

Securely backing up GPG private keys ... to the cloud?

Joey Hess
LibrePlanet 2017

Imagine if everyone used GPG

In a world
where everyone has a GPG key...

In a world
where everyone has a GPG key...

Everyone has a key backup problem.

GPG key backup methods

- Print out GPG key
 - paperkey(1)
 - Hard to back up
 - Hard to restore
- Backup \$HOME to cloud storage
 - GPG passphrases easily cracked
- Backup \$HOME to encrypted cloud storage
 - obnam(1) / attic(1)
 - Encrypted using what key?
- Shard and store on USB drives, etc, scattered here and there
 - Not automated

GPG key backup methods

- Don't back up GPG key
 - Common approach

GPG key backup methods

- Don't back up GPG key
 - Common approach

lost gnupg key

All

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keysafe

- GPG key backup to cloud servers
- Securely
- Easily



Your gpg secret key for Joey Hess <joeyh@joeyh.name> (C910D9222512E3C7) has not been backed up by keysafe yet.

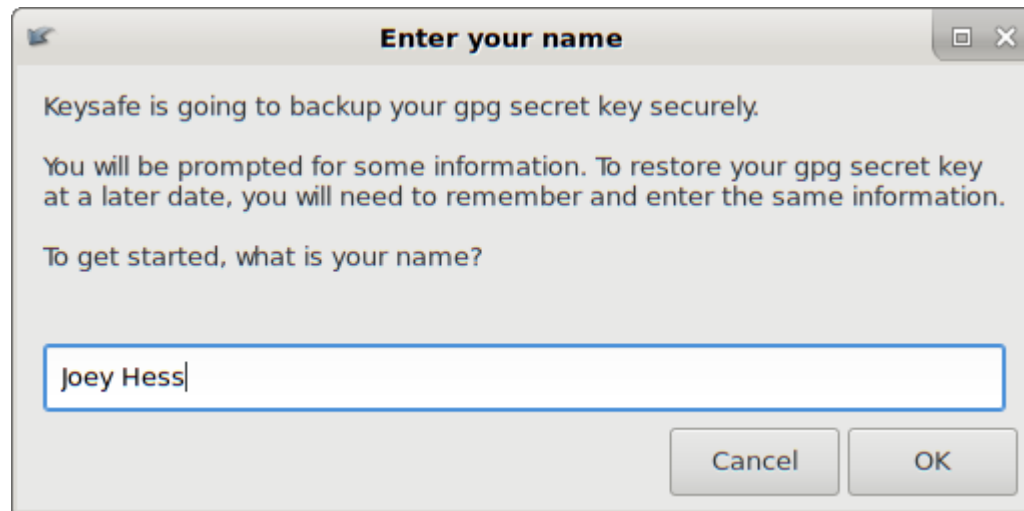
Keysafe can securely back up the secret key to the cloud, protected with a password.

Do you want to back up the gpg secret key now?

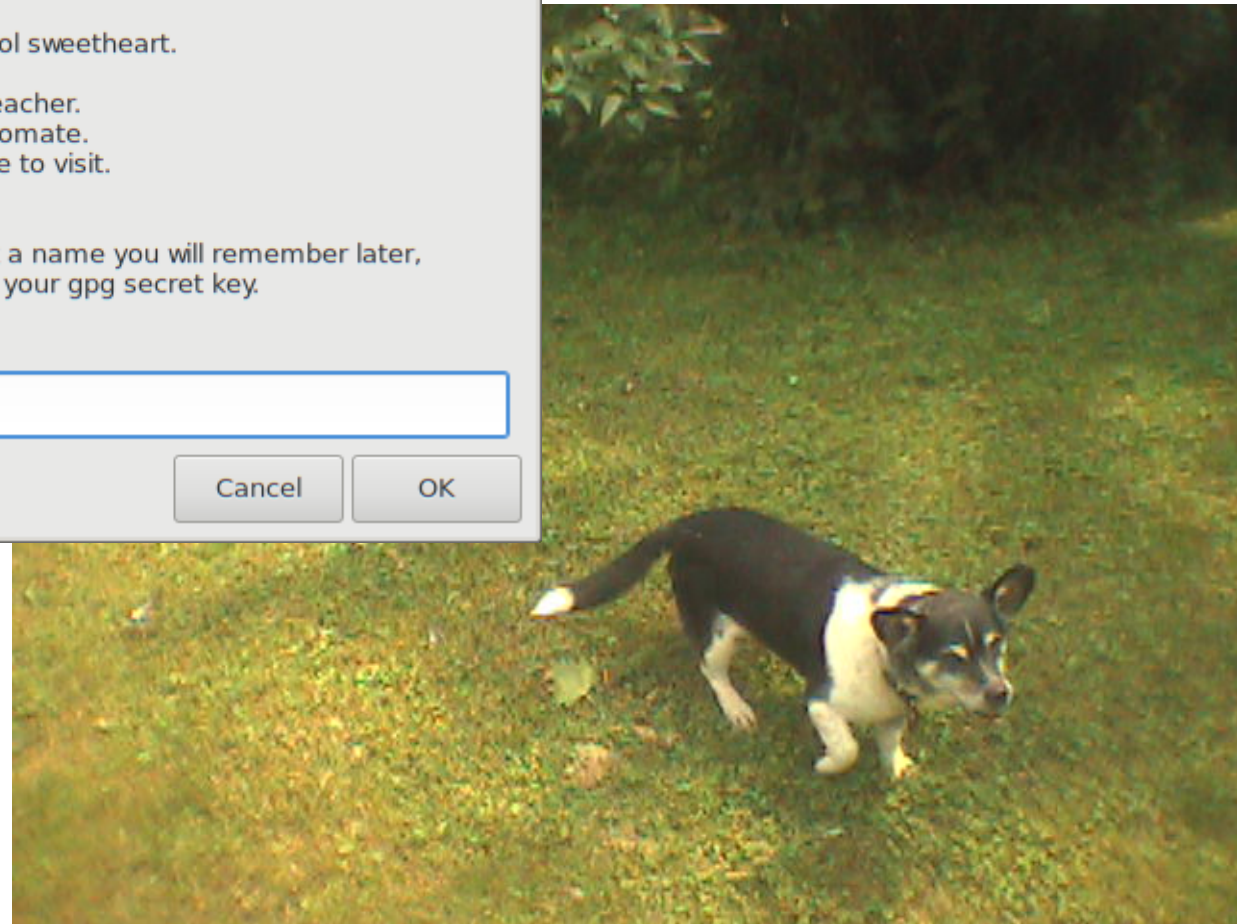
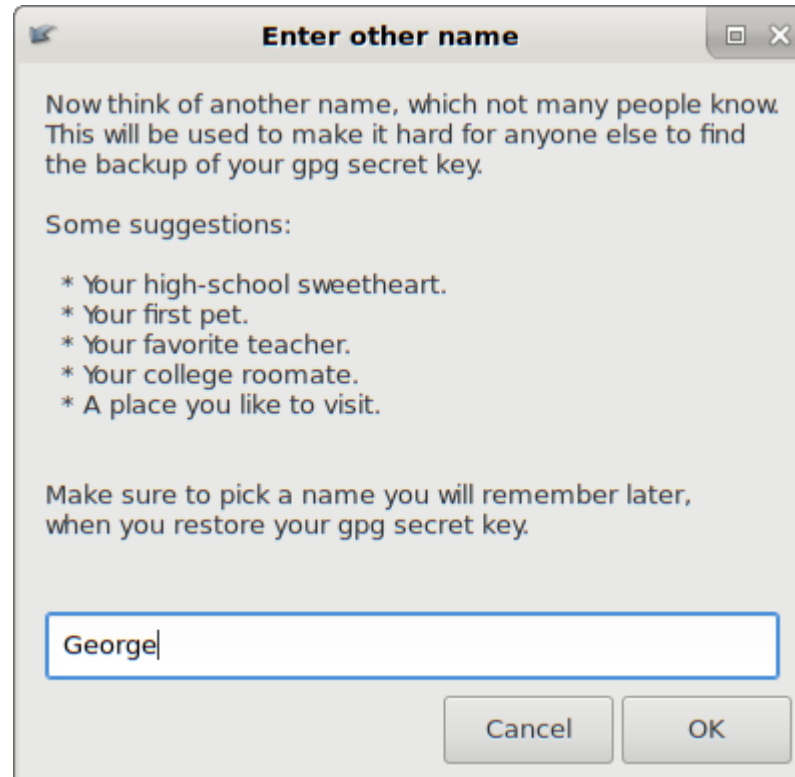
No

