THCON 2024

TOULOUSE HACKING CONVENTION

Présentation

- Une conférence sur la cybersécurité
- Rassemble étudiants, pros et chercheurs
- Depuis 2016 à Paul Sabatier
- Plusieurs sponsors et partenaires

THCON

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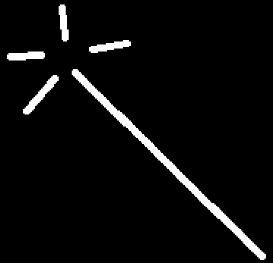
RootMe
PRO
#1
LA VERSION PRO
de LA PLATEFORME
DE RÉFÉRENCE
EN CYBERSÉCURITÉ
ENTRAINEZ & SENSIBILISEZ
IDENTIFIEZ & RECRUTEZ
CHALLENGEZ & FÉDÉREZ
CONTRIBUEZ & COMMUNIQUEZ
REJOIGNEZ LA

Notre sélection :

- Bringing the Science of Cybersecurity out of the Dark Ages
- Vulnérabilitée Ubuntu ShiftFS
- Security analysis of radio water meters
- Exploring OS administratives privileges
- Hunting for Evidence of Malicious Behavior

- Dark ages : ignorance and error
- Age of Enlightment : knowledge and understanding

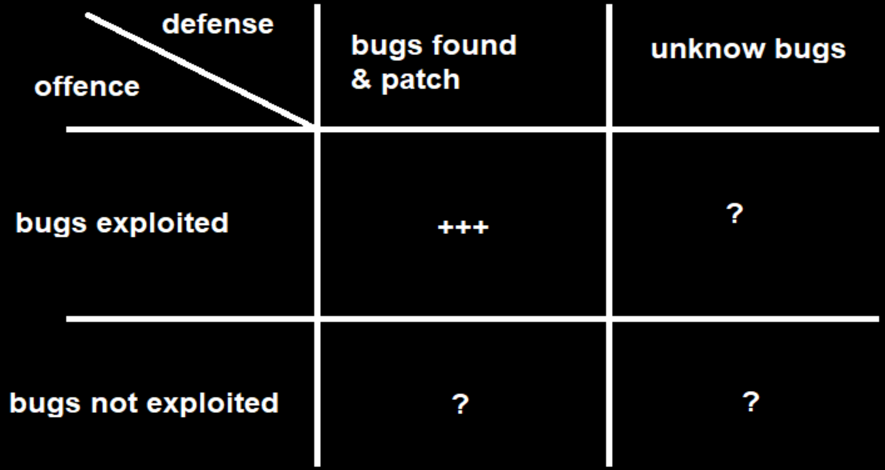


Bringing the Science of Cybersecurity out of the Dark Ages
by Jiska Classen Hasso Plattner Institute, University of Potsdam

- Where are we at the moment ?
- The Philosopher stone <=> unhackable systeme
- Metal to gold <=> bug to CVE

Bringing the Science of Cybersecurity out of the Dark Ages
by Jiska Classen Hasso Plattner Institute, University of Potsdam

- What is happenning rn ? Bluid & break loop



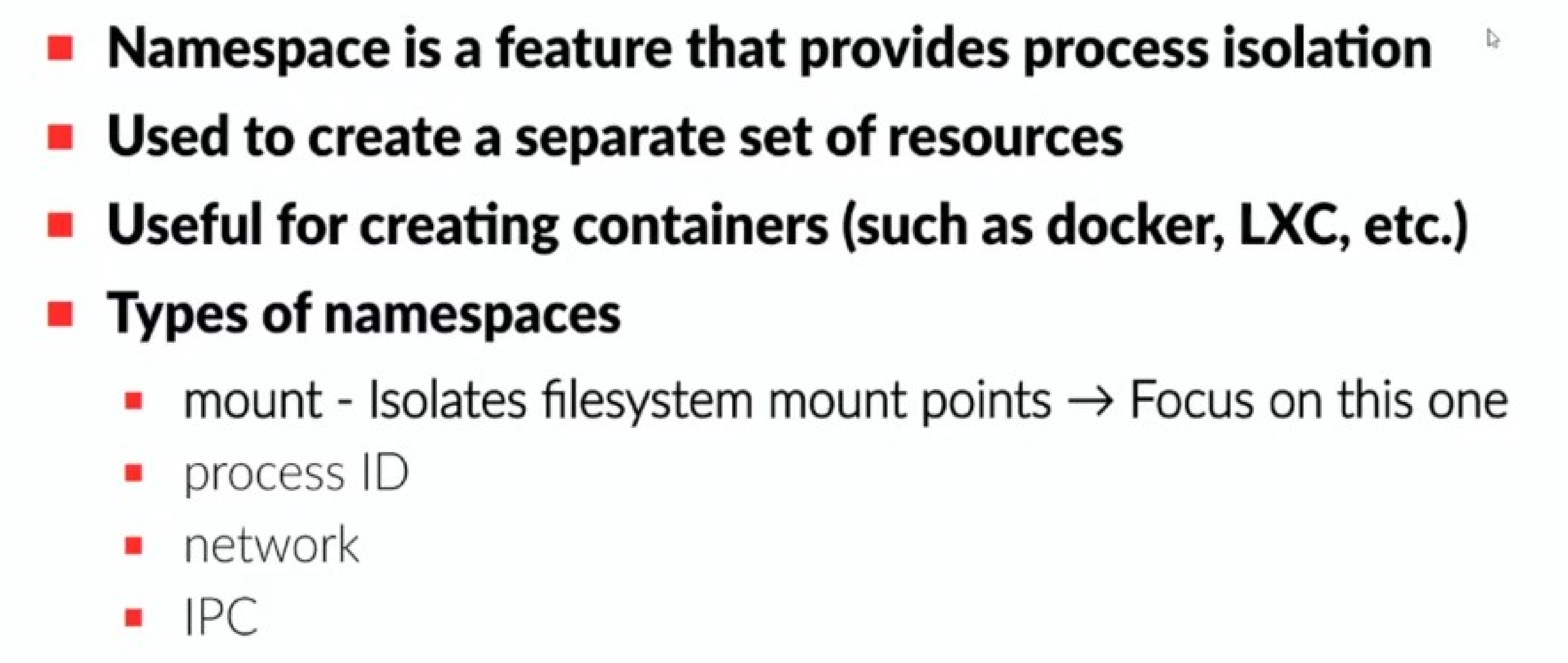
defense offence	bugs found & patch	unknow bugs
bugs exploited	+++	?
bugs not exploited	?	?

- What next ?
- Break to patch loop => kinda ok at the moment
- Open source will help
- Court alchemist = fraud vendor
- IA fussing

Ubuntu ShiftFS :

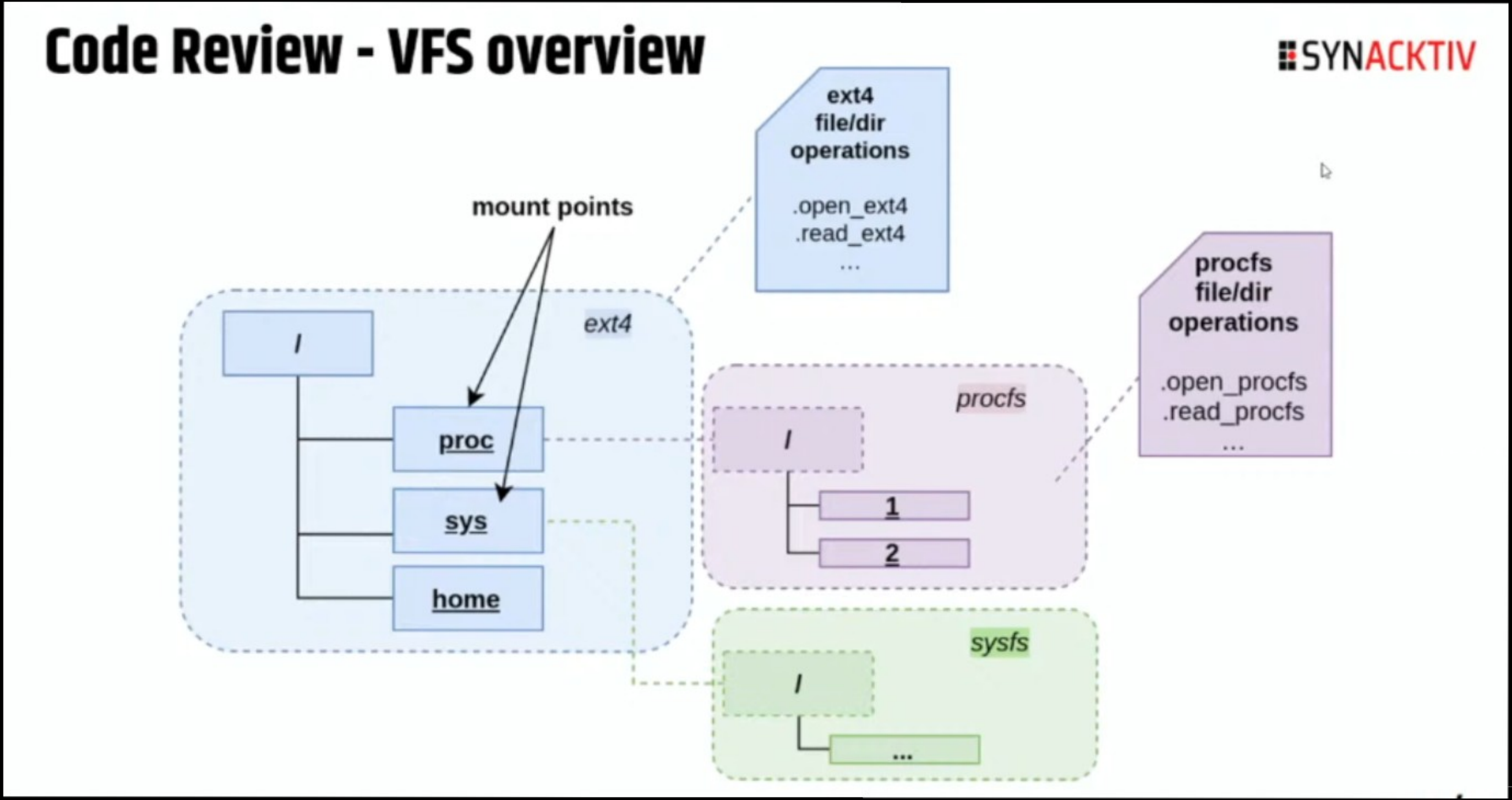
- ShiftFS est un Filesystem présent uniquement sous Ubuntu
- La faille a été remontée dans la CVE-2023-2612
- L’exploit permet d’obtenir des droits root sur un dossier
- Le noyau contenait une condition de concurrence critique lors de la gestion du verrouillage des inodes dans certaines situations
- L’attaquant pourrait ensuite exploiter du code malveillant

Ubuntu ShiftFS :



- **Namespace is a feature that provides process isolation**
- **Used to create a separate set of resources**
- **Useful for creating containers (such as docker, LXC, etc.)**
- **Types of namespaces**
  - mount - Isolates filesystem mount points → Focus on this one
  - process ID
  - network
  - IPC

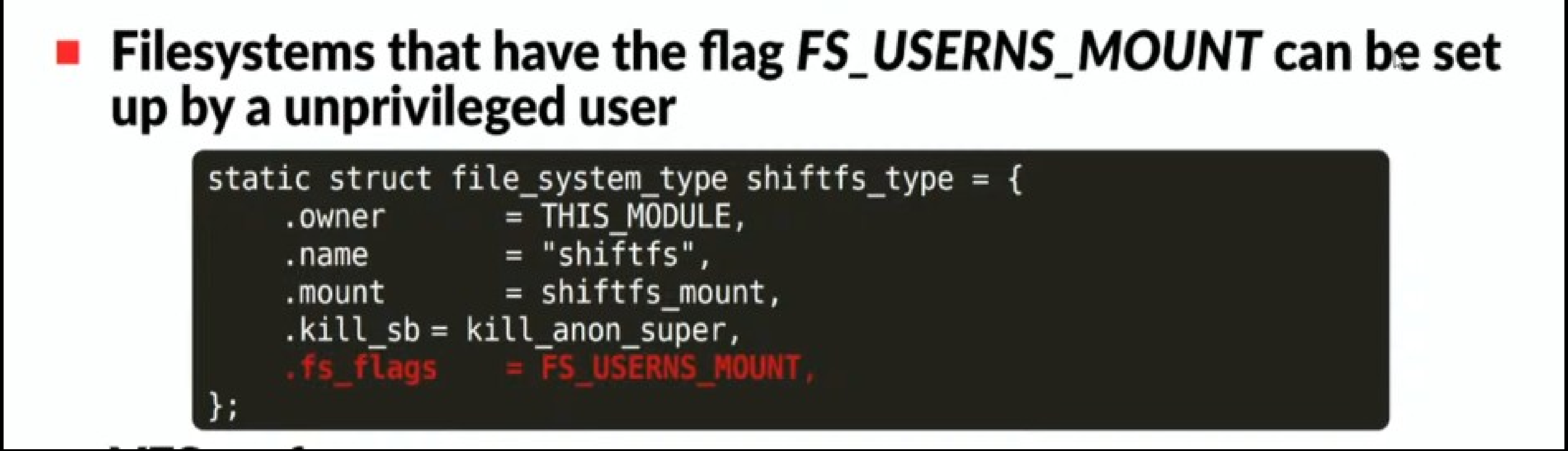
Ubuntu ShiftFS



Code Review - VFS overview

SYNACKTIV

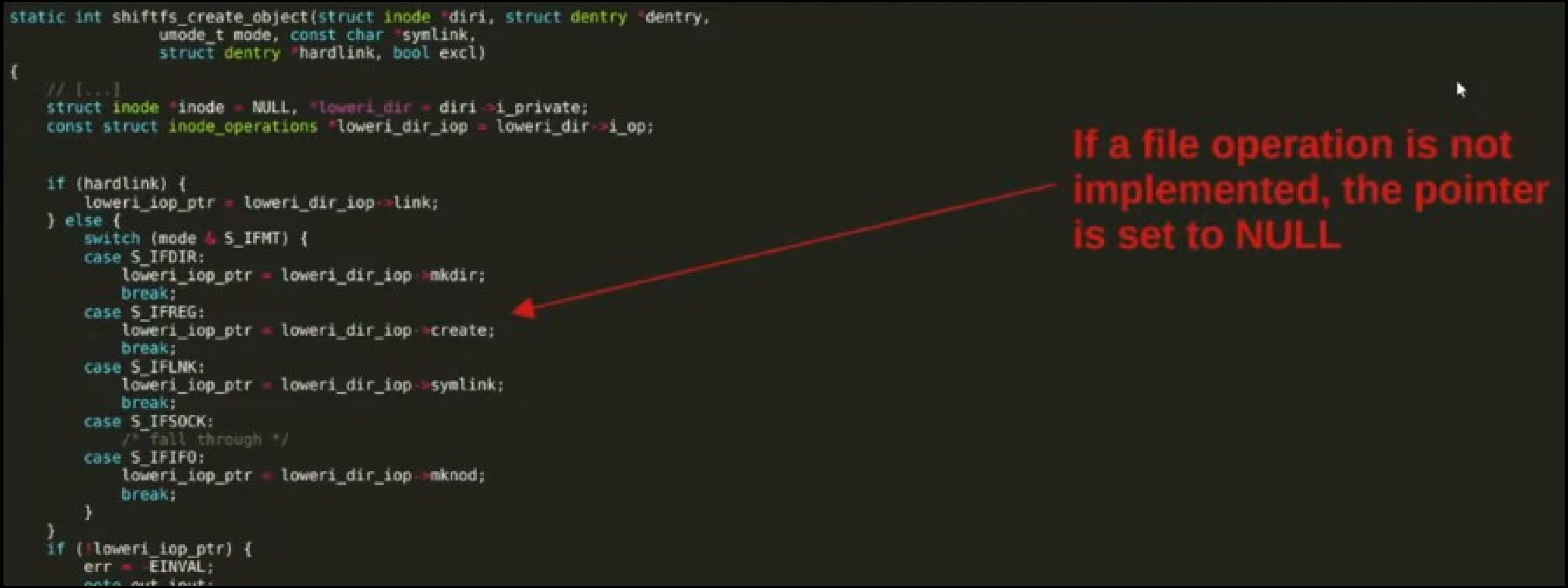
Ubuntu ShiftFS :



