

Encryption at Rest

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Akron Linux Users Group
October 4th, 2018

JJ Quinlivan

- **Computer Consultant for 25 Years**
- **Disabled for last 10 years**
- **Linux Enthusiast**
 - Lots of time to research and play with Linux and open source software!
- **Not an Expert!**

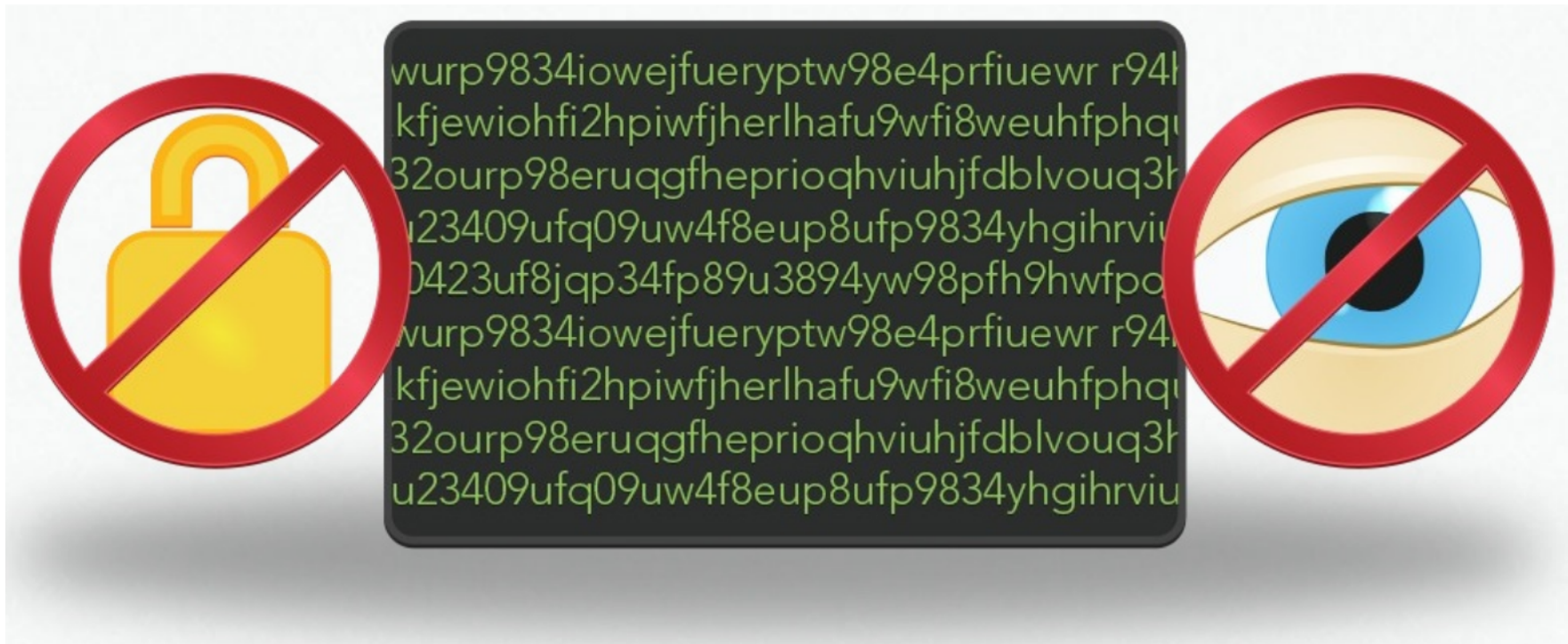
Agenda

- **Encryption Overview**
- **Encryption at Rest**
 - Full Disk Encryption: SED, LUKS, VeraCrypt
 - File Encryption: Encryptfs, Cryptomator, GPG
 - Encryption in the Cloud: Zero Knowledge



Encryption: What is it for?

- Encryption is **not security**
- Encryption is about **privacy**



Encryption Myths

A CRYPTO NERD'S IMAGINATION:

HIS LAPTOP'S ENCRYPTED.
LET'S BUILD A MILLION-DOLLAR
CLUSTER TO CRACK IT.

