Life of a Password

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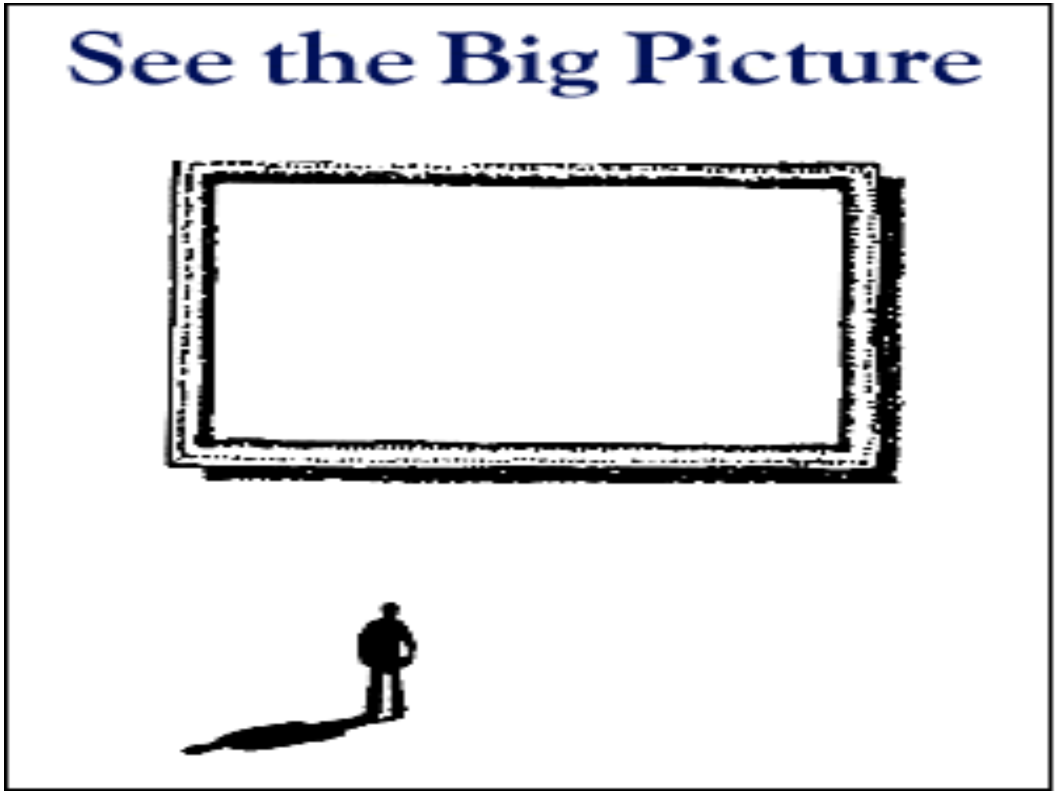


Secure user account.

Agenda

We cover the following topics:

- Hashing
- Transport
- Storage

Not covered:

monitoring, host and network security, access control, other account protection mechanisms.

Unsalted Password Hash

User id	hash
m1	F(“monkey”)
m2	F(“123456”)

- Brute force short passwords
- Dictionary attack
- Rainbow Table

Salted Password Hashes

Cheap Salt (performance; what’s wrong?)

User id	hash
m1	F(“monkey”, m1)
m2	F(“123456”, m2)

Random Salt

User id	hash	salt (64/96 bit)
m1	F(“JI6aerwhm”, s1)	s1
m2	F(“$^%YRTYFYU”, s2)	s2

Susceptible to Targeted attack

Keyed Crypto Hash (MAC)

User id	hash
m1	F("Jl6aerwhm", "**secret**")
m2	F("$^%YRTYFYU", "**secret**")

- Prevents dictionary attack
- Common passwords are revealed
- Prevents targeted attack

