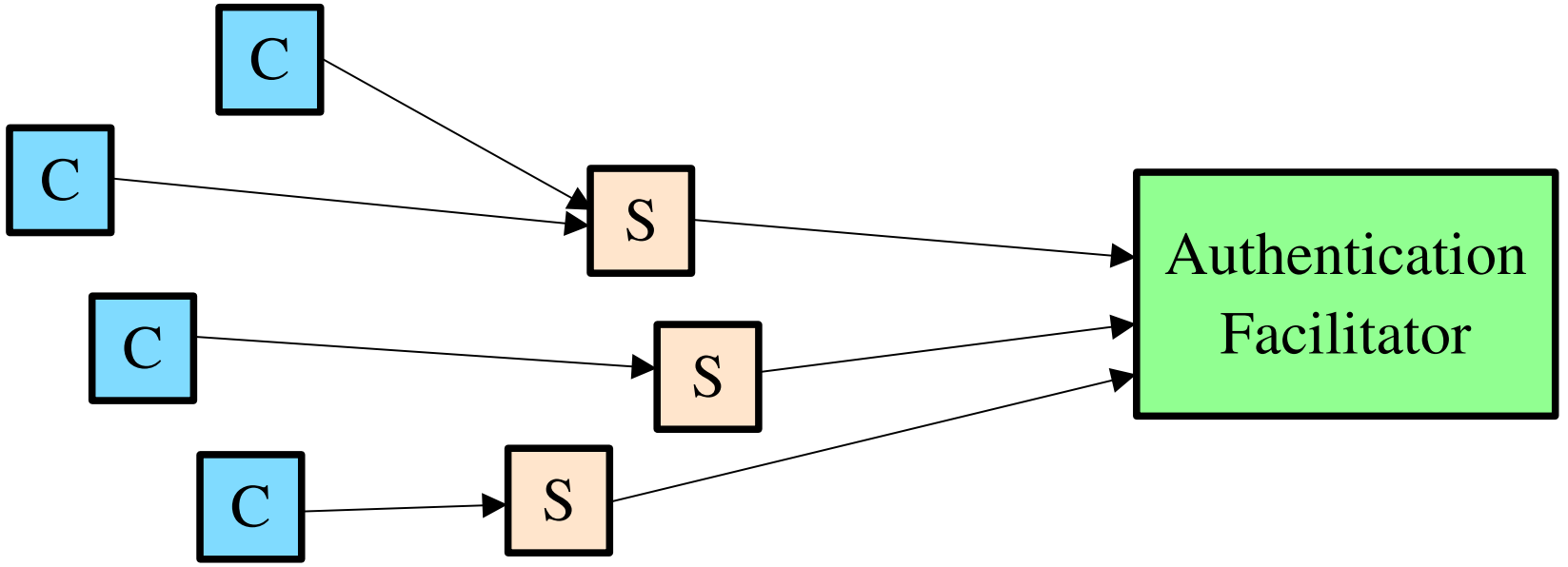

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3. Let user decide - `.rhosts` file in user's account <address, remote-account>

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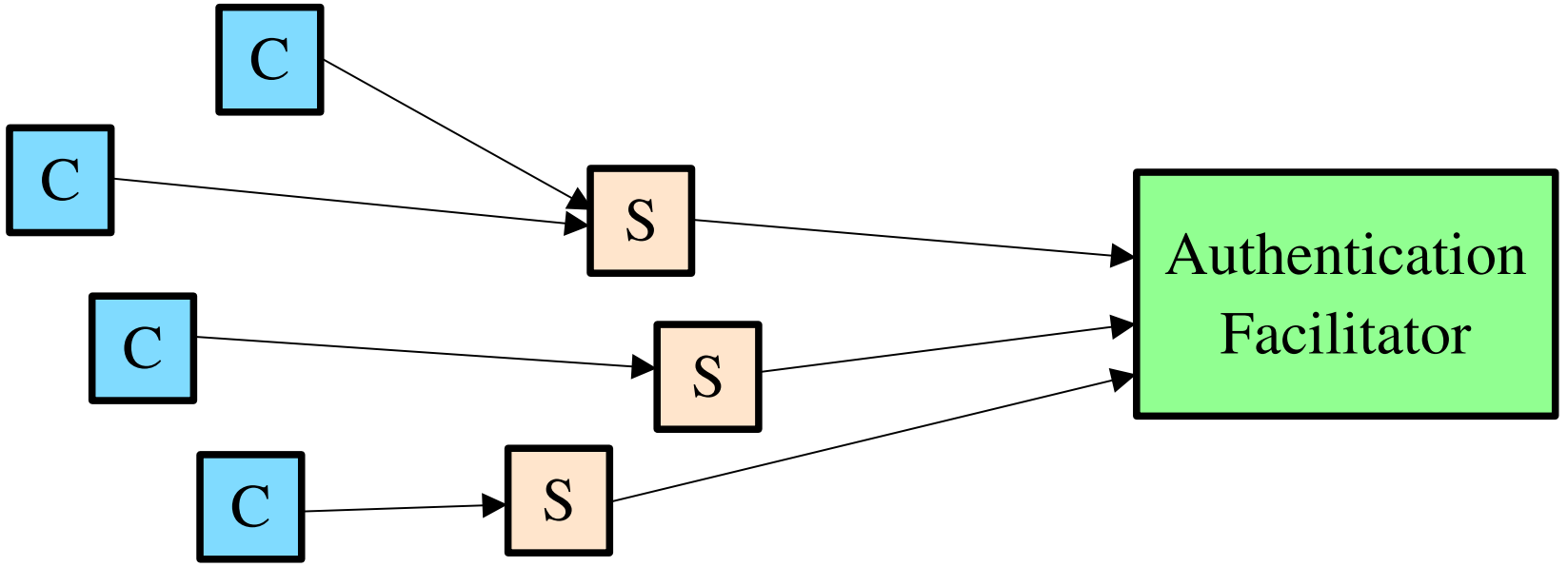
Password Authentication



Address-based Authentication

Safe from eavesdropping but has the following problems:

1. If attacker gains superuser access on machine A, it can access network resources of any user with an account on A by getting A to claim the request is from that user.

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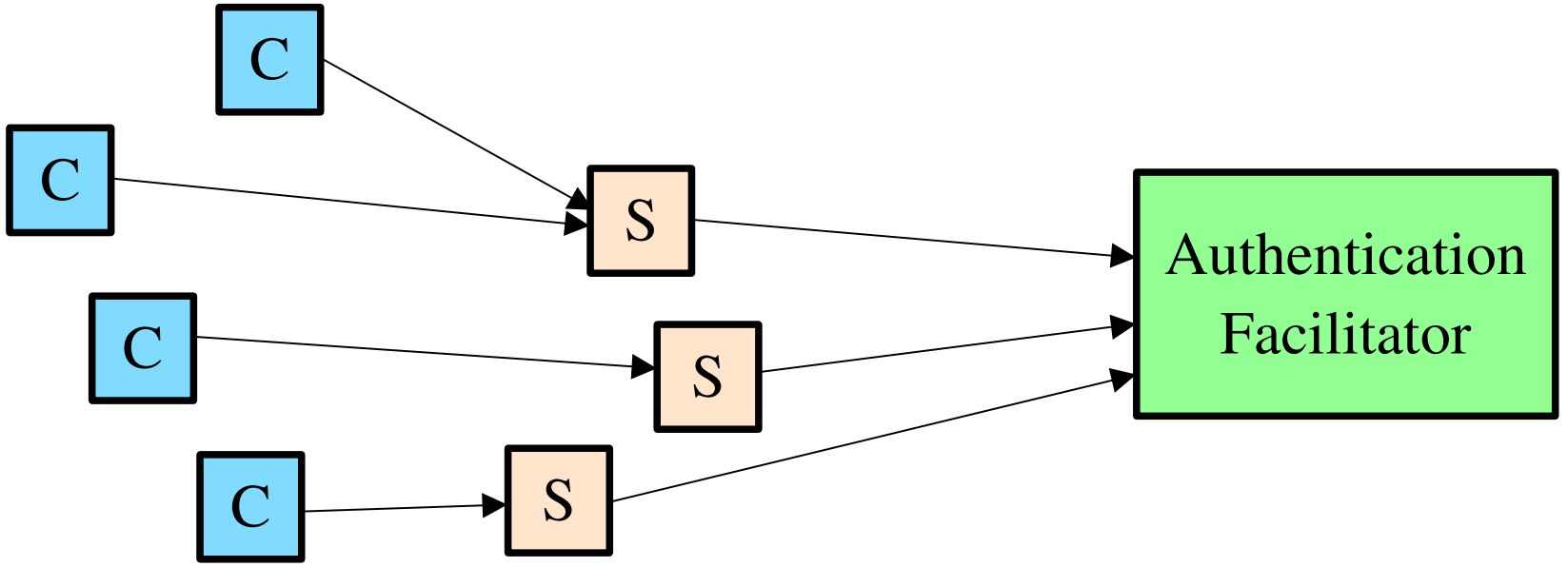


