Passwords in Peer-to-Peer

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KTH – Royal Institute of Technology

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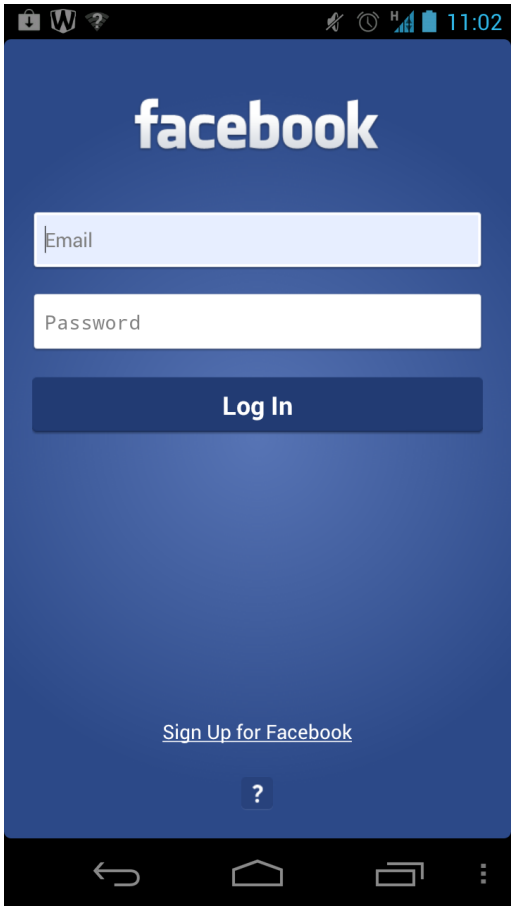
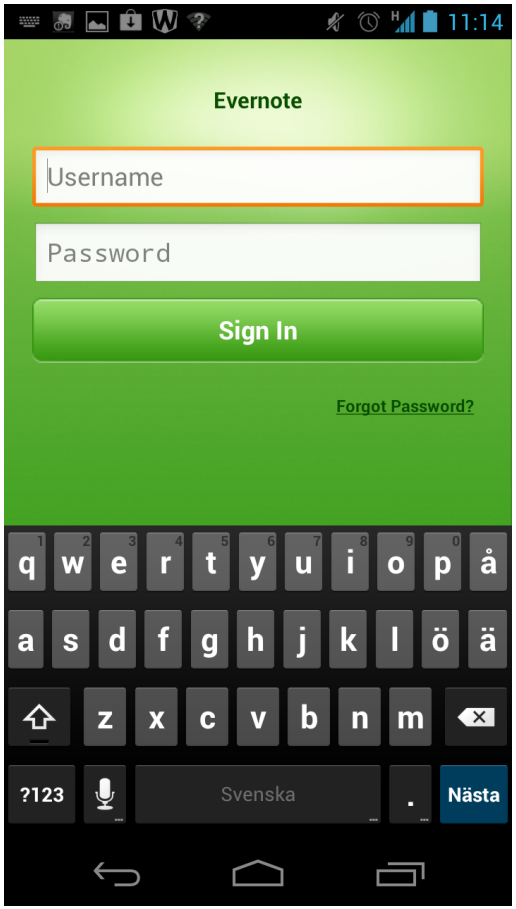
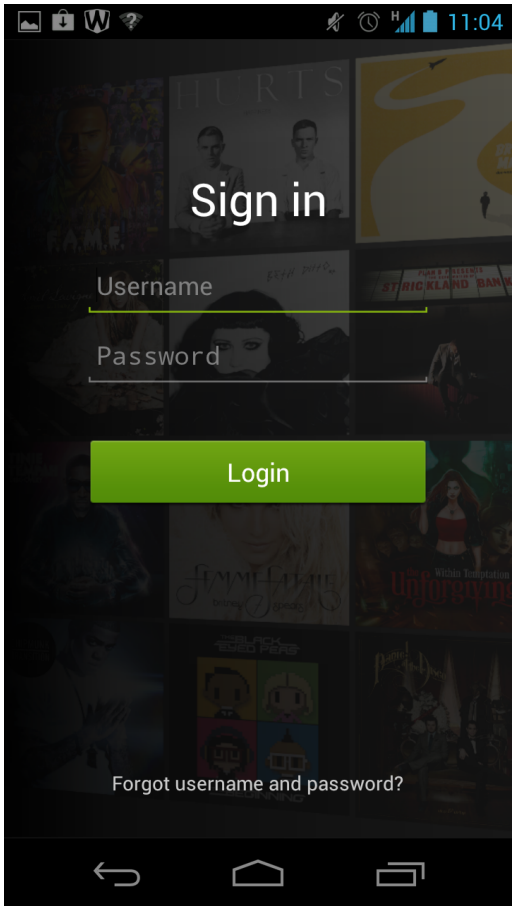
Modern End-User Services







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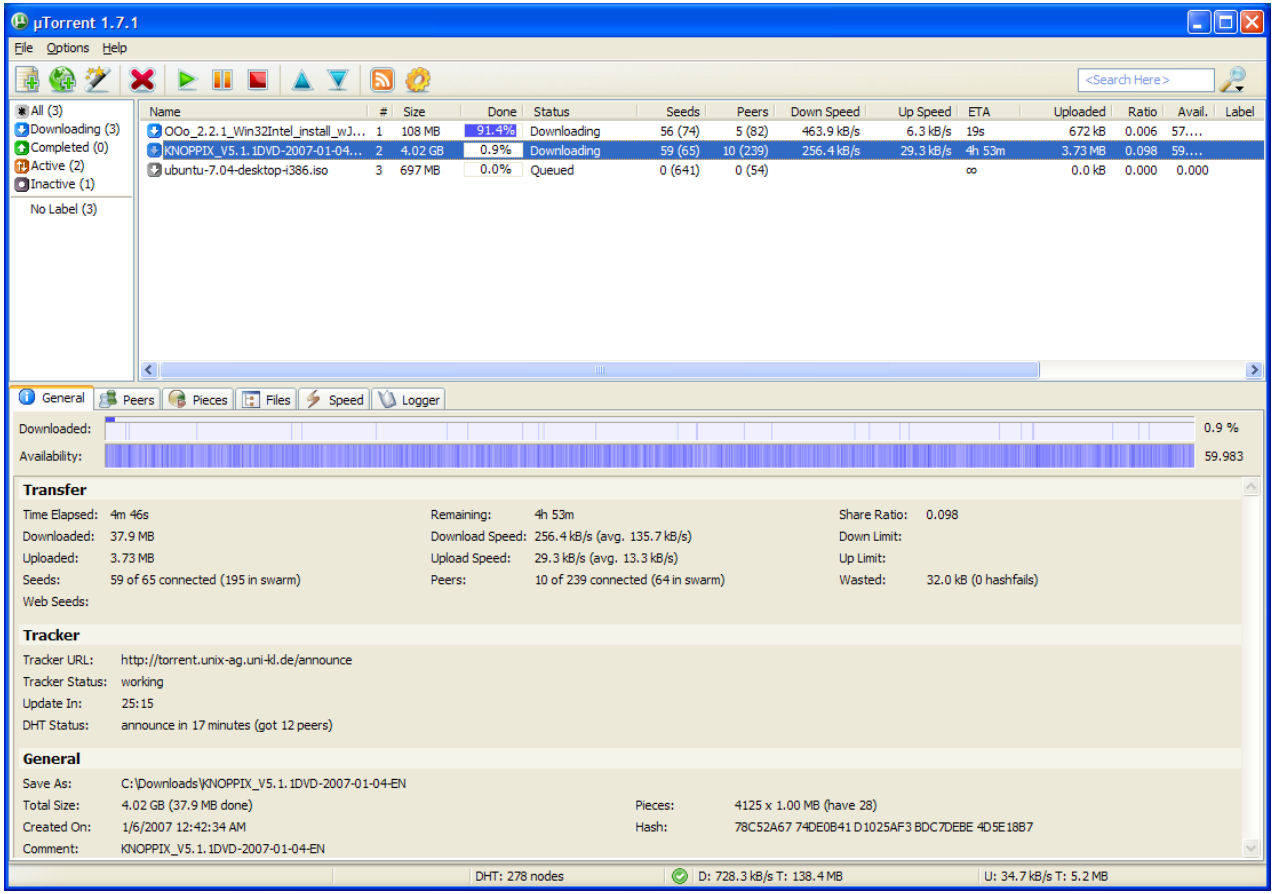
Logging in to P2P?