Next: Online attacks

Overwrite Attack

User id	hash	salt
m1	F("ashjrgqwu3nk", s1)	s2
m2	F("%RYThj#WY", s2)	s2

User id	hash	salt
m1	F("password", s)	s
m2	F("password", s)	s

Attacker overwrites m1 and m2's real passwords

Swap Attack

User id	hash	salt
m1	F("password", s1, "**secret**")	s1
m2	F("$^%YRTYFYU", s2, "**secret**")	s2

User id	hash	salt
m1 (attacker)	F("password", s1, "secret")	s1
m2 (victim)	F("password", s1, "secret"	s1

Keyed Hash

Pros

- One-way
- Correlated input secure

Cons

- Hash computation is fast
- Fixed input, fixed output

Password Recipe

- Key Derivation Function (KDF) instead of crypto hash
- Random salt
- User or member id
- Work factor (active accounts)
- Application secret
- Encrypted Hashes vs MAC

Ongoing Key Rotation

- Increase likelihood that not all stored credentials can be cracked.
- You have fingerprinted your database – stolen hashes can pinpoint “when”

Except if…

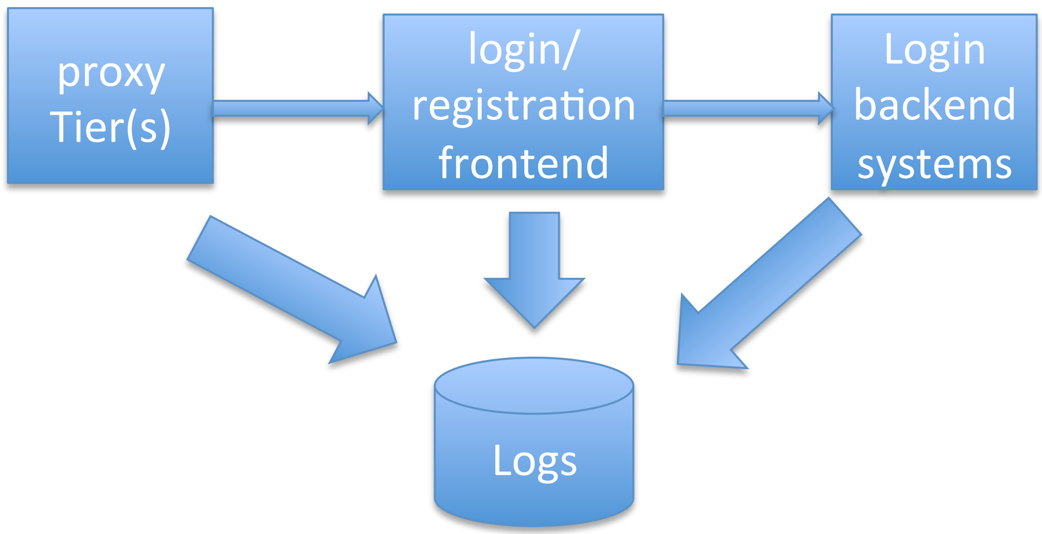
Password History Table

User id	hash	salt
m1	F("password", s1, m1, "secret")	s1

Password Table

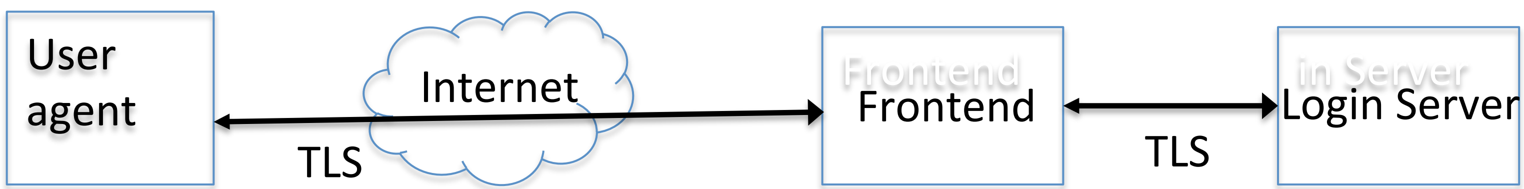
User id	hash	salt
m1	F("^%$TRsfwe", s2, m1, "secret")	s2

