LUKS Full Disk Encryption Upside-Down

Where full disk encryption do not do what you expected

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TLP:CLEAR

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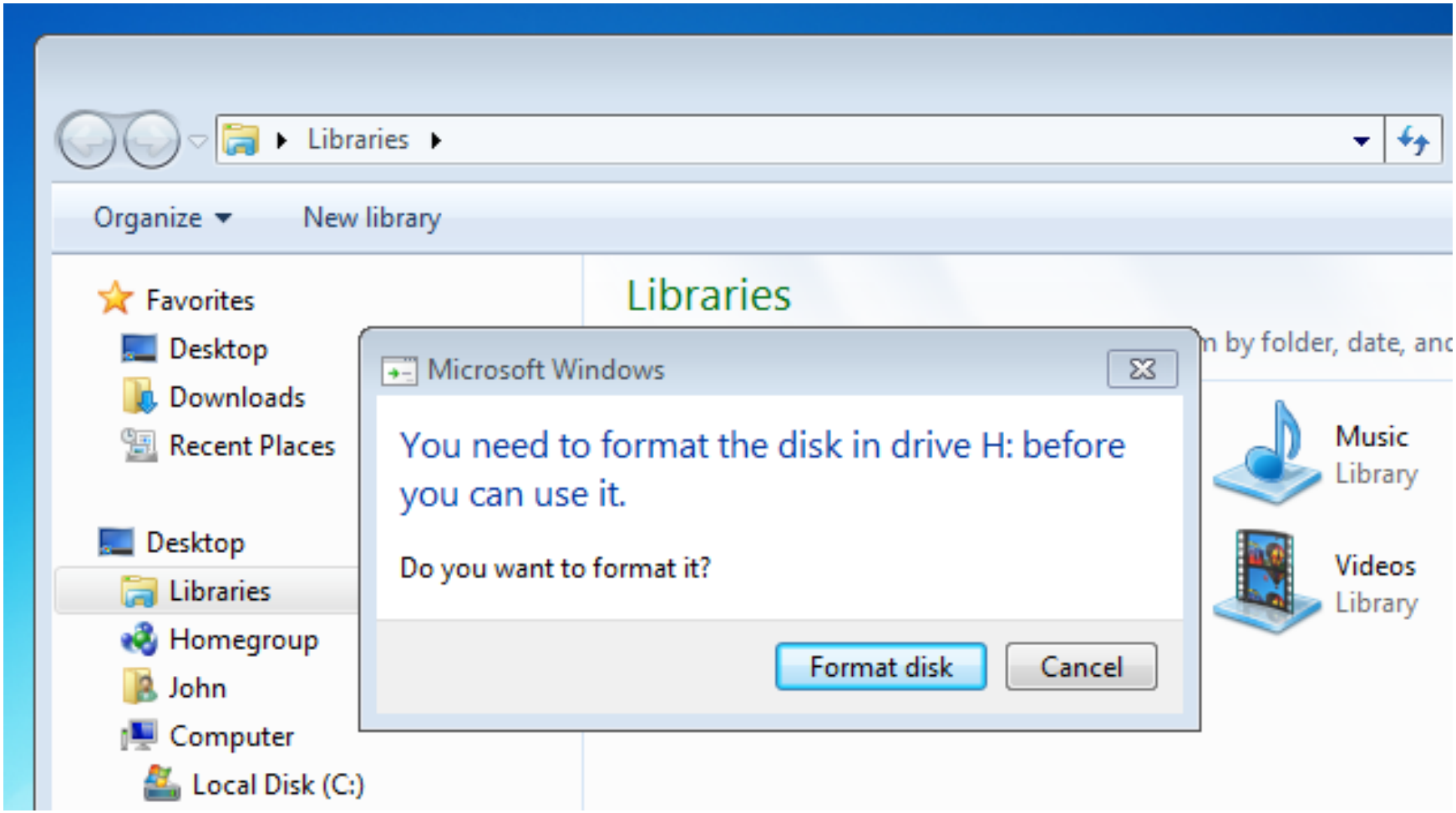
1. Create NTFS partition