What was the last P2P application you logged in to?

The Easy Case



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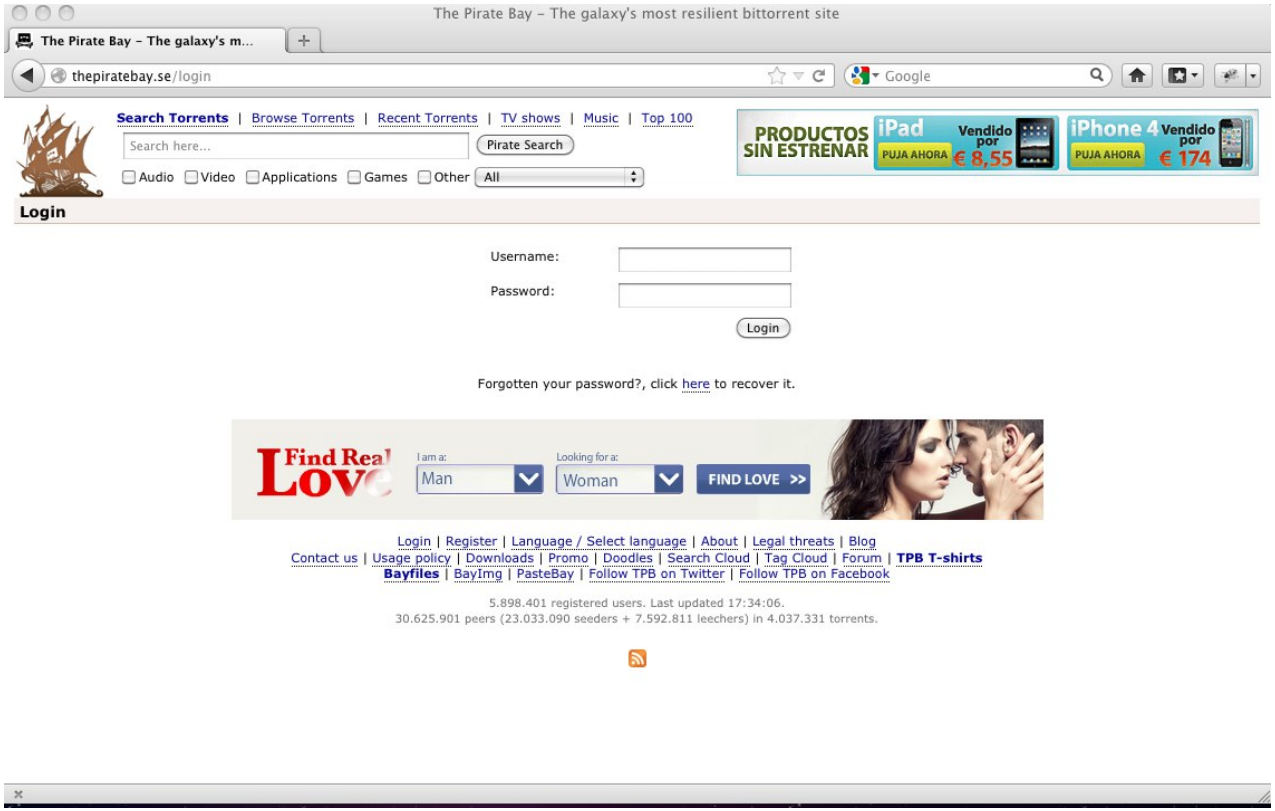
Sometimes we Want Authentication



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Standard P2P Solution

- Generate a cryptographic key
- Whoever knows key is authenticated as user
- On a single machine it Just Works^{TM}

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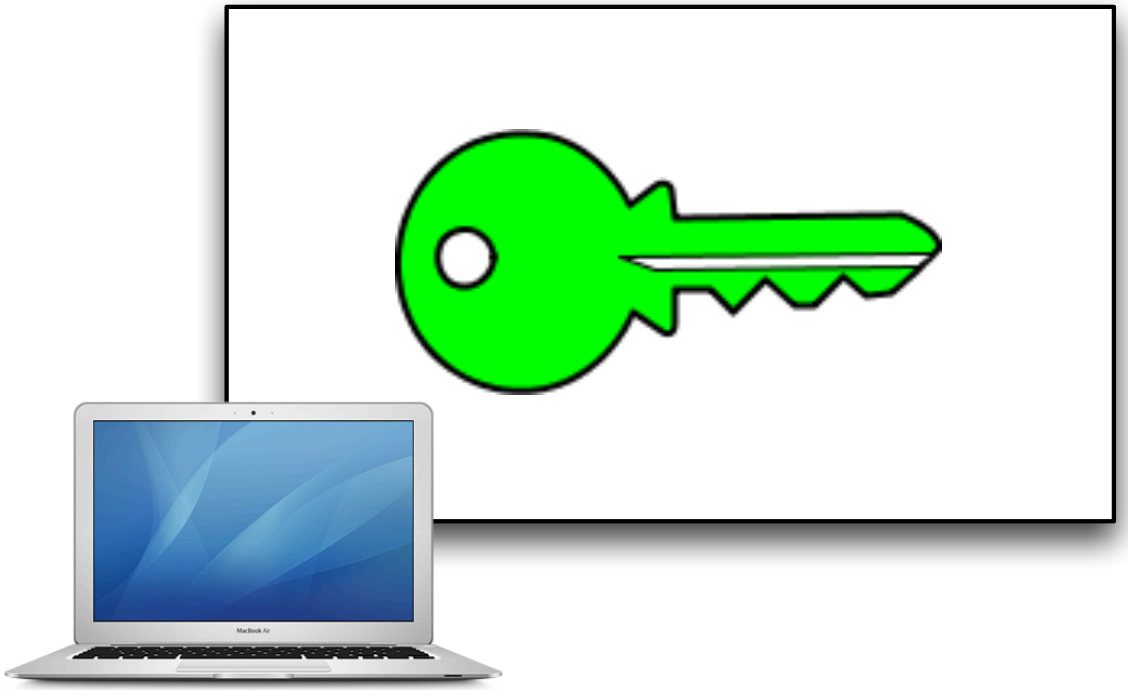
- . . . but, needs to be copied to smartphone.