Accidental Logging



2014/02/25 18:38:55.751 [(prod-host1,login-app,/login,2014/02/25 18:38:55.572) verifyPassword(email="foobar@yahoo.com", **password=monkey**, ip_address="1.1.1.1"), PASS, 11ms

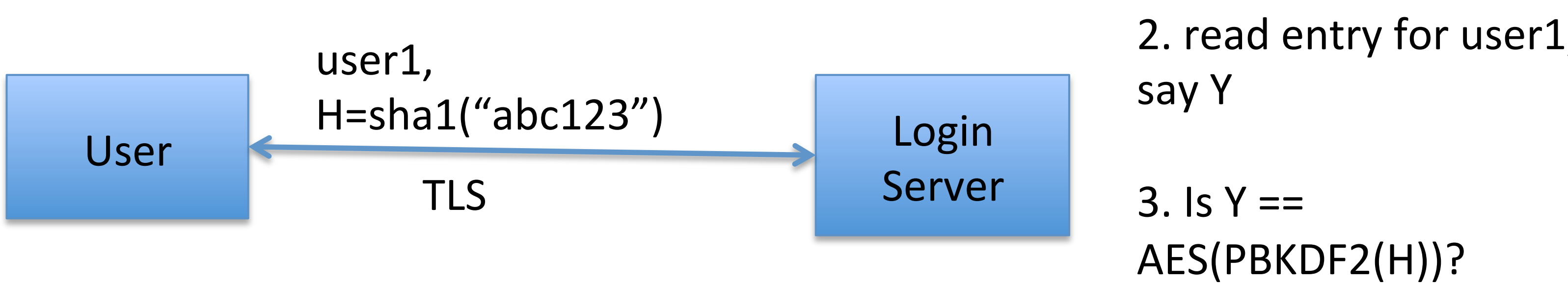
Transport



- TLS throughout, so on network password is always encrypted
- Each hop sees password in clear – potential for improper handling

Fix at User Agent – Attempt 1

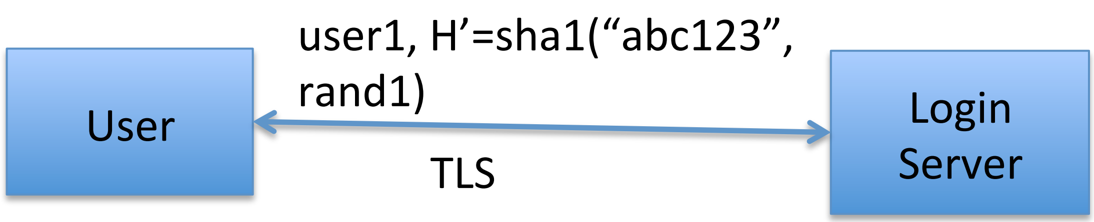
Send Hash(password)



- Equation in Step 3 holds if the sha1 is done consistently during registration, password reset, etc
- **Problem** – hashed password log is as bad as logging cleartext password!

Fix at User Agent – Attempt 2

Send Hash(password, salt)