- Filesystems that have the flag *FS_USERNS_MOUNT* can be set up by a unprivileged user

```
static struct file_system_type shiftfs_type = {
	.owner		= THIS_MODULE,
	.name		= "shiftfs",
	.mount		= shiftfs_mount,
	.kill_sb = kill_anon_super,
	.fs_flags	= FS_USERNS_MOUNT,
};
```

Ubuntu ShiftFS :

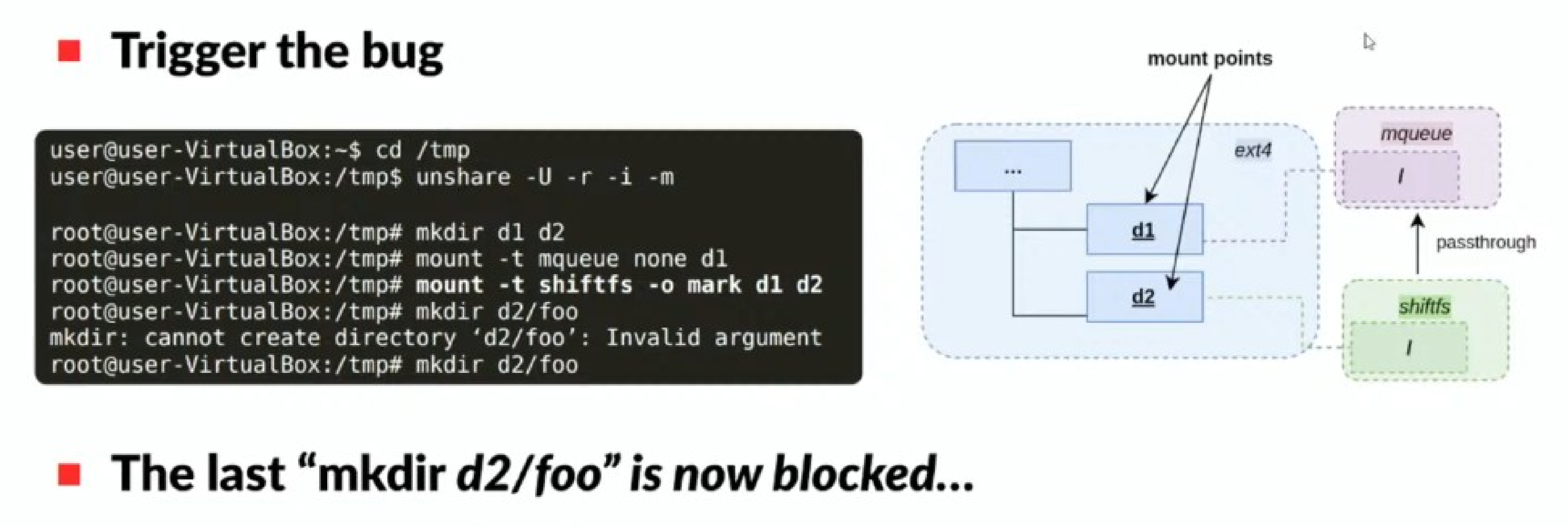


```
static int shiftfs_create_object(struct inode *diri, struct dentry *dentry,
                umode_t mode, const char *symlink,
                struct dentry *hardlink, bool excl)
{
    // [...]
    struct inode *inode = NULL, *loweri_dir = diri->i_private;
    const struct inode_operations *loweri_dir_iop = loweri_dir->i_op;


    if (hardlink) {
        loweri_iop_ptr = loweri_dir_iop->link;
    } else {
        switch (mode & S_IFMT) {
        case S_IFDIR:
            loweri_iop_ptr = loweri_dir_iop->mkdir;
            break;
        case S_IFREG:
            loweri_iop_ptr = loweri_dir_iop->create;
            break;
        case S_IFLNK:
            loweri_iop_ptr = loweri_dir_iop->symlink;
            break;
        case S_IFSOCK:
            /* fall through */
        case S_IFIFO:
            loweri_iop_ptr = loweri_dir_iop->mknod;
            break;
        }
    }
    if (!loweri_iop_ptr) {
        err = -EINVAL;
        goto out_iput;
```

If a file operation is not implemented, the pointer is set to NULL

Ubuntu ShiftFS :



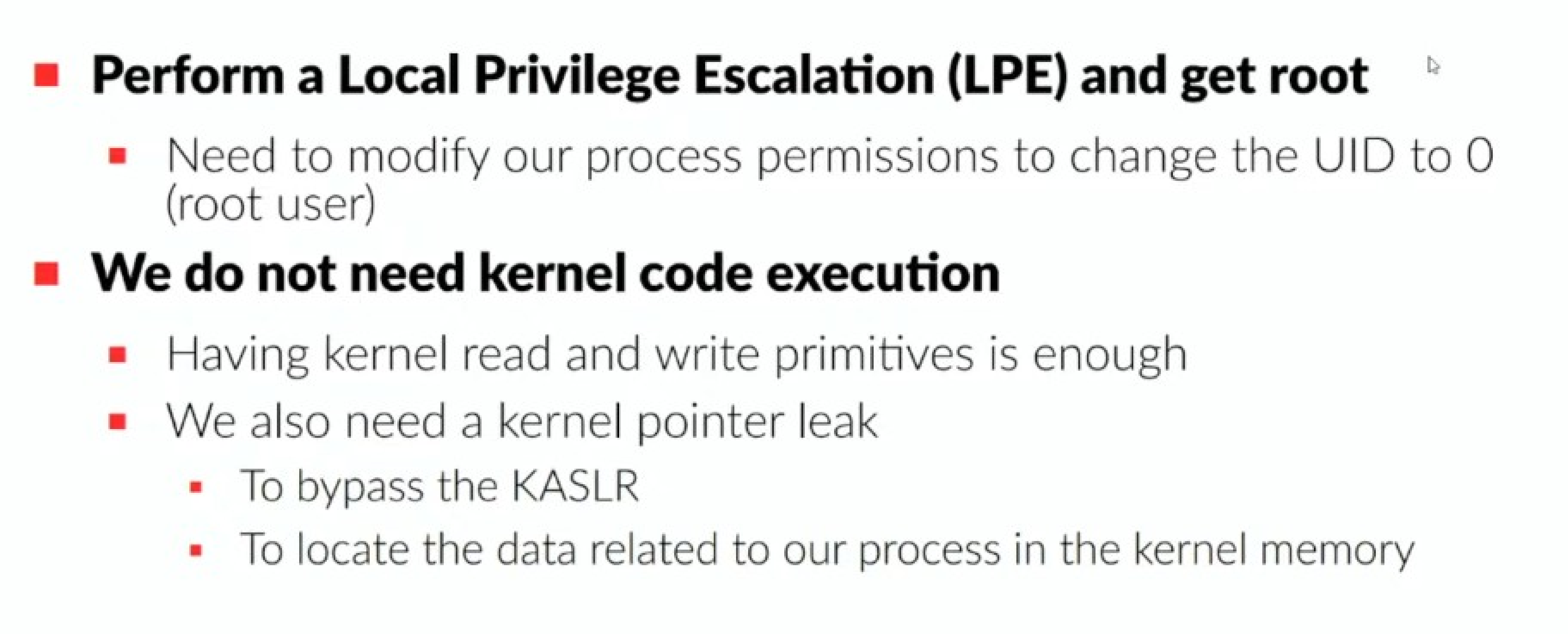
- **Trigger the bug**

```
user@user-VirtualBox:~$ cd /tmp
user@user-VirtualBox:/tmp$ unshare -U -r -i -m

root@user-VirtualBox:/tmp# mkdir d1 d2
root@user-VirtualBox:/tmp# mount -t mqueue none d1
root@user-VirtualBox:/tmp# mount -t shiftfs -o mark d1 d2
root@user-VirtualBox:/tmp# mkdir d2/foo
mkdir: cannot create directory ‘d2/foo’: Invalid argument
root@user-VirtualBox:/tmp# mkdir d2/foo
```

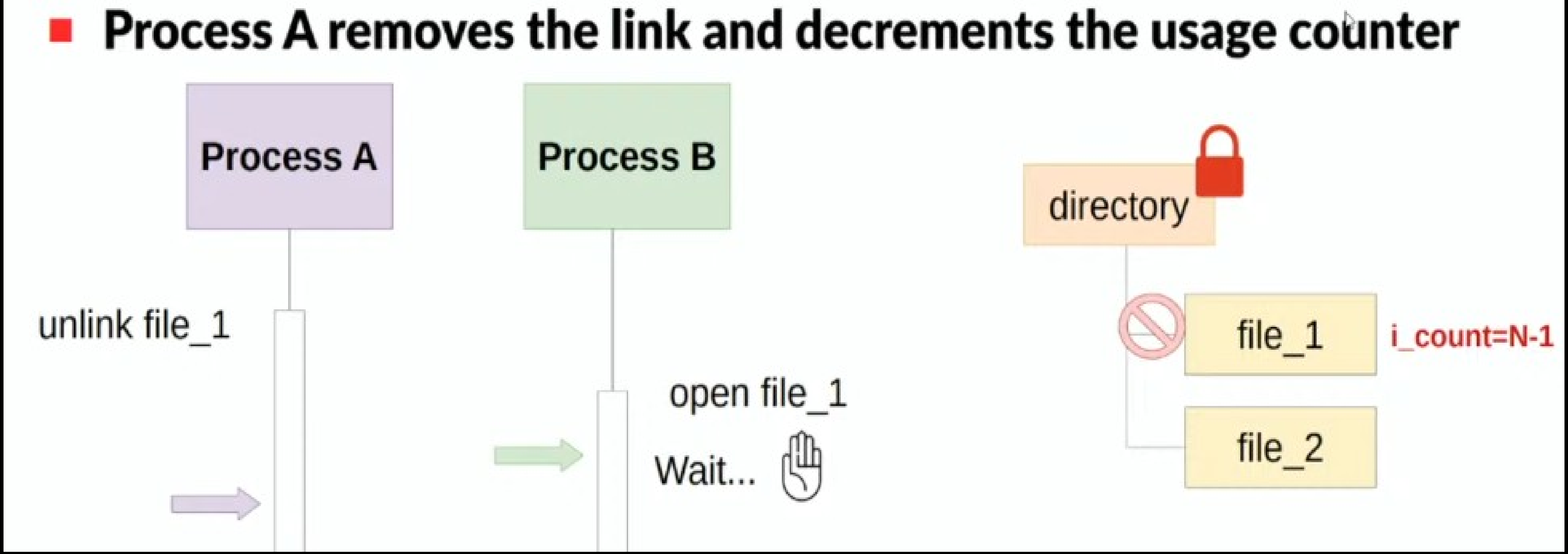
- **The last “mkdir *d2/foo*” *is now blocked...***

Ubuntu ShiftFS :



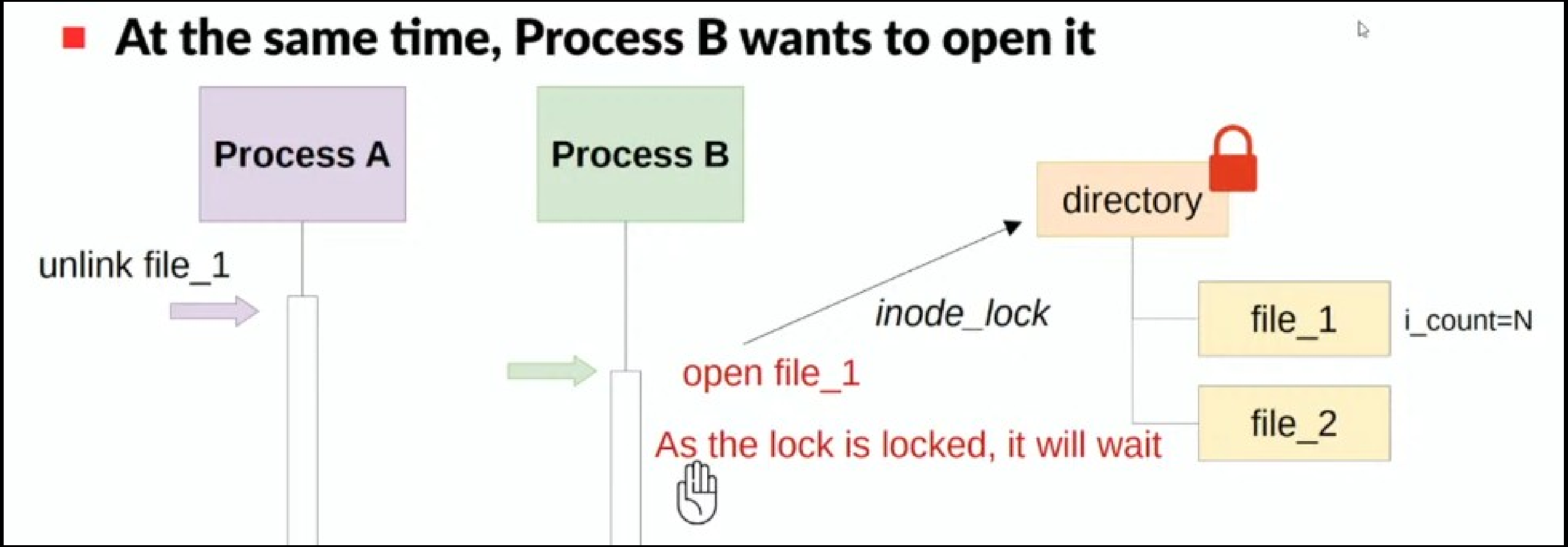
- **Perform a Local Privilege Escalation (LPE) and get root**
  - Need to modify our process permissions to change the UID to 0 (root user)
- **We do not need kernel code execution**
  - Having kernel read and write primitives is enough
  - We also need a kernel pointer leak
    - To bypass the KASLR
    - To locate the data related to our process in the kernel memory