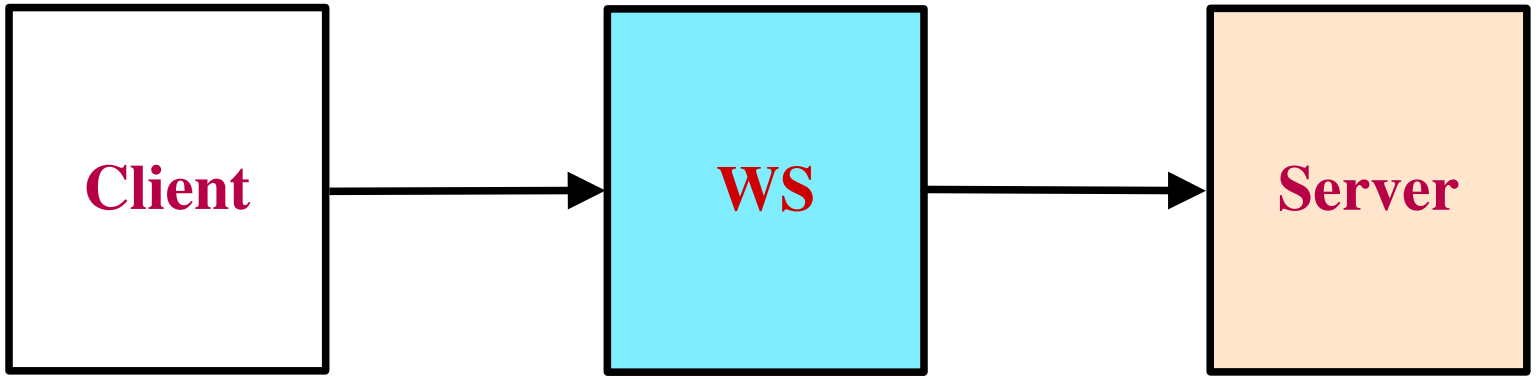
Address-based Authentication

Safe from eavesdropping but has the following problems:

1. If attacker gains superuser access on machine A, it can access network resources of any user with an account on A by getting A to claim the request is from that user.
2. If attacker can impersonate the network address of a machine then all network resources of all users with accounts on those machines are compromised.

Authentication Protocols

Password Authentication

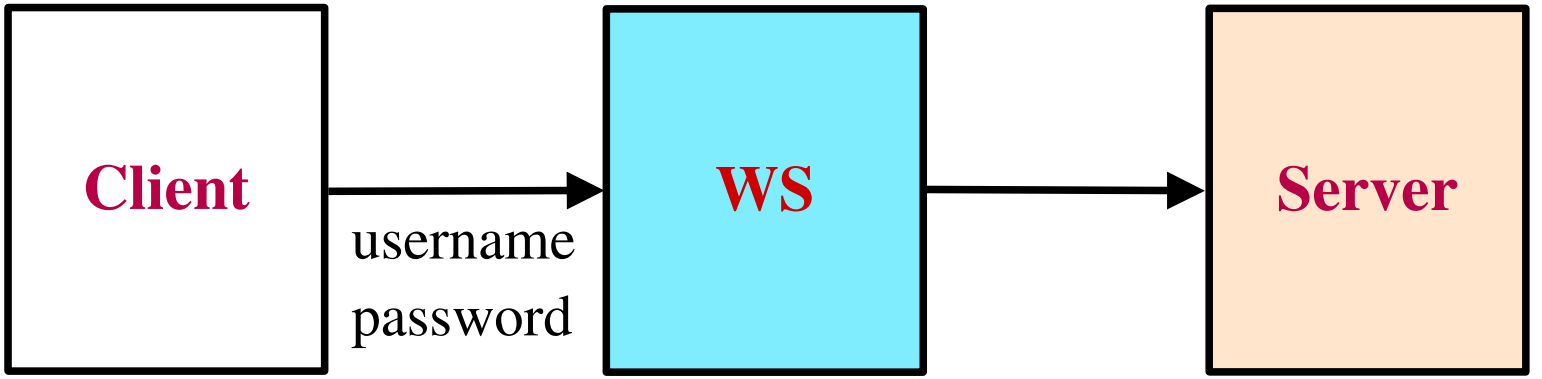


Lamport's Hash (safe from eavesdropping, server attack; no public keys)

Server has client's username, counter (decr by 1 when client is authenticated), hash(hash(... n times...(hash(password))...))

Authentication Protocols

Password Authentication



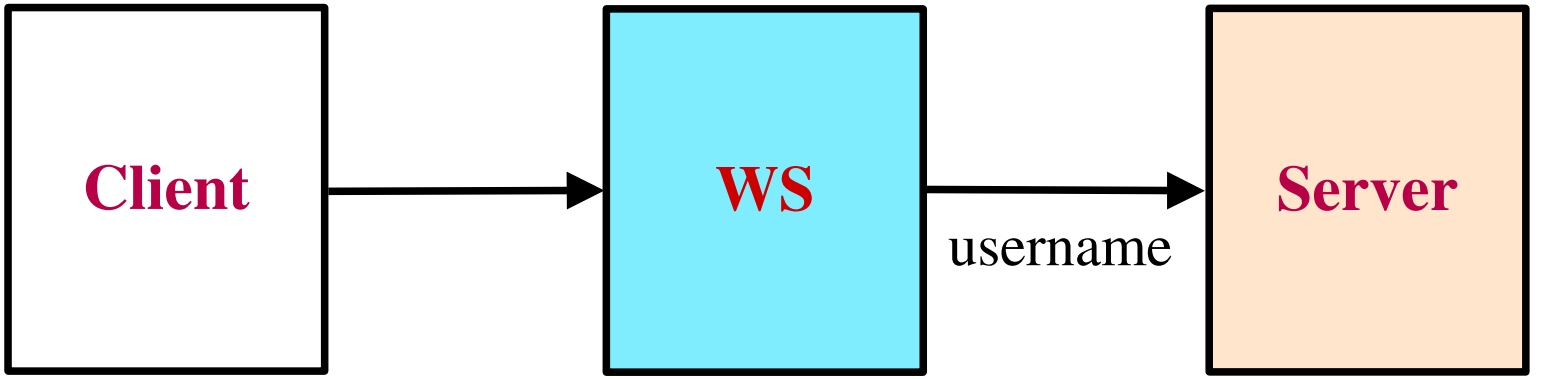
Lamport's Hash

Server has client's username, counter (decr by 1 when client is authenticated), hash(hash(... n times...(hash(password))...))

Client sends username, password to Workstation

Authentication Protocols

Password Authentication



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Workstation sends username to Server

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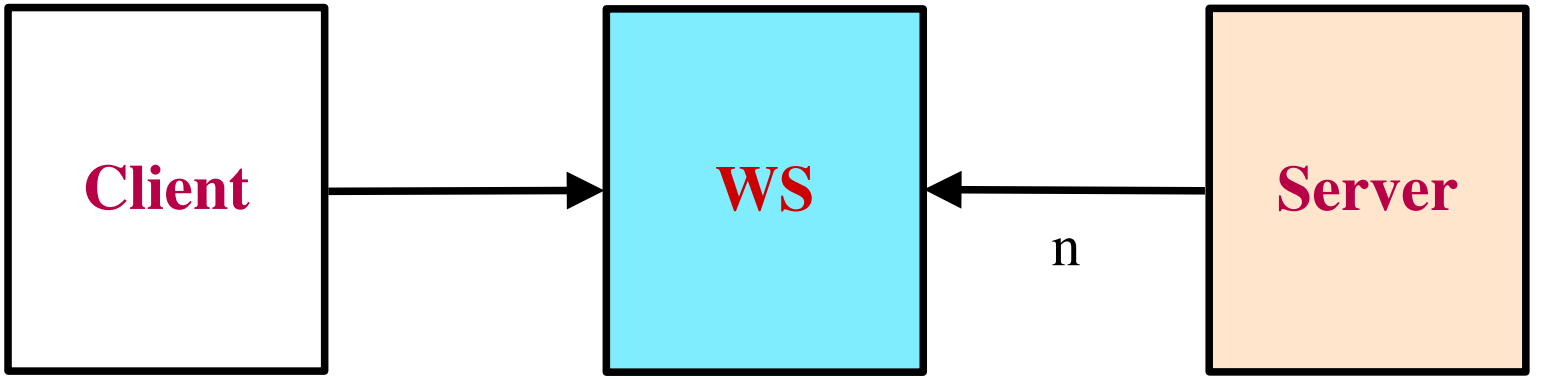

Lamport's Hash

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Server sends the number n to the Workstation

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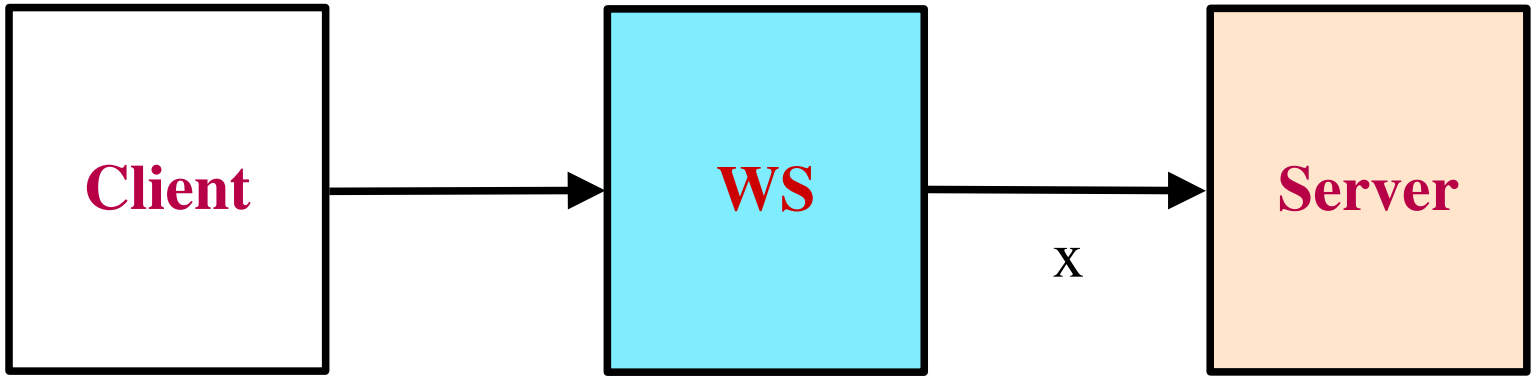

Lamport's Hash

Server has client's username, counter (decr by 1 when client is authenticated), hash(hash(... n times...(hash(password))...))

