Mandos

https://www.recompile.se/mandos

Disk encryption is essential for physical computer security, but seldom used due to the trouble of remembering and typing a password at every restart. We describe Mandos, a program which solves this problem, its security model, and the underlying concepts of its design.

Any security system must have a clear view of its intended threat model – i.e. what threats it is actually intended to protect against; the specific choices and tradeoffs made for Mandos will be explained. Another danger of security system design is the risk of its non-use; i.e. that the system will not be used for some real or perceived drawbacks, such as complexity. The deliberate design choices of Mandos, involving low-interaction, "invisible" and automatic features, will be covered.

```
pub   4096R/CA34C2C4 2013-10-05
      Key fingerprint = 153A 37F1 0BBA 0435 987F  2C4A 7223 2973 CA34 C2C4
uid                  Mandos Maintainer Team <mandos@recompile.se>
```

Mandos

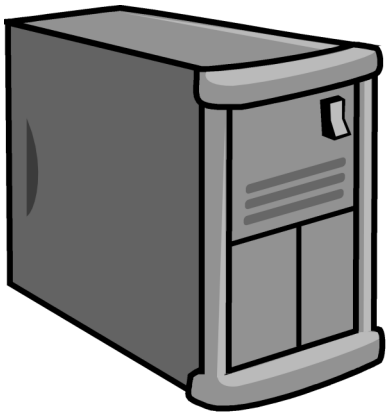
https://www.recompile.se/mandos

TL;DL

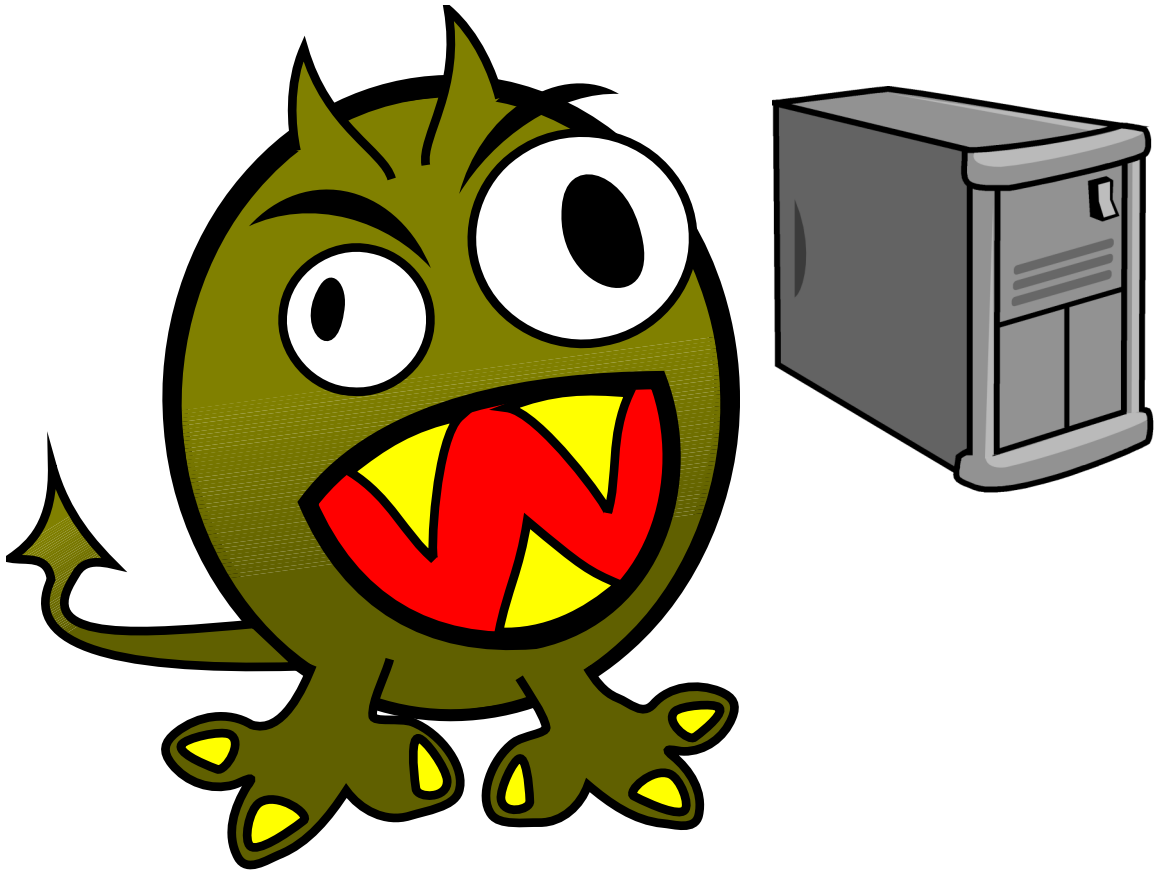
```
aptitude install mandos
aptitude install mandos-client
```