Standard P2P Solution Depicted



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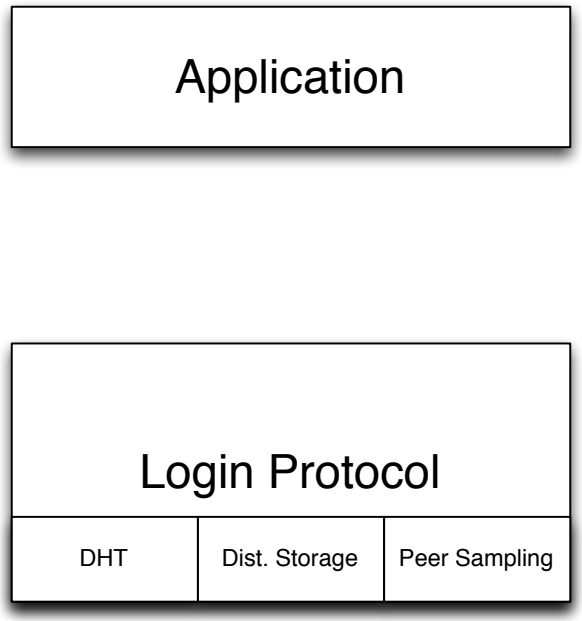
Problem Crops up in P2P Backup

- Default solution fails spectacularly for backup
- Some punt problem to user: back up the key separately
- Some derive master key from a password

Target Scenario



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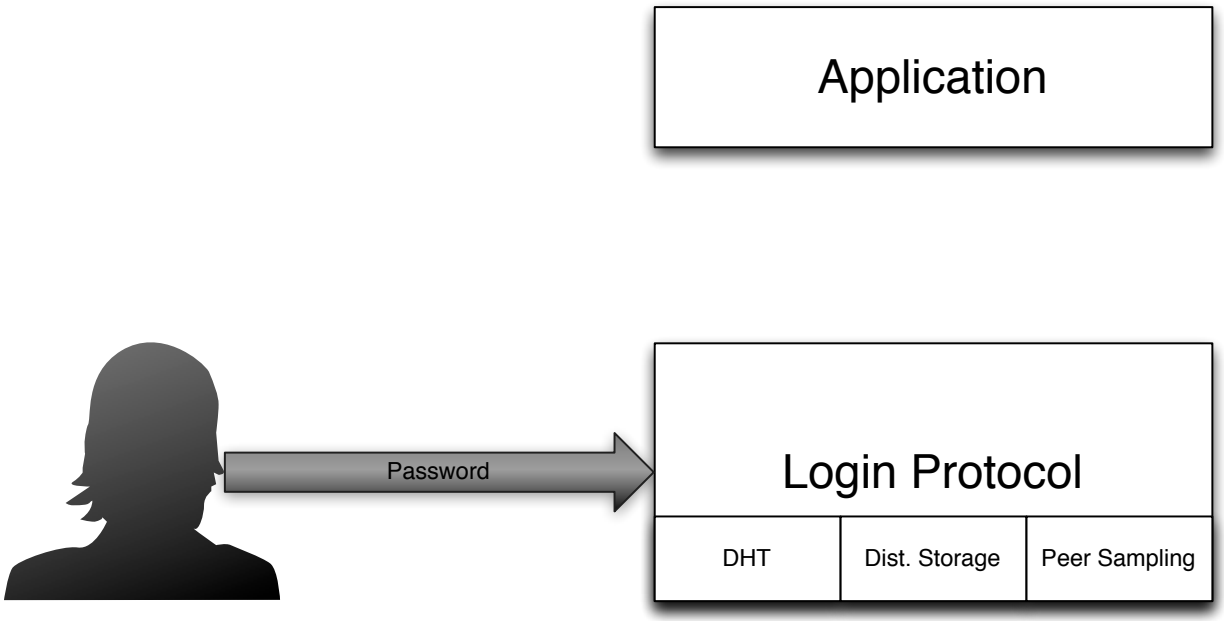
Target Scenario



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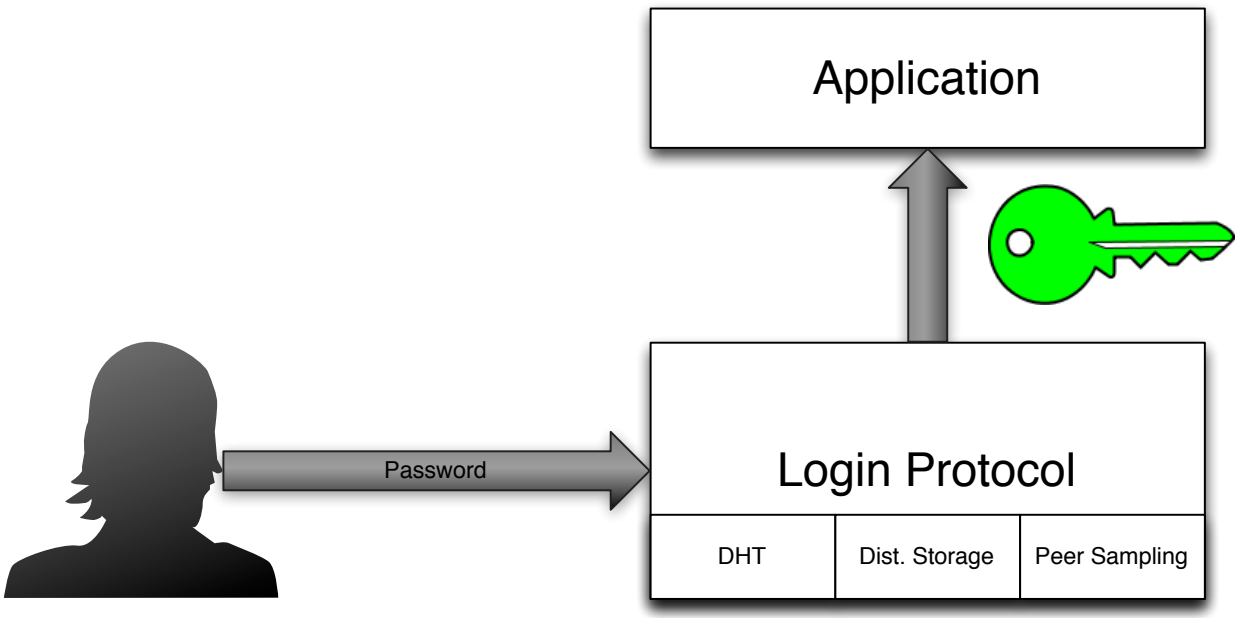
Target Scenario