Workstation computes x = hash(hash(...n-1 times...(hash(password))...)), sends to Server

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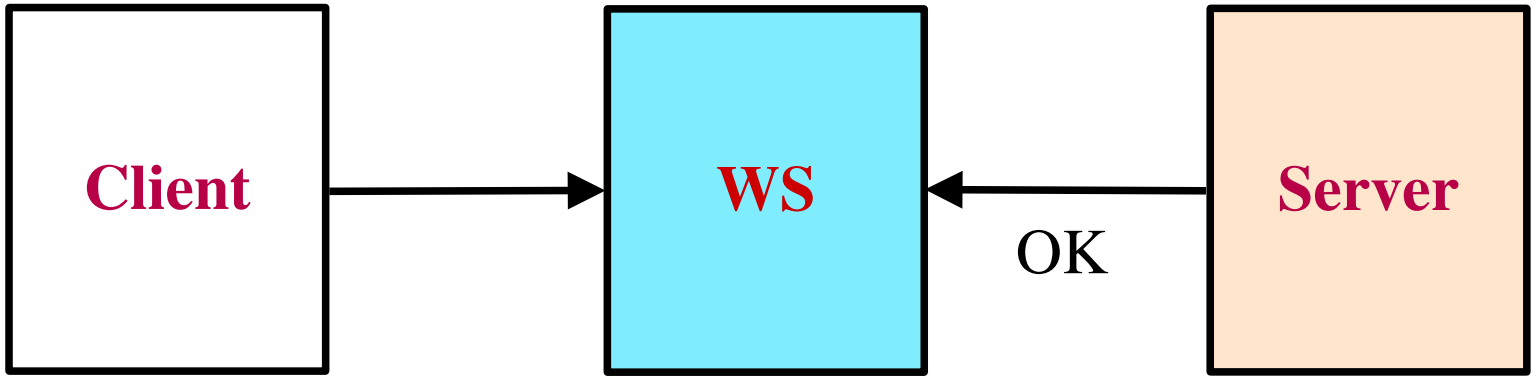

Lamport's Hash

Server has client's username, counter (decr by 1 when client is authenticated), hash(hash(... n times...(hash(password))...))

Server computes hash(x)...if it matches, authorizes Client to login to Server, replaces database item with x.

Authentication Protocols

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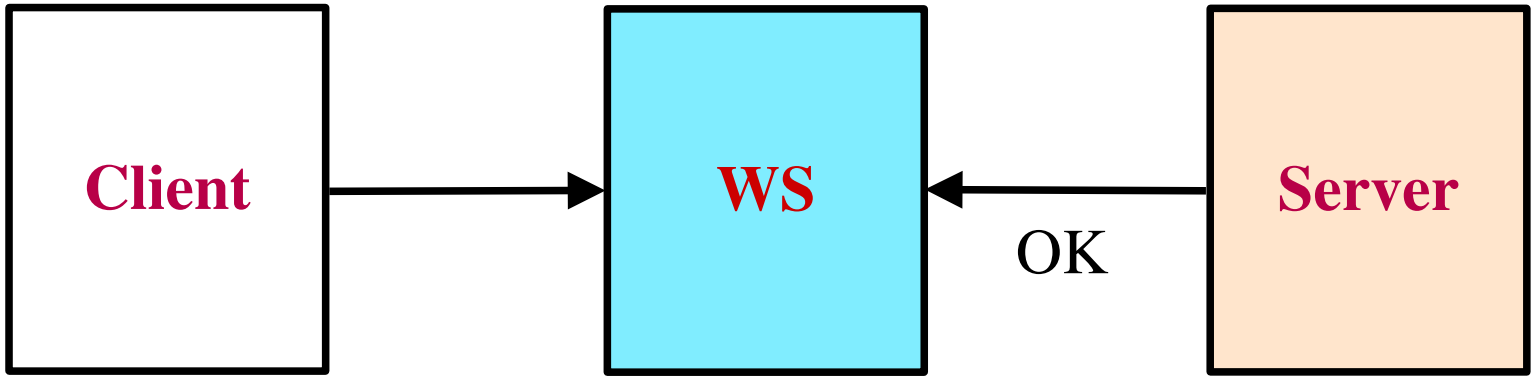

Lamport's Hash

Server has client's username, counter (decr by 1 when client is authenticated), hash(hash(... n times...(hash(password))...))

Two questions: What happens when n goes to 0?

If client talks to several servers, there will be a different n for each – isn't this vulnerable to a replay attack?

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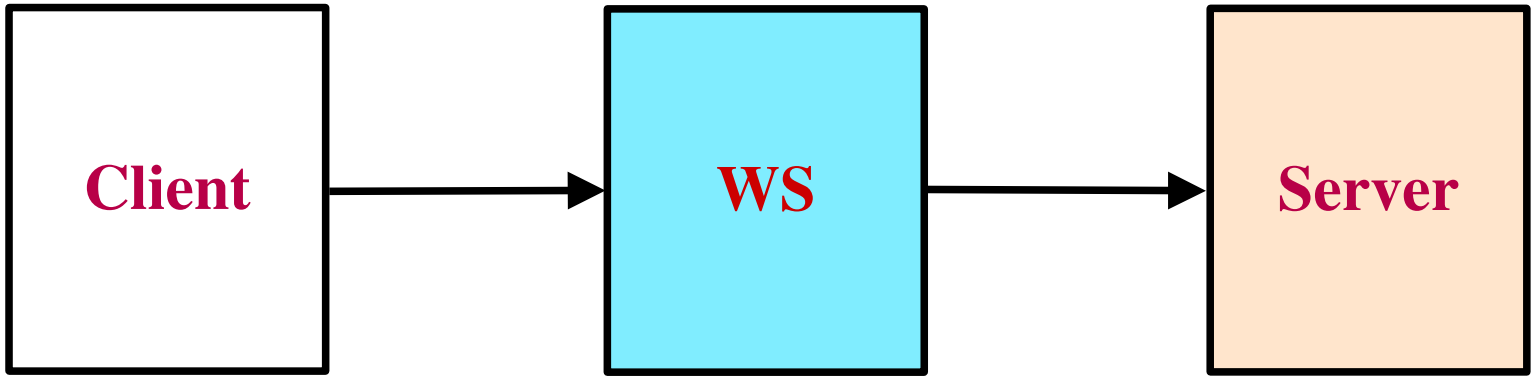
Password Authentication



Lamport's Hash

Server has client's username, counter (decr by 1 when client is authenticated), hash(hash(... n times...(hash(password | salt | server))...))