Ubuntu ShiftFS :



- Process A removes the link and decrements the usage counter

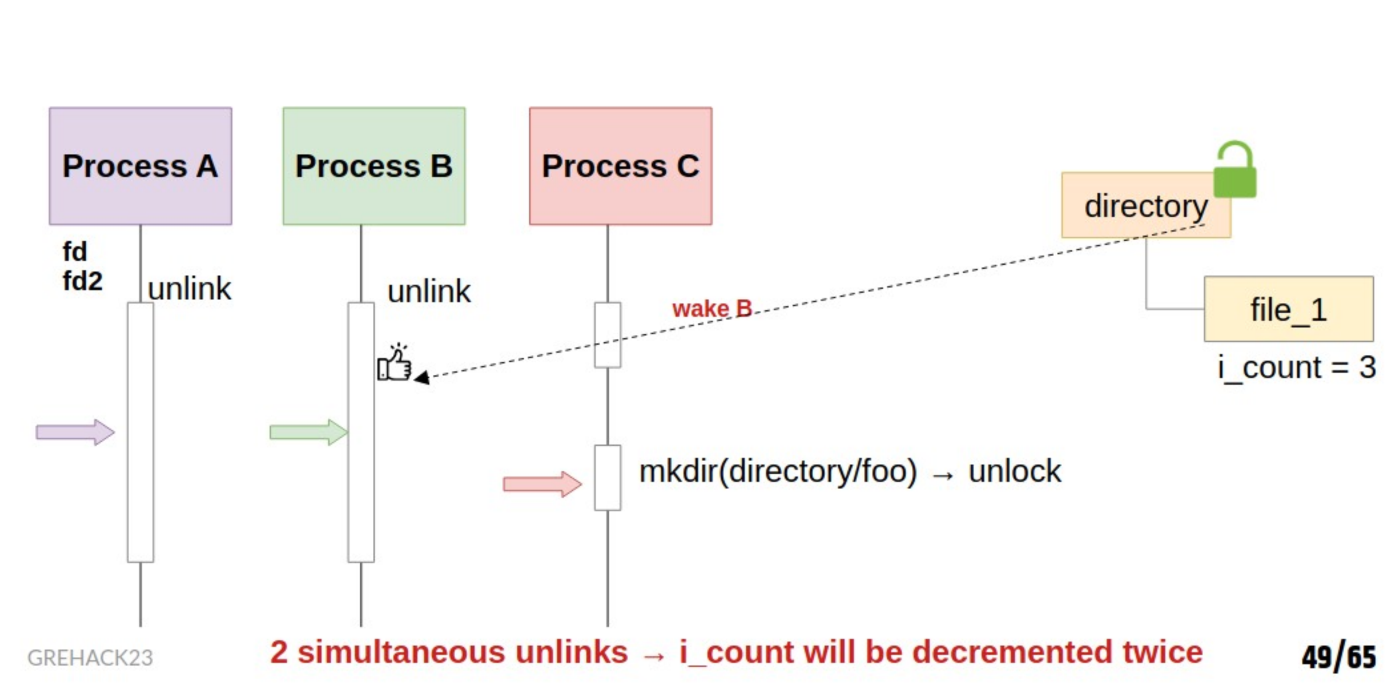
Ubuntu ShiftFS :



- At the same time, Process B wants to open it

As the lock is locked, it will wait

Ubuntu ShiftFS :



2 simultaneous unlinks → i_count will be decremented twice

GREHACK23

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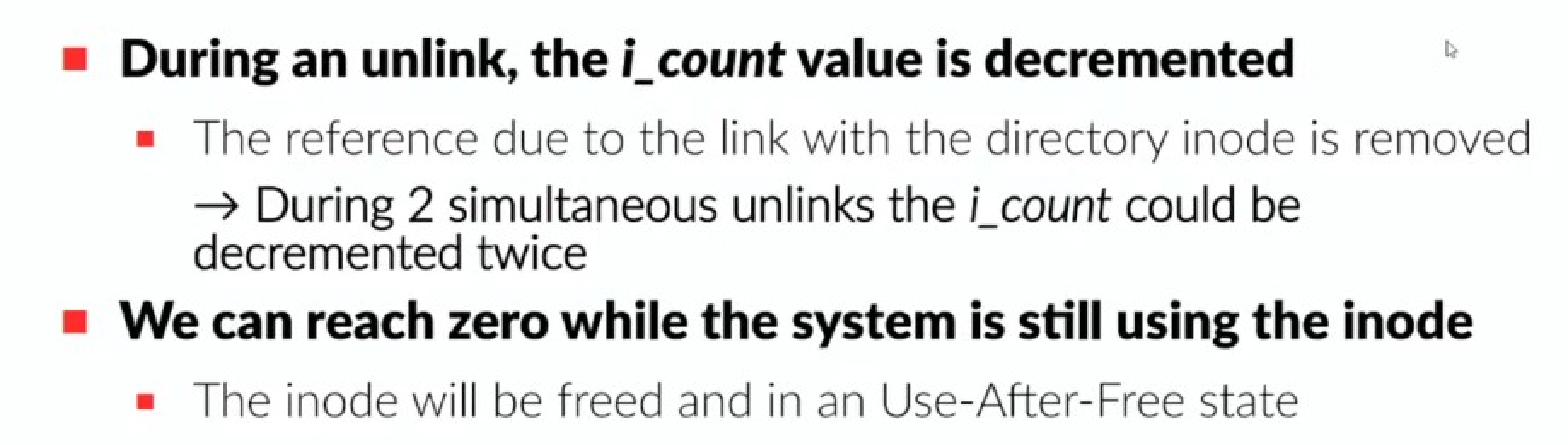
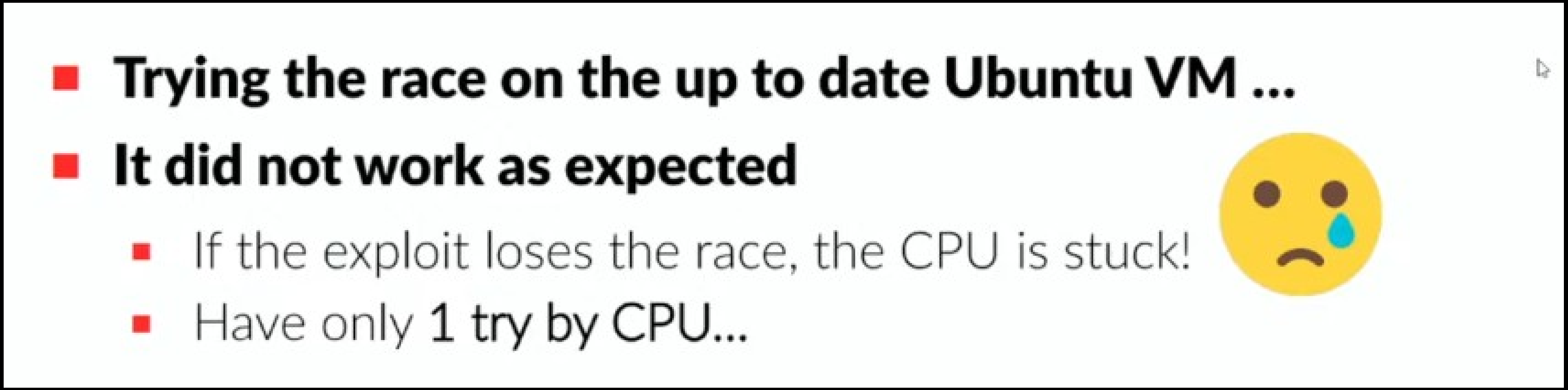
Ubuntu ShiftFS :



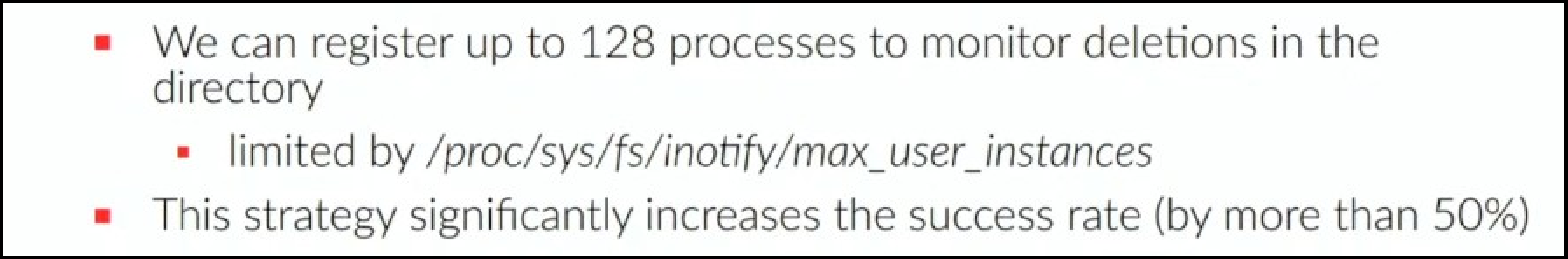
- **During an unlink, the *i_count* value is decremented**
  - The reference due to the link with the directory inode is removed

    → During 2 simultaneous unlinks the *i_count* could be decremented twice
- **We can reach zero while the system is still using the inode**
  - The inode will be freed and in an Use-After-Free state

Ubuntu ShiftFS :

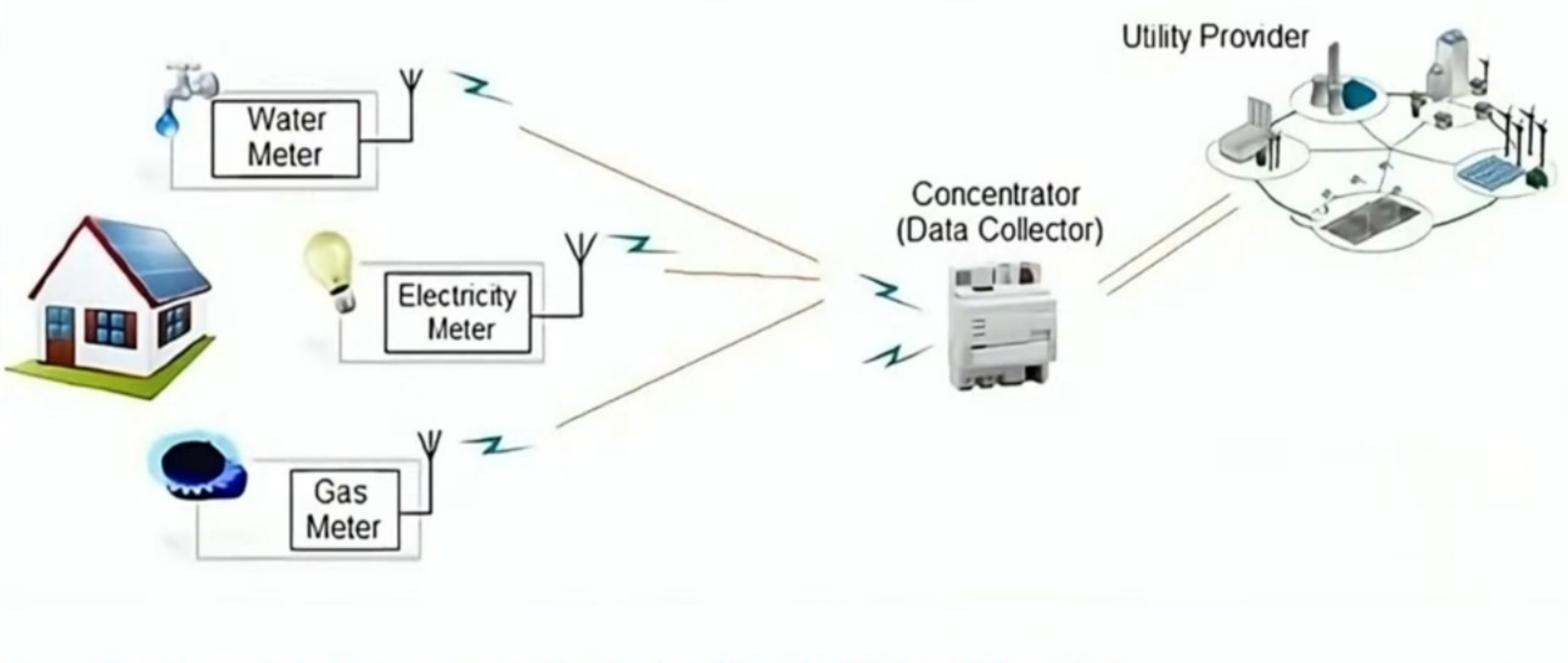


- **Trying the race on the up to date Ubuntu VM ...**
- **It did not work as expected**
  - If the exploit loses the race, the CPU is stuck! 😢
  - Have only **1 try by CPU...**