Yes


keysafe backup (1/4)



keysafe backup (2/4)



keysafe backup (3/4)



Enter password

Pick a password that will be used to protect your secret key.

It's very important that this password be hard to guess.

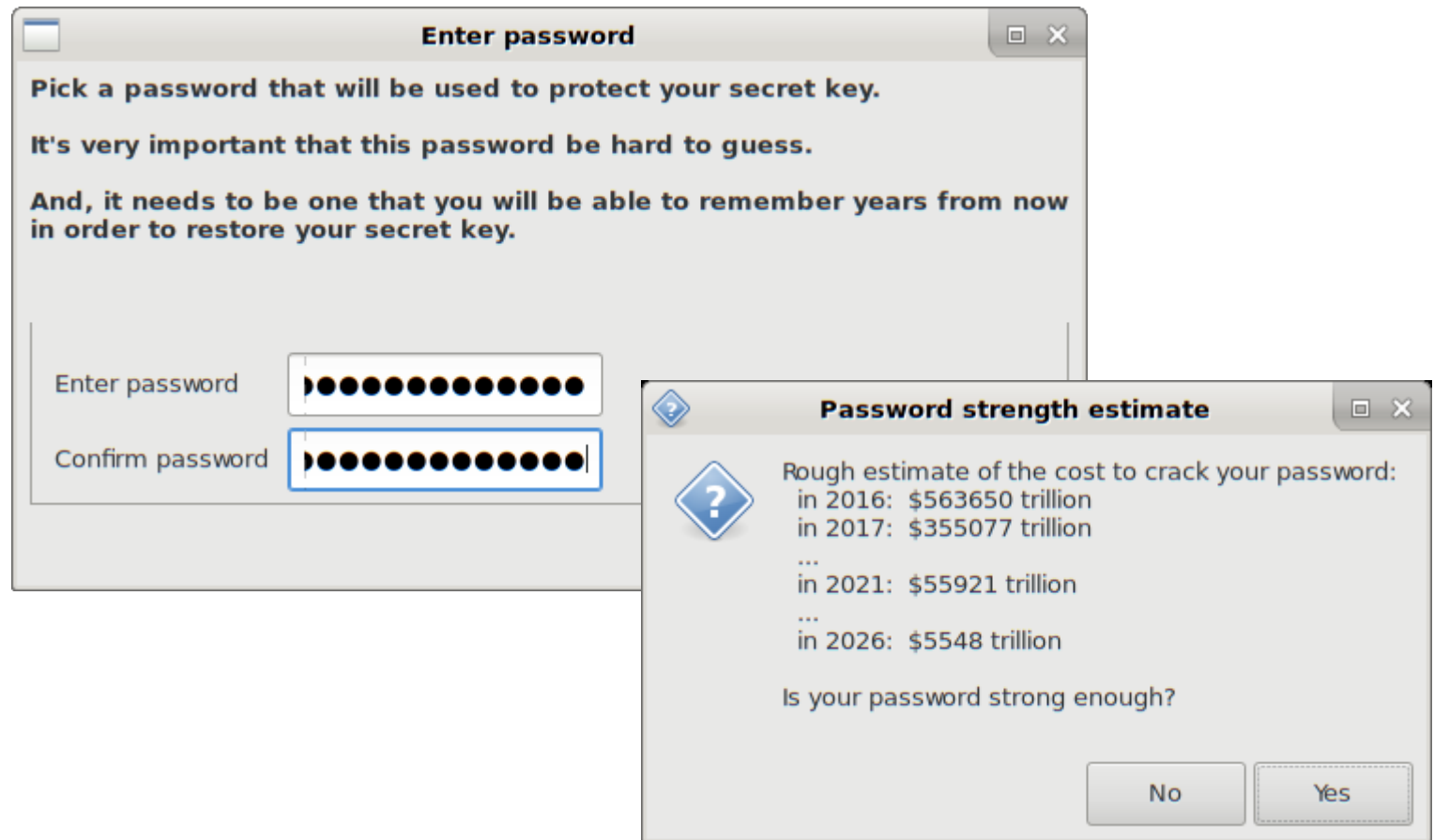
And, it needs to be one that you will be able to remember years from now in order to restore your secret key.