Salt: a number chosen at password installation to be unique to Client

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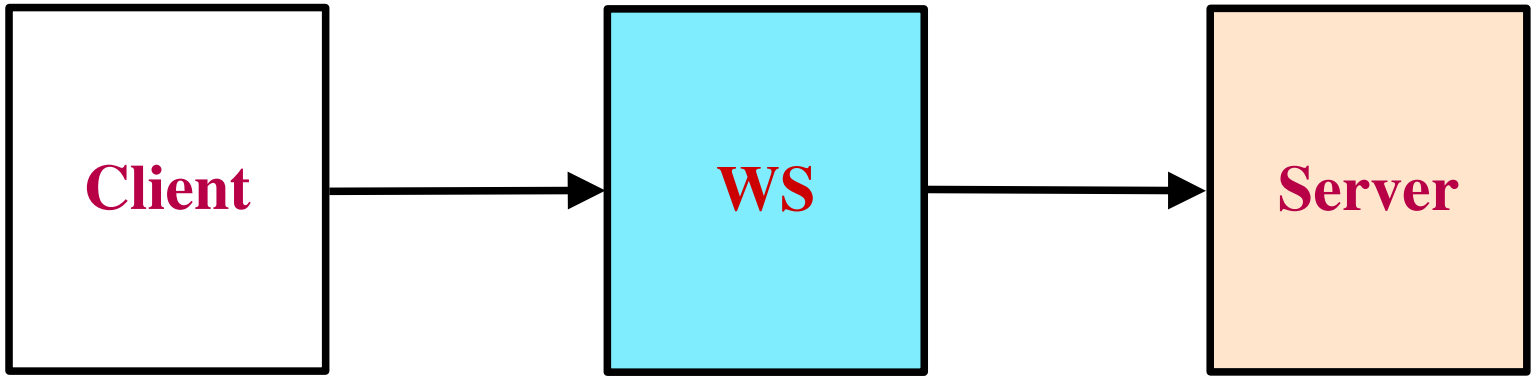

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Server: adding this makes sure the extra stuff is different for each server

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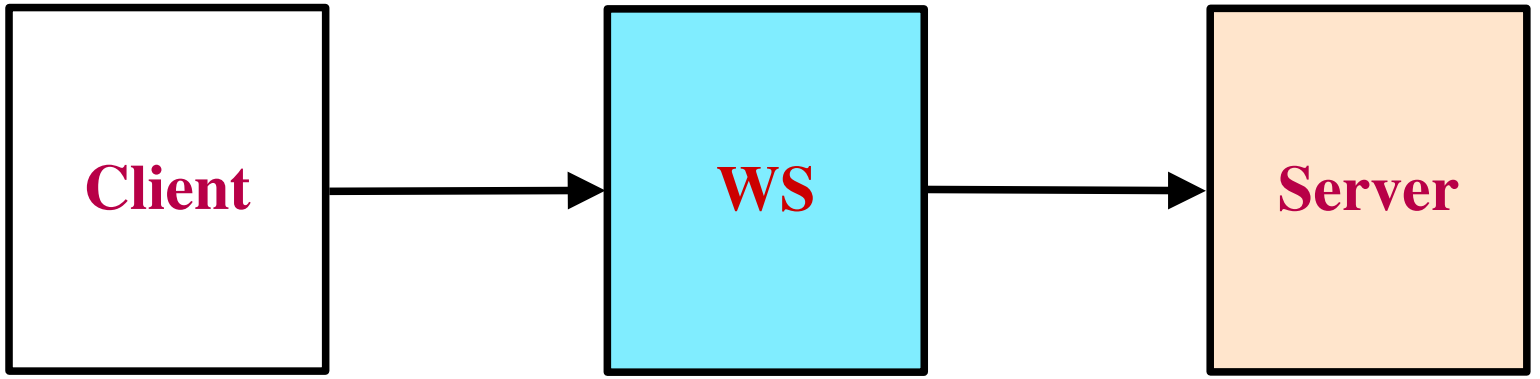

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Server: adding this makes sure the extra stuff is different for each server

Client can use same password on lots of Servers with different salt values, n is different on all the Servers. No need to change password when n=1, just choose a different salt.

Authentication Protocols

Password Authentication

Lamport's Hash - Problems

1. No mutual authentication - client does not know Server is on other end hence vulnerable to man-in-the-middle attack

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x = hash(hash(...n-p-1 times...(hash(password))...))

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Protection: WS needs to tell the user what n it got from the server?

Authentication Protocols

Password Authentication

Lamport's Hash - Problems

1. No mutual authentication - client does not know Server is on other end hence vulnerable to man-in-the-middle attack
2. Small n attack - Attacker impersonates Server by spoofing network addr. Attacker sends small n (less than current n) and salt (from prior look) to Workstation. Client computes hash, n times. Sends result to Attacker who hashes a few more times to get hash(... current n times ...(hash(.))...) and sends result to Server who thinks Attacker is the Client and allows login.

Protection: better – use on top of something like ssl to encrypt session

Authentication Protocols

Password Authentication

Strong Password Protocols

Designed so Attacker cannot gain information from authentication that will assist in an off-line attack (password guesses).

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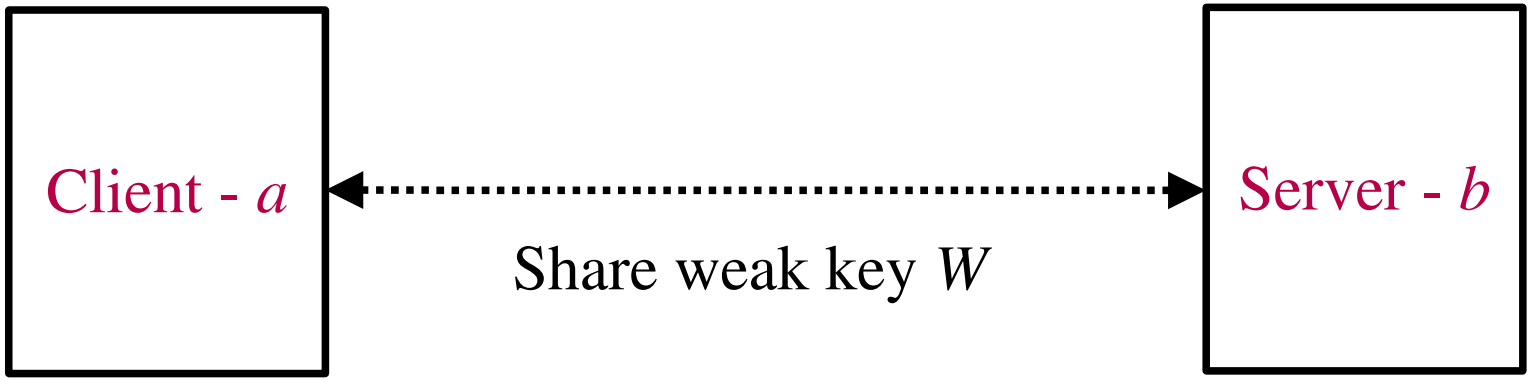
Do Diffie-Hellman exchange encrypting p,g with W and then mutual authentication based on the new Diffie-Hellman secret which is strong.

Authentication Protocols

Password Authentication

Strong Password Protocols



Start out with weak key *W* which is hash(password)

Authentication Protocols

Password Authentication

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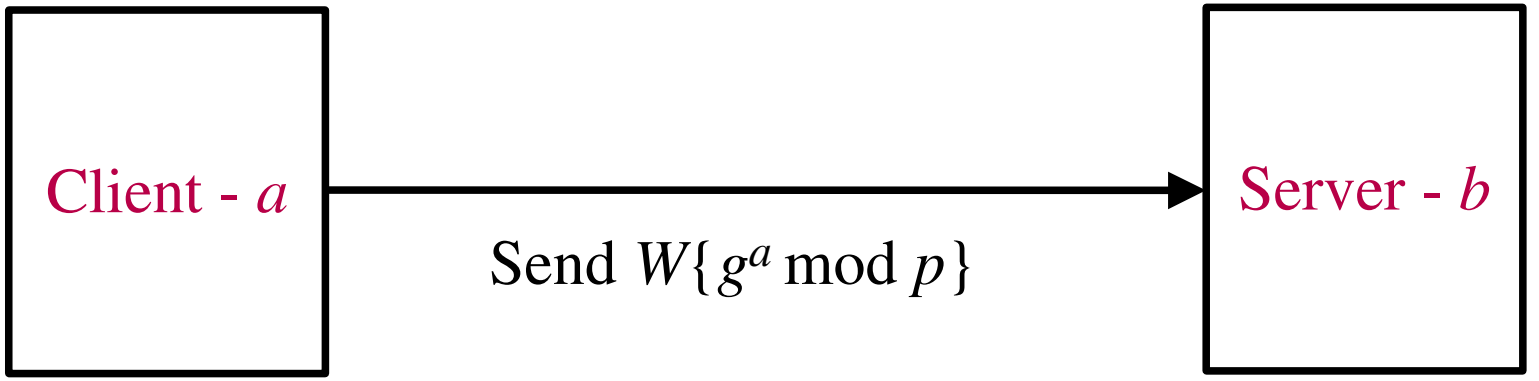

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Authentication Protocols

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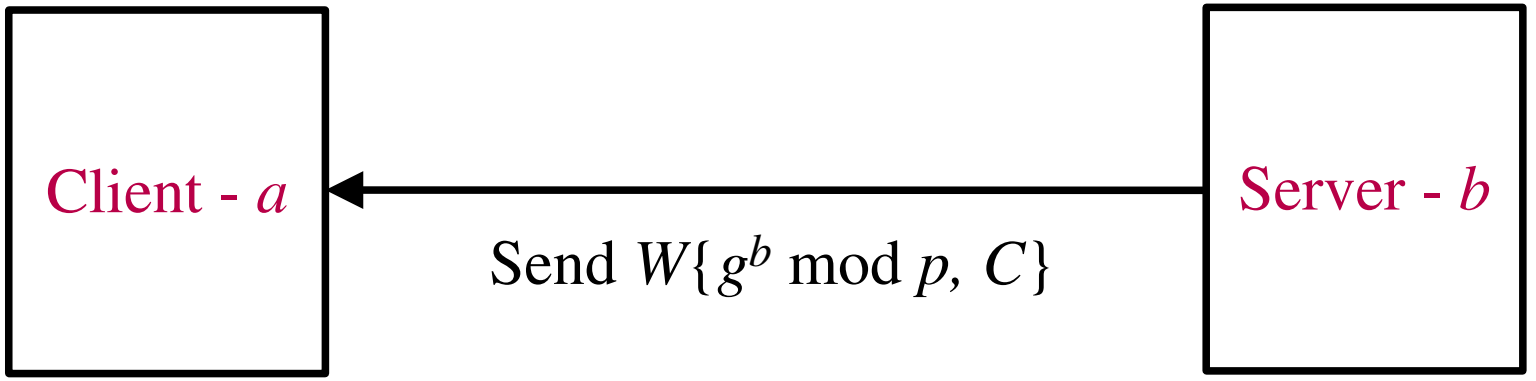