Threat Model

Threat Model

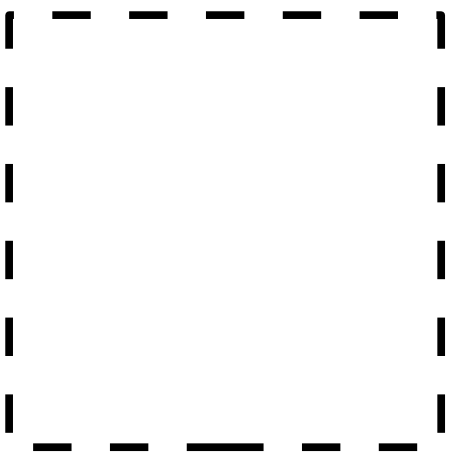


Threat Model

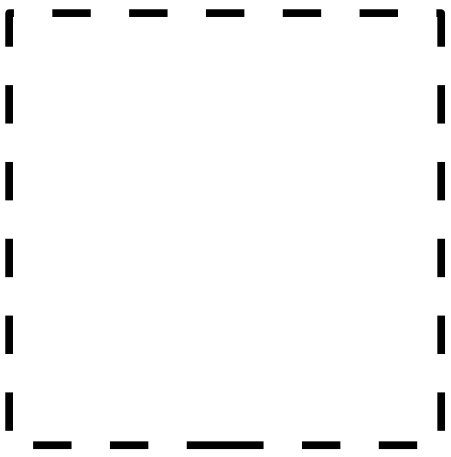


Threat Model

Threat Model

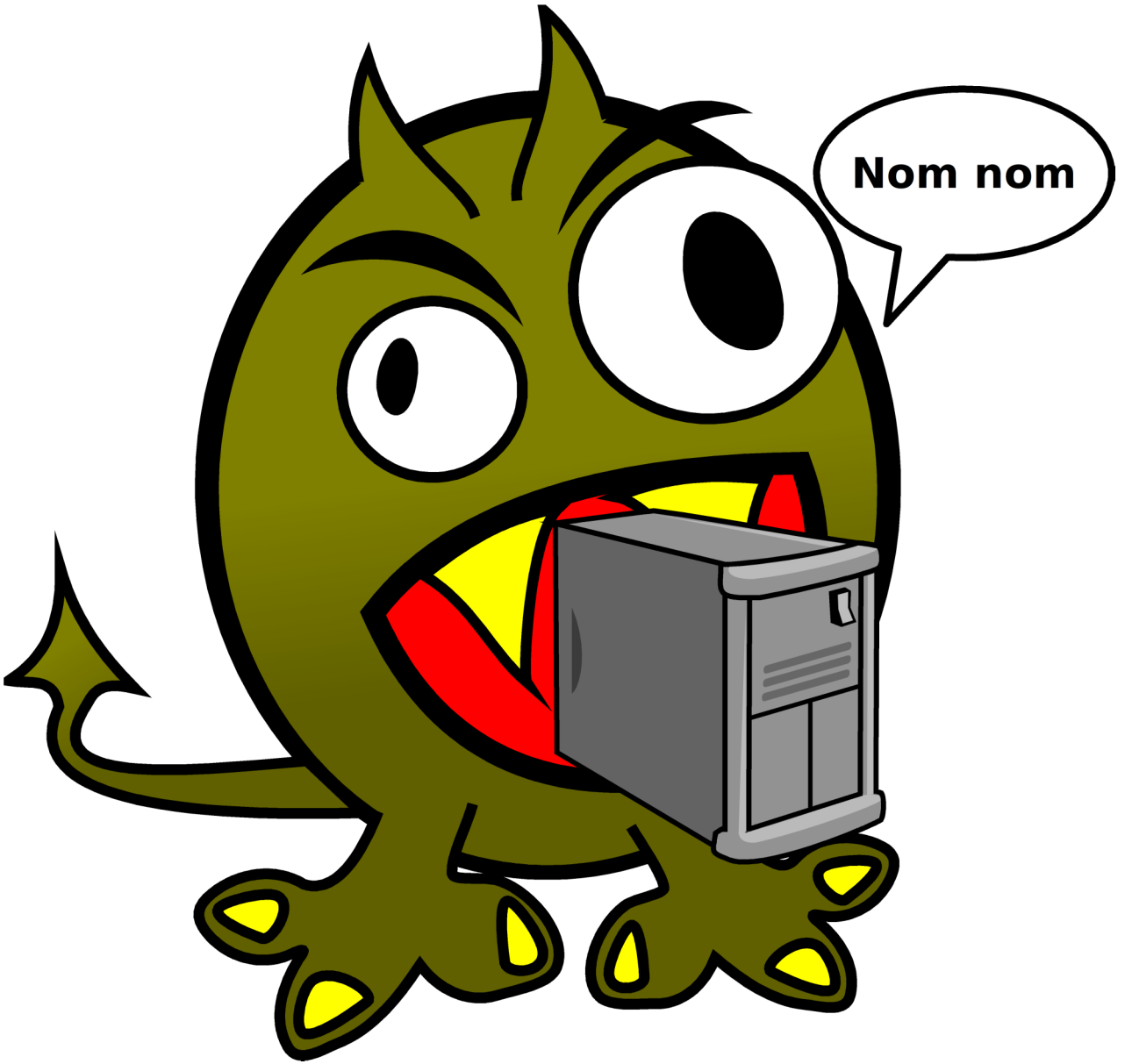


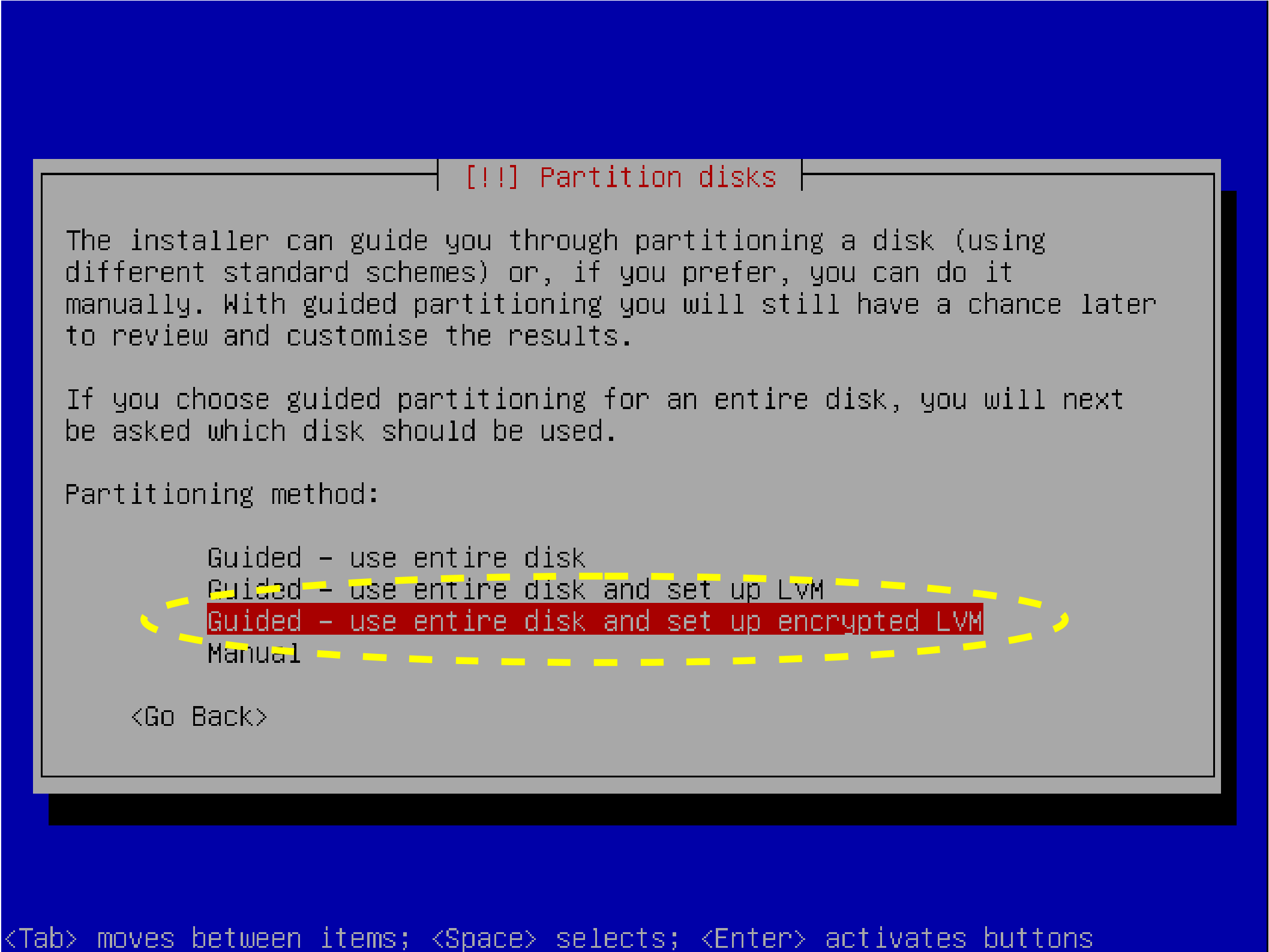
Threat Model

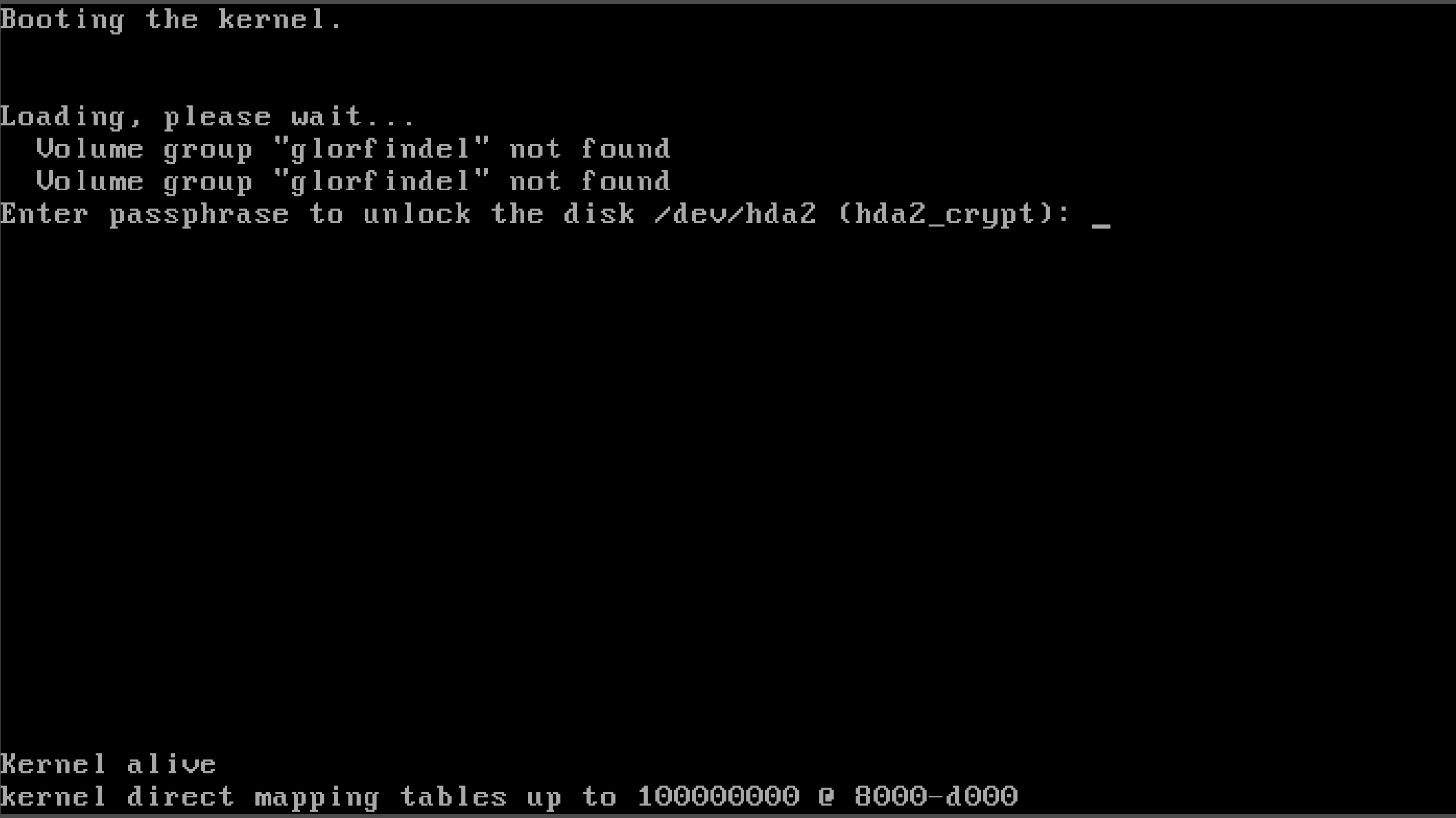


No Server

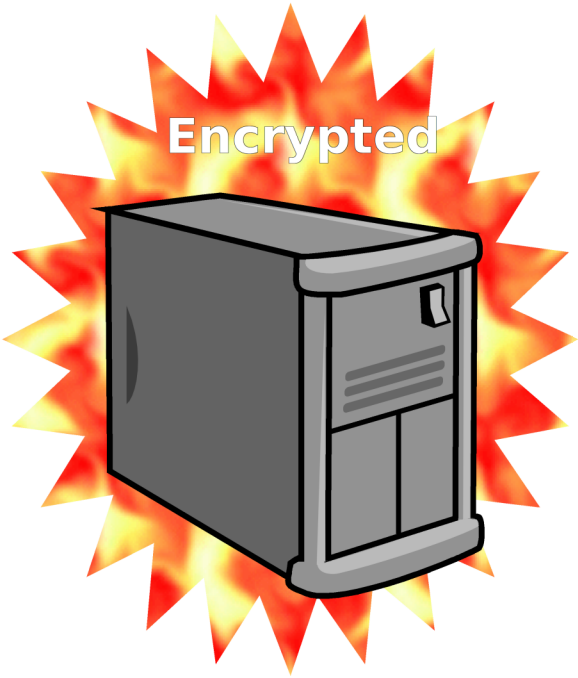
Threat Model




[!!] Partition disks
The installer can guide you through partitioning a disk (using different standard schemes) or, if you prefer, you can do it manually. With guided partitioning you will still have a chance later to review and customise the results.