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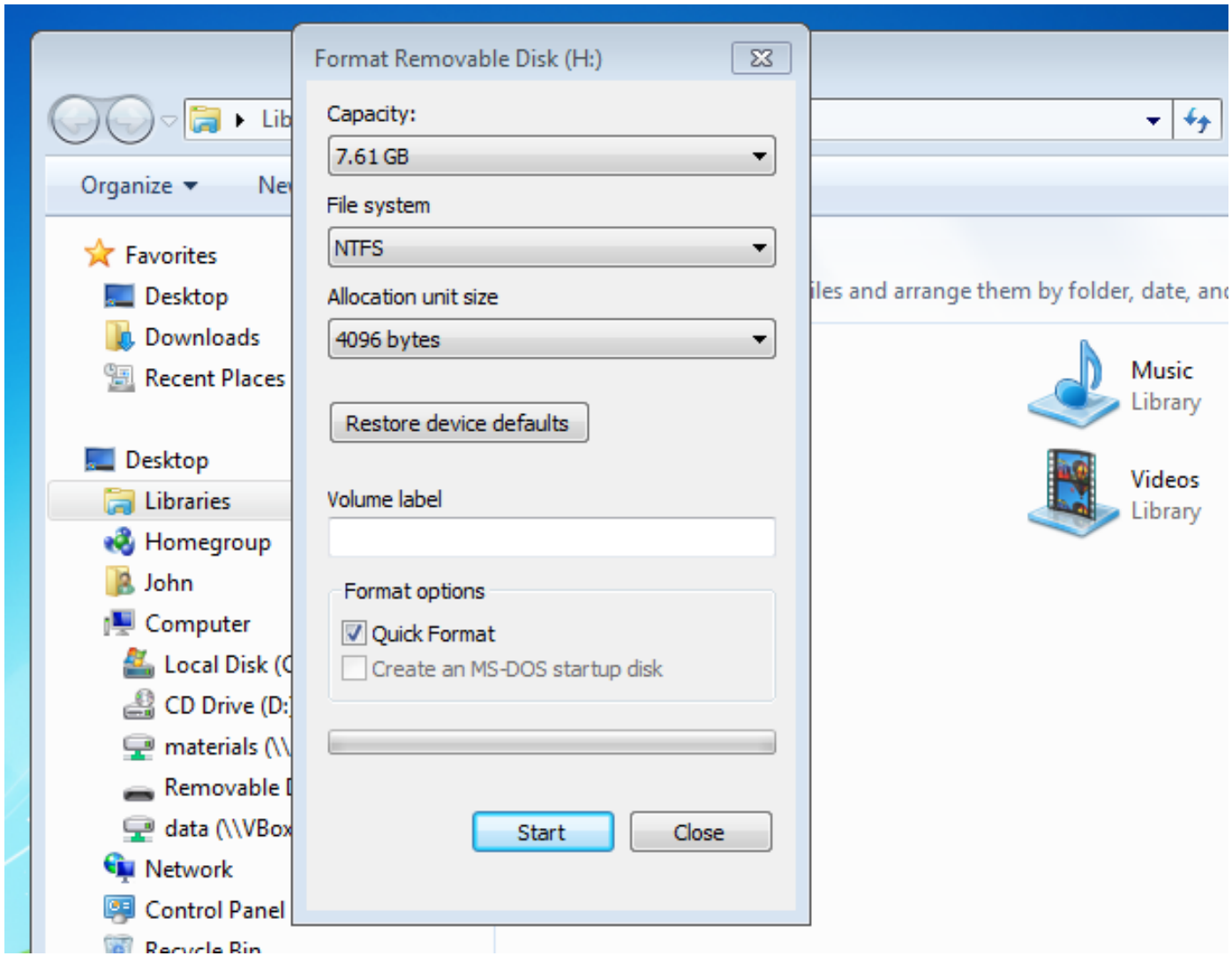
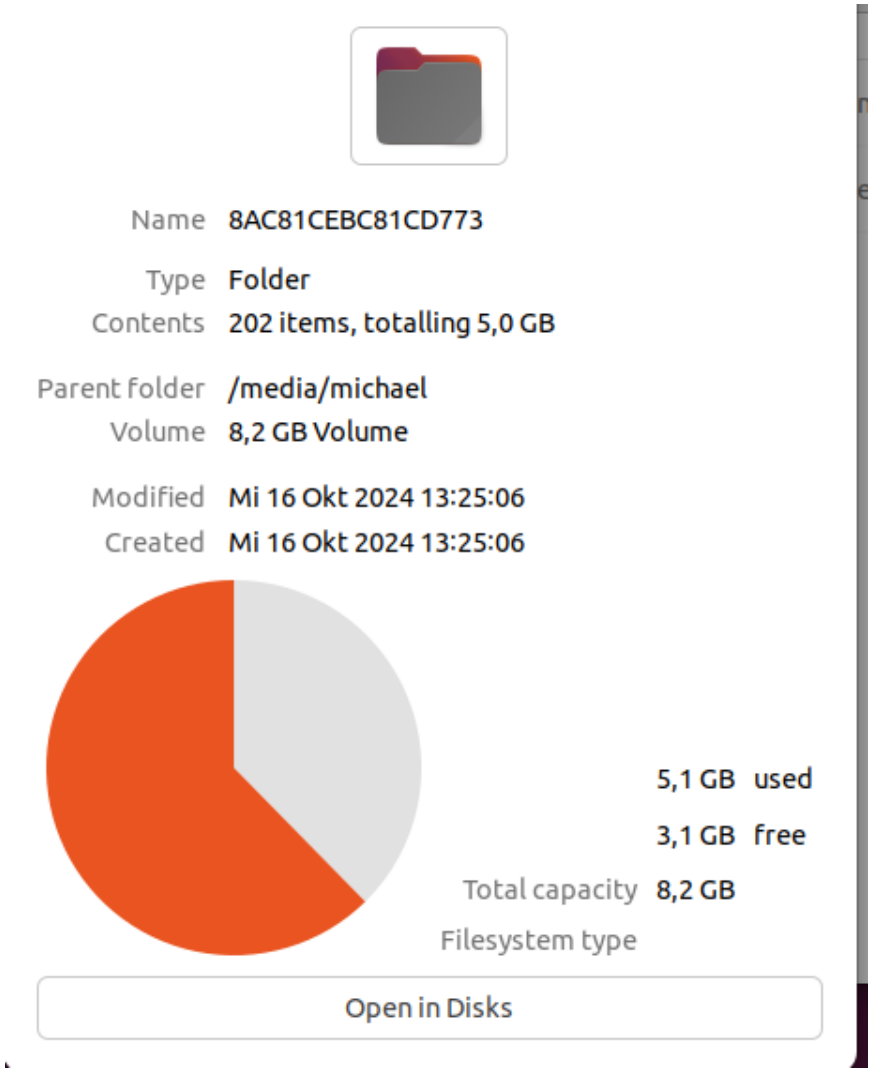