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Authentication Protocols

Password Authentication

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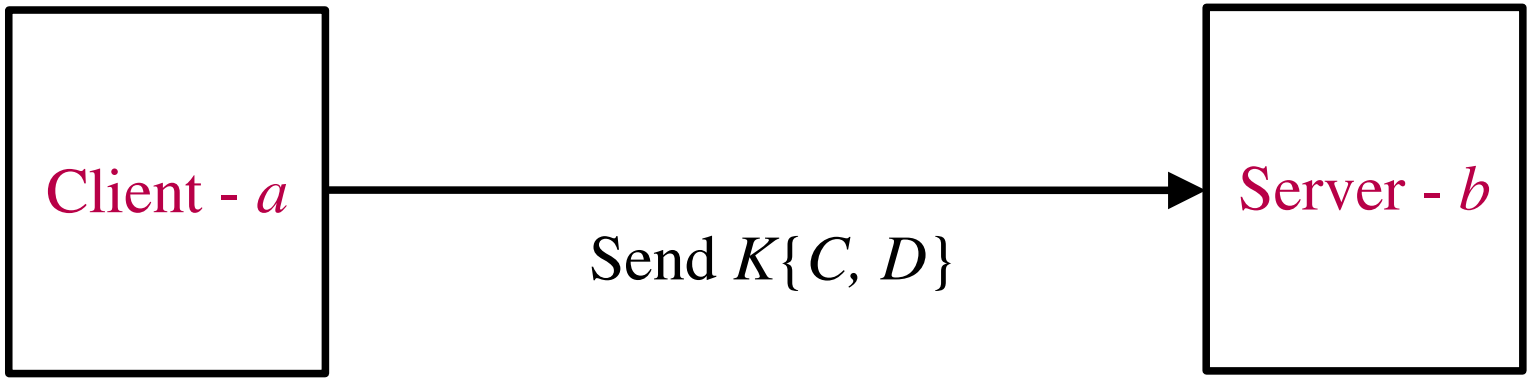

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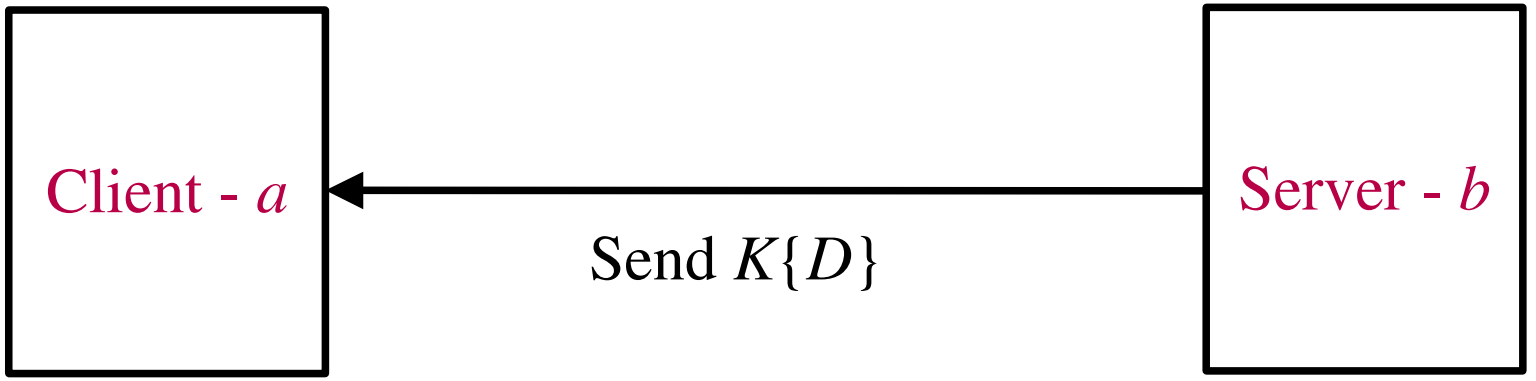
Client computes strong key $K = g^{ab}$ mod p, choose challenge, encrypts with K and sends to Server

Authentication Protocols

Password Authentication

Strong Password Protocols



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Server sends Client's challenge back to client encrypted with K

Authentication Protocols

Password Authentication

Strong Password Protocols - Why does this work?

g^a mod p looks random so $W\{g^a \text{ mod } p\}$ looks random too - cannot verify in an off-line attack that the password has been found - decryption with any password still gives a "random" looking number.

Subtleties:

Assume straightforward encryption of g^a mod p - then any off-line password guess that comes up with a number greater than p cannot be that password

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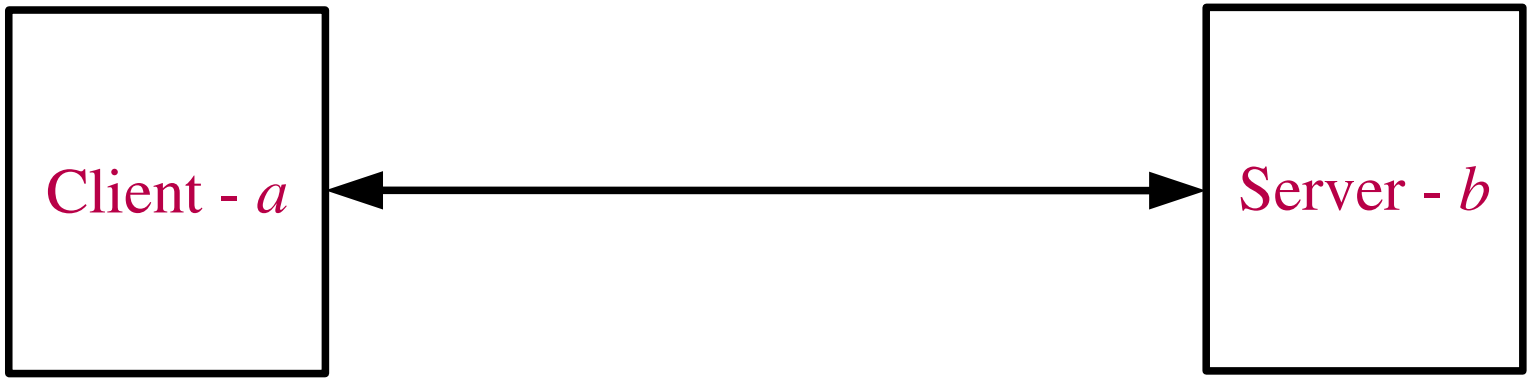
If p is a little more than a power of 2 then an incorrect password has 50% chance of being eliminated. Wait for second message to get another 25% and so on.

Authentication Protocols

Password Authentication

Strong Password Protocols - SPEKE



Start out with weak key W which is hash(password)

Let $g = W^2 \bmod p$

Client sends $K_c = g^a \bmod p$ to Server

Server sends $K_s = g^b \bmod p$ to Client

Client and Server compute strong key $K = g^{ab} \bmod p$

Same K for Client and Server if and only if the same password was hashed

Abort if K_c or K_s is not between 2 and p-2

Authentication Protocols

Password Authentication

Two Factor Authentication

Requestor uses two independent means of evidence when claiming ID
Something one knows (PIN), has (dongle), is (fingerprint, DNA)
Seeks to decrease the probability that a requestor is presenting false ID
Common example: ATM card (has) + PIN (knows)
RSA SecureID

How might it work?

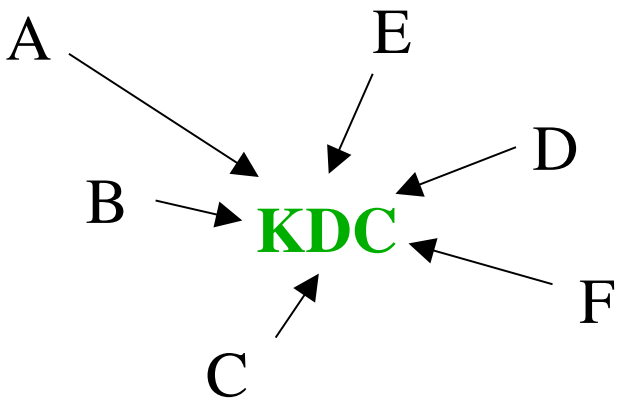
- Server sends some signal to the dongle
- The dongle interprets the signal and displays a number on the screen
- The requestor enters the number – this convinces the server that the requestor has the dongle

- The dongle may have a clock – the server gets the count to verify

Authentication

Key Distribution Centers

If the keys are in a few places, the explosion of needed keys is eliminated. The KDC knows keys for all machines. A new machine in the network causes update between that machine and KDC, not all other machines.