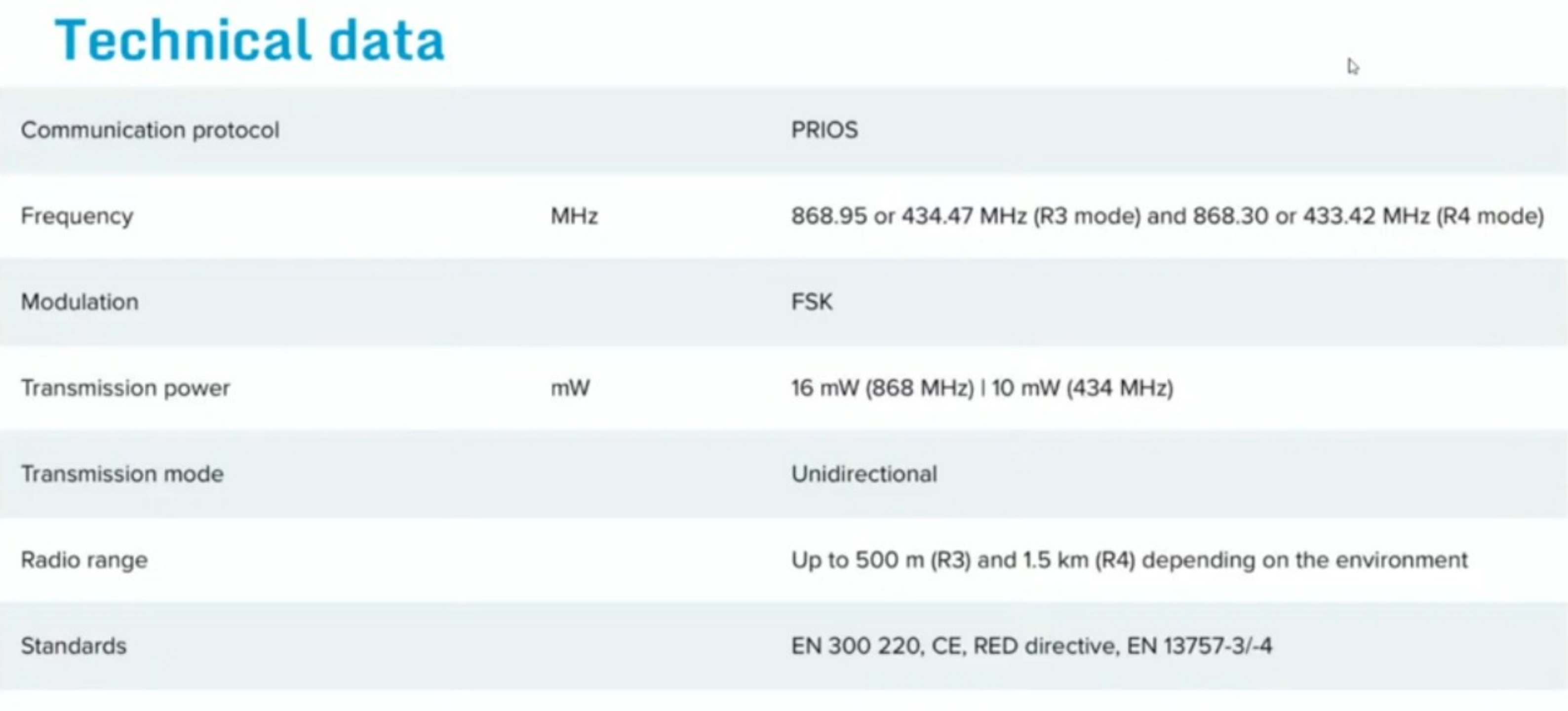


- We can register up to 128 processes to monitor deletions in the directory
  - limited by */proc/sys/fs/inotify/max_user_instances*
- This strategy significantly increases the success rate (by more than 50%)

Security analysis of radio water meters
by Lucas Georget - LAAS-CNRS Toulouse

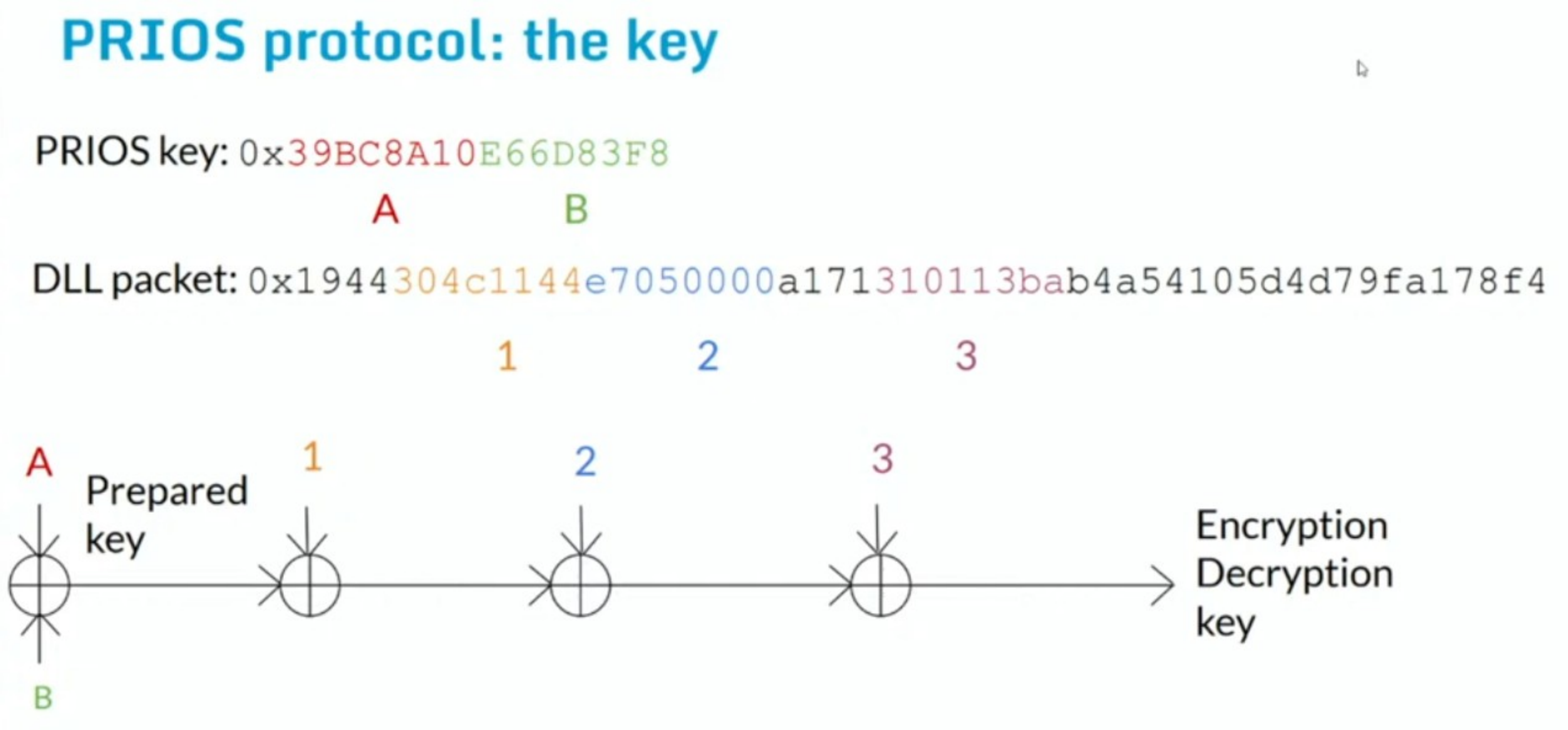


From https://www.rfwireless-world.com/Terminology/What-is-Wireless-M-Bus.html



Technical data

Communication protocol		PRIOS
Frequency	MHz	868.95 or 434.47 MHz (R3 mode) and 868.30 or 433.42 MHz (R4 mode)
Modulation		FSK
Transmission power	mW	16 mW (868 MHz) I 10 mW (434 MHz)
Transmission mode		Unidirectional
Radio range		Up to 500 m (R3) and 1.5 km (R4) depending on the environment
Standards		EN 300 220, CE, RED directive, EN 13757-3/-4



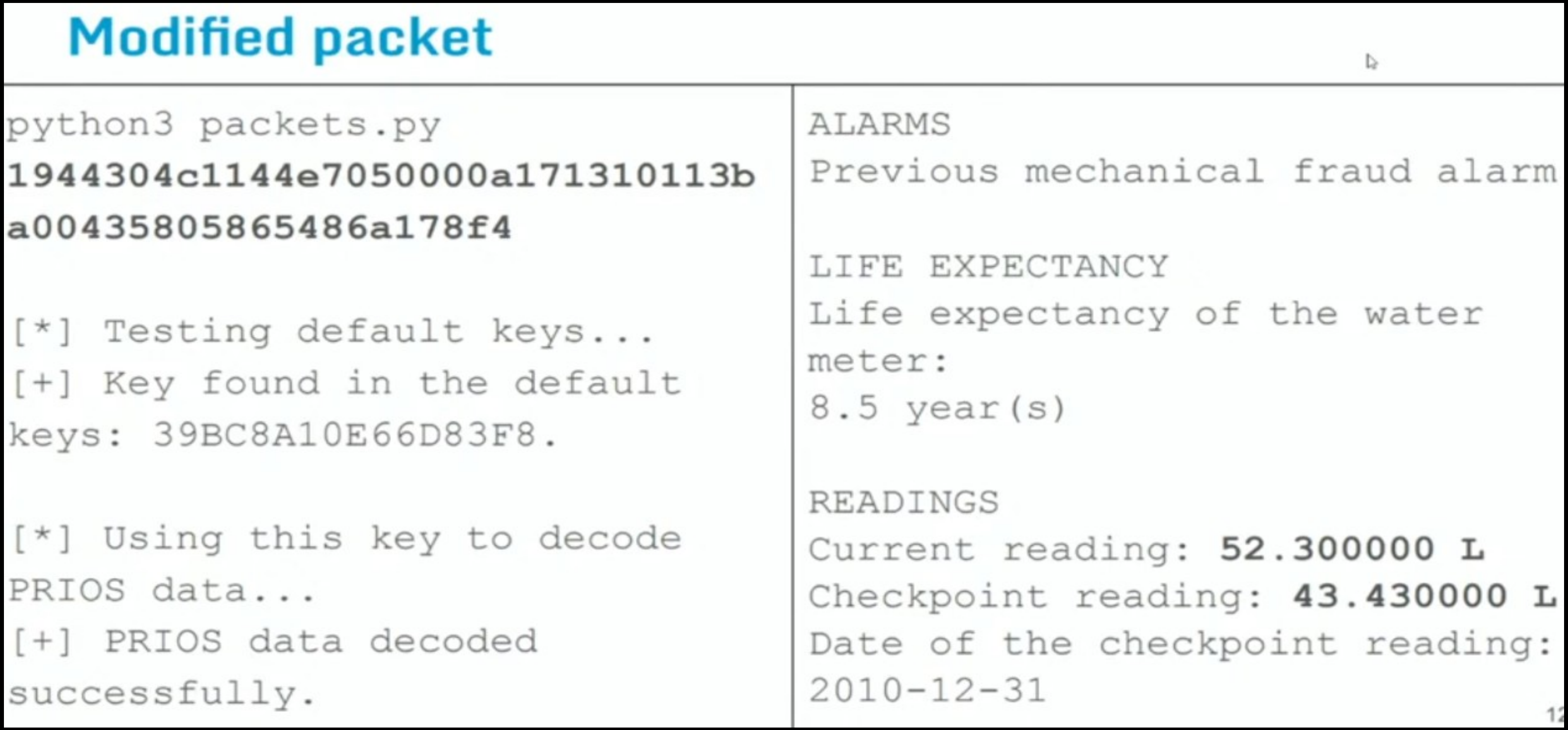
PRIOS protocol: the key

PRIOS key: 0x39BC8A10E66D83F8

A B

DLL packet: 0x1944304c1144e7050000a171310113bab4a54105d4d79fa178f4

1 2 3



Modified packet

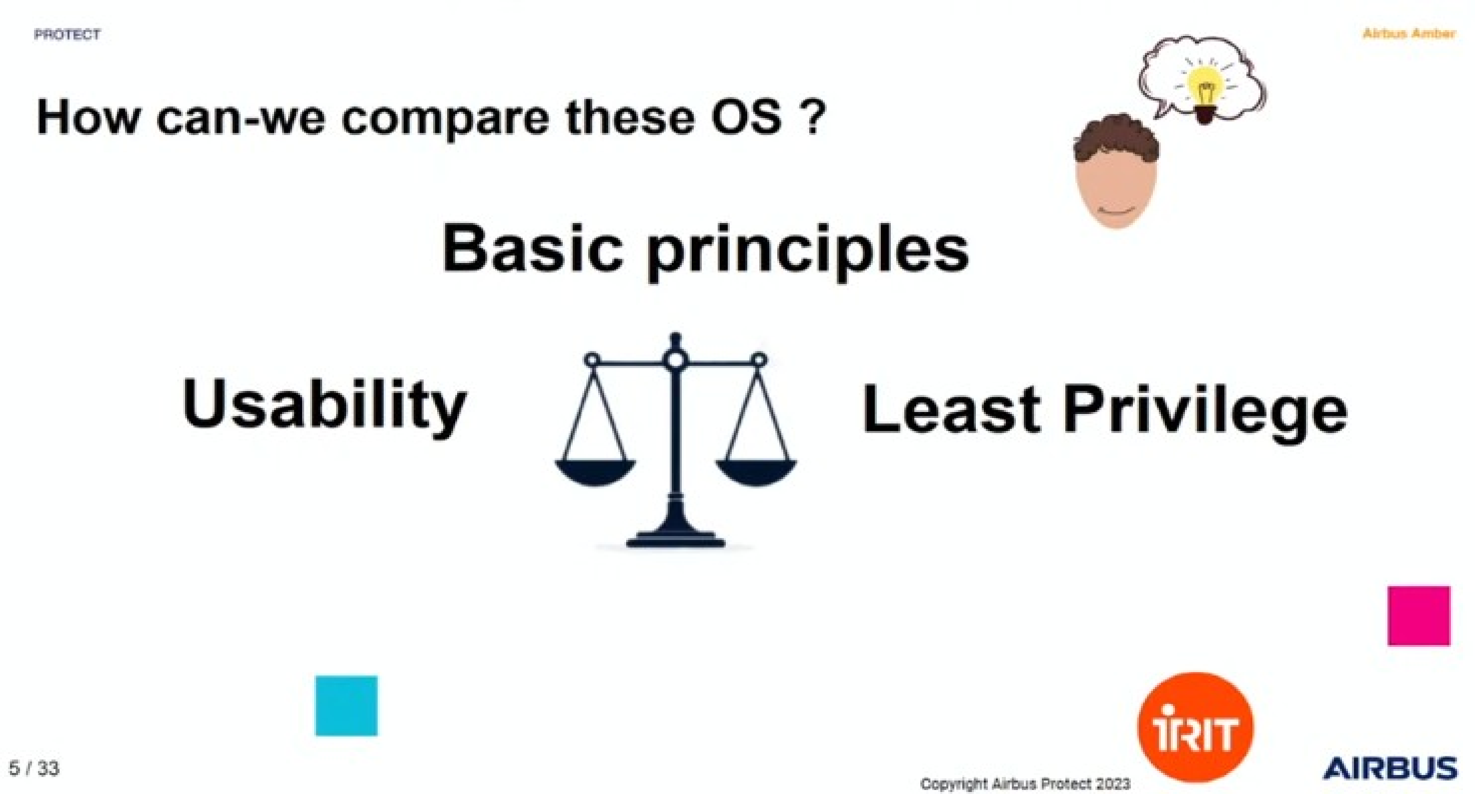
```
python3 packets.py
1944304c1144e7050000a171310113b
a00435805865486a178f4

[*] Testing default keys...
[+] Key found in the default
keys: 39BC8A10E66D83F8.

[*] Using this key to decode
PRIOS data...
[+] PRIOS data decoded
successfully.
```

```
ALARMS
Previous mechanical fraud alarm

LIFE EXPECTANCY
Life expectancy of the water
meter:
8.5 year(s)

READINGS
Current reading: 52.300000 L
Checkpoint reading: 43.430000 L
Date of the checkpoint reading:
2010-12-31
```