NO GOOD! IT'S
4096-BIT RSA!

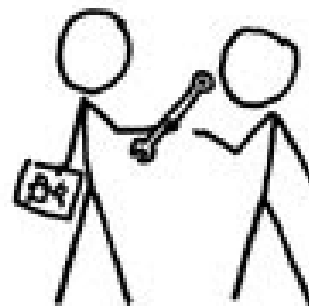
BLAST! OUR
EVIL PLAN
IS FOILED!



WHAT WOULD ACTUALLY HAPPEN:

HIS LAPTOP'S ENCRYPTED.
DRUG HIM AND HIT HIM WITH
THIS \$5 WRENCH UNTIL
HE TELLS US THE PASSWORD.

GOT IT.



What to worry about

- **Strength of Algorithm used**
- **Prefer Open Source Software**
 - Code can be audited and reviewed by public
- **Hide file structure/location of files**
 - More difficult to locate and decrypt sensitive files
- **Plausible Deniability?**



How Encryption Works

- Uses a encryption algorithm and key to convert data to cyphertext

PLAINTEXT:

secret

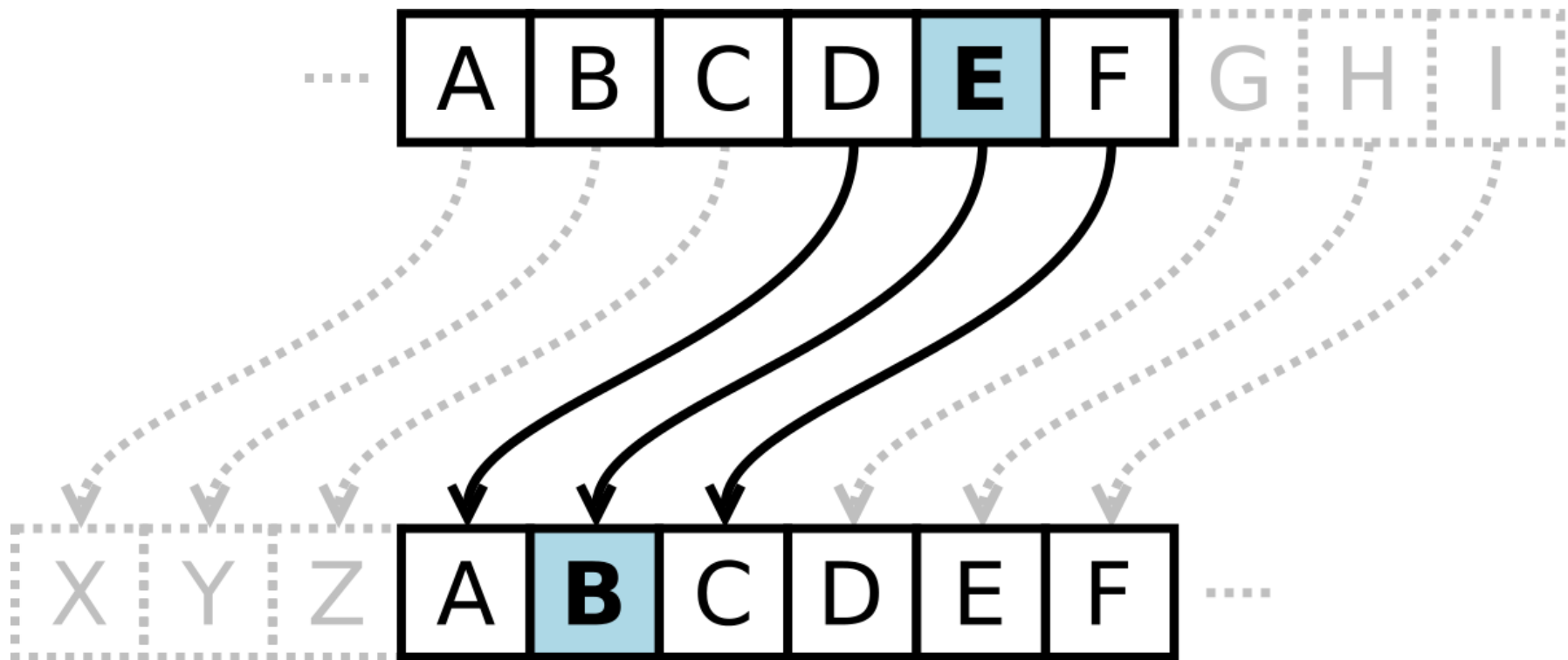
CYPHERTEXT:

AB1qQNCRoB2dG8PdDko5SFE
sstWZZrw9axC7JZ2DoMbjJjOhf9
JddG8PdDko5SFExJBoxRdmGCR
LZY/KHqk8u4udm3tRLKCi1



Caesars Cypher

- One of the first recorded encryption standards
- Moved each letter a fixed number of spaces



Today's Encryption Algorithms

- Uses complex math called:

One Way Functions

easy to make

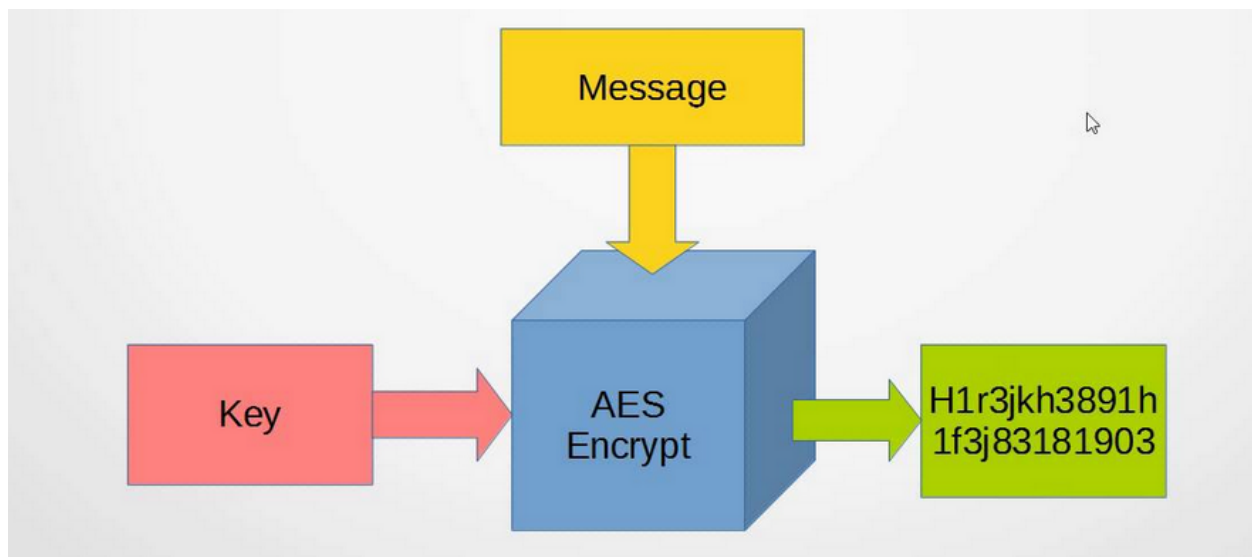
$$\Pr[f(A(f(x))) = f(x)] < \frac{1}{p(n)}$$

hard to solve



Advanced Encryption Standard (AES)

- **Adopted in 2001 by NIST**
- **Considered best symmetric algorithm available today**
- **Key sizes of 128, 192, 256 or 512**



Symmetric vs Asymmetric Encryption

- **Symmetric means the same key used to encrypt the message will also decrypt it**
 - Very efficient = can easily and quickly encrypt and decrypt
 - Key distribution is a problem
- **Asymmetric means uses a key pair one to encrypt, one to decrypt**
 - One of the keys is designated as private, the other public
 - Arbitrary which is which
 - Requires more resources/slower than symmetric