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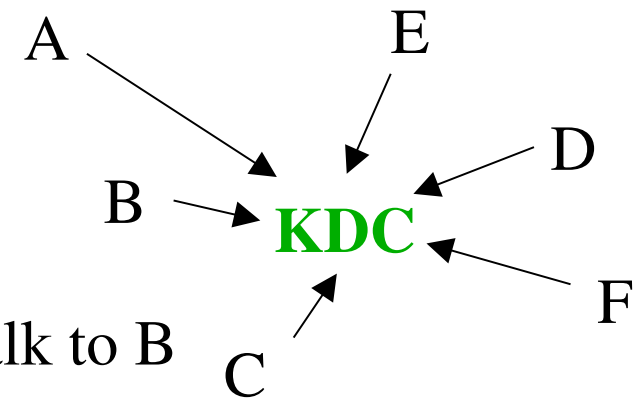

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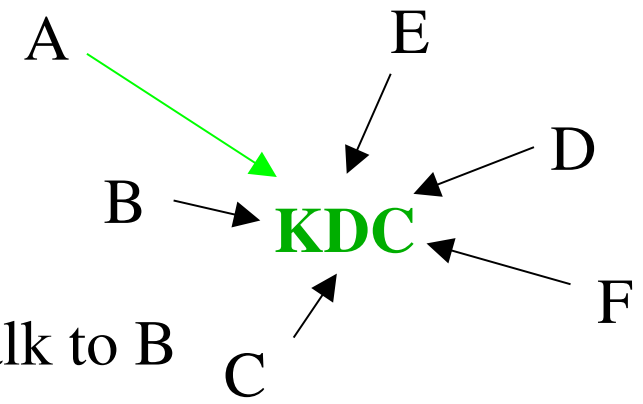

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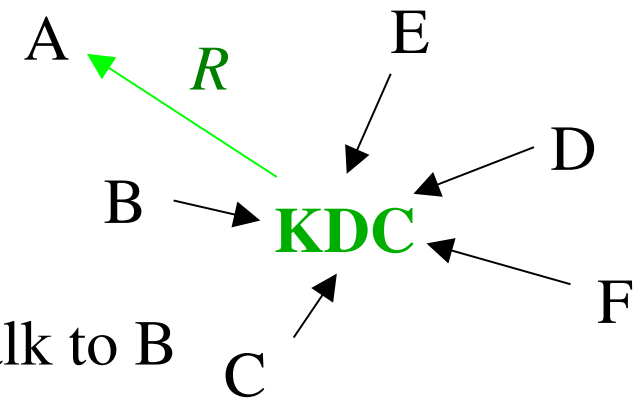

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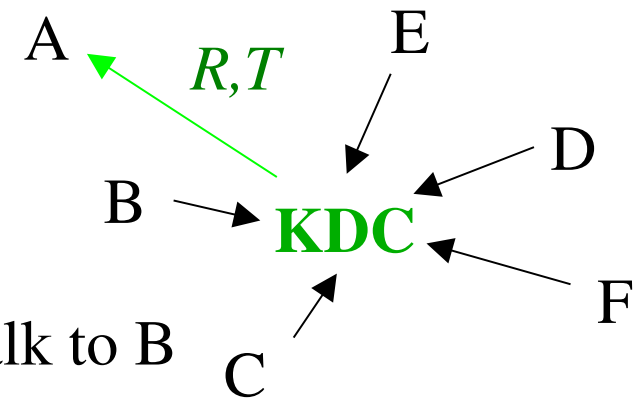

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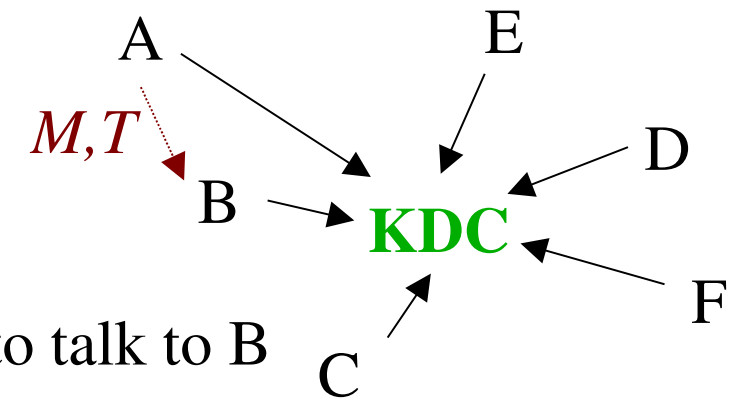

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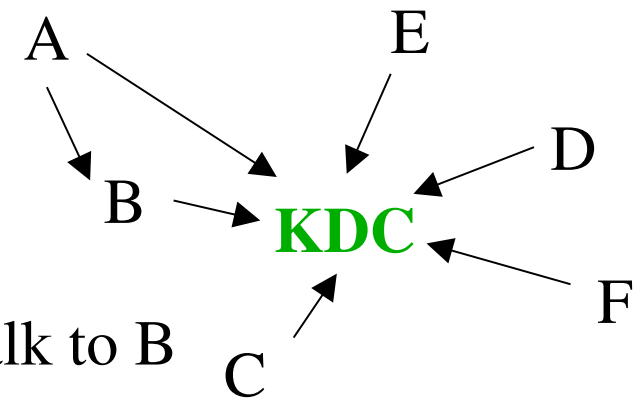

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B decrypts *T* to get the secret, then uses the secret on *M* to reveal message

Authentication

Key Distribution Centers

Problems:

Authentication

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   If it is compromised the ballgame is over.

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2. KDC is a single point of failure. If it goes down the ballgame is suspended. Additional KDCs for fault tolerance results in more vulnerability.
3. KDC could be a performance bottleneck

Authentication

Certification Authorities

For public keys:

Authentication

Certification Authorities

For public keys:

A trusted machine containing all public keys for public key LANs.

Generates certificates - signed message with name + public key.

Certificates have a termination date.

Certificates may be stored at each machine

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Advantages:

1. Need not be on-line
2. Hence should be more secure and simpler
3. If CA crashes, network still functions, but no new users accommodated
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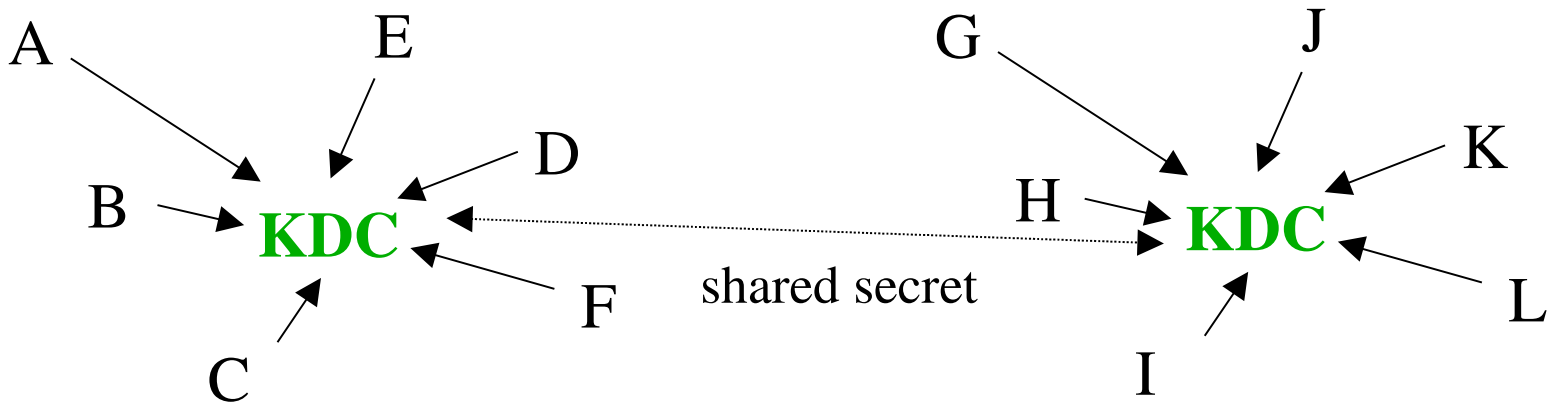
Authentication