If you choose guided partitioning for an entire disk, you will next be asked which disk should be used.
Partitioning method:
Guided - use entire disk
Guided - use entire disk and set up LVM
Guided - use entire disk and set up encrypted LVM
Manual
<Go Back>
<Tab> moves between items; <Space> selects; <Enter> activates buttons


Booting the kernel.
Loading, please wait...
Volume group "glorfindel" not found
Volume group "glorfindel" not found
Enter passphrase to unlock the disk /dev/hda2 (hda2_crypt): _
Kernel alive
kernel direct mapping tables up to 100000000 @ 8000-d000

Threat Model



New threat: non-use

Inconvenient
Burdensome
"I'll do it some day"

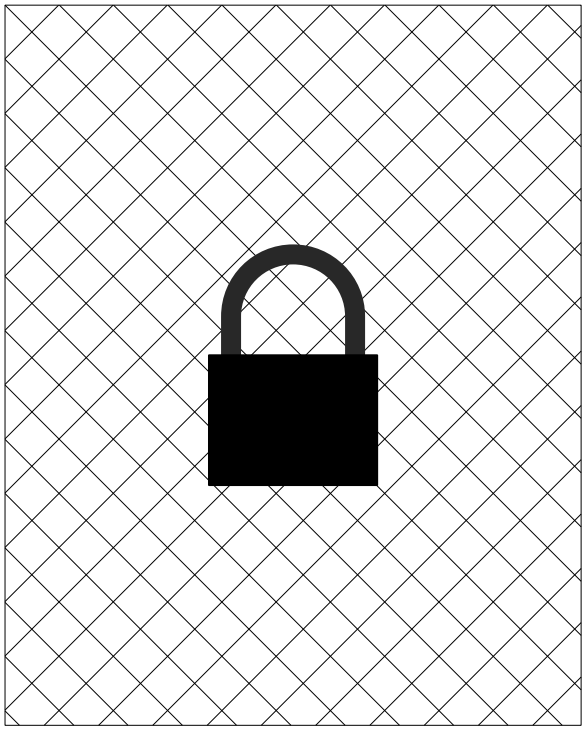
New threat:

Security needs to be transparent

Full Disk Encryption

/boot

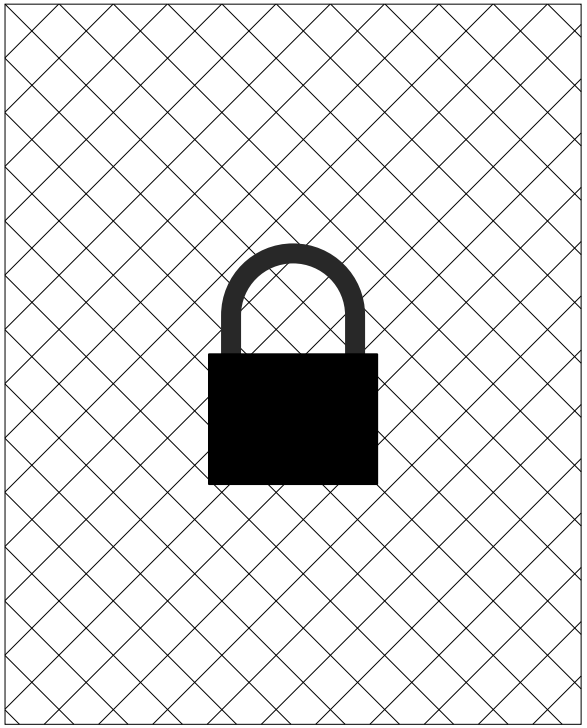
(rest of disk)



Full Disk Encryption

/boot

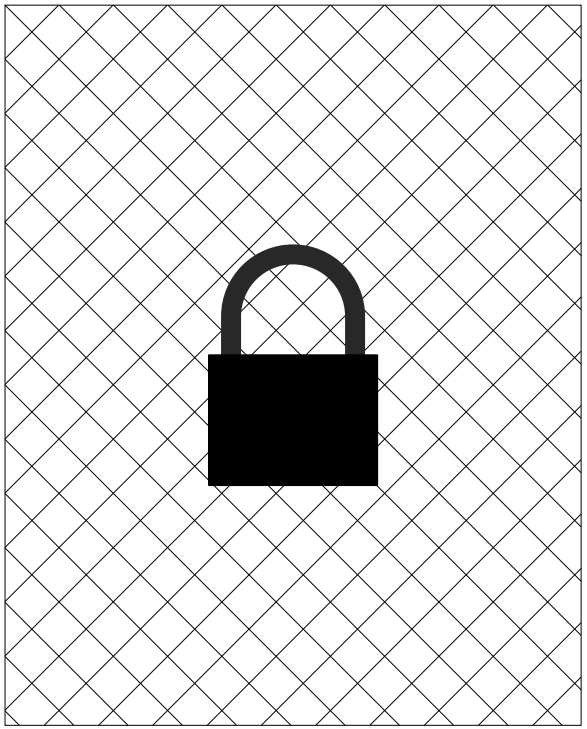
(rest of disk)



Full Disk Encryption

/boot

(rest of disk)



Full Disk Encryption

/boot

(rest of disk)