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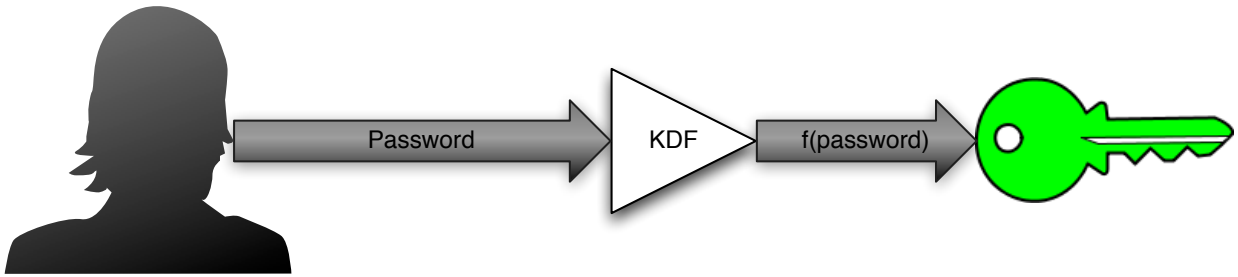
The Basic Solution

- Basic solution: derive key from user-entered password
- Cryptographic key-derivation function (PBKDF-2, bcrypt)

Basic Solution Depicted



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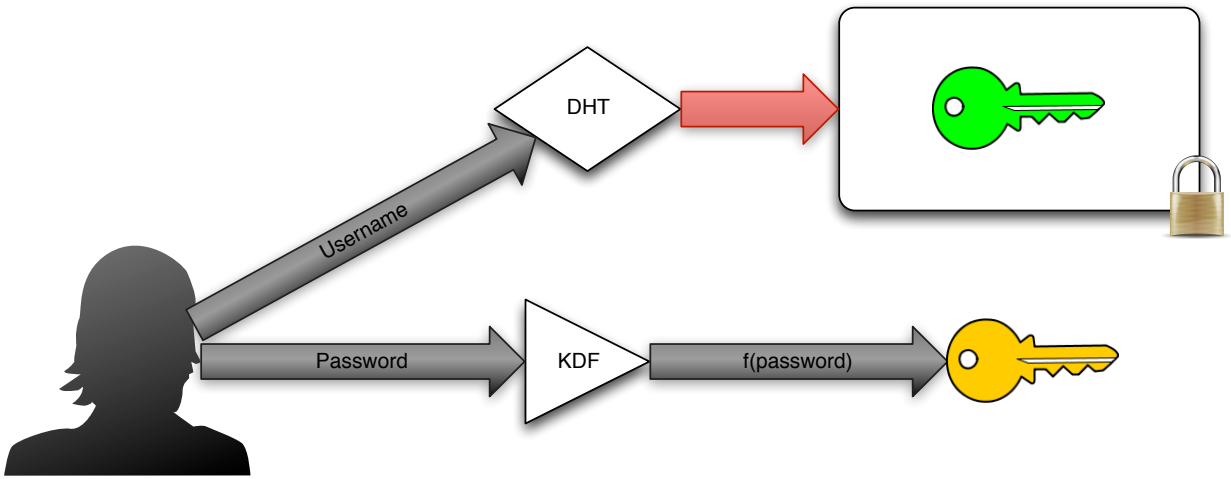
Adding some flexibility

- Tying key we use to password can be limiting
- Add a *key store* where keys we need are stored
- Key store is encrypted with key derived from password

Locating the key store

- How does one find the key store?
- Lookup service (DHT) mapping username to storage location
- Needs to be write-once to prevent DoS

Flexible Basic Solution Depicted



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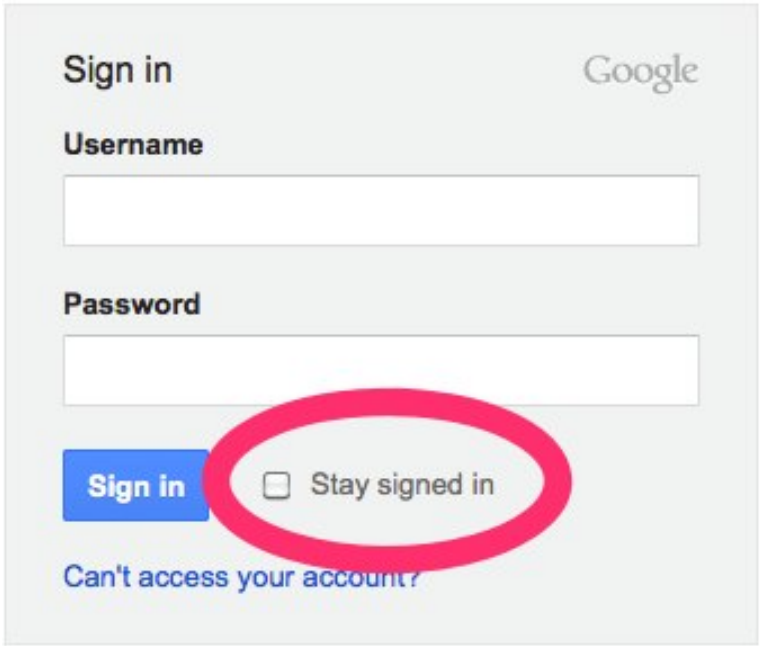
Why not just use a Cloud?

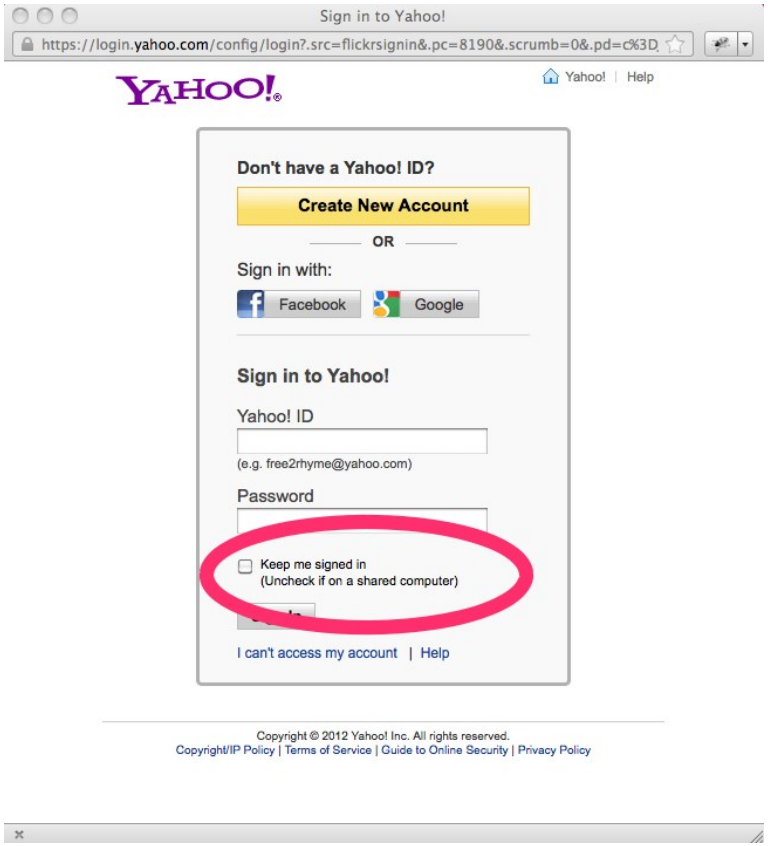
- Censorship resistance
- Administrative cost
- Requires trust in cloud provider