Enter password

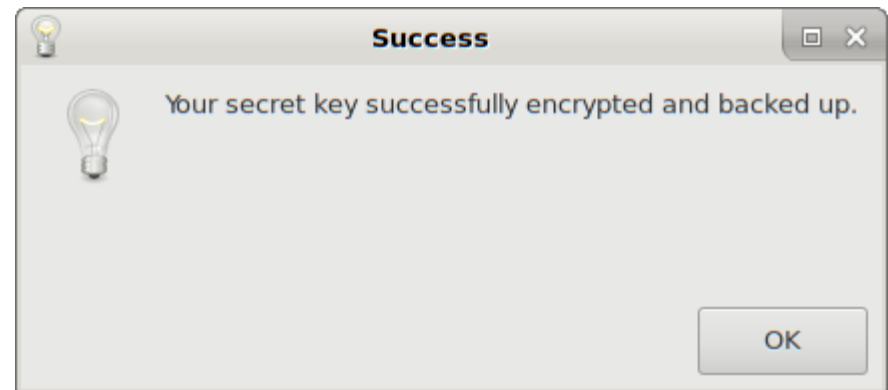
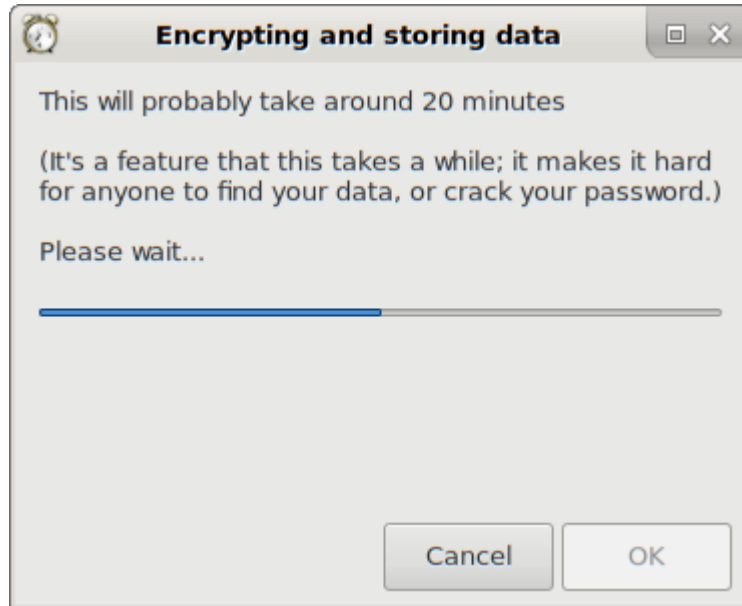
Confirm password

Cancel OK

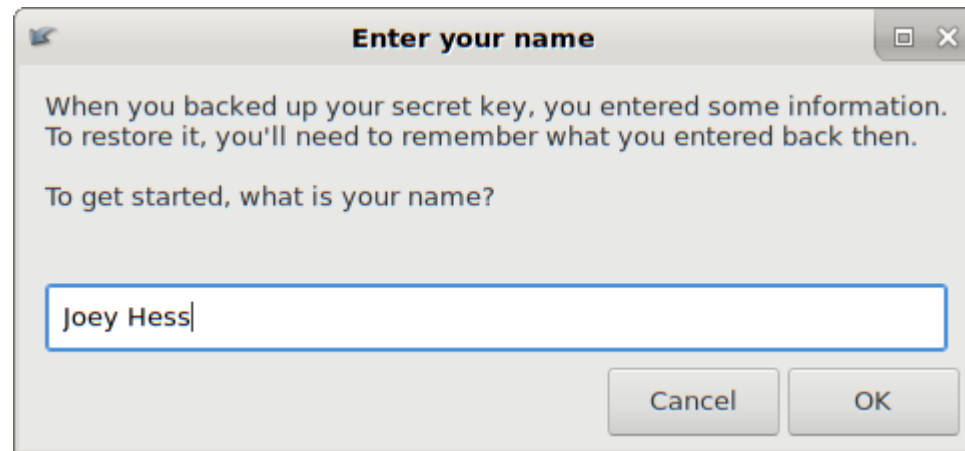
keysafe backup (3/4)



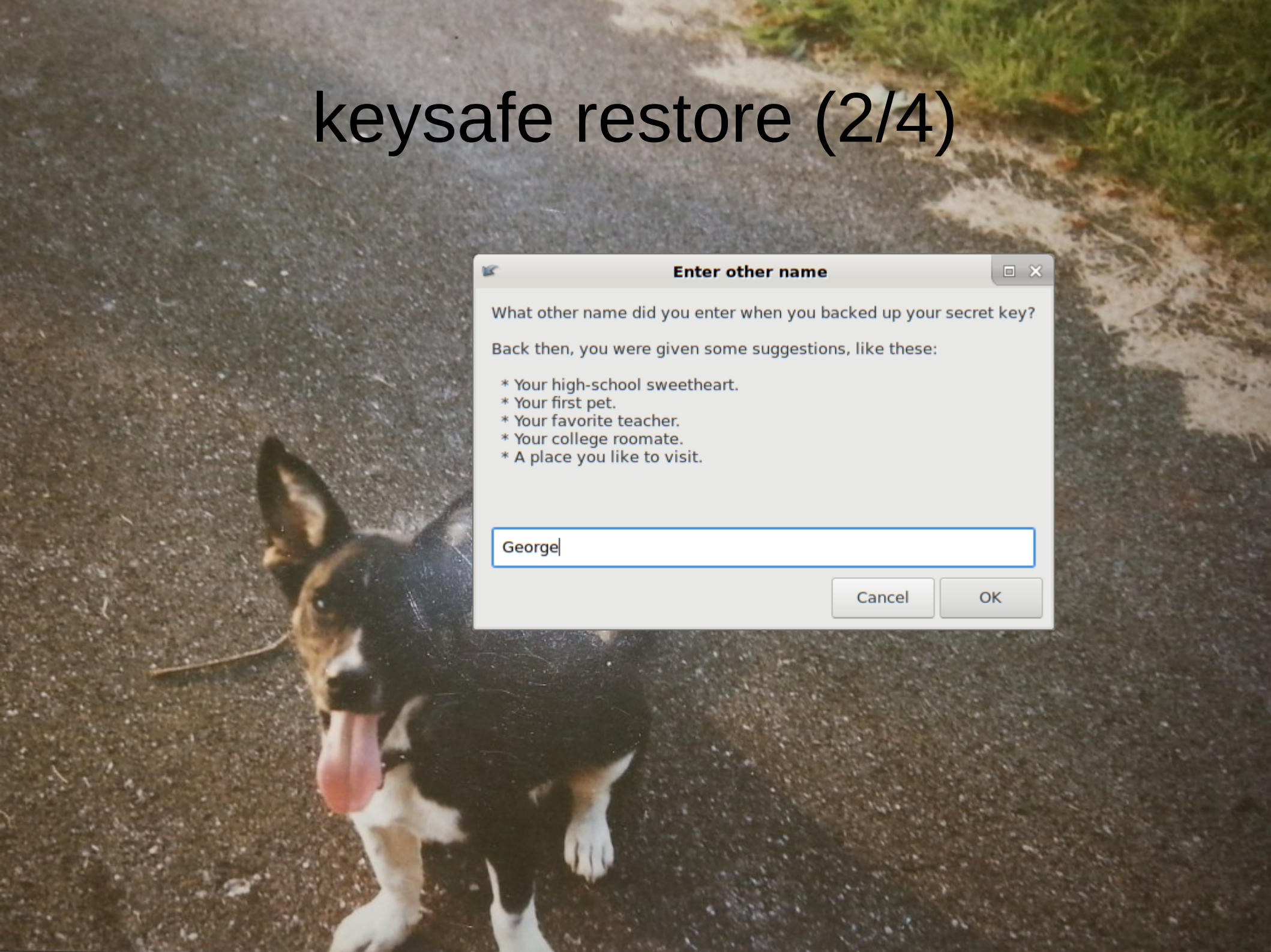
keysafe backup (4/4)



keysafe restore (1/4)



keysafe restore (2/4)



Enter other name

What other name did you enter when you backed up your secret key?