2 Create plaintext data



2 Create plaintext data

Create 100 very small files:

```
smallFiles
            00.txt        48 Byte
            01.txt        48 Byte
            ....
            ....
            99.txt        48 Byte
```

Create 100 large files:

```
bigFiles
            00.txt        48 MByte
            01.txt        48 MByte
            ....
            ....
            99.txt        48 MByte
```

Content:

```
My small secret message is 01234567890987654321
```

Hide content somewhere:

```
echo -n "My small secret message is 01234567890987654321" | dd of=/dev/sda seek=10
```

3 Re-format the disk

Create partition table (default parameter):

```
umount /dev/sda
fdisk /dev/sda
                        d d d d
                        n
                        w
fdisk -l /dev/sda

        Device     Boot Start       End   Sectors  Size Id Type
        /dev/sda1         2048 15974399 15972352  7,6G 83 Linux
```

Activate full disk encryption:

```
cryptsetup luksFormat /dev/sda1

        WARNING!
        ========
        This will overwrite data on /dev/sda1 irrevocably.

        Are you sure? (Type 'yes' in capital letters): YES
```

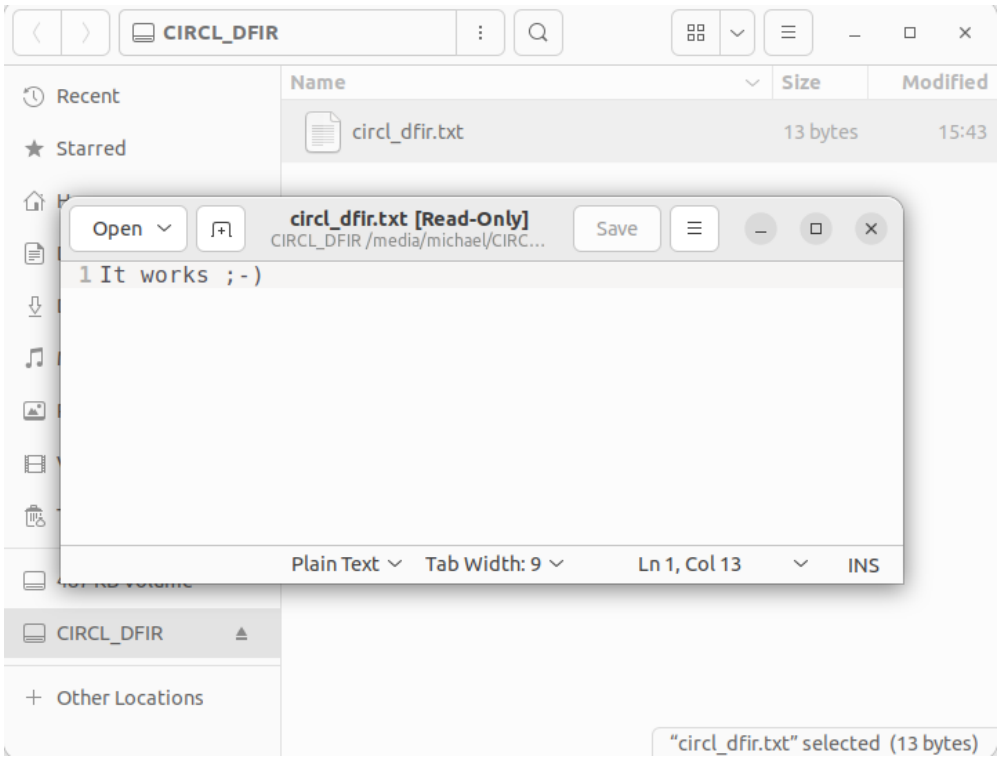
Create file system:

```
cryptsetup luksOpen /dev/sda1 myusb
mkfs.ext4 /dev/mapper/myusb -L CIRCL_DFIR
cryptsetup luksClose myusb
```

3 Re-format the disk

Mount encrypted partition and create a file:

```
echo "It works ;-)" > /media/michael/CIRCL_DFIR/circl_dfir.txt
```



Unmount encrypted partition:

```
umount /media/michael/CIRCL_DFIR/
cryptsetup luksClose luks-01b0d6a2-...........
```

4 Launch investigation

Create a forensic copy:

```
dd if=/dev/sda of=2_ext4.raw bs=$((4*4096)) status=progress
```

Read partition table:

```
fdisk -l 2_ext4.raw
```

```
Device       Boot Start      End  Sectors  Size Id Type
2_ext4.raw1        2048 15974399 15972352  7,6G 83 Linux
```