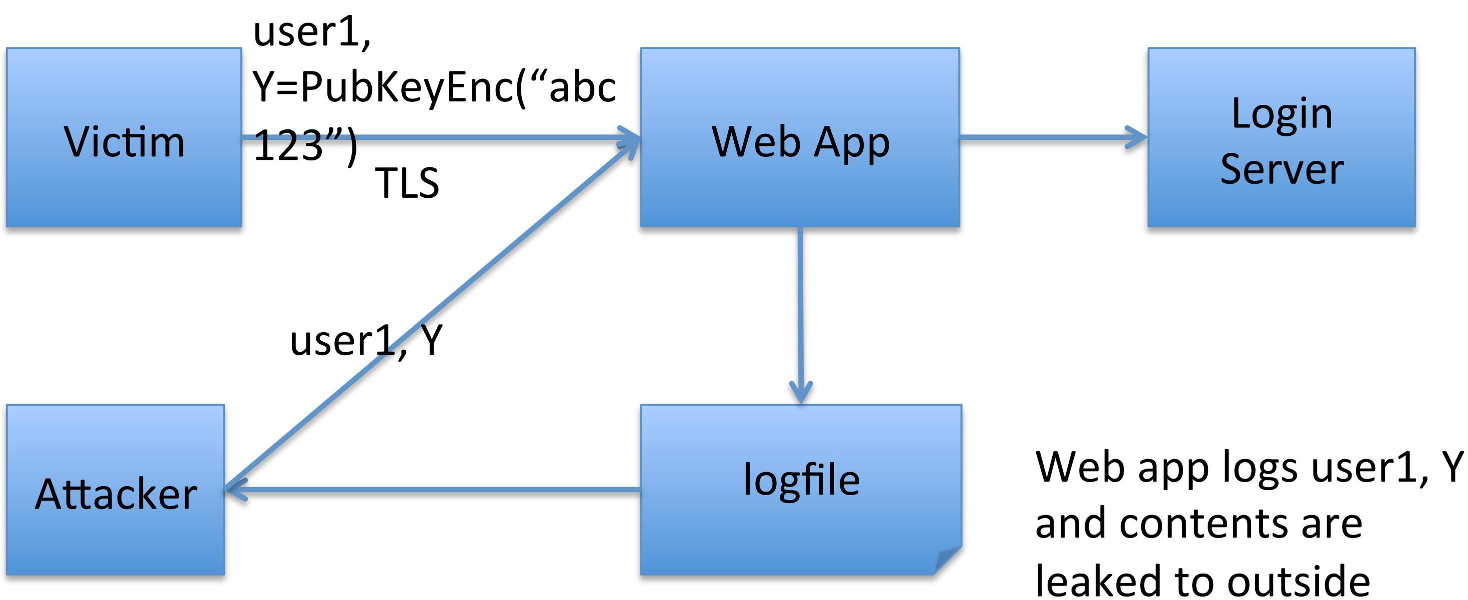
2. read entry for user1, say Y

3. Is Y == AES(PBKDF2(H'))?

- Salt used in computing Y using PBKDF2 can't be same as rand1
- **Problem** - Equation in Step 3 can't hold for any verification, scheme not feasible

Fix At User Agent – Attempt 3

Send PublicKeyEncryption(password)



Problem – Can replay and use encrypted password instead of real password to login as user

Fix At User Agent - Summary

Send PublicKeyEncryption(password) + nonce

- Good news – this finally works!
- Bad news – must support all user agents including native mobile, some clients can't be upgraded