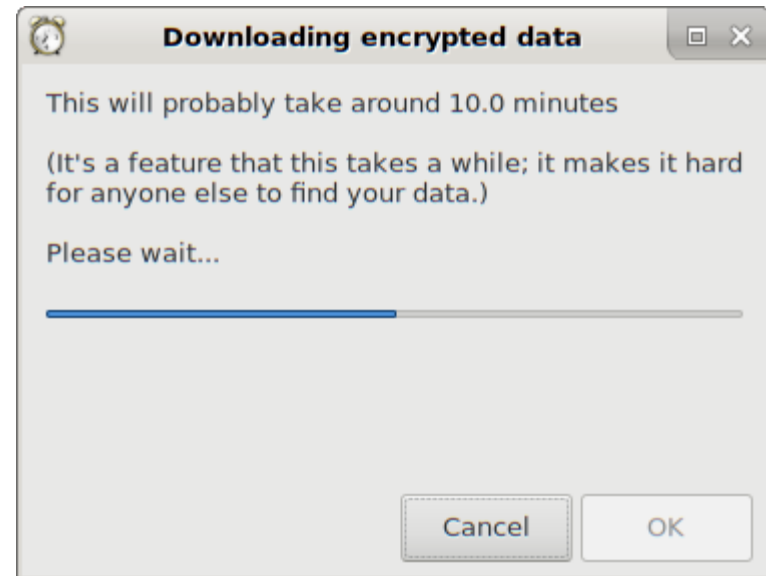
Back then, you were given some suggestions, like these:

- * Your high-school sweetheart.
- * Your first pet.
- * Your favorite teacher.
- * Your college roommate.
- * A place you like to visit.

George|

Cancel OK

keysafe restore (3/4)



keysafe restore (4/4)

- Wait 25 minutes to 1 hour for decryption...

keysafe's building blocks

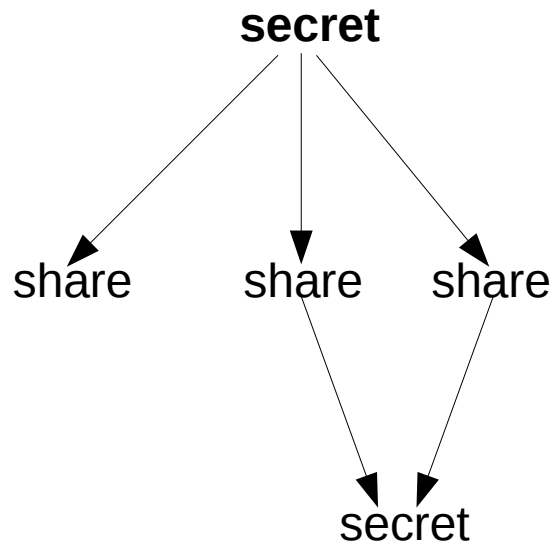
- argon2
- Shamir Secret Sharing
- AES
- The Cloud
- Tor
- zxcvbn

argon2

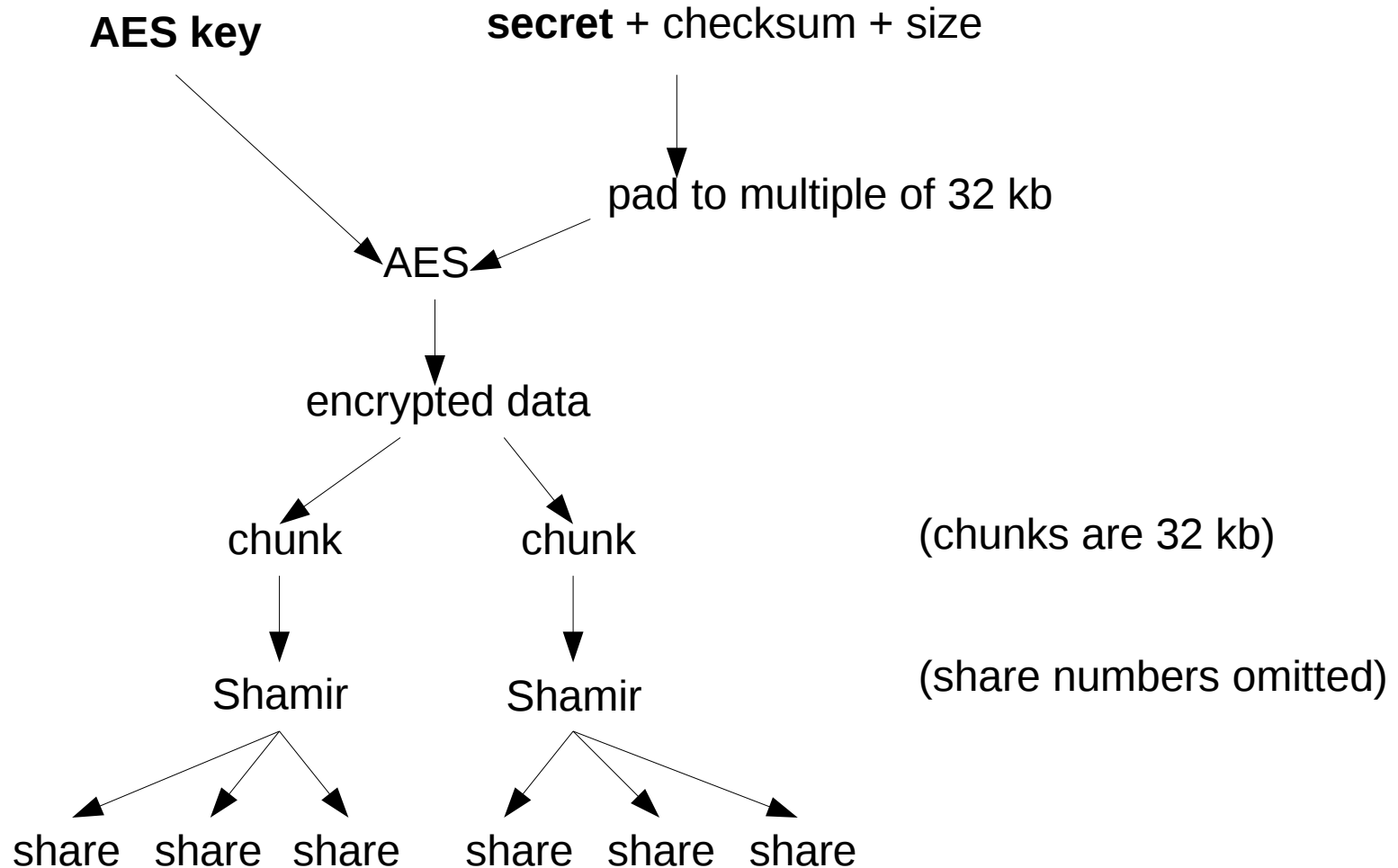
- Password hash
- Password Hashing Competition winner (2015)
<https://password-hashing.net/>
- Memory-Hard
- GPU and ASIC cracking resistance
- Tunable difficulty
 - Iterations
 - Memory use
 - Threads