Mandos

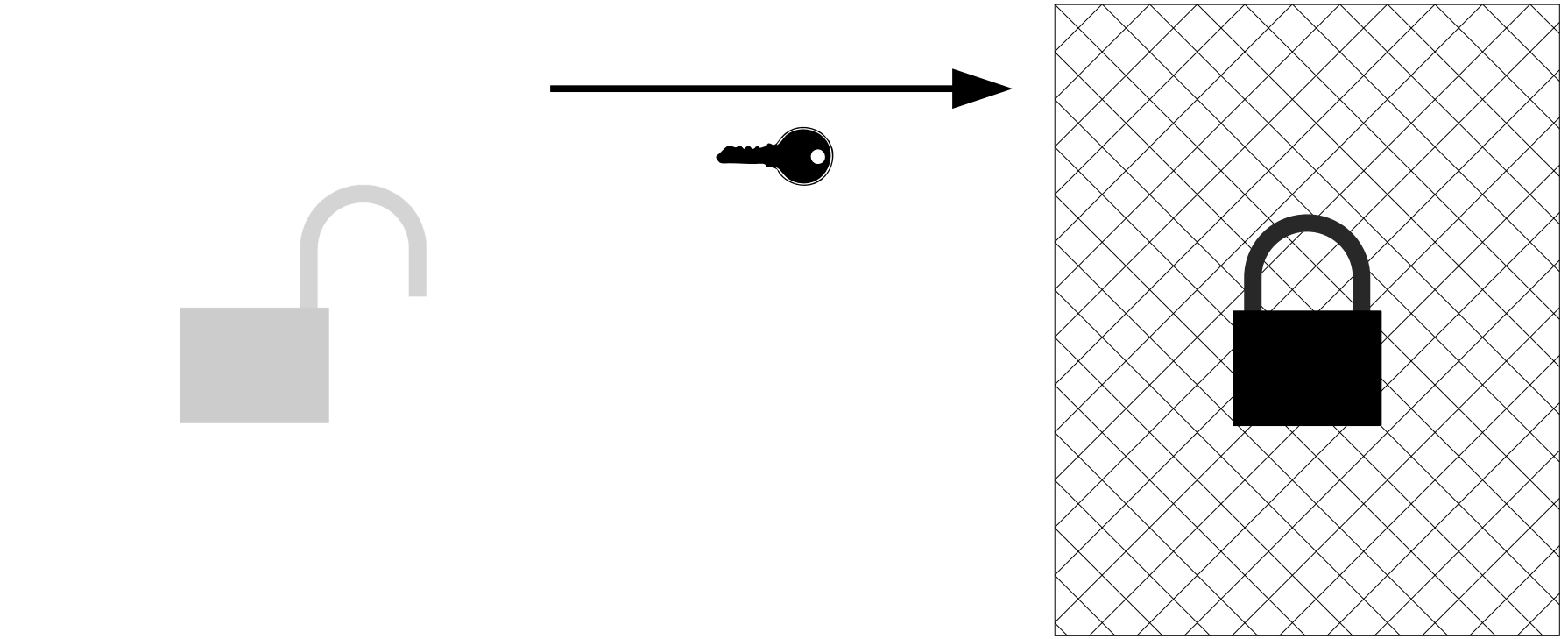
http://www.recompile.se/mandos

Servers provide passwords to each other

Mandos

https://www.recompile.se/mandos

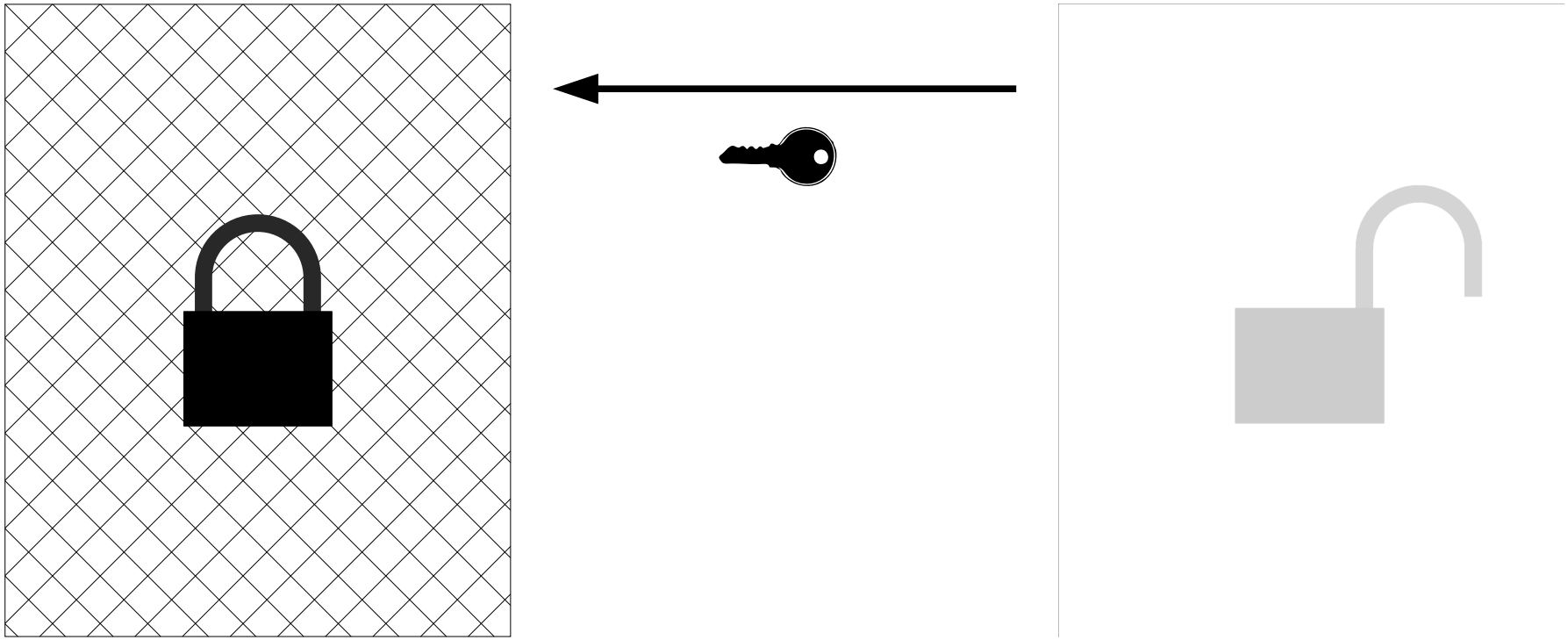
Normal operation



Mandos

https://www.recompile.se/mandos

Normal operation

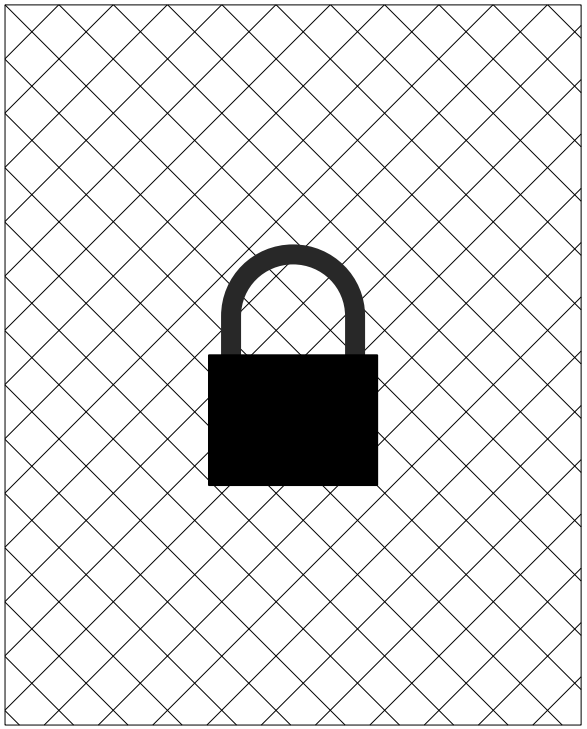


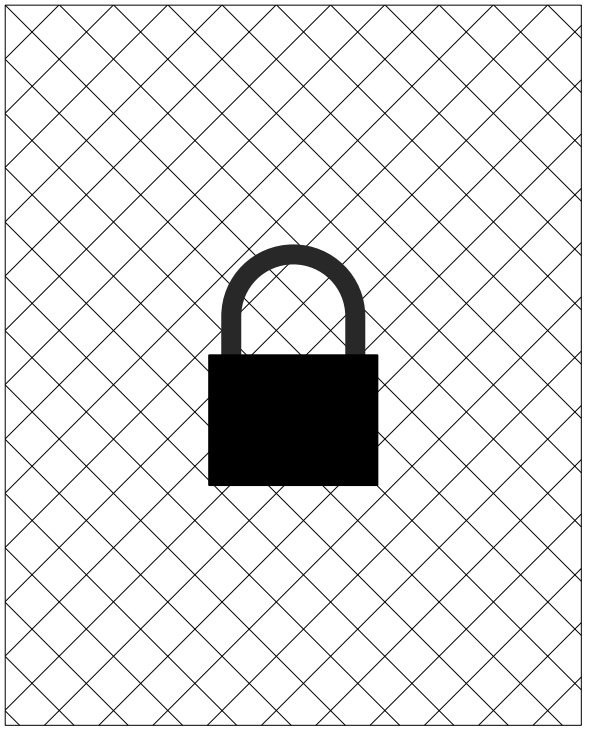
Mandos

https://www.recompile.se/mandos

Lockdown state

Administrator attention required



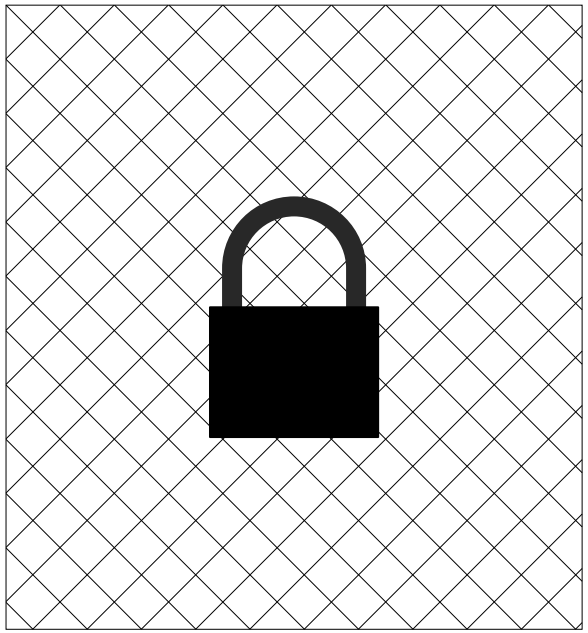


Mandos

https://www.recompile.se/mandos

/boot

(rest of disk)