OS administratives privileges

- Explication de l’évolution de l’administration des privilèges
- Linux est le premier OS à avoir implémenté une séparation
- La recherche porte sur la capacité des autres OS à séparer
- Le but est de savoir lequel est le meilleur pour manager les privilèges

OS administratives privileges



PROTECT

Airbus Amber

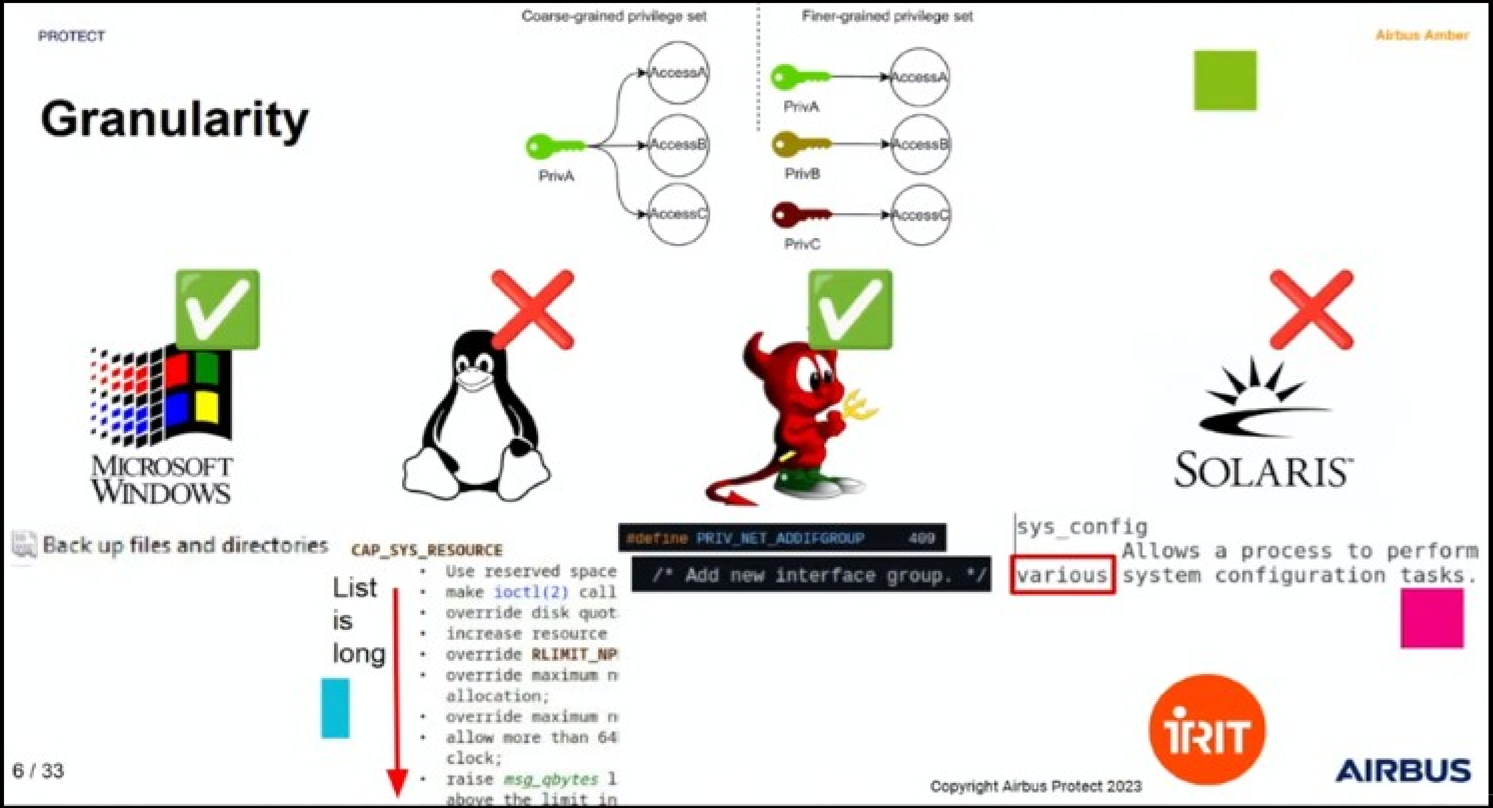
How can-we compare these OS ?

Basic principles

Usability

Least Privilege

OS administratives privileges



PROTECT

Airbus Amber

Granularity

Back up files and directories

List is long

CAP_SYS_RESOURCE

- Use reserved space
- make ioctl(2) call
- override disk quot
- increase resource
- override RLIMIT_NP
- override maximum n allocation;
- override maximum n
- allow more than 64 clock;
- raise msg_qbytes l above the limit in

```
#define PRIV_NET_ADDIFGROUP      409
```

```
/* Add new interface group. */
```

```
sys_config
        Allows a process to perform
various system configuration tasks.
```

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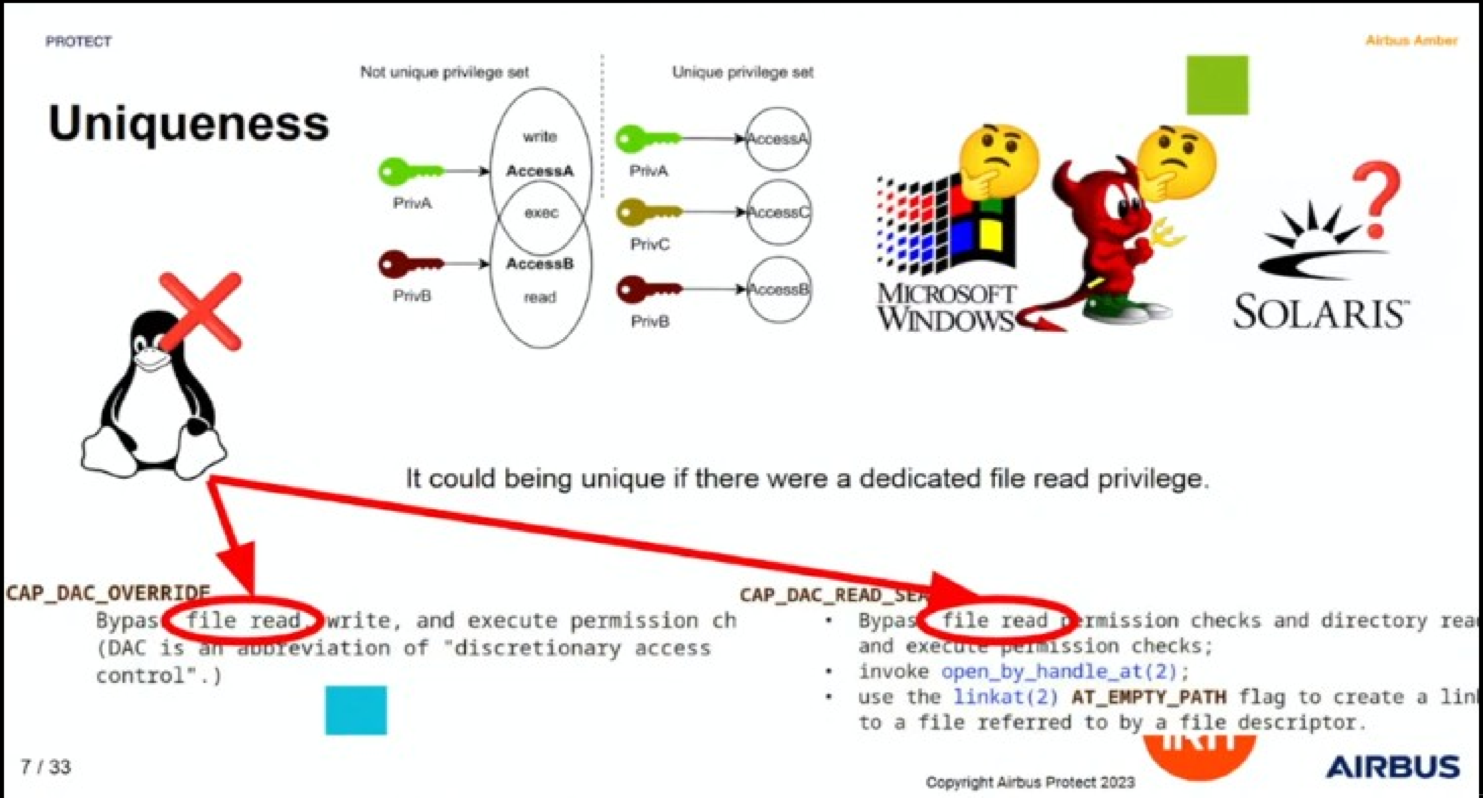
IRIT

AIRBUS

OS administratives privileges



PROTECT

Airbus Amber

Uniqueness

It could being unique if there were a dedicated file read privilege.

```
CAP_DAC_OVERRIDE
       Bypass file read, write, and execute permission ch
       (DAC is an abbreviation of "discretionary access
       control".)
```

```
CAP_DAC_READ_SEA
       •  Bypass file read permission checks and directory rea
          and execute permission checks;
       •  invoke open_by_handle_at(2);
       •  use the linkat(2) AT_EMPTY_PATH flag to create a lin
          to a file referred to by a file descriptor.
```

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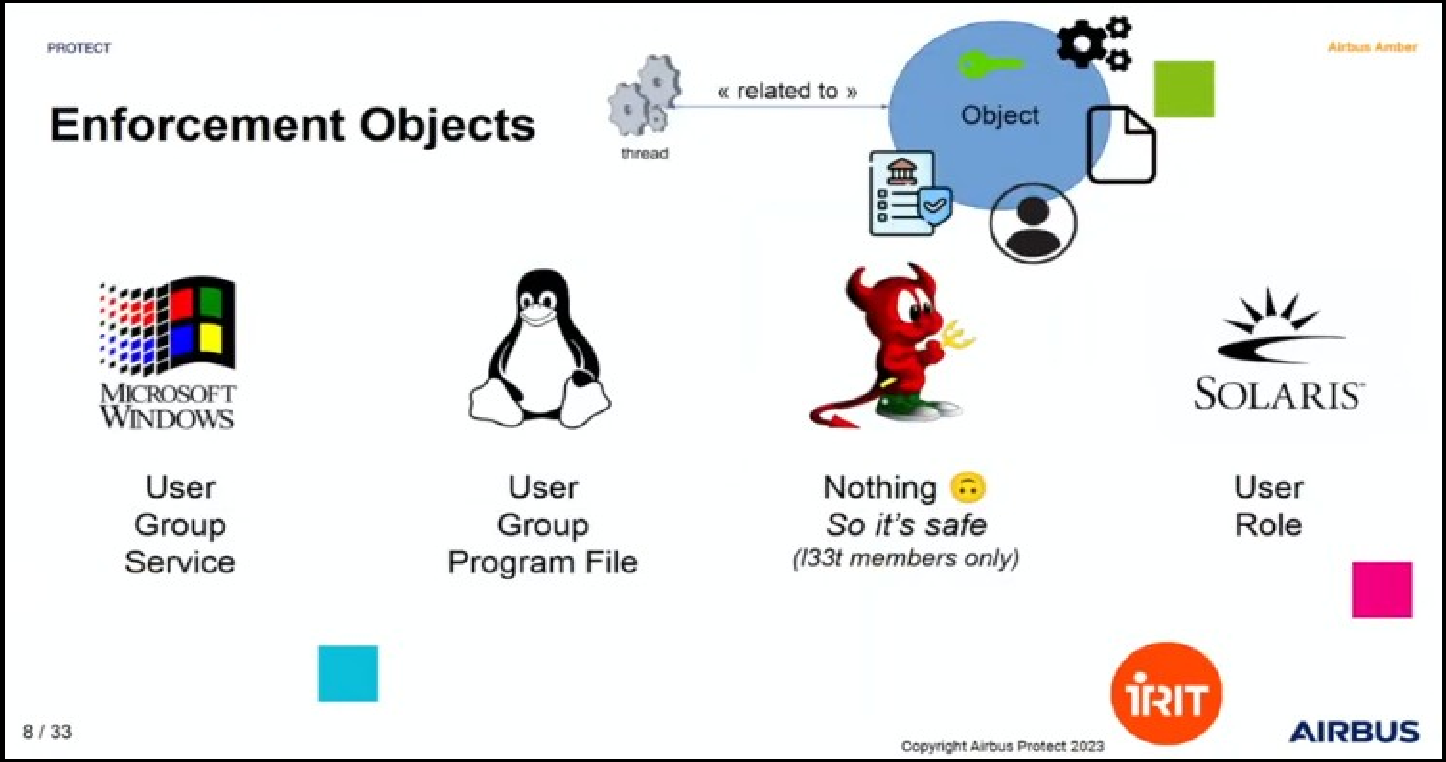
AIRBUS