Multiple Trusted Authorities - KDCs



Authentication

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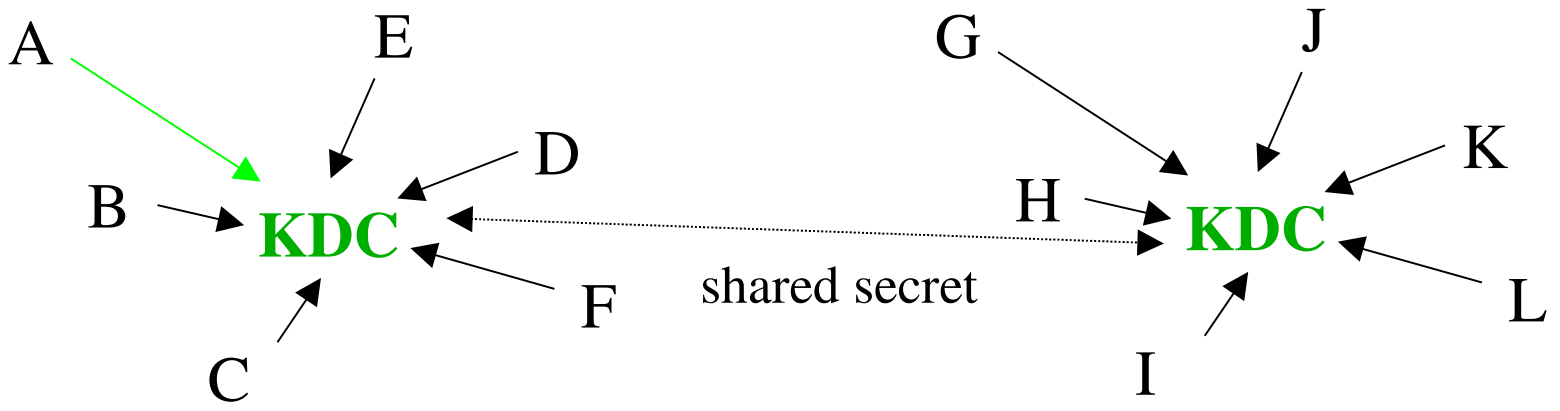

A requests to communicate with L

Authentication

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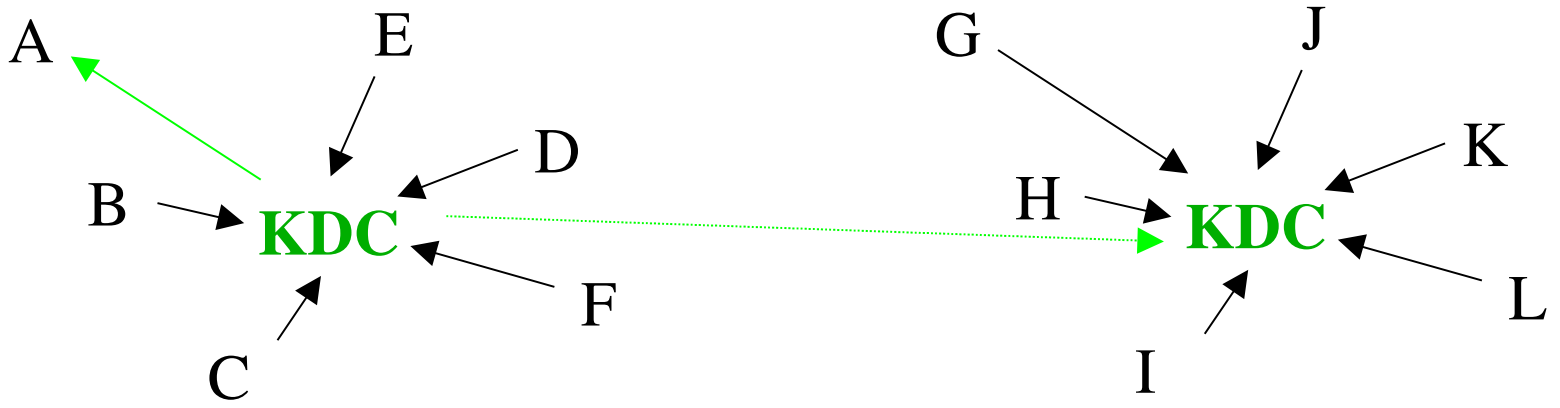

A requests to communicate with L

A's KDC generates key K_A for the transaction

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Authentication

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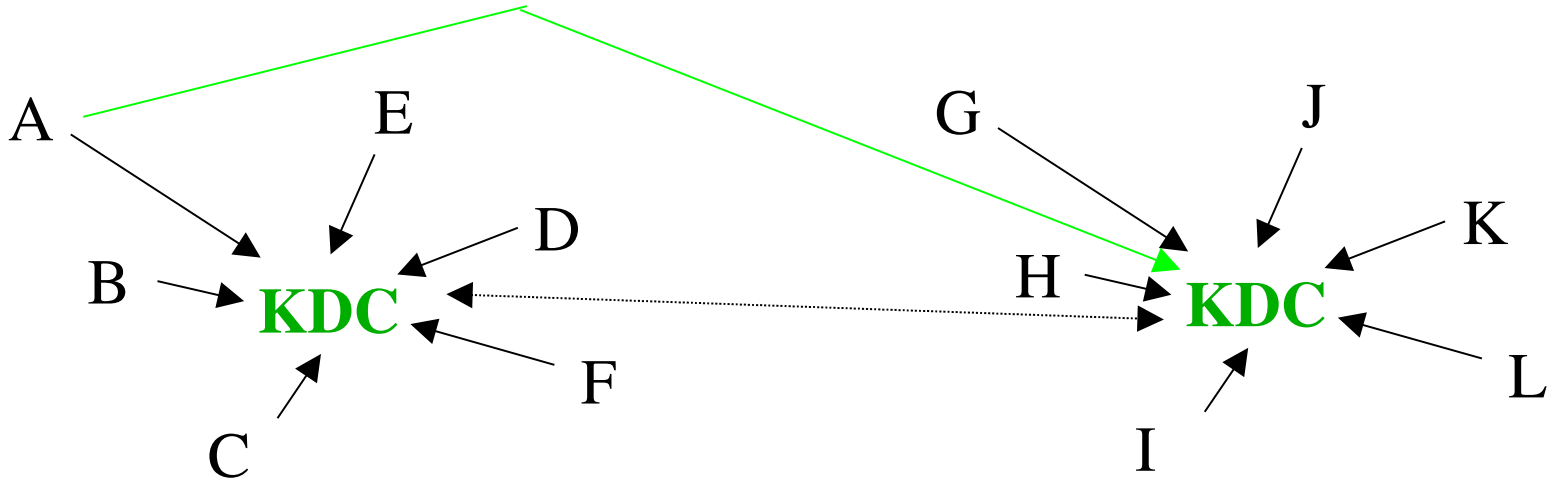

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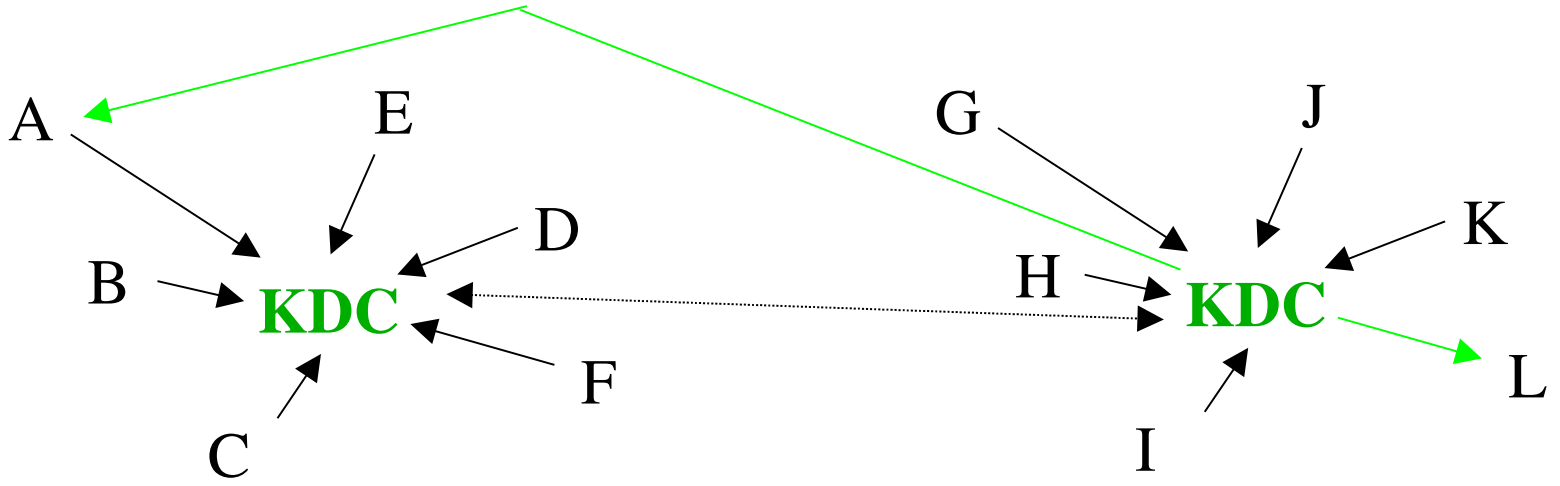

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A sends request to communicate with L to L's KDC