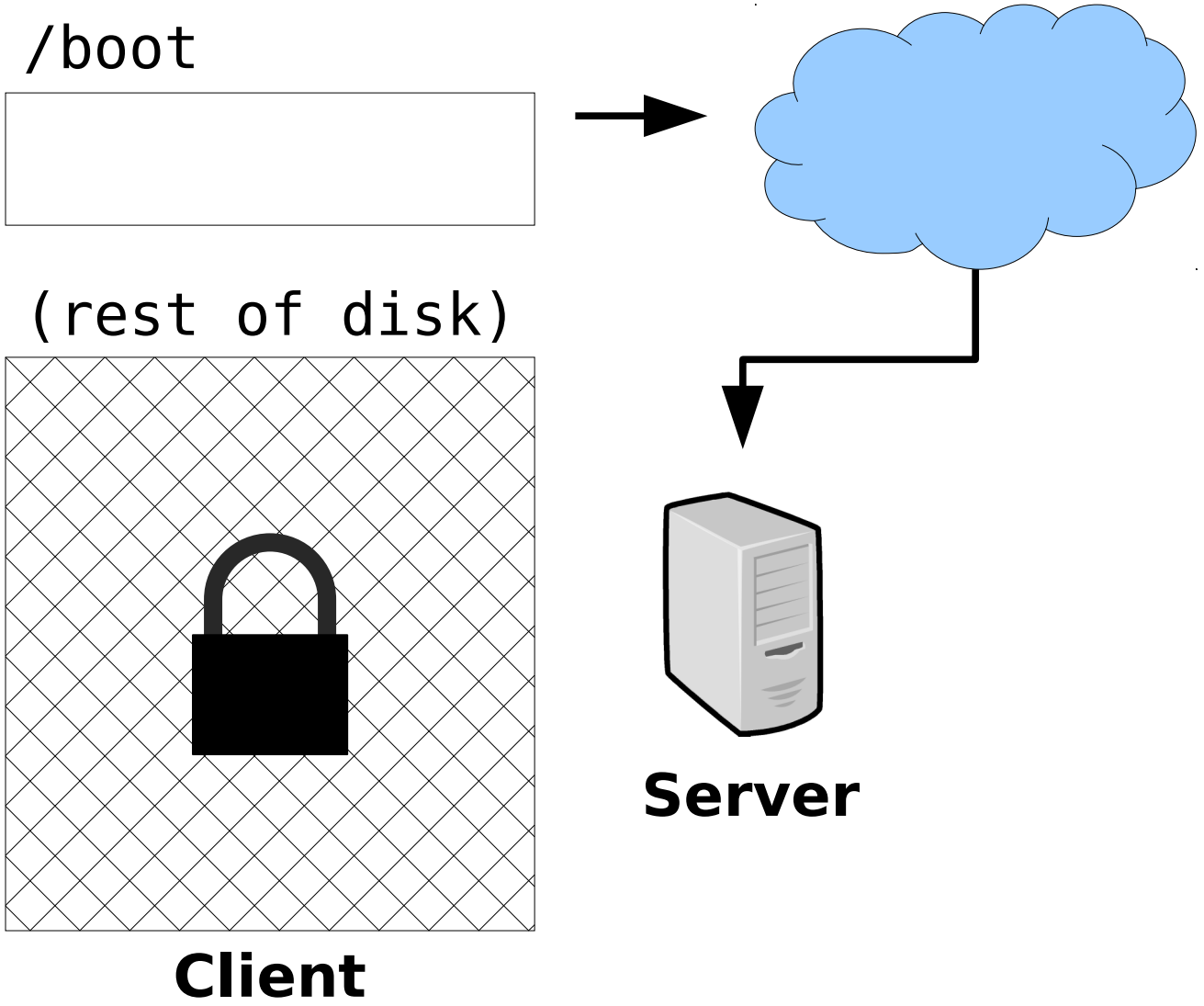


Client

Server

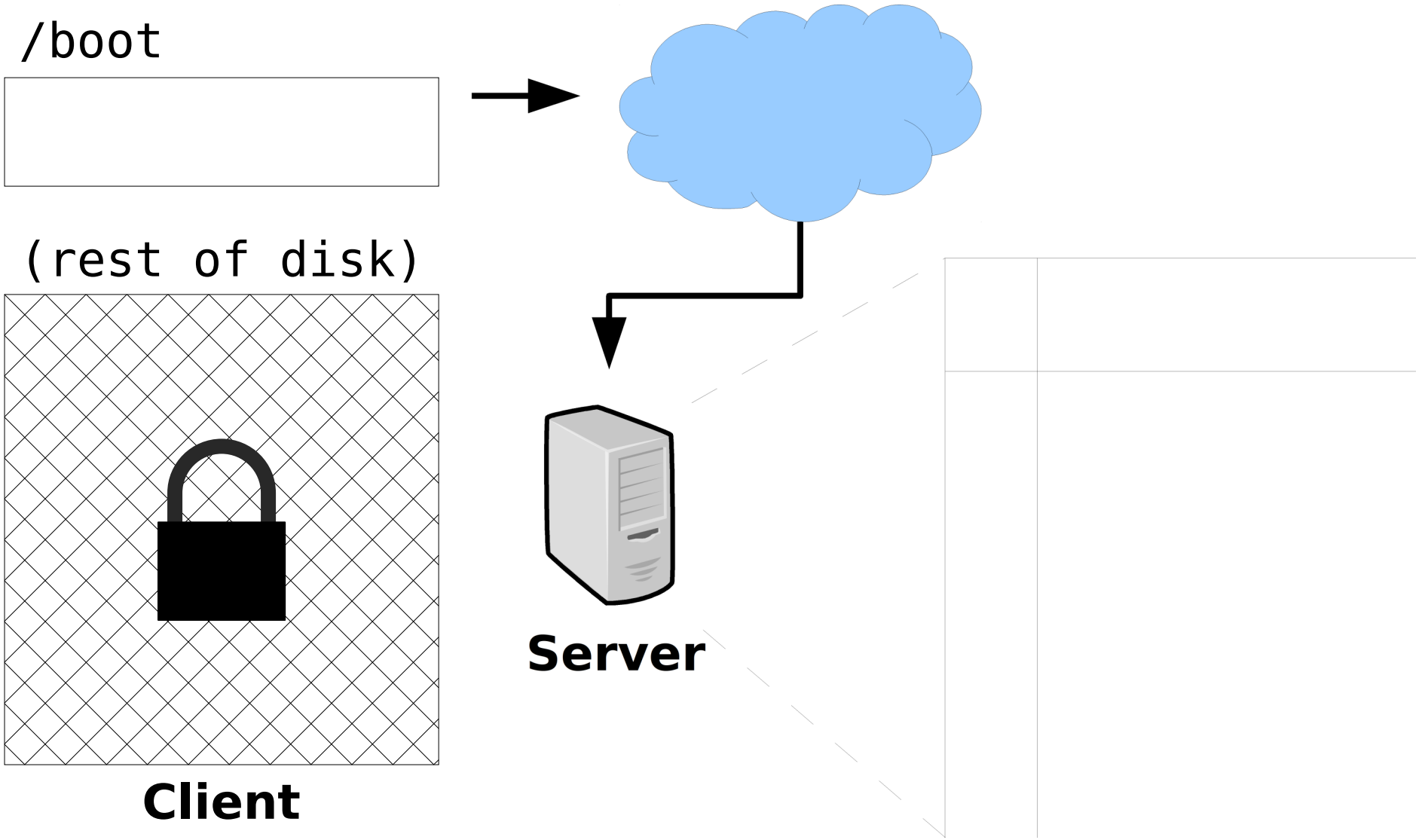
Mandos

https://www.recompile.se/mandos



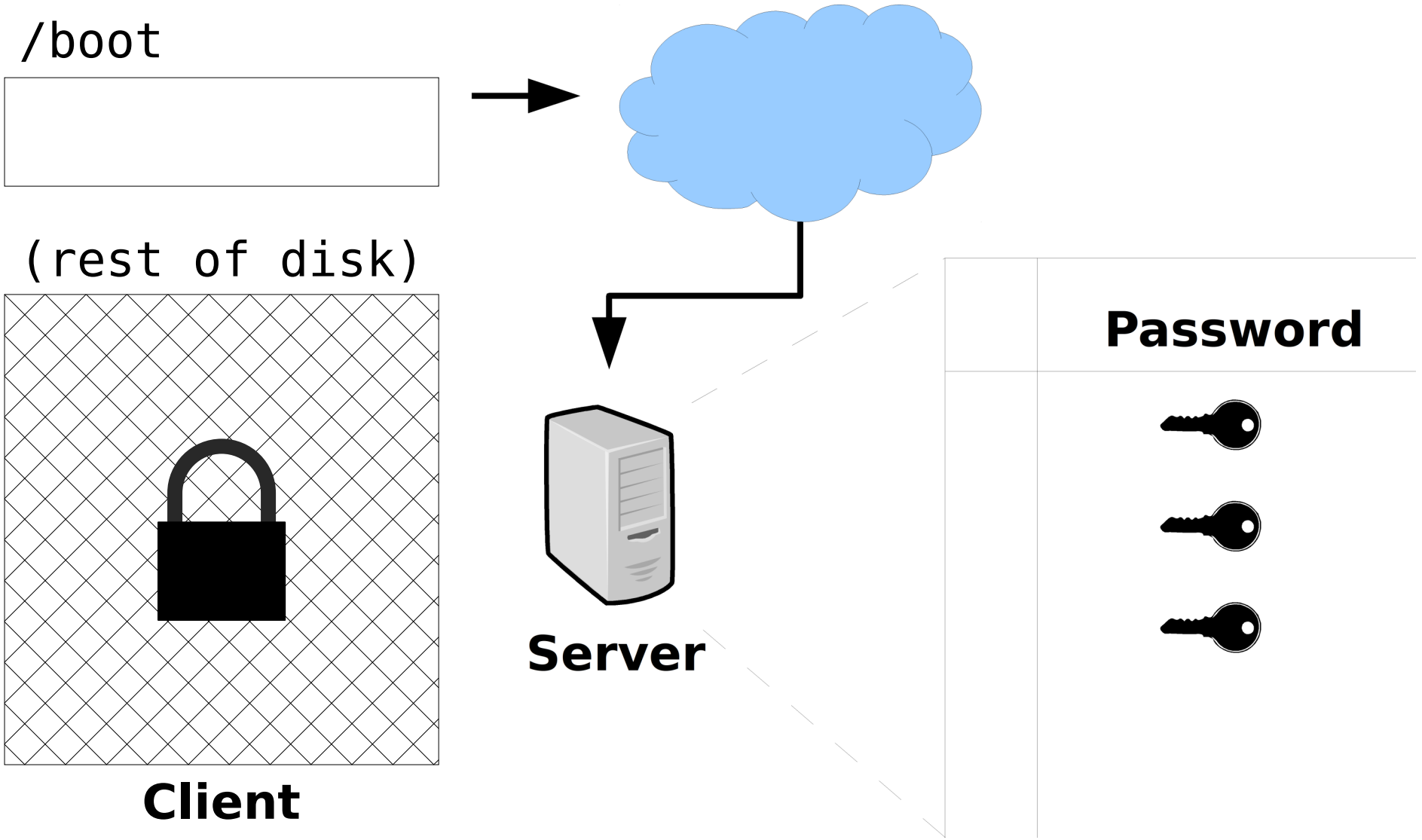
Mandos