Why not just use a Cloud?

- Censorship resistance
- Administrative cost
- Requires trust in cloud provider
- Our protocol can be deployed on cloud storage

Remember Me





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Requirements

- Password must not be recoverable from device
- Must be able to revoke stored credentials on other devices

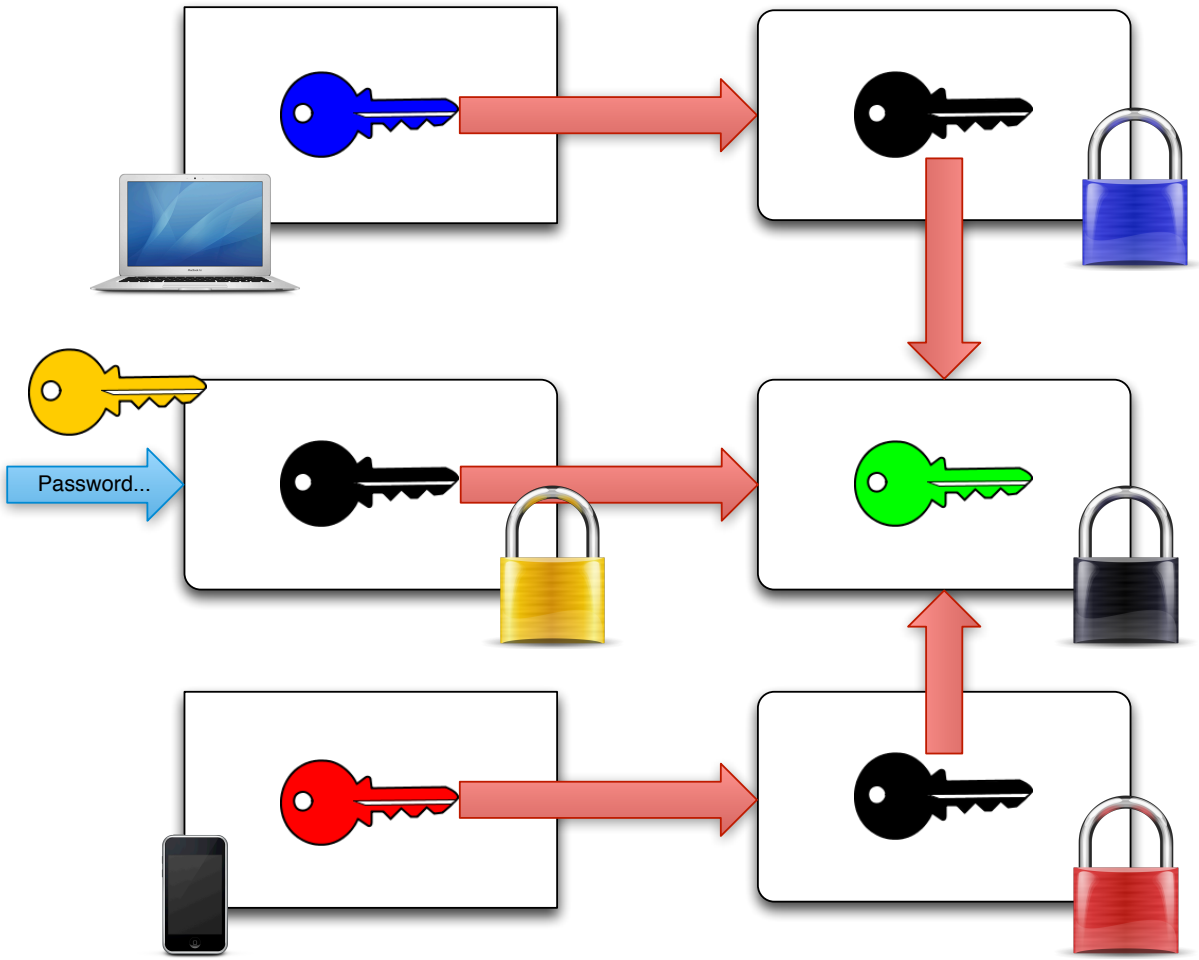
Design

- All problems in computer science can be solved by another level of indirection

Design

- All problems in computer science can be solved by another level of indirection
- For each device, a device login information file in distributed storage
- File contains encrypted copy of key store key
- Device stores key to decrypt its device login file