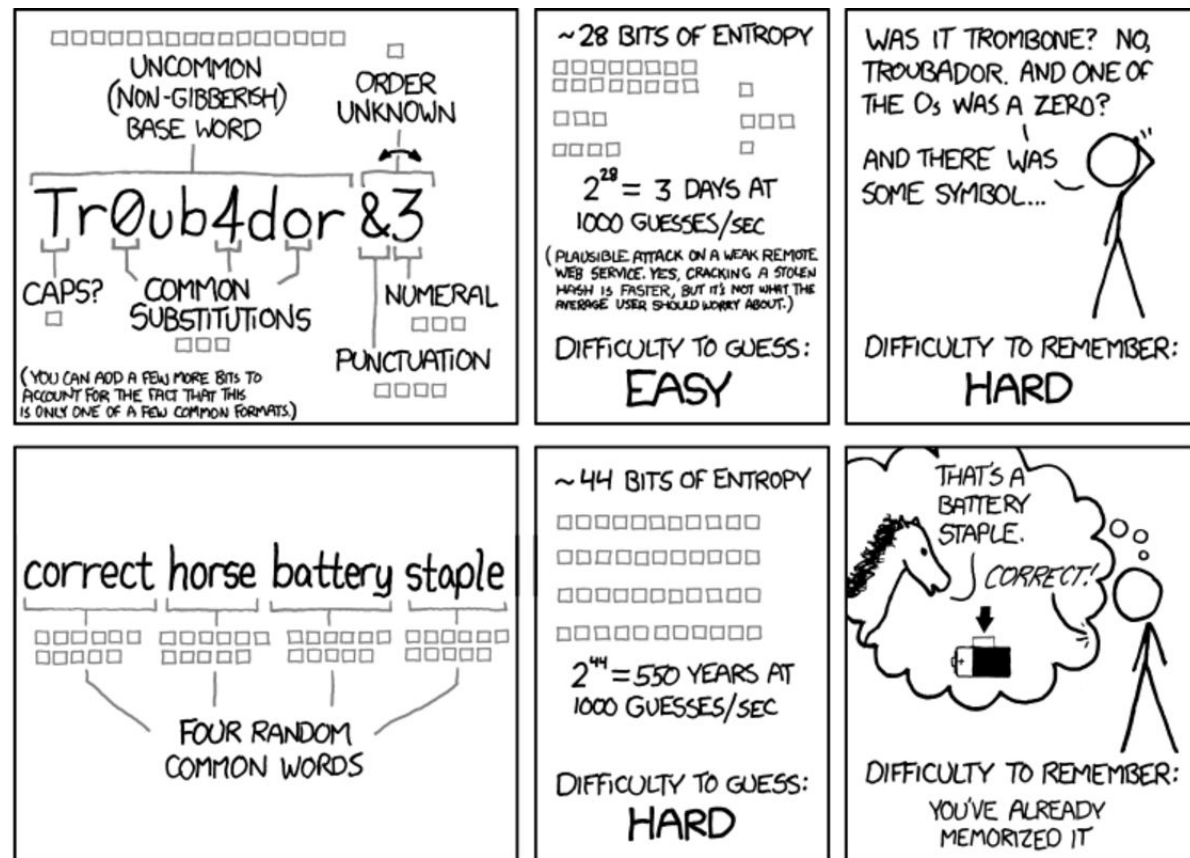
Importance of strong Passphrase

- **Encryption is only as good as the passphrase used to secure it**
- **Use passphrases not passwords**
- **Use Password Manager:**
 - Open Source Password Managers
 - Bitwarden – similar to LastPass
 - KeePassXC – Passwords stored locally
 - Master Password – No stored passwords



Good Passphrases

- Group of random words
- Use Diceware



THROUGH 20 YEARS OF EFFORT, WE'VE SUCCESSFULLY TRAINED EVERYONE TO USE PASSWORDS THAT ARE HARD FOR HUMANS TO REMEMBER, BUT EASY FOR COMPUTERS TO GUESS.