https://www.recompile.se/mandos



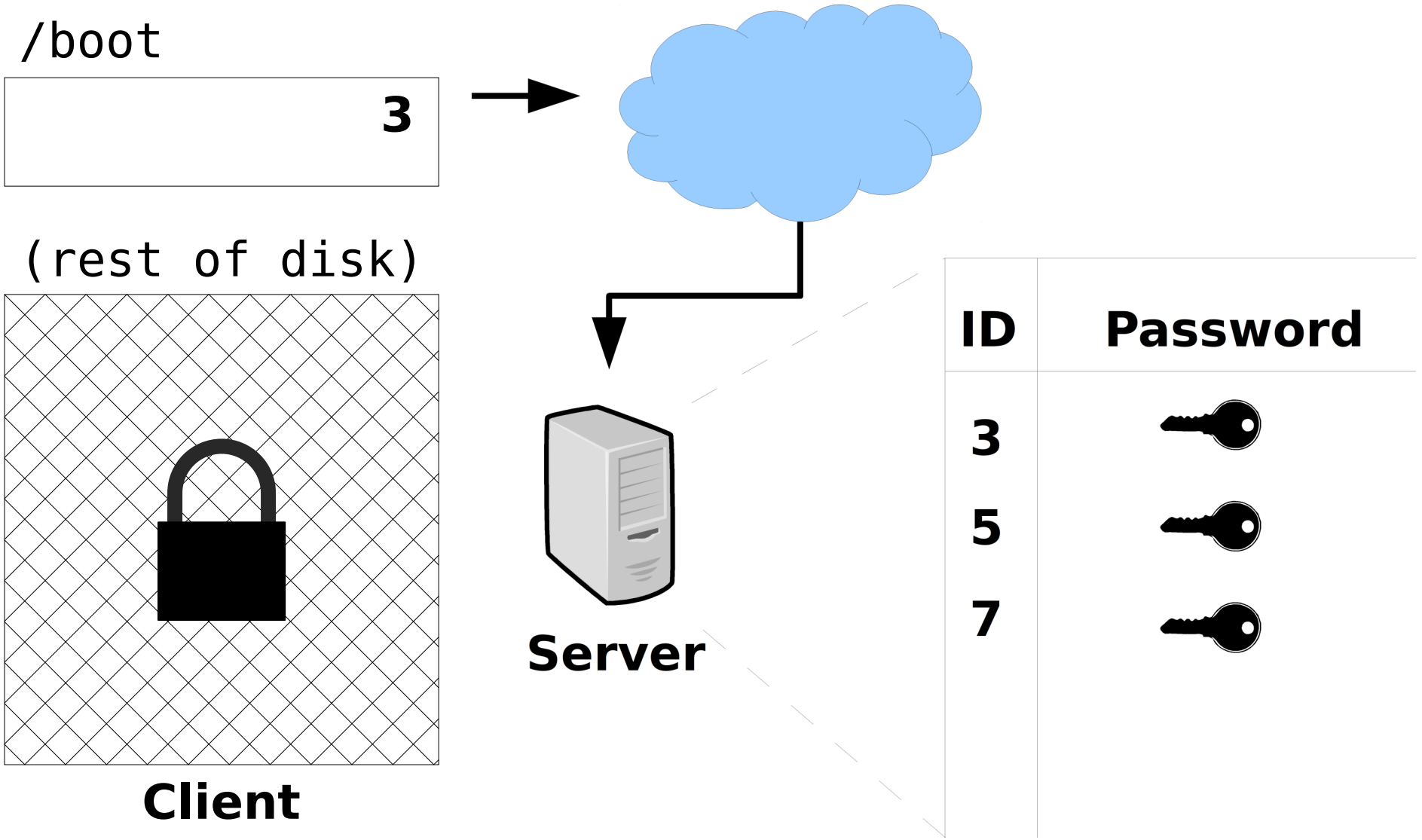
Mandos

https://www.recompile.se/mandos



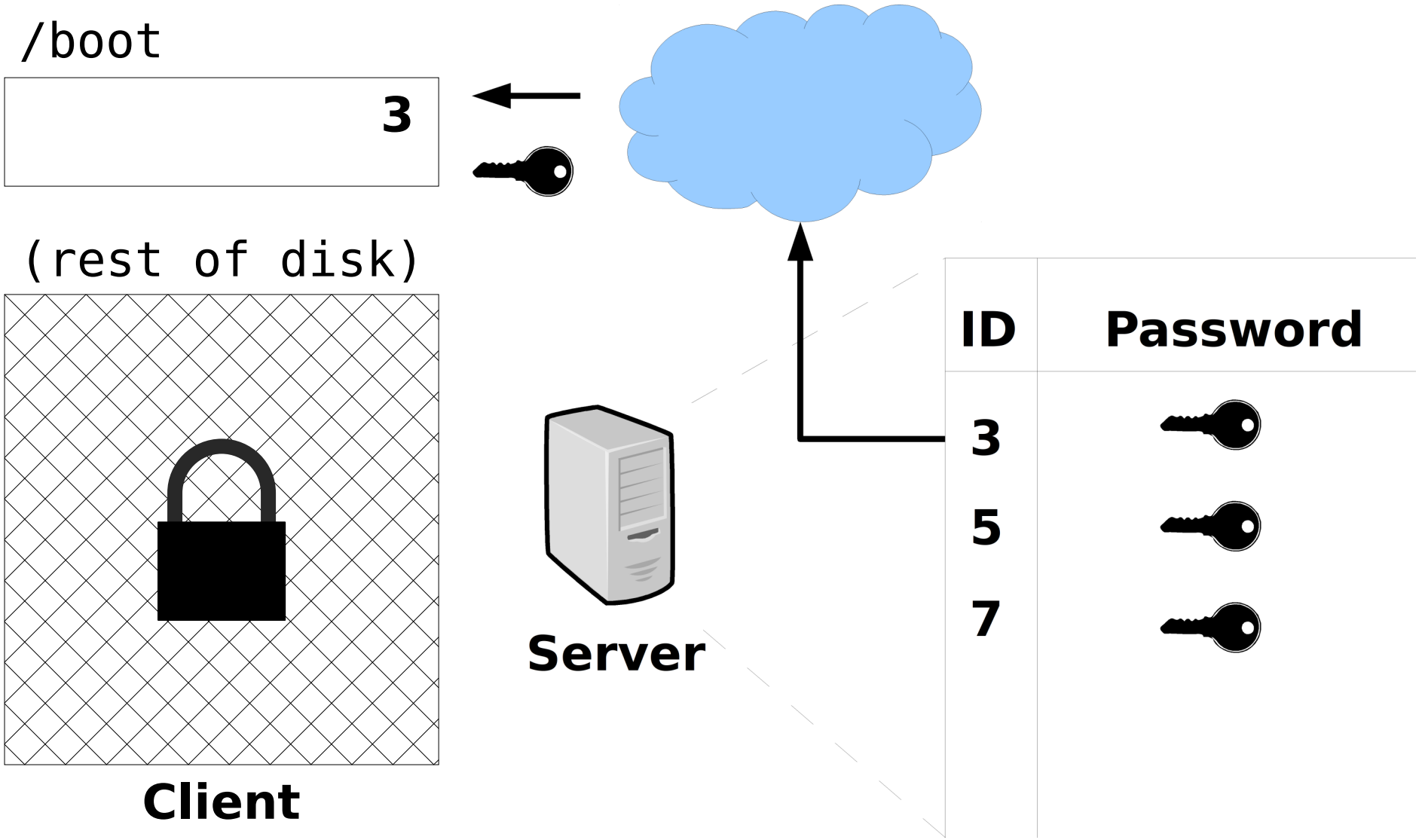
Mandos

https://www.recompile.se/mandos