OS administratives privileges



Enforcement Objects

thread « related to » Object

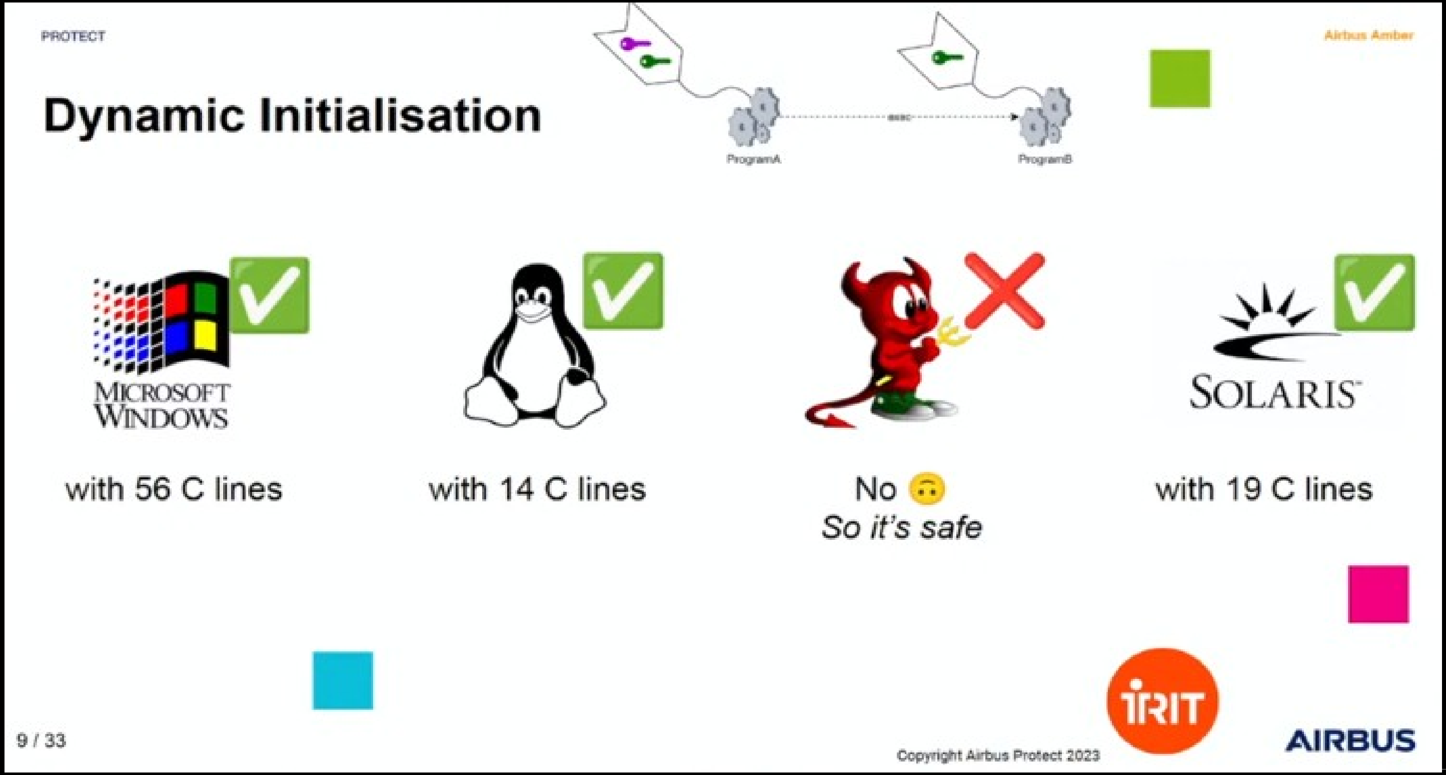
User
Group
Service

User
Group
Program File

Nothing 🙃
So it's safe
(l33t members only)

User
Role

OS administratives privileges



PROTECT

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Dynamic Initialisation

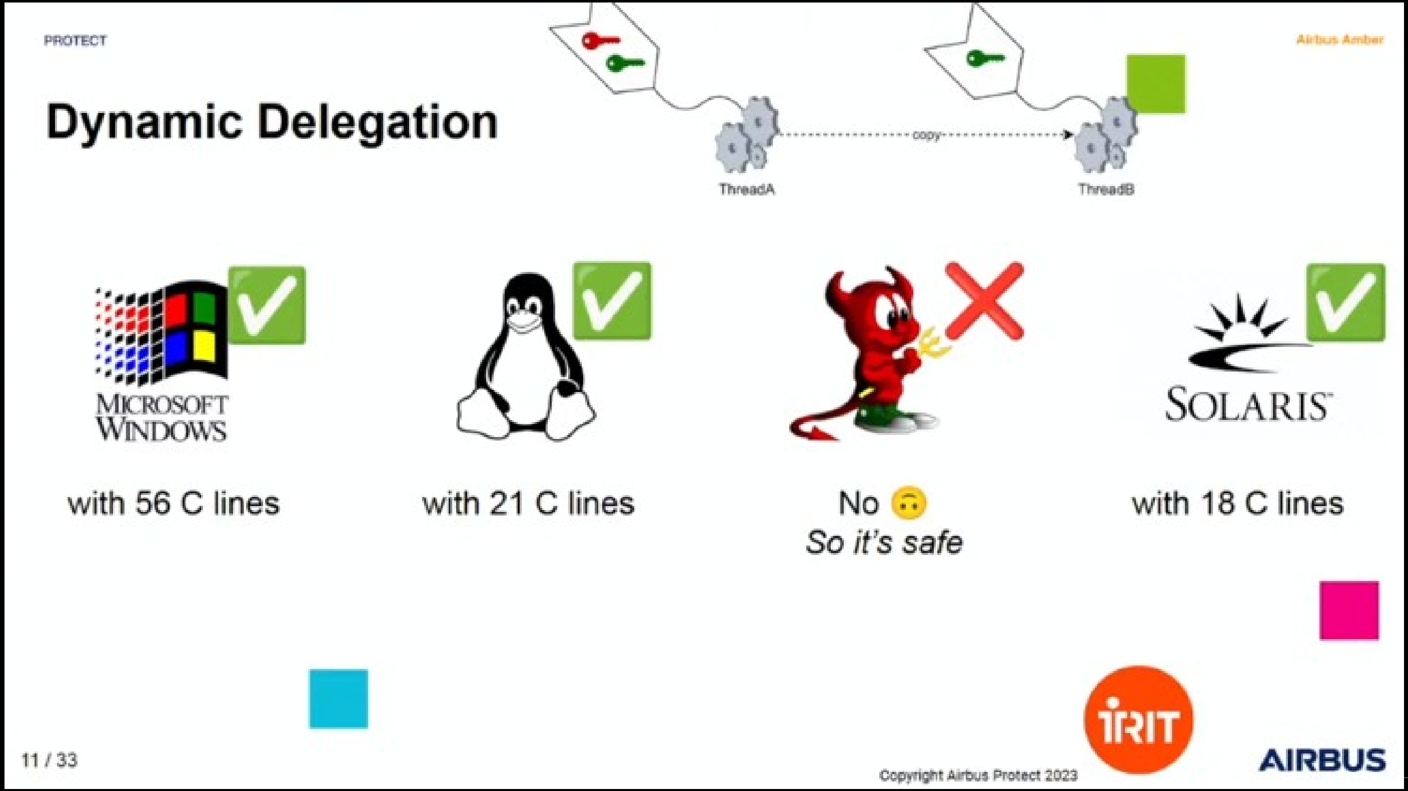
with 56 C lines ✅

with 14 C lines ✅

No 🙃 ❌
So it's safe

with 19 C lines ✅

OS administratives privileges



PROTECT

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Dynamic Delegation

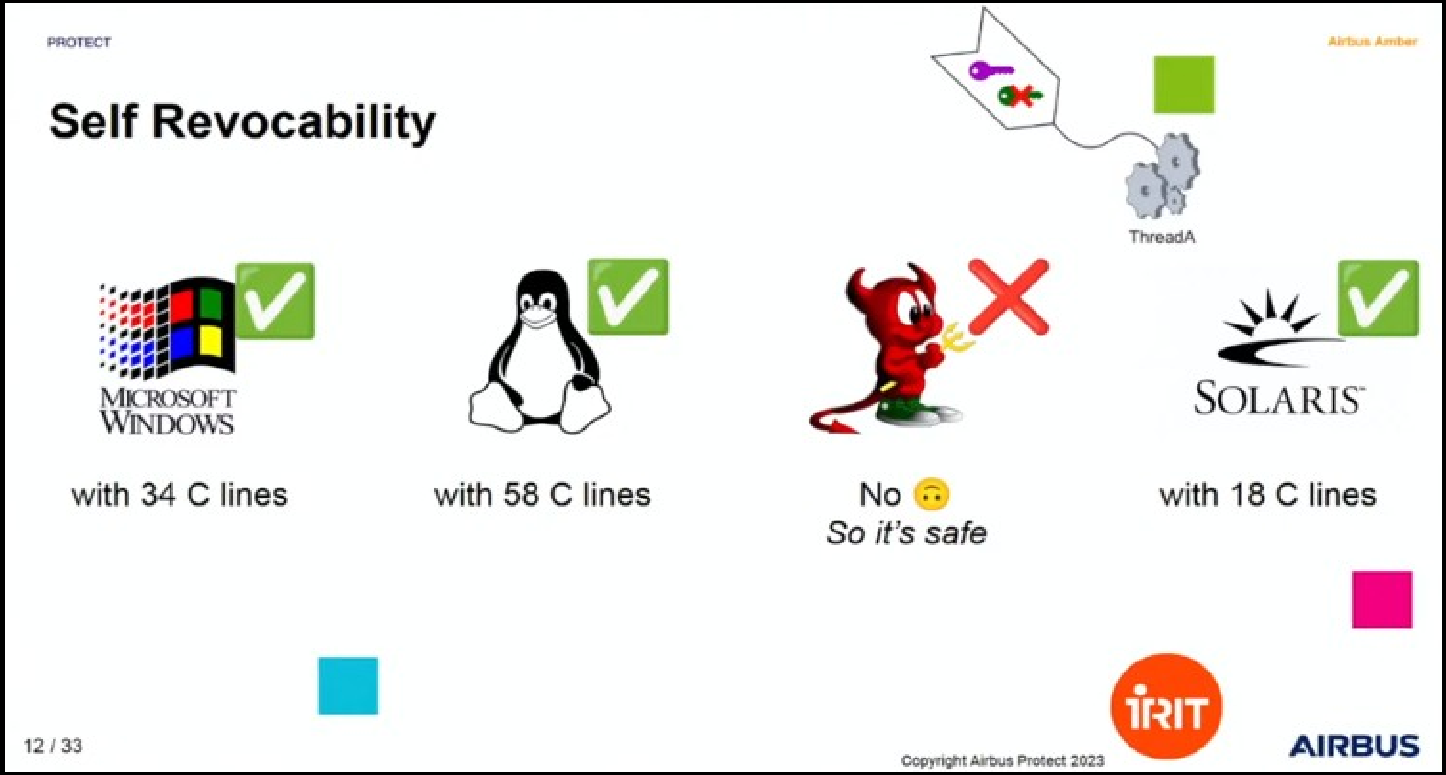
✓ with 56 C lines

✓ with 21 C lines

✗ No 🙃
So it's safe

✓ with 18 C lines

OS administratives privileges



PROTECT

Airbus Amber

Self Revocability

ThreadA

✓ with 34 C lines

✓ with 58 C lines

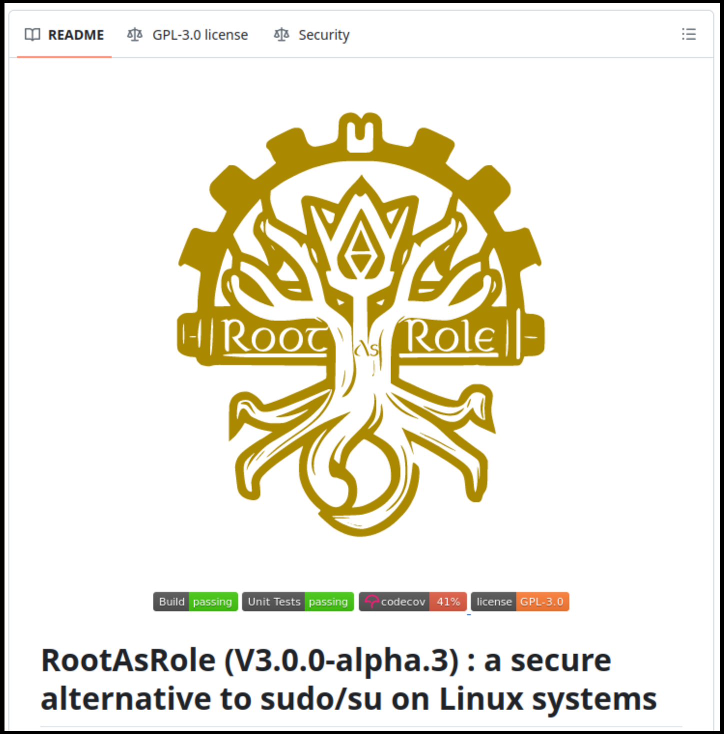
✗ No 🙃
So it's safe

✓ with 18 C lines

OS administratives privileges

- Conclusion, lequel est donc safe ?
- Aucun ne propose un compromis parfait entre sécurité et usabilité
- Freebsd reste le plus sécure
- Mais l’intervenant nous a présenté une solution alternative, avec Linux et le projet RooAsRole.