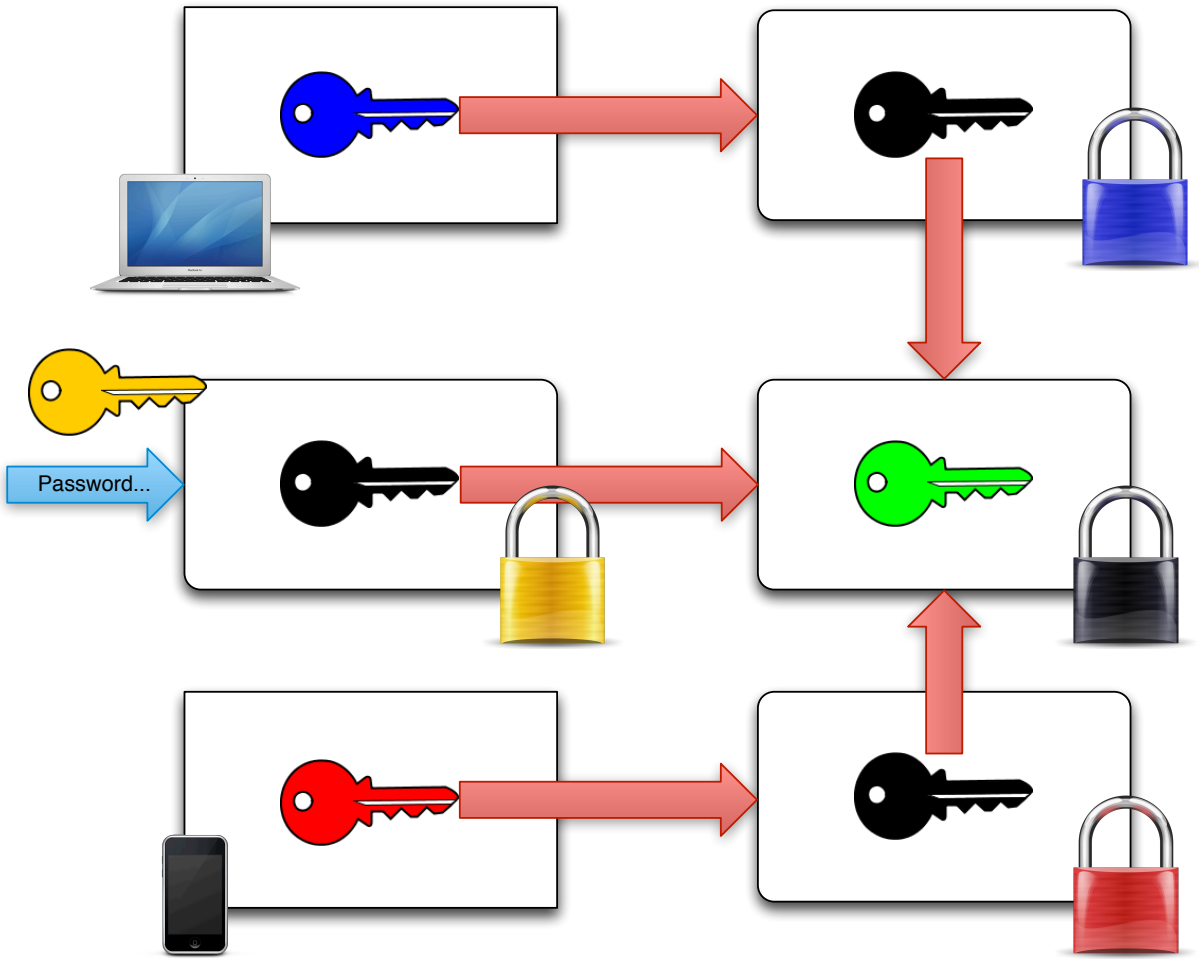
Simplified Remember Me in Pictures



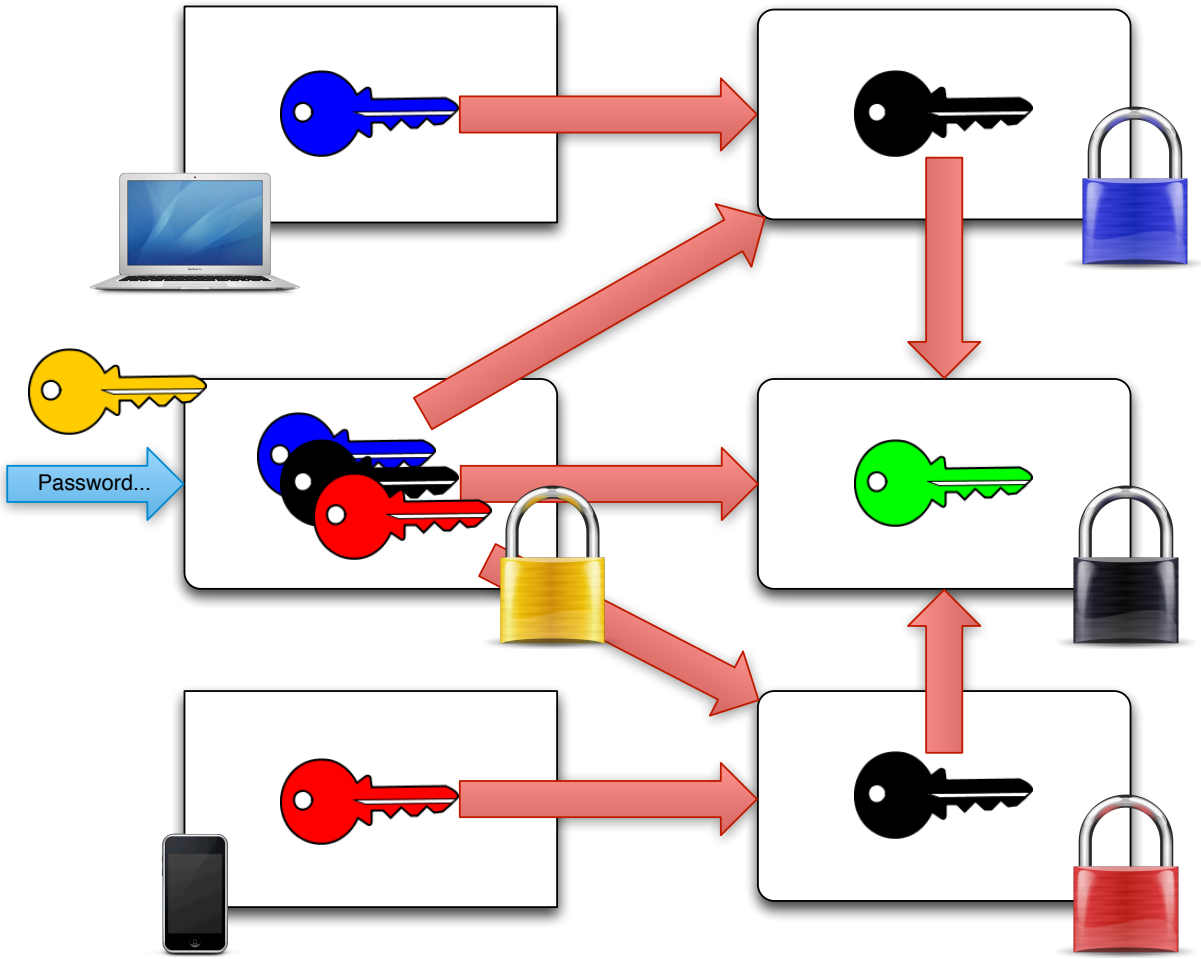
Revokation

- To support revokation, devices' keys are also escrowed
- Key store key is replaced
- All non-revoked devices' login information files are updated
- Application keys from key store must also be updated!