L's KDC generates key K_L for the transaction

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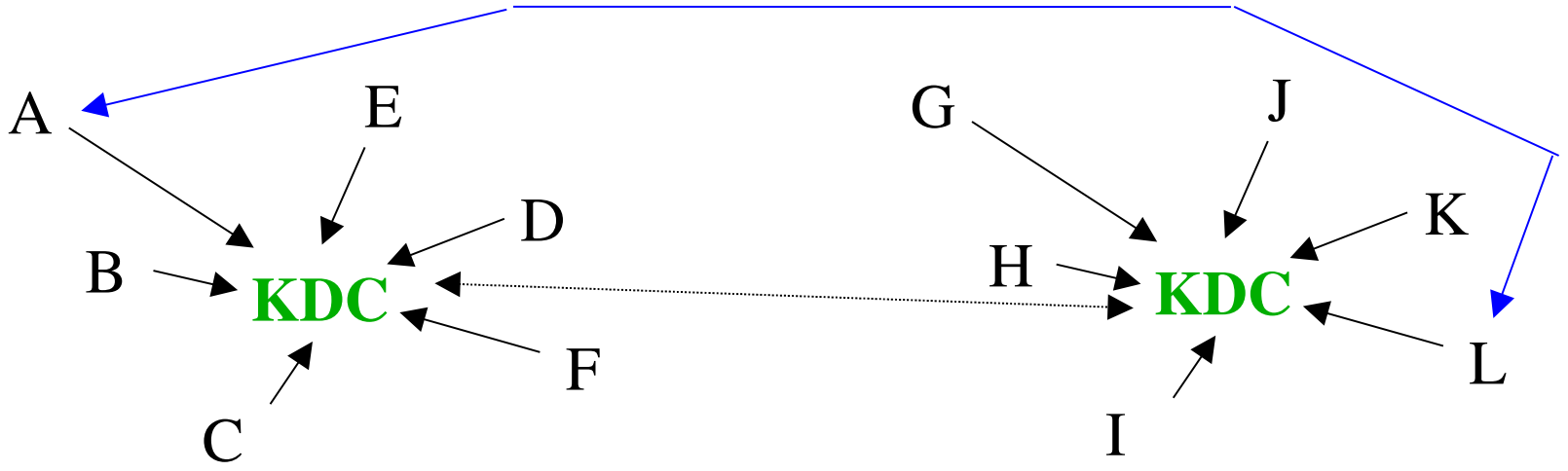
Authentication

Multiple Trusted Authorities - KDCs



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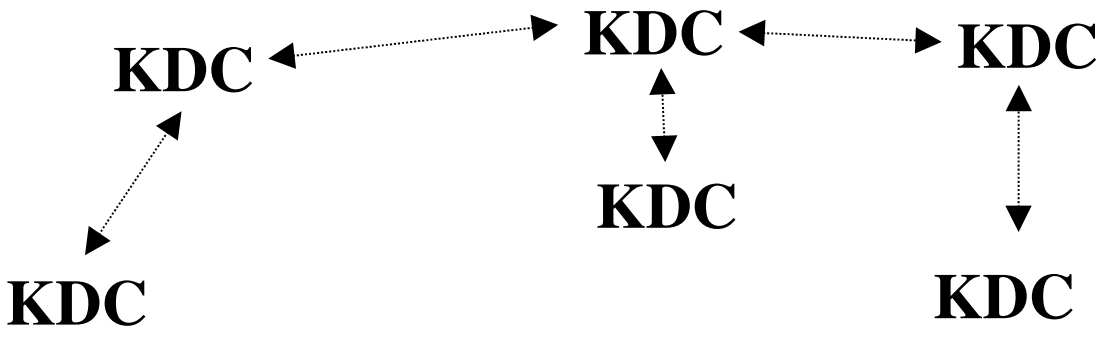
A and L communicate using key K_L

Authentication

Multiple Trusted Authorities - KDCs



Unworkable due to explosion of shared keys unless there is some tree-like hierarchy of KDCs.

Authentication

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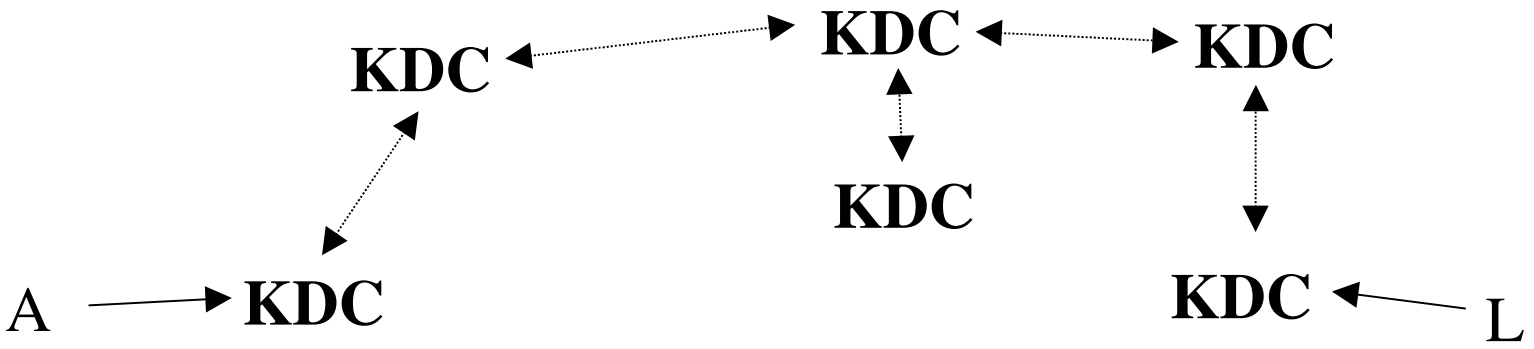

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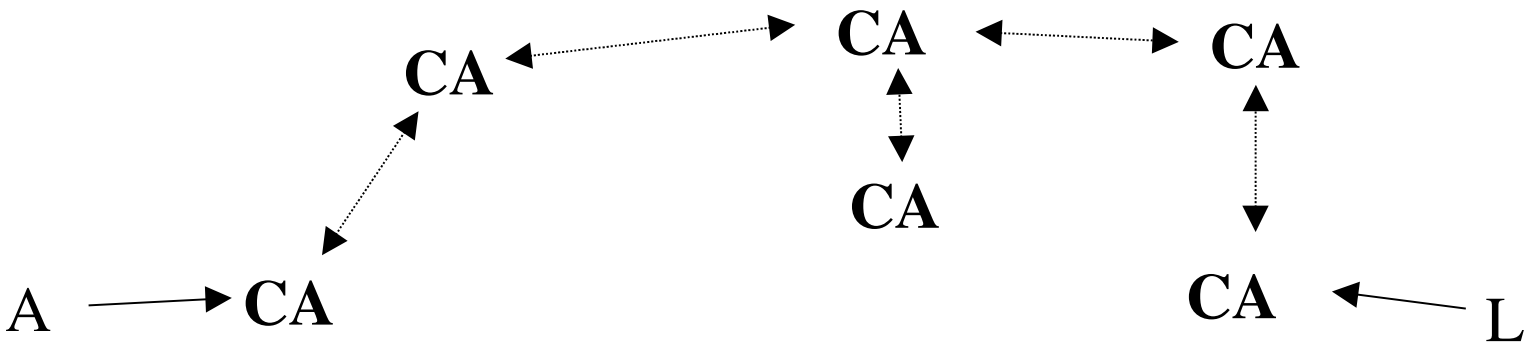
A must negotiate through a chain of KDCs before communicating with L each time getting a new key for the next transaction until finally getting a transaction key for A-L.

Authentication

Multiple Trusted Authorities - CAs

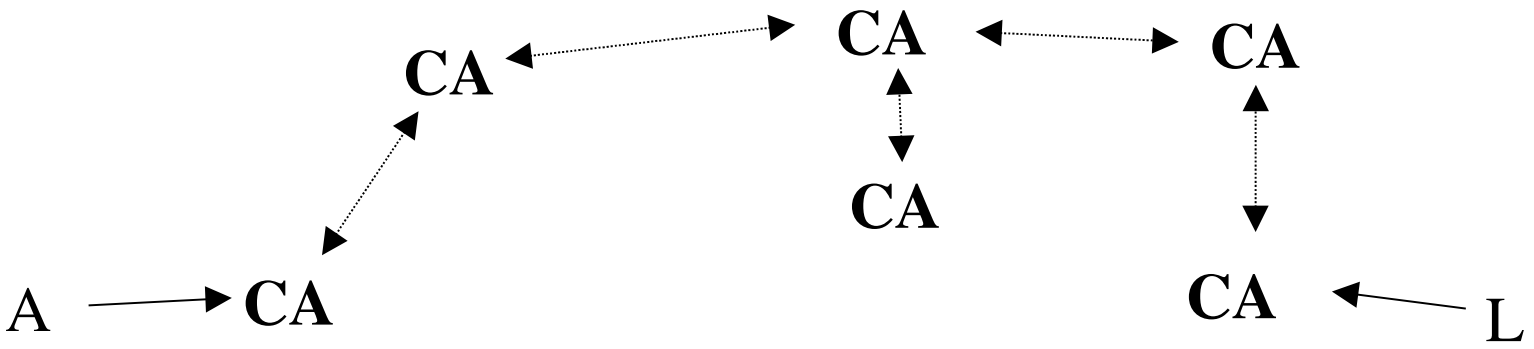


Each CA issues certificates for its own domain

All users in a domain can verify their certificates because they know the public key of their own CA

Authentication

Multiple Trusted Authorities - CAs



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If A wants to communicate with L verification proceeds in a chain, as before, with each CA in the chain having certificates for the other

Example:

A gets L's CA's certificate stating its public key is PC signed by A's CA

A gets L's certificate stating its public key is PL signed with key PC

Hence A is sure it has L's public key