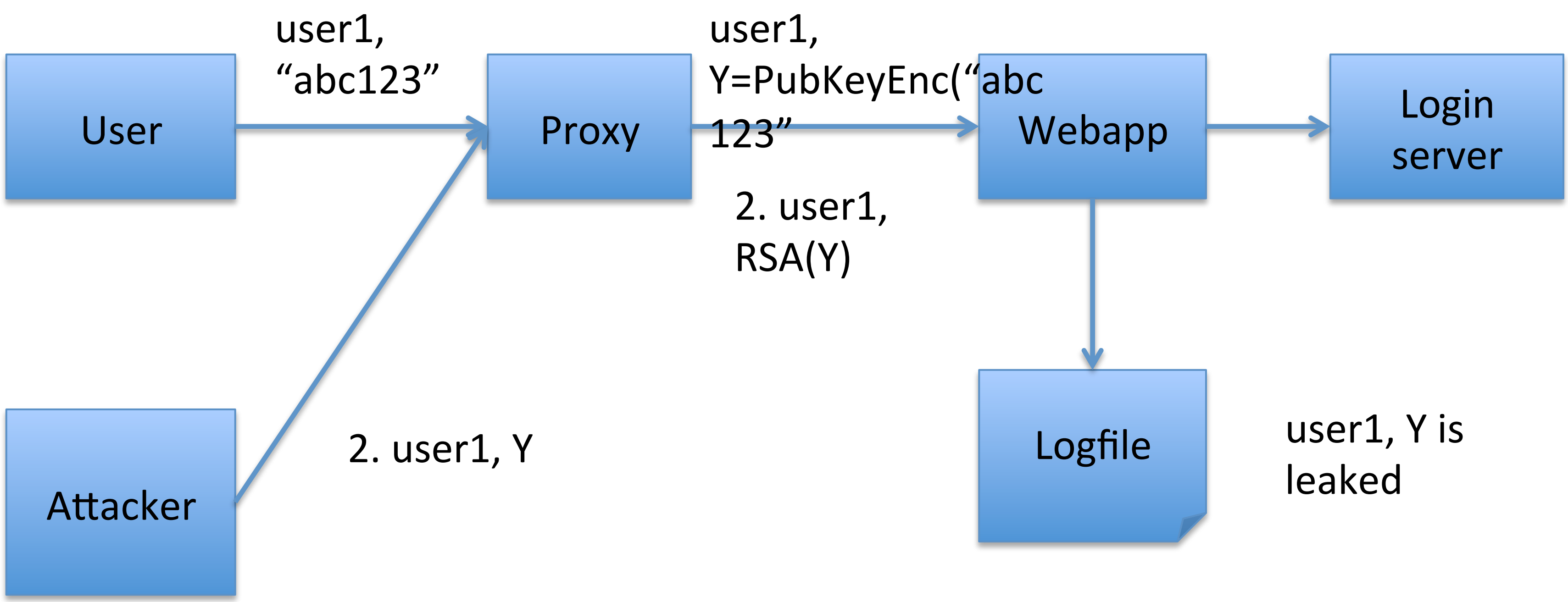
Fix at Ingress – Attempt 1

Instead of sending password, over TLS send either:

- Hash(password, salt)
- Password token not derived from password

Fix at Ingress – Attempt 2

PublicKeyEncryption(password)



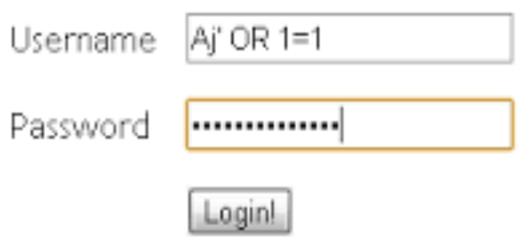
No replay from outside, can replay from inside network

Cloaked Password

- Password encrypted $PublicKey_{loginserver}$
- Ciphertext is randomized
- Replay protection via short expiry or nonce infrastructure
- Can be decrypted only by verification end point