Shamir Secret Sharing

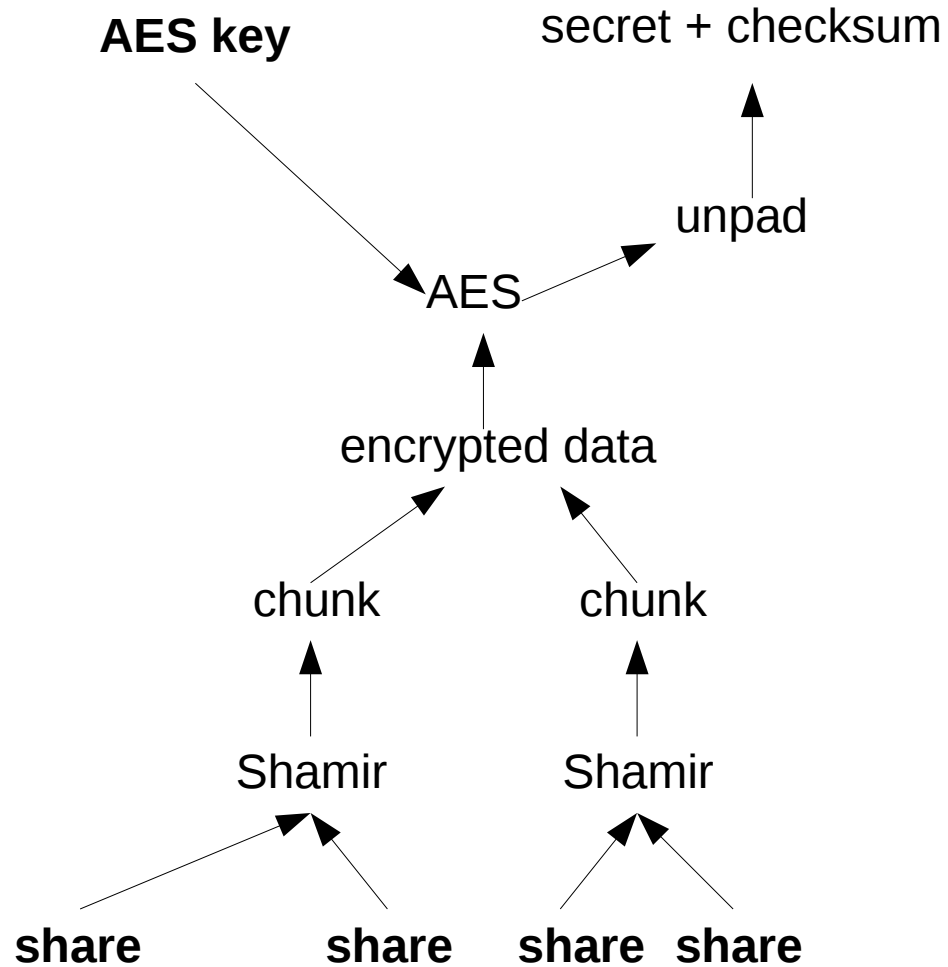
- Boring 70's technology
- Also completely awesome