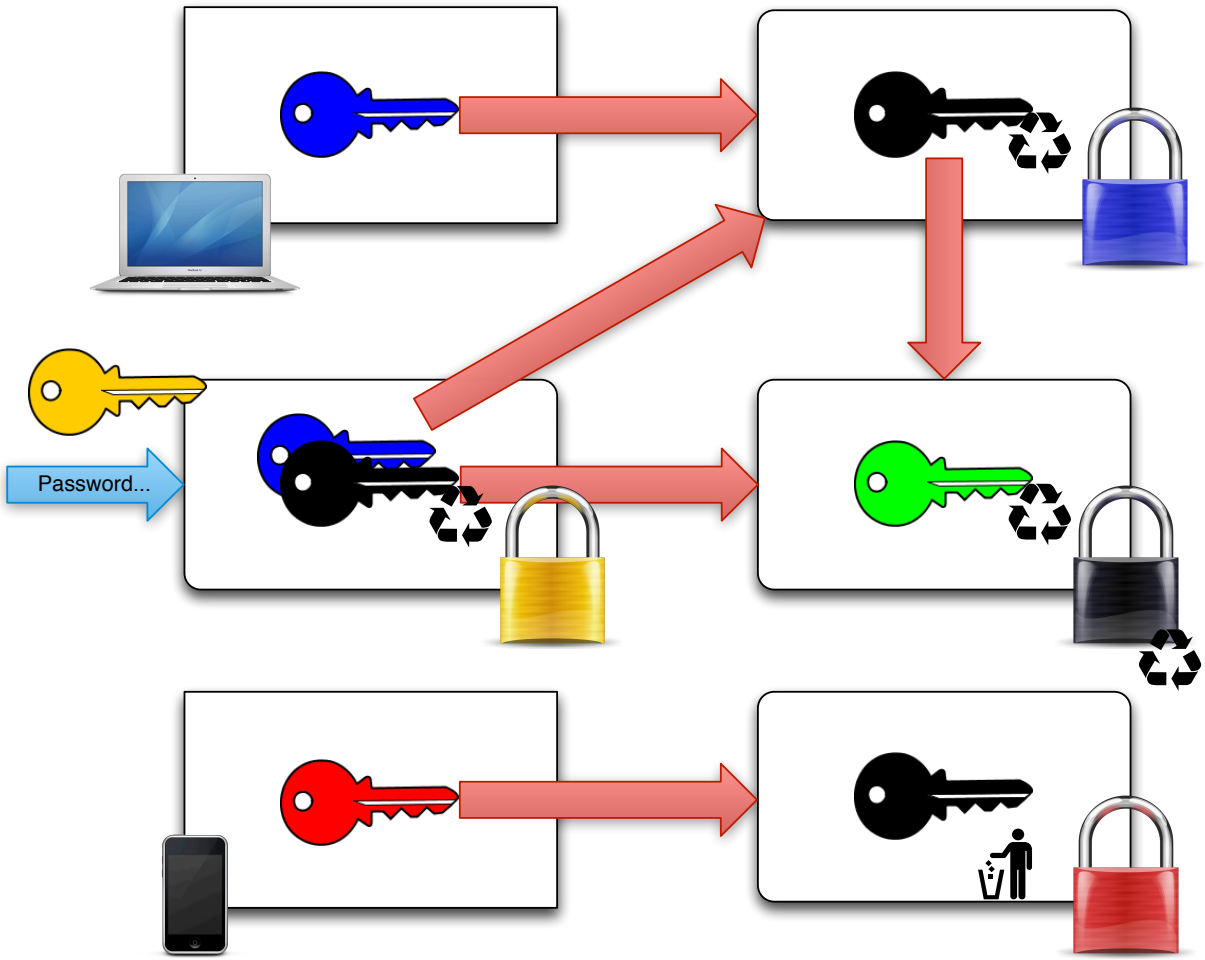
Remember Me in Pictures



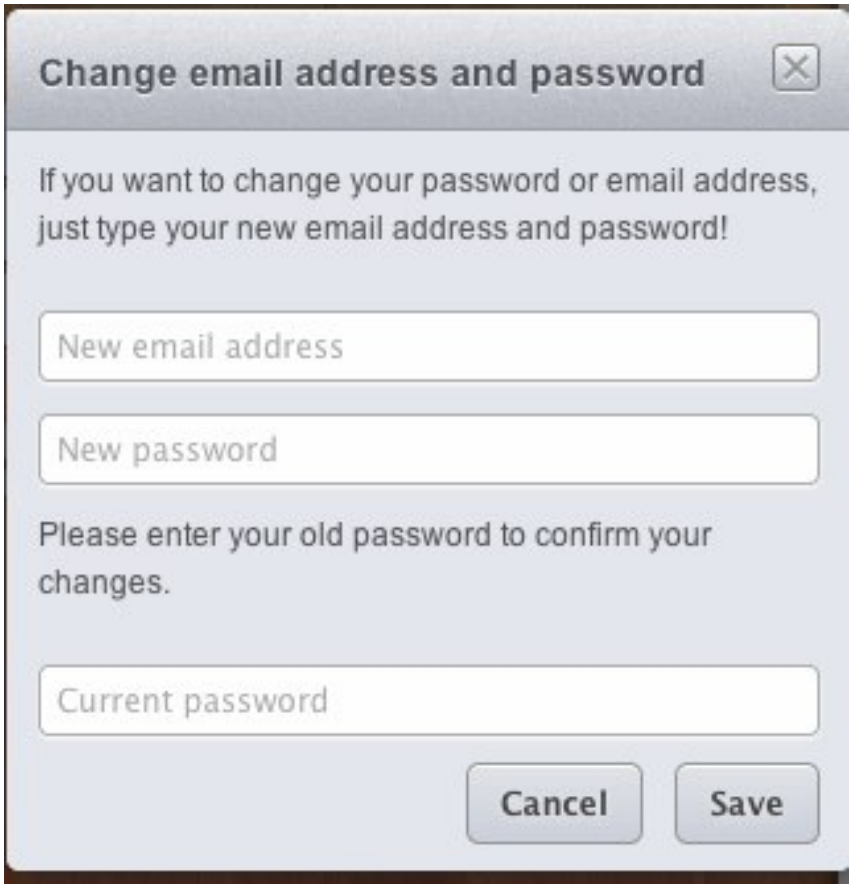
Remember Me in Pictures



Remember Me in Pictures



Password Change



Requirements

- User must know old password to change it

Authentication for distributed storage

- How to authenticate for the distributed storage (Catch-22)?

Authentication for distributed storage

- How to authenticate for the distributed storage (Catch-22)?
- With cryptographic keys, of course! (It's a normal P2P protocol)
- All files are world-readable, only writing requires key
- Write-permission for most files from key store
- Write-permission for login info only if one can decrypt login info