Storage

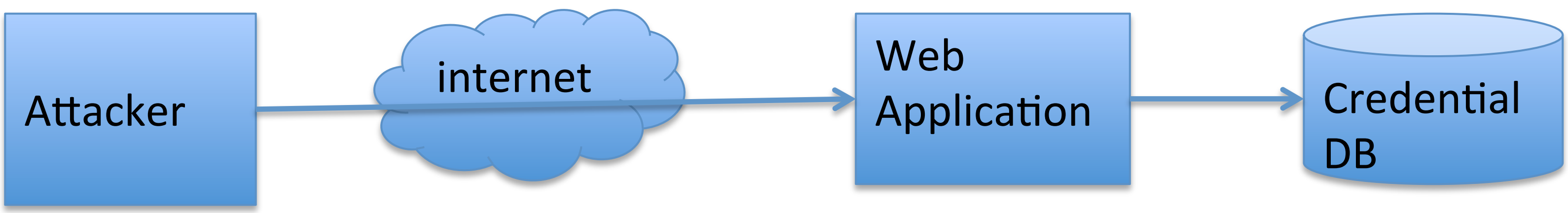
- SQL injection



- Attacker has username/password of database
- Attacker has access to filesystem

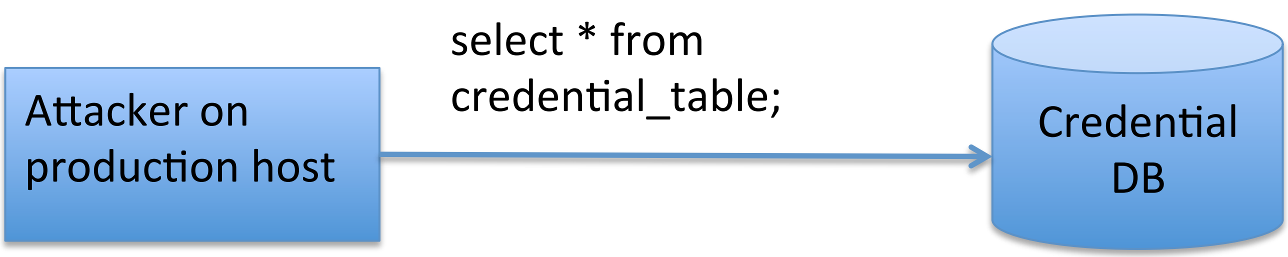
Dump credentials

- SQL injection (nosql stores are not by default safe)