Types of Encryption

- **Full Disk Encryption**

- Protection from Physical Theft, Law Enforcement Seizure

- **File Encryption**

- Protection of sensitive files while computer is running
- Protection of files stored in the cloud

- **Encryption in Transit**

- Not covered today



Full Disk Encryption

- **Self-Encrypting Drives (SED)**
- **DM-Crypt/LUKS**
 - (Linux Unified Key Setup)
- **VeraCrypt**



Use Full Disk Encryption Everywhere

- **Don't Encrypt just your sensitive files**
- **Anyone who picks up your device even if locked can attach the storage to another machine and access your files**
- **Your data can be stored in:**
 - **/tmp**
 - **Swapfile**
 - **/var subdirectories**



Self-Encrypting Drives (SED)

- **What is it:**

- Hardware encryption built-in to SSD and spinning disks
- Opal 2.0 Standard
- Drives are always encrypted – unlocked until passphrase added

- **How to use it:**

- Boot drives are split into small hidden boot partition and rest of drive.
- While locked only small partition is available
- Download SEDUTIL to lock drives and set passphrase



Self-Encrypting Drives (SED)

- **Pros**

- Encryption on by default
- Does not use CPU to decrypt/encrypt
- Very Fast
- All drives set with same password
- Does not require BIOS support (SEDUTIL)

- **Cons**

- Drive unlocked until PC loses power
- Drive easily accessible if PC is powered or suspended
- Does not support External drives
- Some BIOS confused about boot partitions when locked



Self-Encrypting Drives (SED)

- **When to use:**

- Desktop Computers
- Most SSDs support Opal 2.0 standard today

Do not use on Notebooks unless you always poweroff (no suspend)



SEDUTIL

Download SEDUTIL USB Image

```
#linuxpba
DTA LINUX Pre Boot Authorization
Please enter pass-phrase to unlock OPAL drives: *****
Scanning....
Drive /dev/nvme0 Samsung SSD 960 EVO 250GB           is OPAL NOT LOCKED
Drive /dev/sda   Crucial_CT250MX200SSD1             is OPAL NOT LOCKED
Drive /dev/sdb   Samsung SSD 850 EVO 500GB          is OPAL NOT LOCKED
Drive /dev/sdc   ST500LT025-1DH142                  is OPAL NOT LOCKED
Drive /dev/sdd   Samsung SSD 850 EVO 250GB          is OPAL NOT LOCKED

sedutil-cli --initialsetup debug /dev/sdc

sedutil-cli --enablelockingrange 0 debug /dev/sdc

sedutil-cli --setlockingrange 0 lk debug /dev/sdc

sedutil-cli --setmbrdone off debug /dev/sdc

gunzip /usr/sedutil/UEFI64-n.nn.img.gz <-- Replace n.nn with the release number.

sedutil-cli --loadpbaimage debug /usr/sedutil/UEFI64-n.nn.img /dev/sdc <-- Replace n.nn with the
release number.
```



DM-Crypt/LUKS

- **What is it:**

- LUKS – Linux Unified Key Setup
- Widely used Encryption standard used in Linux
- Encrypts Entire drive or partition
- Can be used to Encrypt Files
- Many distributions support LUKS encryption for root by default in installer
- LUKS Header can hold 8 separate passphrases
- One master key unlocked with passphrase



DM-Crypt/LUKS

- **Pros**

- Long lasting encryption standard
- Independently audited
- Easy to setup

- **Cons**

- Drive must be wiped to setup
- *nix only (No Windows/MAC Support)
- Although rare LUKS header can be corrupted
 - Header can be backed up or even removed



DM-Crypt/LUKS

- **When to use:**

- All bootable drives be encrypted with either SED or LUKS
- Any USB flash drives that hold sensitive data
- All drives used for backup