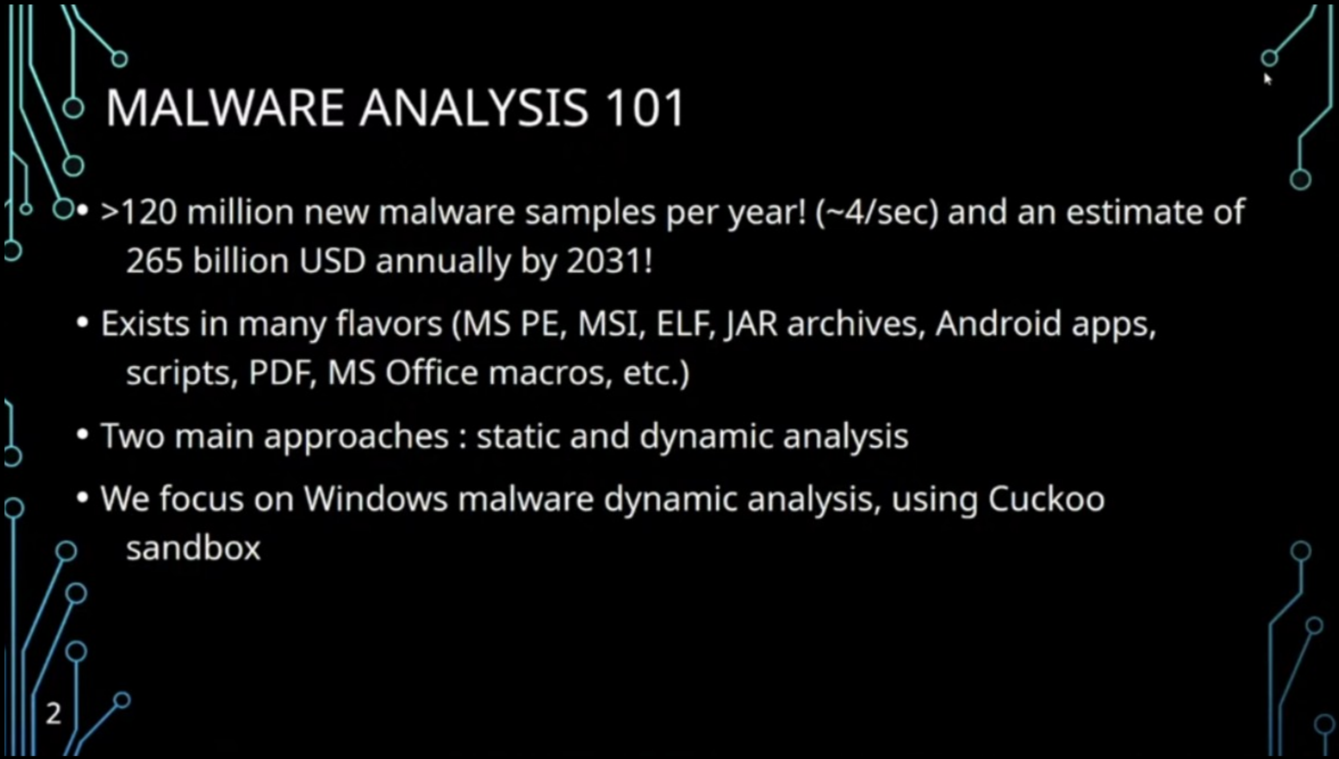
OS administratives privileges



RootAsRole (V3.0.0-alpha.3) : a secure alternative to sudo/su on Linux systems

- Gestion sécure des accès
- Alternative à sudo avec du « least privileges »
- Modèle RBAC
- Les privileges sont réduits pour chaque tache
- Prévient les « privileges escalation »

BAGUETTE: Hunting for Evidence of Malicious Behavior
by Pierre-François Gimenez - INRIA Rennes



MALWARE ANALYSIS 101

- >120 million new malware samples per year! (~4/sec) and an estimate of 265 billion USD annually by 2031!
- Exists in many flavors (MS PE, MSI, ELF, JAR archives, Android apps, scripts, PDF, MS Office macros, etc.)
- Two main approaches : static and dynamic analysis
- We focus on Windows malware dynamic analysis, using Cuckoo sandbox

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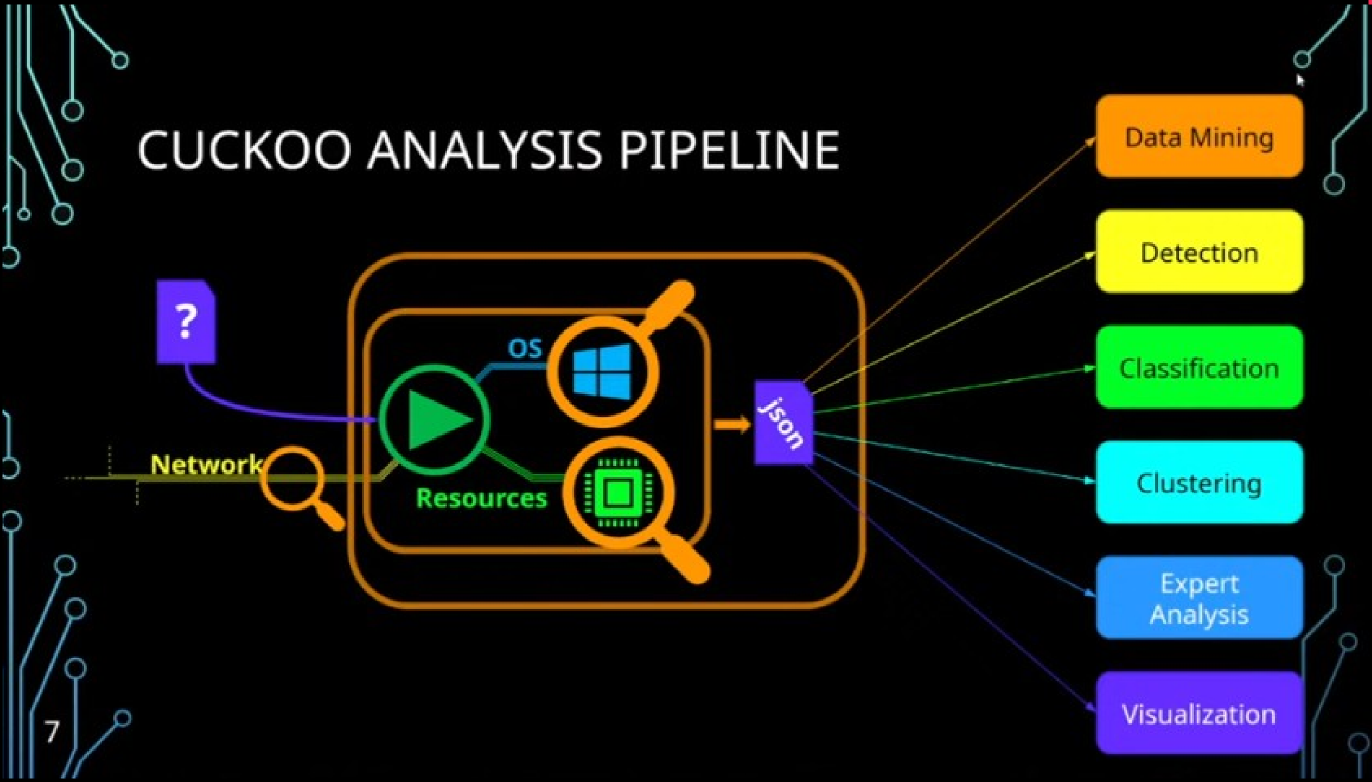
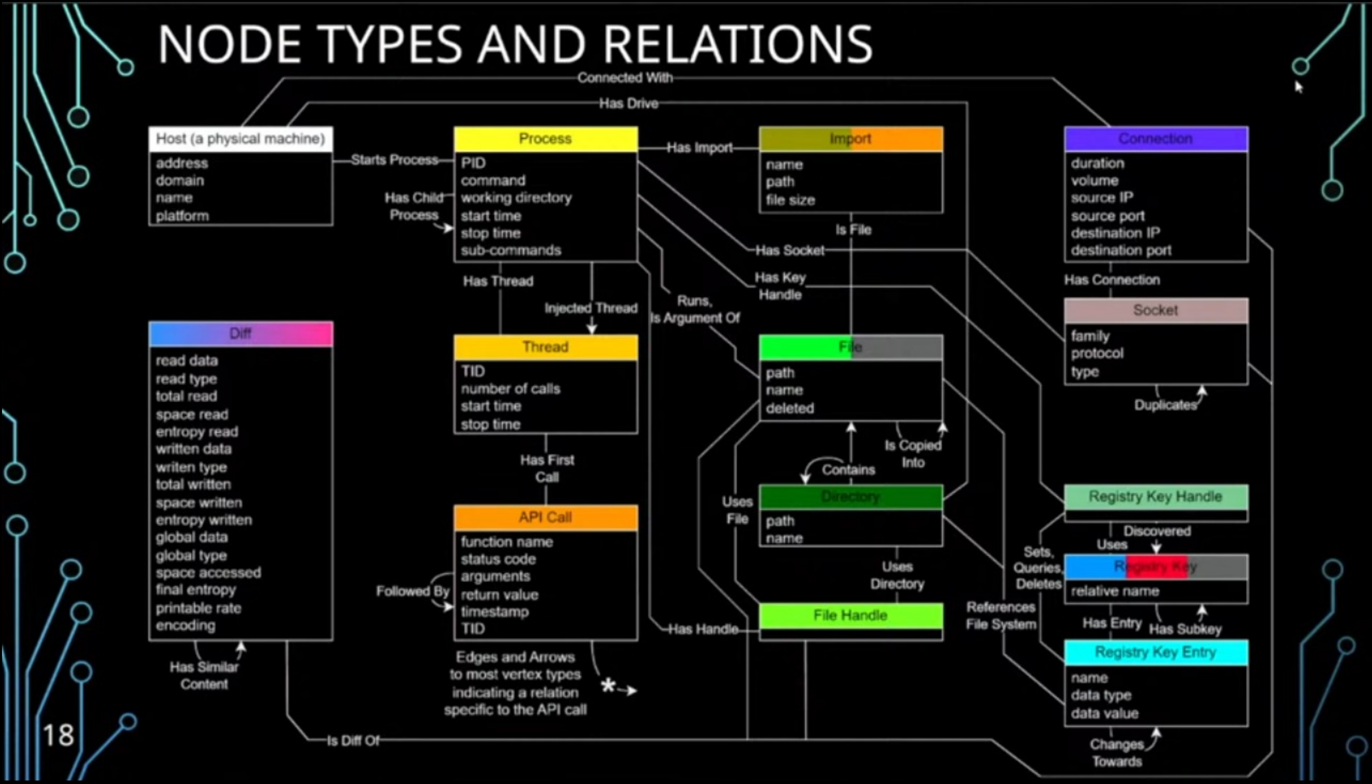


CUCKOO ANALYSIS PIPELINE

BAGUETTE: Hunting for Evidence of Malicious Behavior by Pierre-François Gimenez - INRIA Rennes



NODE TYPES AND RELATIONS

Host (a physical machine)
- address
- domain
- name
- platform

Process
- PID
- command
- working directory
- start time
- stop time
- sub-commands

Import
- name
- path
- file size

Connection
- duration
- volume
- source IP
- source port
- destination IP
- destination port

Socket
- family
- protocol
- type

Diff
- read data
- read type
- total read
- space read
- entropy read
- written data
- writen type
- total written
- space written
- entropy written
- global data
- global type
- space accessed
- final entropy
- printable rate
- encoding

Thread
- TID
- number of calls
- start time
- stop time

File
- path
- name
- deleted

Directory
- path
- name

API Call
- function name
- status code
- arguments
- return value
- timestamp
- TID

File Handle

Registry Key Handle

Registry Key
- relative name

Registry Key Entry
- name
- data type
- data value

Edges and Arrows to most vertex types indicating a relation specific to the API call *→

BAGUETTE: Hunting for Evidence of Malicious Behavior
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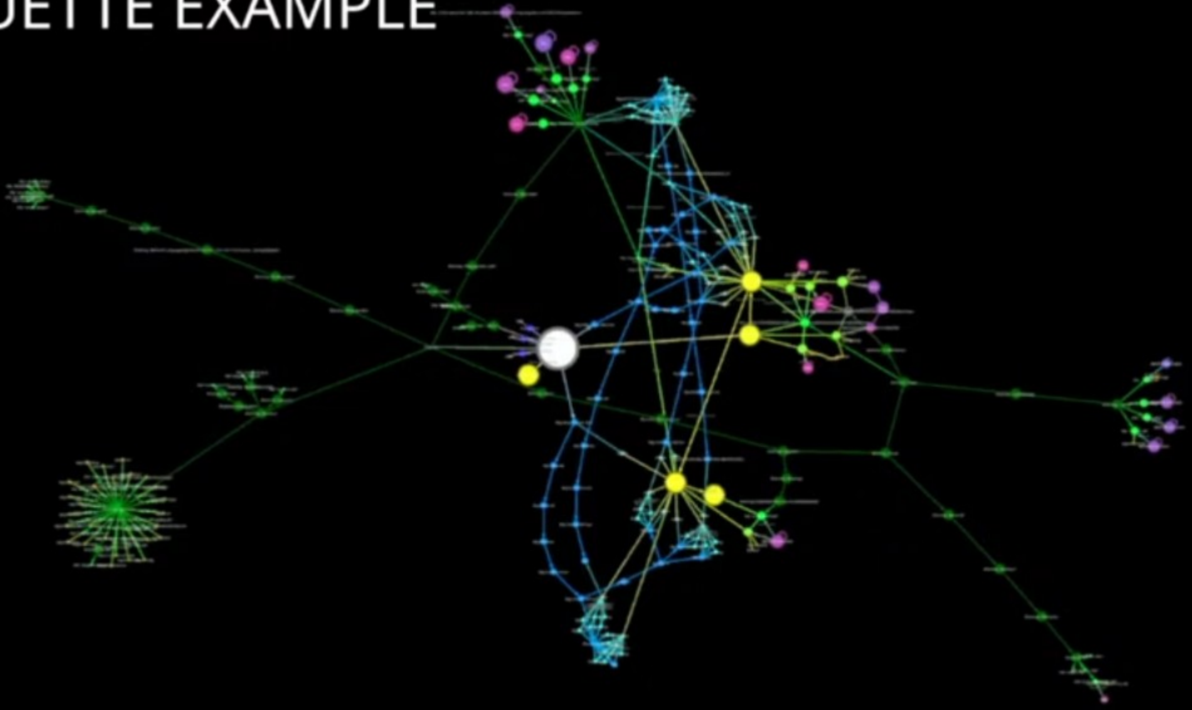
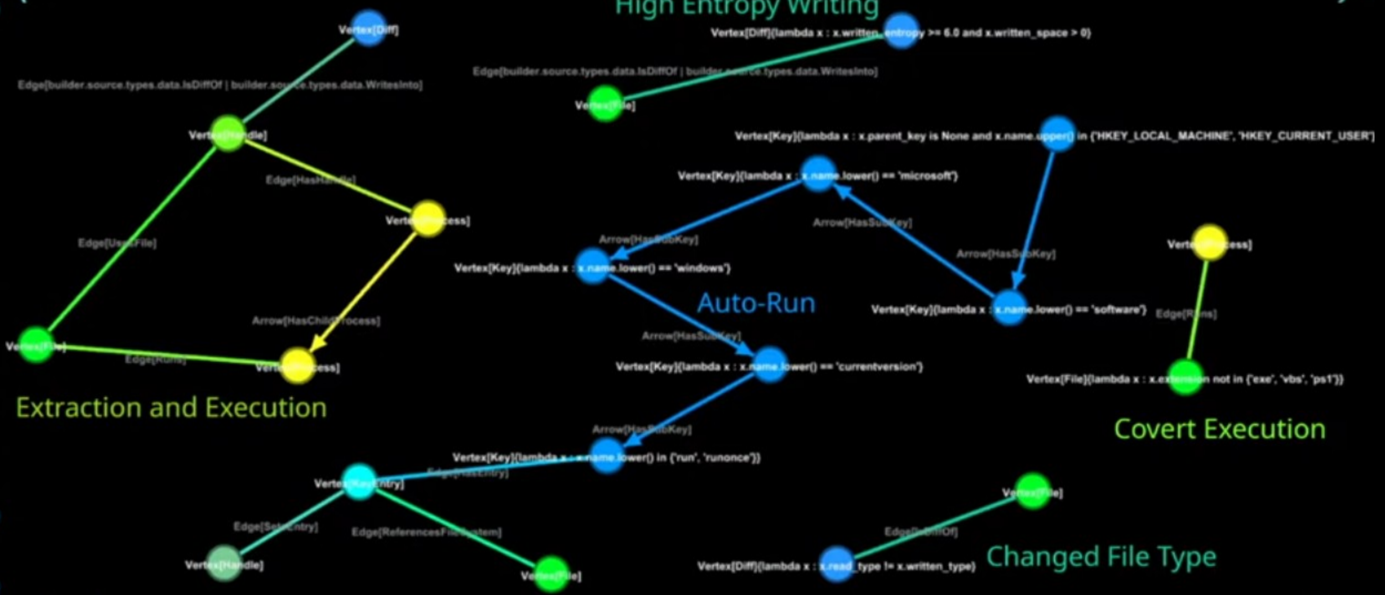
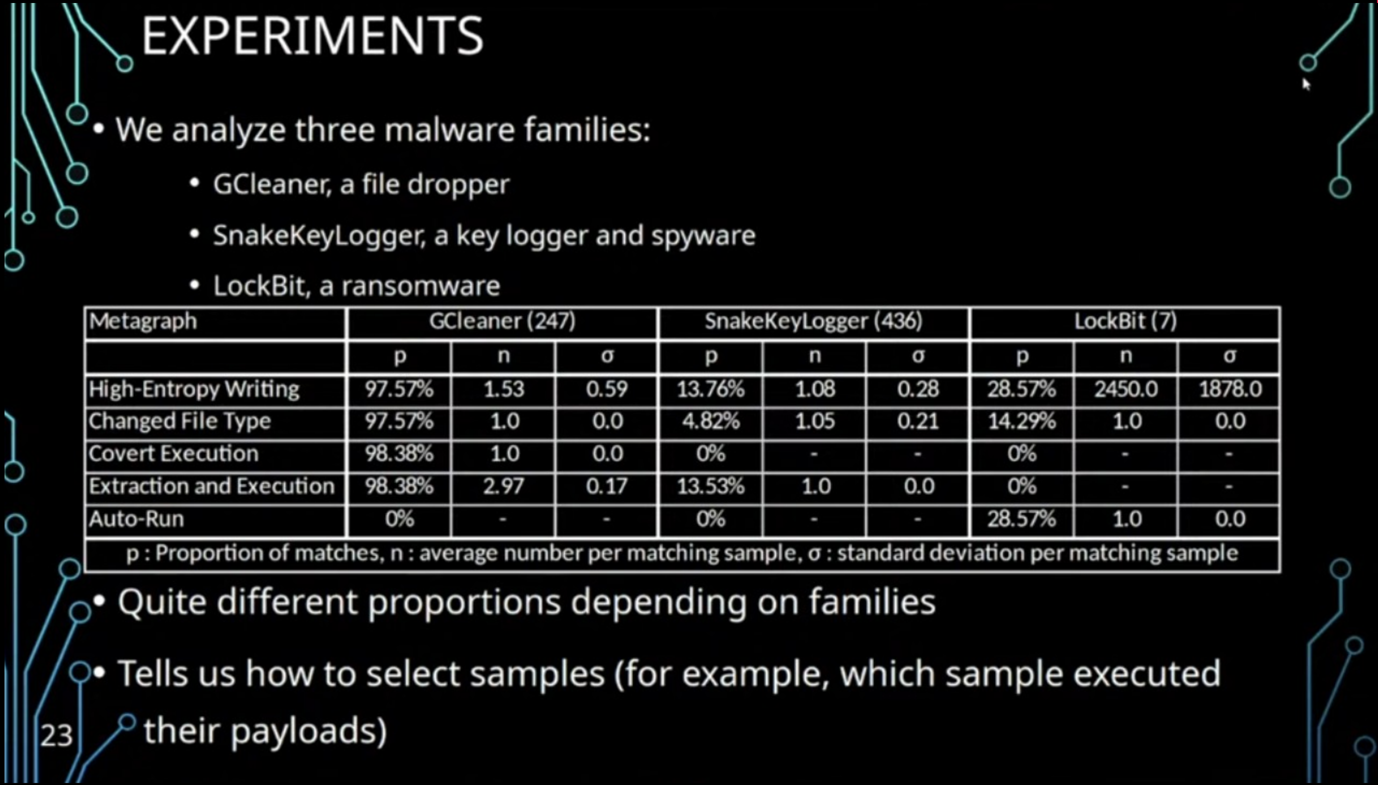
BAGUETTE EXAMPLE