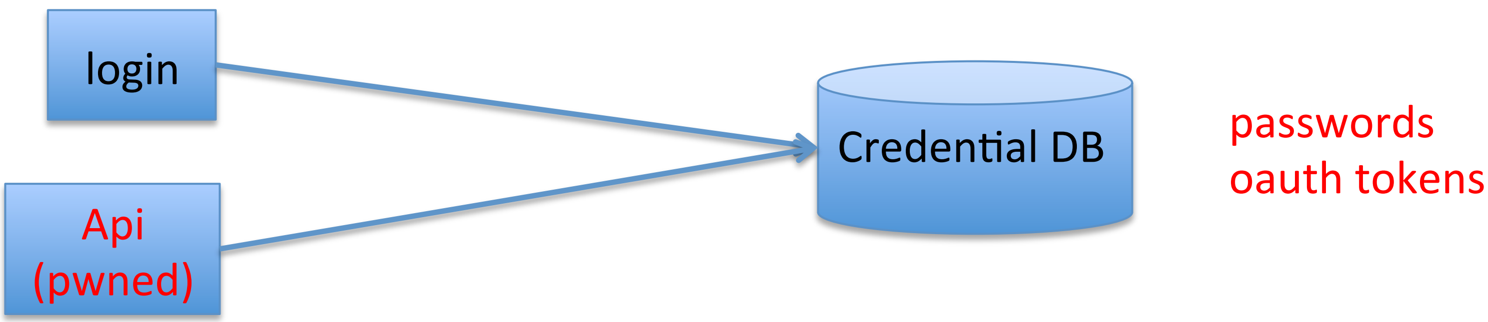
password='foo' or 1=1 --

- Attacker with DB credential

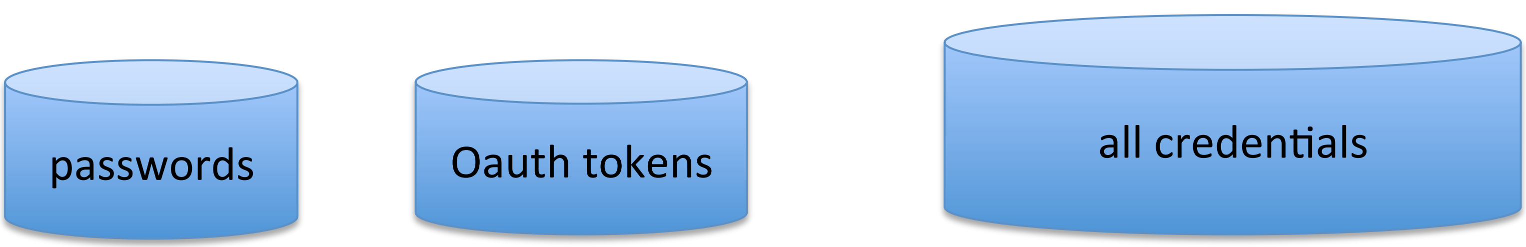


Centralizing Storage

- Many types of credentials – isolate application credentials



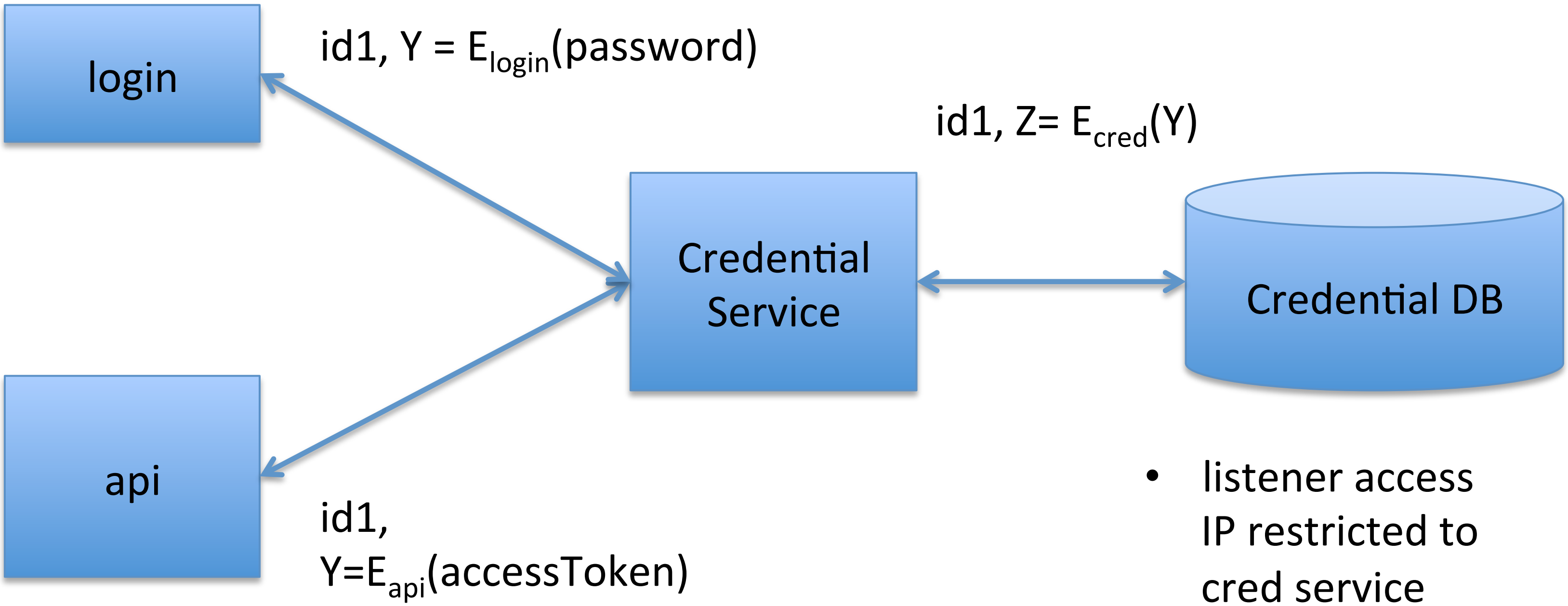
- Single point of attack



Credential Store

- Access via Stored Procedure
- Isolate client data via dual encryption
- Access Control
- Auditing
- Monitoring
- Periodic key rotation

Credential Store



- listener access IP restricted to cred service
- Access via Stored procs

- All communication over TLS
- ACLs on operations
- Client encryption

Summary

- Made some progress securing passwords
- Re-usable infrastructure – apply to credit cards, OAuth tokens, etc
- Future Work – Key Management, SRP?, mitigate risk of compromise of critical applications

Acknowledgement

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Questions?

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