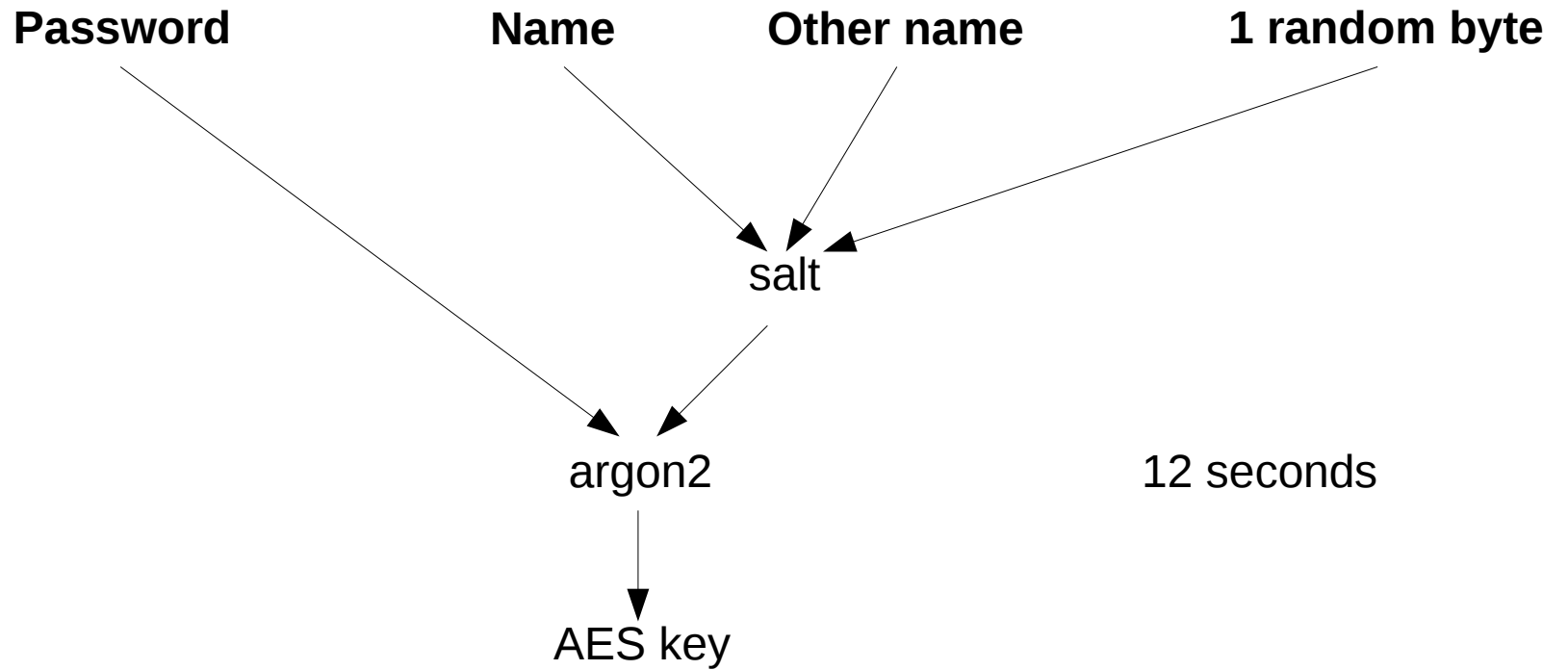
From secret to storable objects



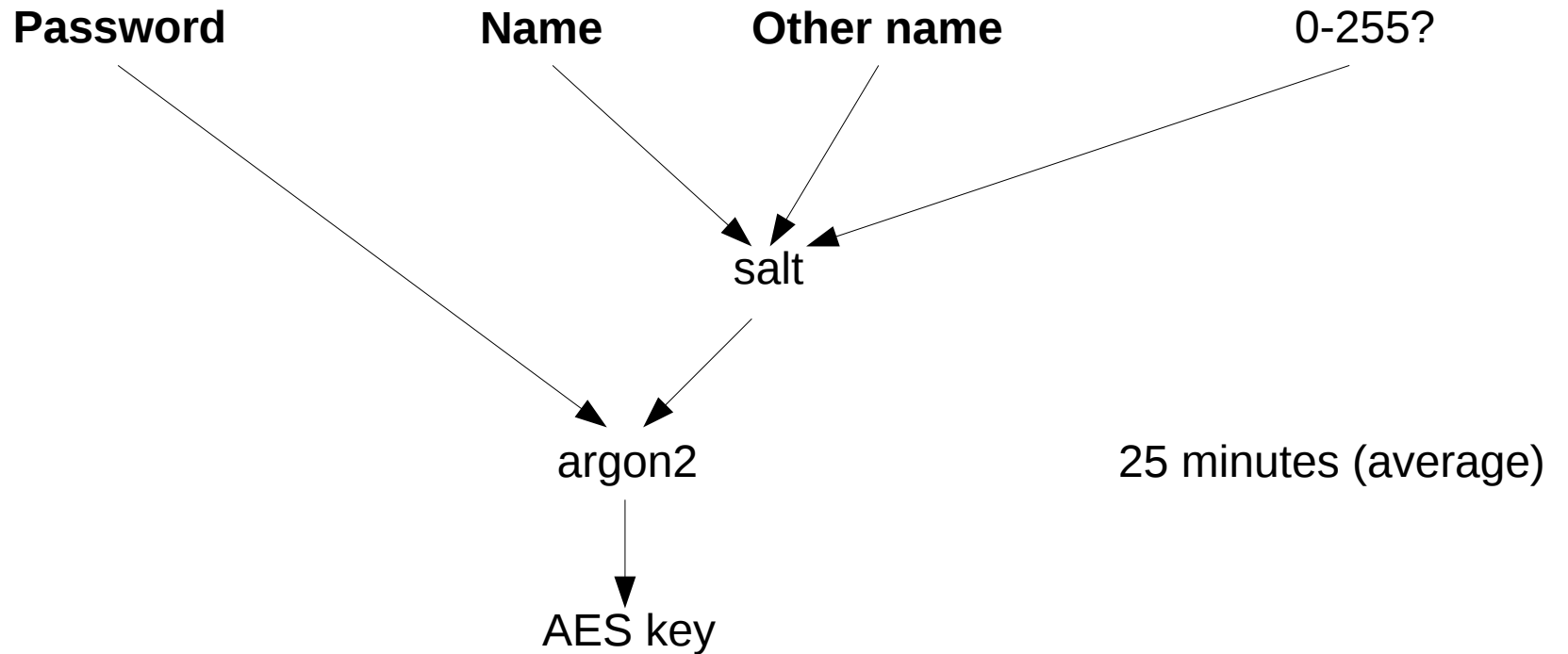
From objects to secret



AES key generation

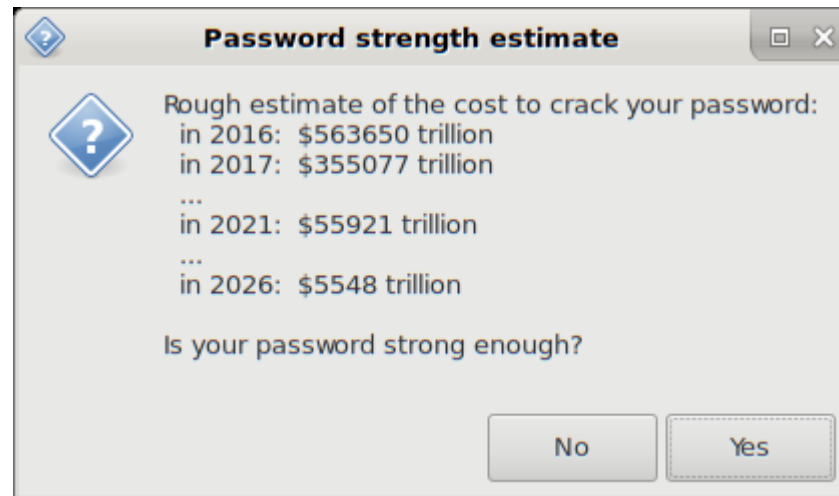


AES key recovery



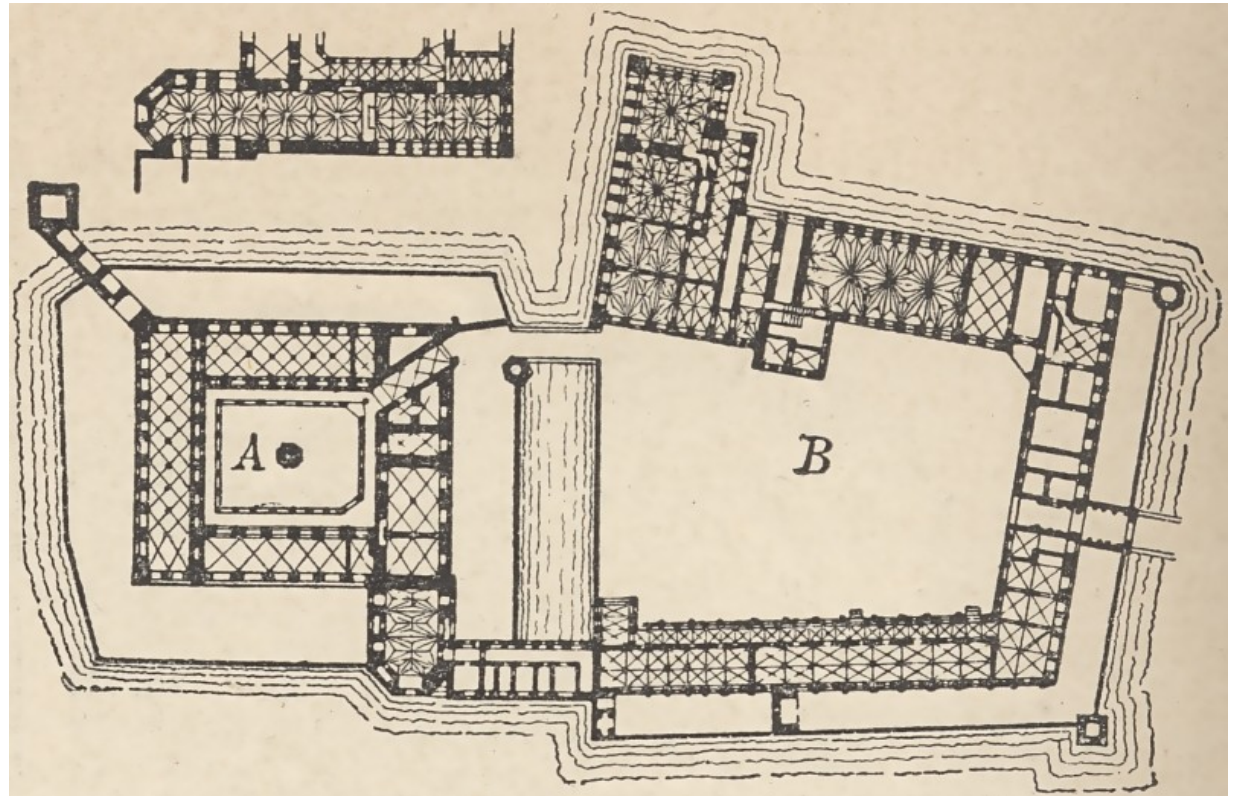
Password cracking cost

- 50 minutes work per guess to generate all 256 possible AES keys
- Weak password (30 entropy) 51072 CPU-years
- Bad password (19 entropy) 25 CPU-years



Layered defenses

- A. Password
- B. Object IDs
- C. Keysafe servers