METAGRAPH EXAMPLES


High Entropy Writing
Vertex[Diff](lambda x : x.written_entropy >= 6.0 and x.written_space > 0)
Edge[builder.source.types.data.IsDiffOf | builder.source.types.data.WritesInto]
Vertex[File]
Vertex[Diff]
Edge[builder.source.types.data.IsDiffOf | builder.source.types.data.WritesInto]
Vertex[Handle]
Edge[HasHandle]
Vertex[Process]
Edge[UsesFile]
Arrow[HasChildProcess]
Vertex[File]
Edge[Runs]
Vertex[Process]
Extraction and Execution
Vertex[Key](lambda x : x.parent_key is None and x.name.upper() in ('HKEY_LOCAL_MACHINE', 'HKEY_CURRENT_USER'))
Vertex[Key](lambda x : x.name.lower() == 'microsoft')
Arrow[HasSubKey]
Arrow[HasSubKey]
Arrow[HasSubKey]
Vertex[Key](lambda x : x.name.lower() == 'windows')
Auto-Run
Vertex[Key](lambda x : x.name.lower() == 'software')
Arrow[HasSubKey]
Vertex[Key](lambda x : x.name.lower() == 'currentversion')
Arrow[HasSubKey]
Vertex[Key](lambda x : x.name.lower() in ('run', 'runonce'))
Edge[HasEntry]
Vertex[KeyEntry]
Edge[SetsEntry]
Edge[ReferencesFileSystem]
Vertex[Handle]
Vertex[File]
Vertex[Process]
Edge[Runs]
Vertex[File](lambda x : x.extension not in ('exe', 'vbs', 'ps1'))
Covert Execution
Vertex[File]
Edge[IsDiffOf]
Vertex[Diff](lambda x : x.read_type != x.written_type)
Changed File Type



EXPERIMENTS

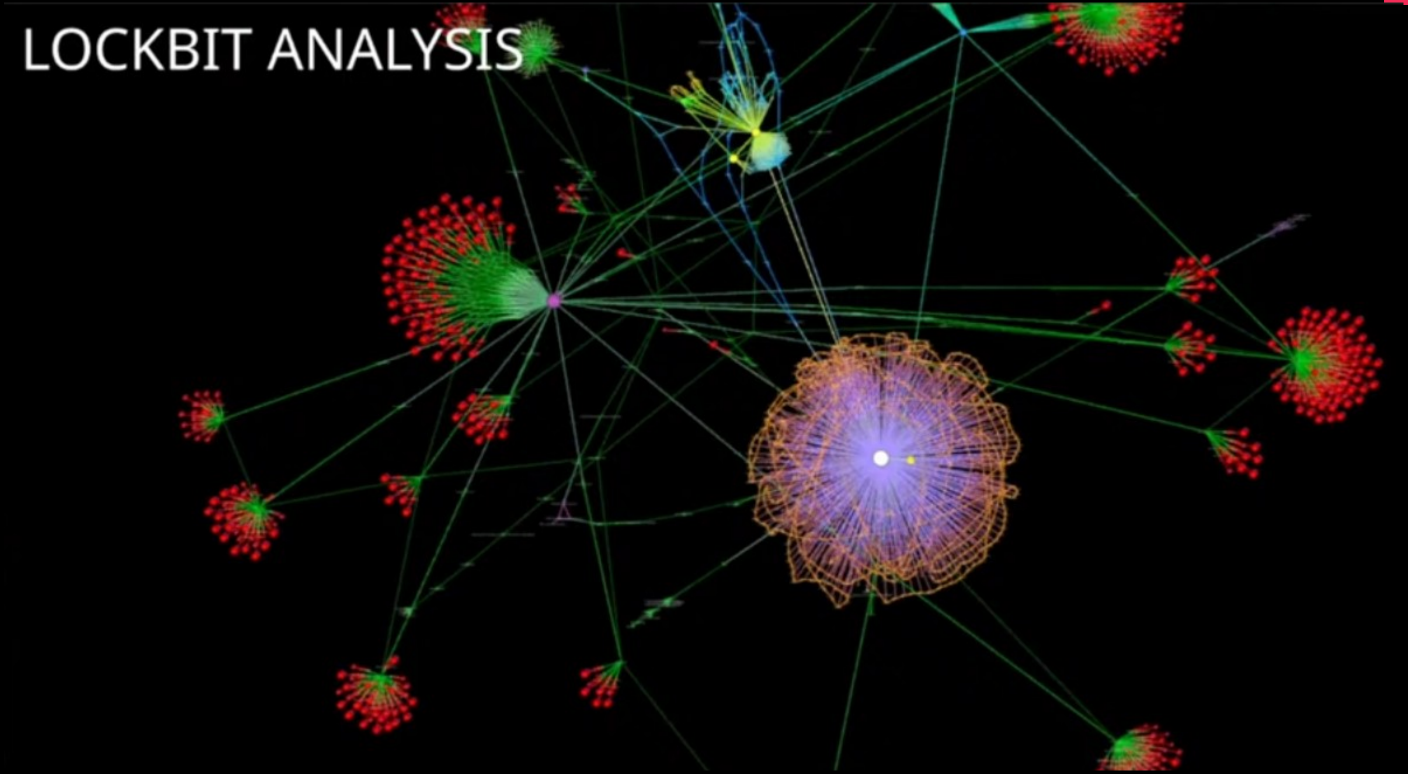
- We analyze three malware families:
  - GCleaner, a file dropper
  - SnakeKeyLogger, a key logger and spyware
  - LockBit, a ransomware

Metagraph	GCleaner (247)			SnakeKeyLogger (436)			LockBit (7)		
	p	n	σ	p	n	σ	p	n	σ
High-Entropy Writing	97.57%	1.53	0.59	13.76%	1.08	0.28	28.57%	2450.0	1878.0
Changed File Type	97.57%	1.0	0.0	4.82%	1.05	0.21	14.29%	1.0	0.0
Covert Execution	98.38%	1.0	0.0	0%	-	-	0%	-	-
Extraction and Execution	98.38%	2.97	0.17	13.53%	1.0	0.0	0%	-	-
Auto-Run	0%	-	-	0%	-	-	28.57%	1.0	0.0

p : Proportion of matches, n : average number per matching sample, σ : standard deviation per matching sample

- Quite different proportions depending on families
- Tells us how to select samples (for example, which sample executed their payloads)

BAGUETTE: Hunting for Evidence of Malicious Behavior
by Pierre-François Gimenez - INRIA Rennes


LOCKBIT ANALYSIS

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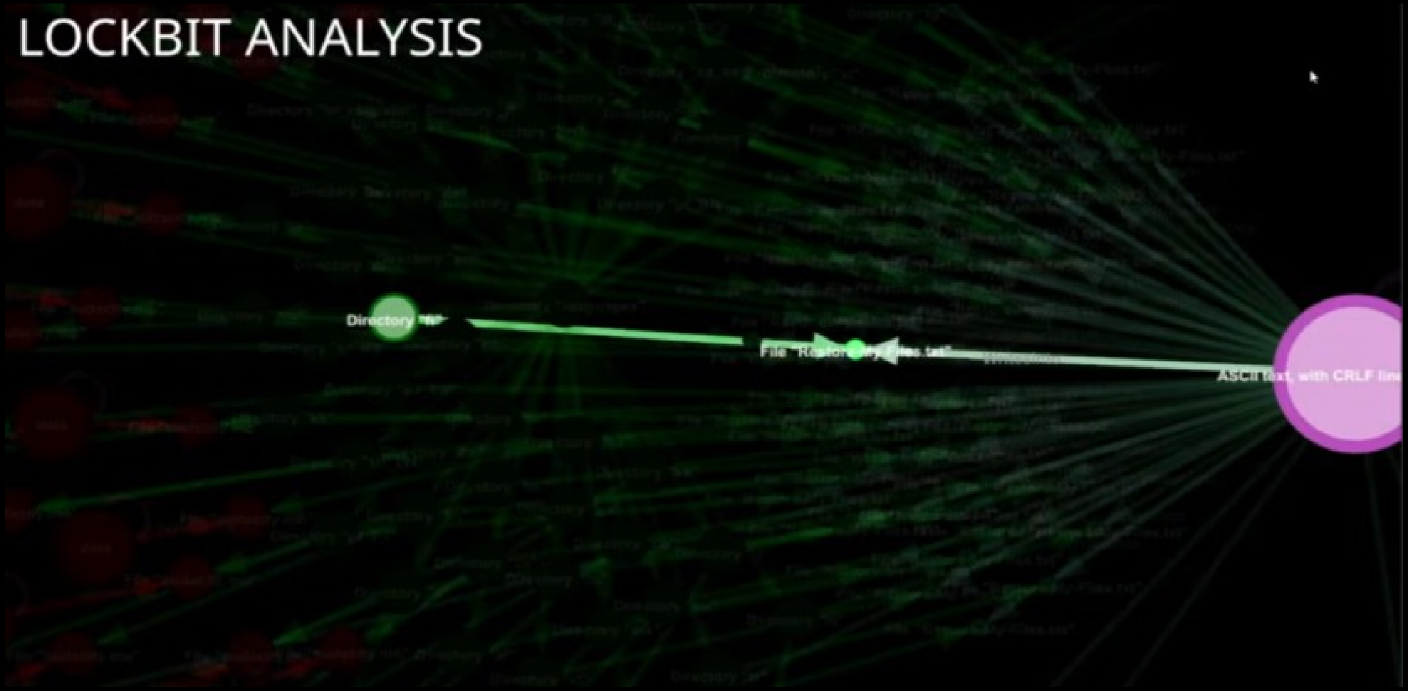

Conclusion

Points positifs :

- Permet de rencontrer des passionnés et pros du domaine
- Des intervenants de qualité
- Accessibilité

Points négatifs :

- L’organisation était moyenne (peu de capacité d’accueil)
- Certaines conférences peu claires (issues de la recherche)
- Qualité des conférences disparates

Ressources complémentaires

Baguette :

https://hal.science/hal-04102144/file/SECRYPT_2023%20%284%29.pdf

RootAsRole :

https://github.com/LeChatP/RootAsRole

Replay conférences :

https://www.youtube.com/@THCon/streams