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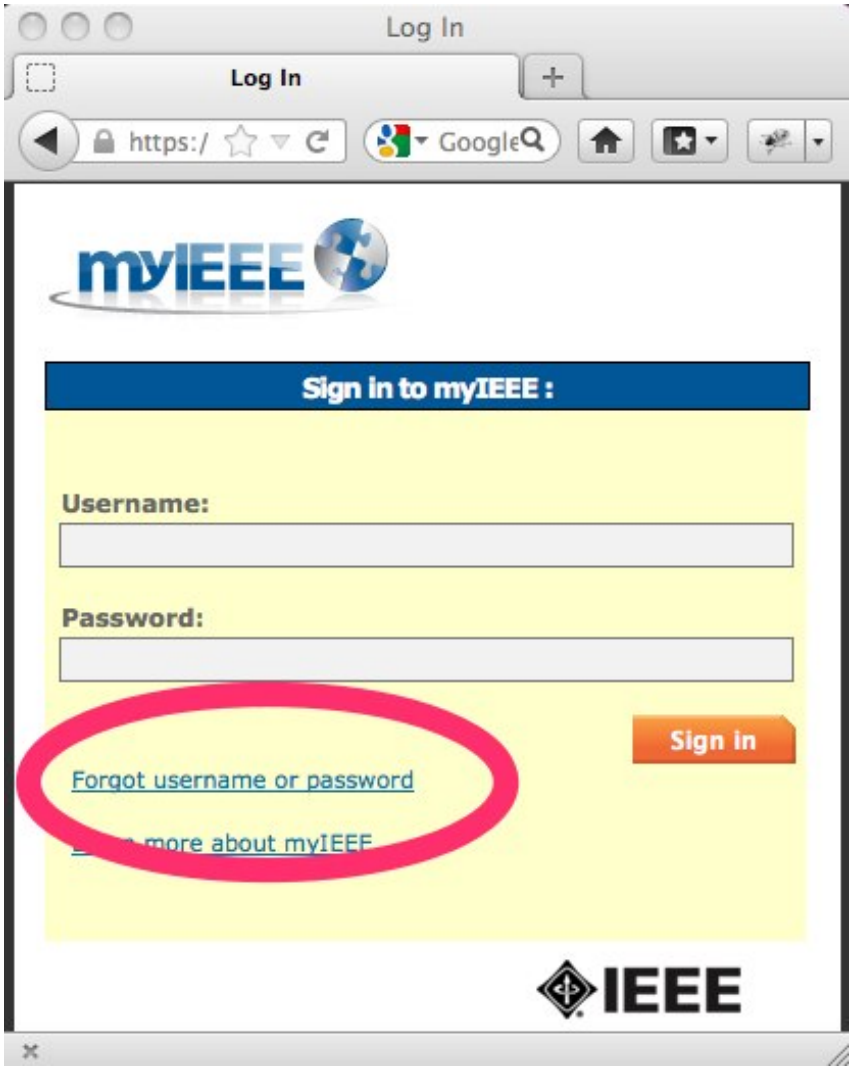
Design

- Using password, retrieve key needed to update login info
- Generate new key for key store
- Store new key store
- Update login info to point to new key store
- Update/remove device login information files

Forgotten Passwords



Requirements

- Should not reveal secret information to others
- Based on e-mail and/or security questions

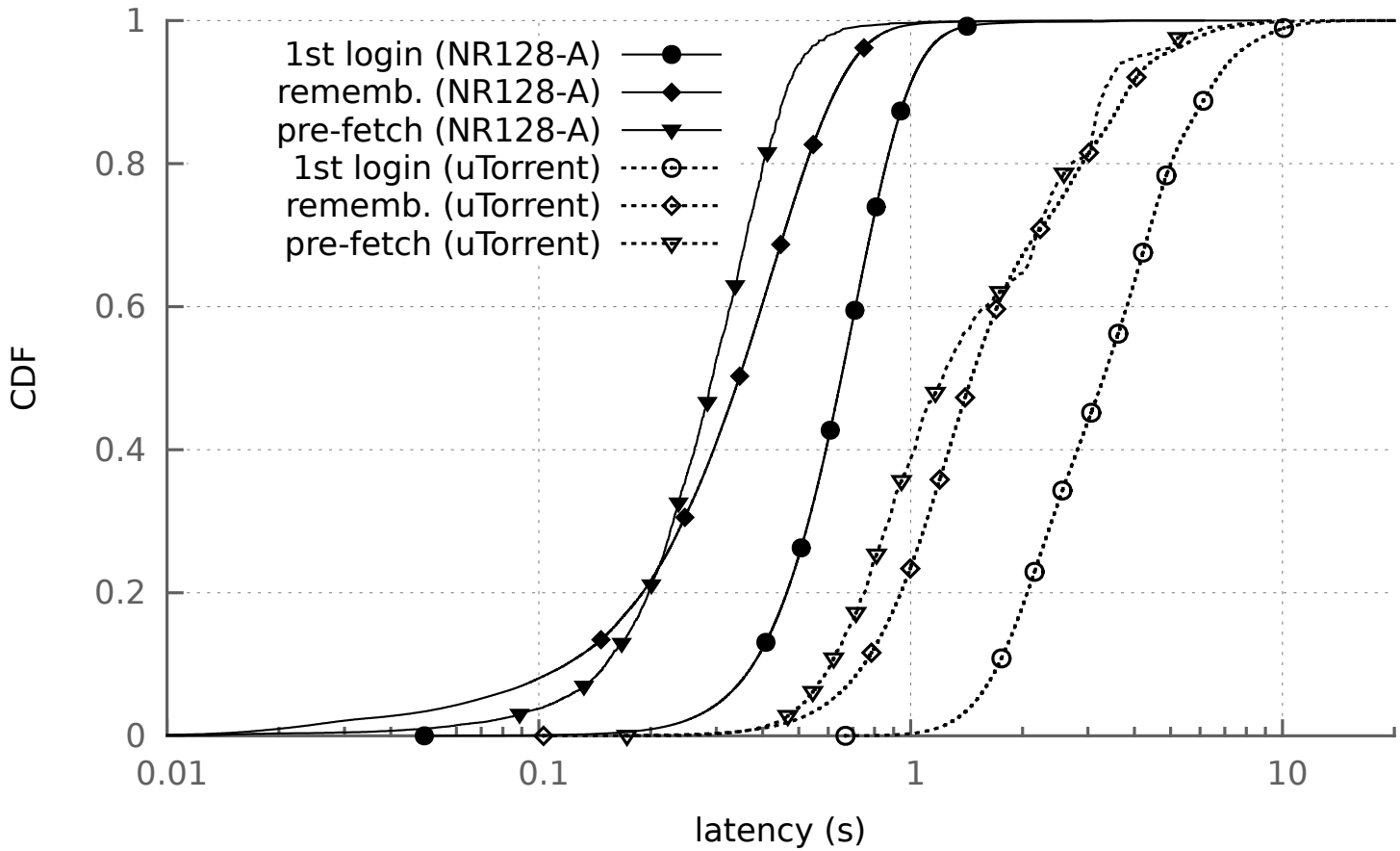
Design

- Two separate schemes for e-mail and questions
- Building on secret sharing
- For questions, shares are encrypted with key derived from answers
- For e-mail, shares are spread among random peers
- Using cryptographic commitments to only reveal e-mail address when actually used

Evaluation Setting

- Simulation using timing from Bittorrent DHT
- DHT timing by Jiménez et al (P2P'11)
- Excludes crypto computation (negligible aside from KDF)

Evaluation Results



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Future Work

- Security proofs
- Prevent offline guessing attacks
- Implementation

Summary

- Fully distributed protocol supporting main features of password-based login
- Including “Remember me”, password change, password reset
- Room for future improvements

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