Analyze the MBR:

```
dd if=2_ext4.raw count=1 | xxd | less
```

```
00000000: eb52 904e 5446 5320 2020 2000 0208 0000  .R.NTFS    .....
00000010: 0000 0000 00f8 0000 3f00 ff00 0000 0000  ........?.......
.....
.....
000001b0: 4752 2069 7320 6d69 7373 696e 6700 0021  GR is missing..!
000001c0: 0300 836b e6fe 0008 0000 00b8 f300 0000  ...k............
000001d0: 0000 0000 0000 0000 0000 0000 0000 0000  ................
000001e0: 0000 0000 0000 0000 0000 0000 0000 0000  ................
000001f0: 0000 0000 0000 0000 0000 0000 0000 55aa  ..............U.
```

4 Launch investigation

What about our hidden message at secotor 11:

```
dd if=2_ext4.raw skip=10 count=1 | xxd | less
```

```
00000000: 4d79 2073 6d61 6c6c 2073 6563 7265 7420  My small secret
00000010: 6d65 7373 6167 6520 6973 2030 3132 3334  message is 01234
00000020: 3536 3738 3930 3938 3736 3534 3332 3100  567890987654321.
00000030: 0000 0000 0000 0000 0000 0000 0000 0000  ................
00000040: 0000 0000 0000 0000 0000 0000 0000 0000  ................
.....
.....
```

Analyze the 1th sector of the partition:

```
dd if=2_ext4.raw skip=2048 | xxd | less
```

```
00000000: 4c55 4b53 babe 0002 0000 0000 0000 4000  LUKS..........@.
00000010: 0000 0000 0000 0003 0000 0000 0000 0000  ................
00000020: 0000 0000 0000 0000 0000 0000 0000 0000  ................
00000030: 0000 0000 0000 0000 0000 0000 0000 0000  ................
00000040: 0000 0000 0000 0000 7368 6132 3536 0000  ........sha256..
.....
.....
```

4 Launch investigation

Scroll down to the first data:

```
dd if=2_ext4.raw skip=2048 | xxd | less
```

```
00008000: 5144 6c6c 2d71 d434 47cf 31c3 ba28 92b1  QDll-q.4G.1..(..
00008010: 3c44 bacb 4ea2 29b6 0a13 dda0 f846 f563  <D..N.).....F.c
00008020: 5e6c eda0 1dcc a58d 5202 edda 47d7 cf34  ^l......R...G..4
00008030: ab02 7e8b 3c4b acb2 ecf3 3911 29e6 453f  ..~.<K....9.).E?
00008040: d222 c53e 1d1f b959 6ac6 f789 495d 75fd  ."."."."."."."."
.....
.....
```

Scroll down ≈52 MByte:

```
dd if=2_ext4.raw skip=2048 | xxd | less
```

```
033e3fd0: d834 f1e0 844a 0dc8 d900 41f2 3142 a20f  .4...J....A.1B..
033e3fe0: 0e7c b383 faca 8549 0ed9 a30b cd6e 7d13  .|.....I.....n}.
033e3ff0: bc82 a73b 9078 67a5 db05 61b8 bd68 77fc  ...;.xg...a..hw.
033e4000: 4d79 2073 6d61 6c6c 2073 6563 7265 7420  My small secret
033e4010: 6d65 7373 6167 6520 6973 2030 3132 3334  message is 01234
033e4020: 3536 3738 3930 3938 3736 3534 3332 310a  567890987654321.
033e4030: 4d79 2073 6d61 6c6c 2073 6563 7265 7420  My small secret
.....
```

5 Conclusion

- MBR is not encrypted
- Space outside the partition is not encrypted
- Other partitions on the disk are not encrypted

$\rightarrow$ Misleading term: Full Disk Encryption

- Encryption is applied in 52 MByte chunks
- Encrypted area is growing with more data stored over time
- Without wiping old data stay on the disk until overwritten

$\rightarrow$ You need to wipe before using Full Disk Encryption