Cryptsetup

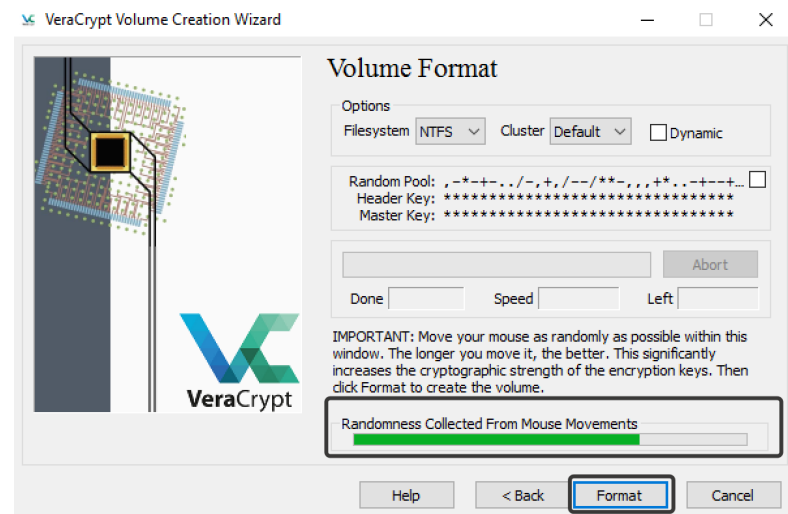
Demo



VeraCrypt

- **What is it:**

- Cross Platform Encryption Software
- Based on TrueCrypt
 - TrueCrypt no longer updated
 - Fixed security bugs in TrueCrypt
- Can be used to encrypt drives or files



VeraCrypt

- **Pros**

- Cross Platform
- Easy Graphical Interface
- Can create hidden encrypted partition

- **Cons**

- More difficult than LUKS to setup as Linux boot/root drive
- One large container created for file encryption

- **When to use**

- Need to access partitions between different operating systems



File Encryption

- **Encryptfs**
- **Cryptomator**
- **GPG**



Encryptfs

- **What is it**

- GPG as a file system
- Uses master key to encrypt each file in directory automatically

- **Pros**

- Many distributions make it easy to encrypt home directory with Encryptfs

- **Cons**

- Linux Only
- Does not hide filenames

- **When to use**

- Don't



Cryptomator

- **What is it**

- Cross Platform
- Encrypts files automatically stored in directory
- Splits files into small encrypted parts

- **Pros**

- Easy to use
- Can be used to sync encrypted files between PC and cloud storage (i.e. Dropbox)

- **When to use**

- Encrypt sensitive files while computer is running or synced to cloud storage



Cryptomator Setup

Demo



GnuPG (GPG)

- **What is it**

- Open source version of Pretty Good Privacy
- Both Symmetric and Asymmetric Encryption
- Primarily used to transfer files/emails to others

- **Pros**

- Can easily encrypt single file
- Public/Private Key Encryption and signing

- **Cons**

- Can be confusing to learn
- Command line interface

- **When to use**

- Encrypting an individual file
- Create for encrypting compressed files (tar files)
- Sending a file to another person



Encrypt/Decrypt Files with GPG

- **Encrypt Command:**

```
gpg --symmetric --cipher-algo AES256 ~/Documents/PrivateFiles/MyPrivateFile.txt
```

- **Will be asked for a passphrase twice**
- **Creates file with .gpg extension**
- **Decrypt Command**

```
gpg -o ~/Documents/PrivateFiles/DecryptedFile.txt -d ~/Documents/PrivateFiles/MyPrivateFile.txt.gpg
```



Other options:

- **Gnome Encfs Manager**
 - Encfs Insecure
- **KDE Vault**
 - Supports Encfs and CryFS
- **KGpg**
- **OpenSSL**



Encryption in the Cloud

- **Zero Knowledge**

- End-to-End Encryption
- Cloud storage service has know nothing about your data stored on their servers
- Data is encrypted and decrypted on the client
- Service has no access to the encryption key

- **Why?**

- Service cannot access your data
- Government cannot demand your data from the cloud service



Encryption in the Cloud

- **Options**

- Manually with Cryptomator, GPG, etc.

- **Services that provide Zero Knowledge Cloud Storage (for Linux)**

- tressorit \$10.42/200GB
- pCloud \$3.99/500GB + \$4.99 for Crypto addon
- SpiderOak \$4.92/150GB
- iDrive \$4.34/2TB (Backup service)