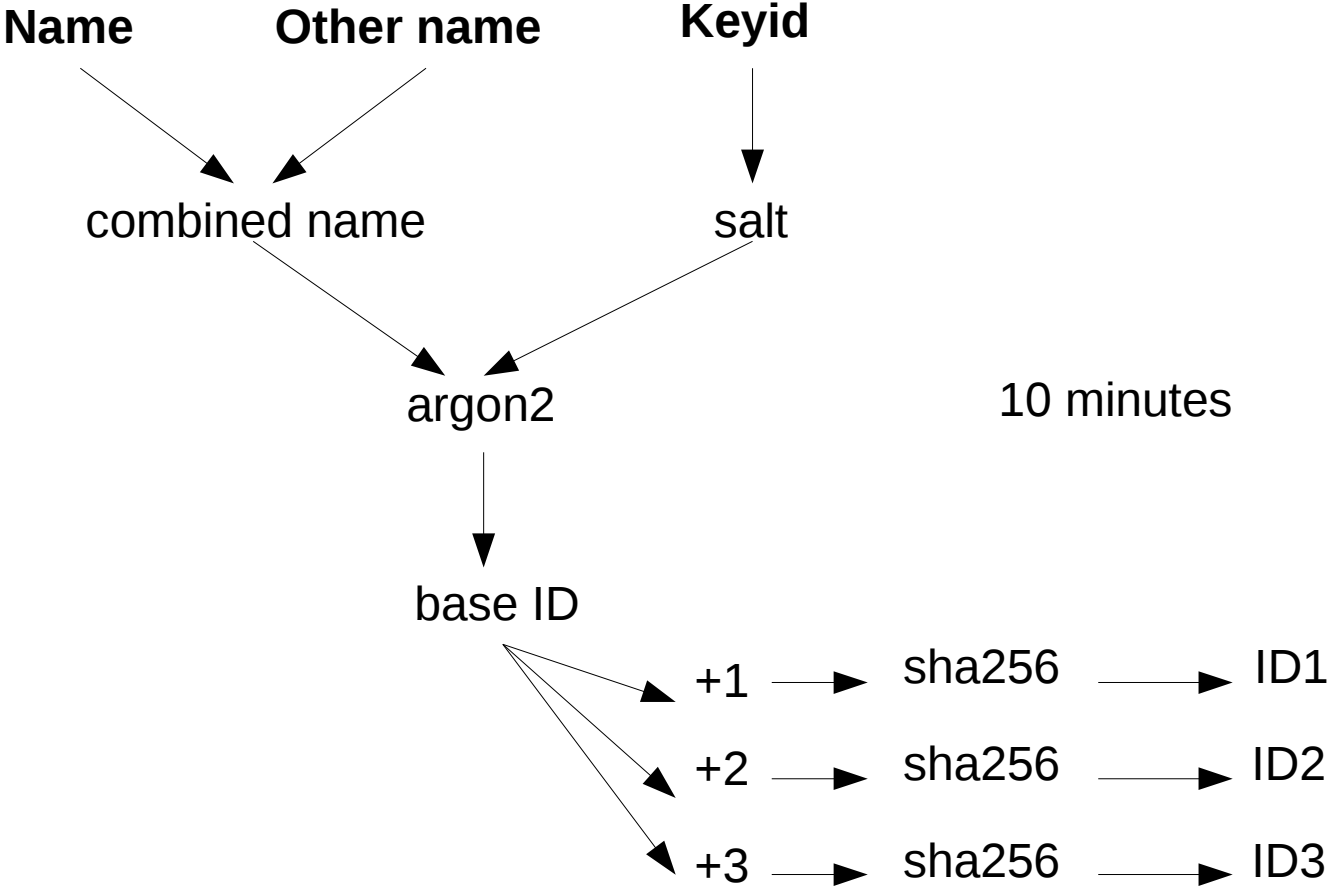
Keysafe servers

- Store only fixed size objects (no large data)
- Store an object by ID
- Retrieve object by ID
- No object ID enumeration
- Self-tuning proof of work to access
- Accessible only via Tor

Keysafe servers

- Other server requirements and best practices (warrant canary)
<https://joeyh.name/code/keysafe/servers/>
- As long as 2 of 3 keysafe servers are uncompromised, no mass password cracking.
- Best hosted by well-known, broadly trusted organizations.

Object ID generation



Object IDs

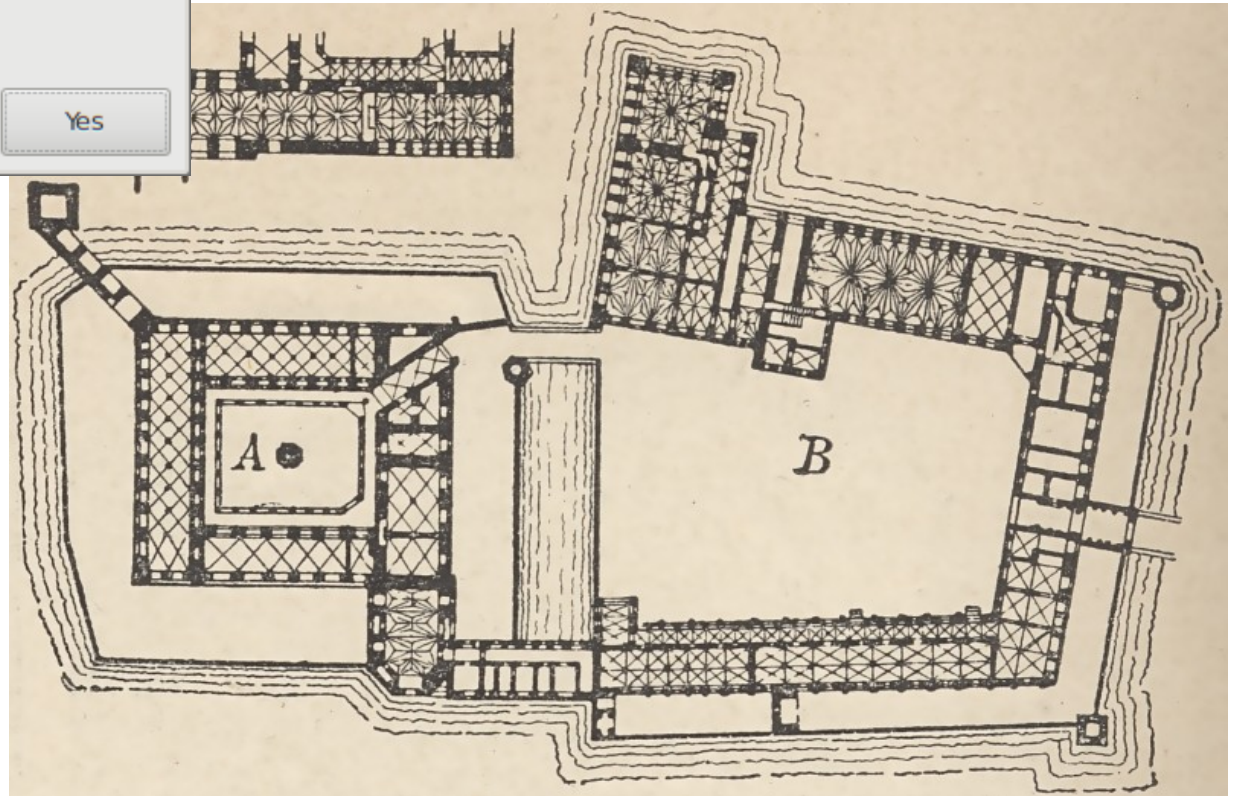
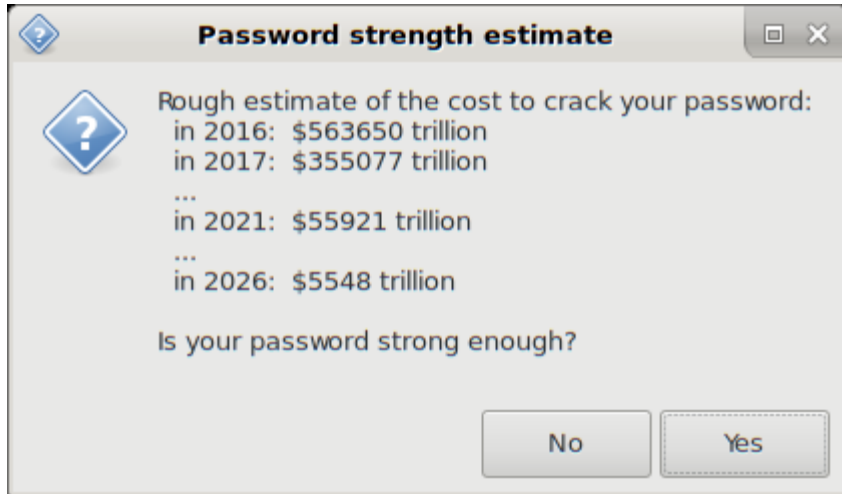
- Attacker needs object IDs to download objects from servers
- Each name guess takes 10 minutes CPU time to calculate object IDs
- Two colluding servers can perform a correlation attack to find related object IDs
- Servers don't record timestamps, or keep logs, to prevent correlation attacks after the fact

Current status

- keysafe client and server implementation in Haskell (3600 LoC)
- In Debian (experimental)
- Needs more design and implementation security review
- Three keysafe servers
 - 1) [Purism](#)
 - 2) [Faelix](#)
 - 3) Mine at Digital Ocean
- More servers needed



Is keysafe safe enough?



Human Limitations

Then it constructed a signature for the new citizen
— two unique **megadigit numbers**, one private, one public —
and embedded them in the orphan's **cypherclerk**, a small
structure which had lain dormant, waiting for these keys.

Greg Egan, *Diaspora*

keysafe

<https://joeyh.name/code/keysafe/>

Thanks

 **Purism**

<https://patreon.com/joeyh>

Bonus: Option for the more paranoid

- Generate 6 shares, with 4 shares needed to recover GPG key
- Store 3 on keysafe servers
- Store 3 locally

- 1 local share + 3 from servers
- 3 local shares + 1 from server

- 64kb share can be stored locally in a variety of hard to detect ways
- End of partition
- Stenography

Bonus: Future proofing key safe

- Decisions, decisions
 - argon2 tuned to take 12 seconds on modern hardware
 - argon2 tuned to take 10 minutes on modern hardware
 - Shamir with 2 of 3 shares
 - 1 byte random salt
 - AES 256 CBC
- May need to change in future in a new version
- Version number metadata would allow partitioning shards
- Solution: Vary object ID generation argon2 memory use parameter depending on version