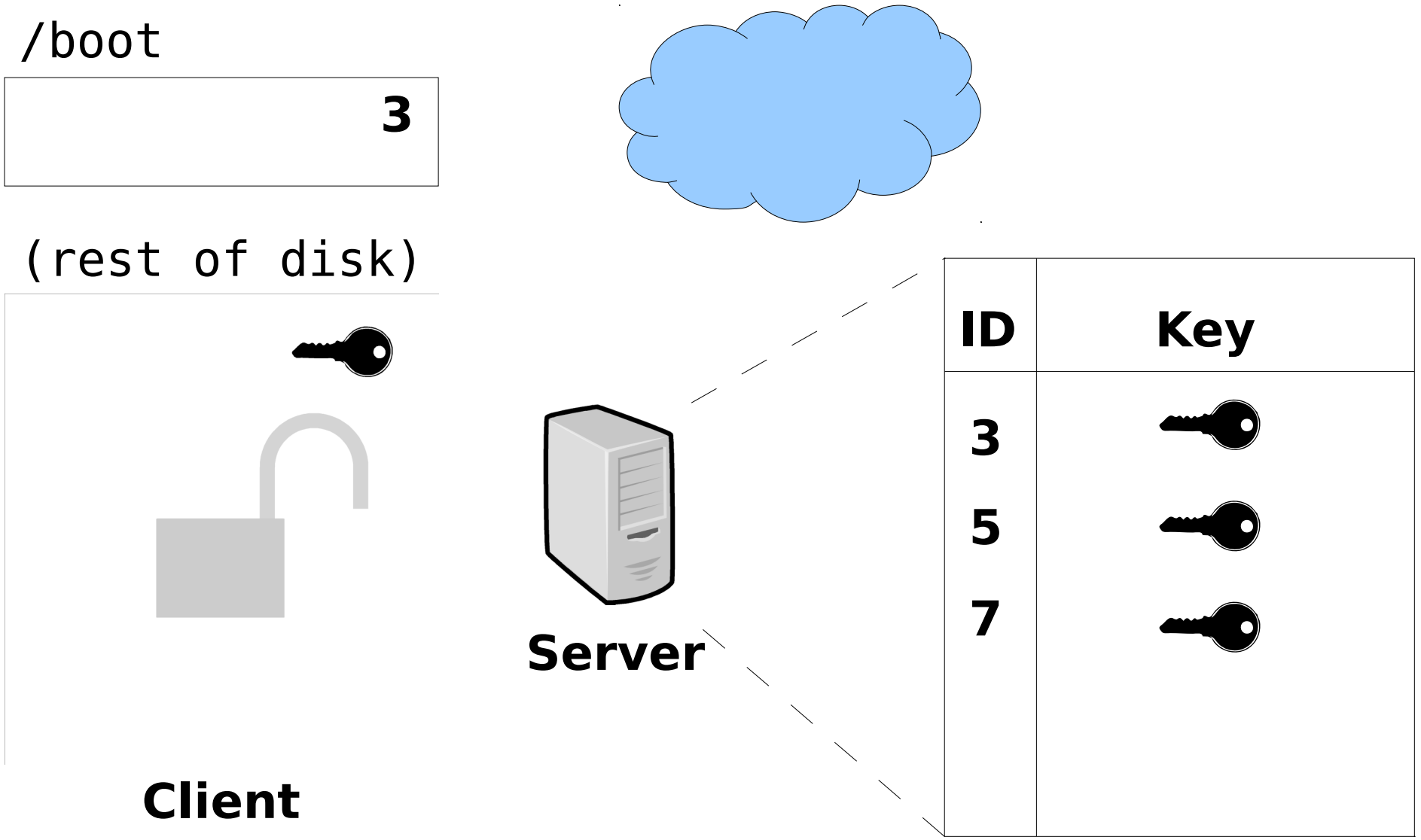
Mandos

https://www.recompile.se/mandos



Mandos

https://www.recompile.se/mandos



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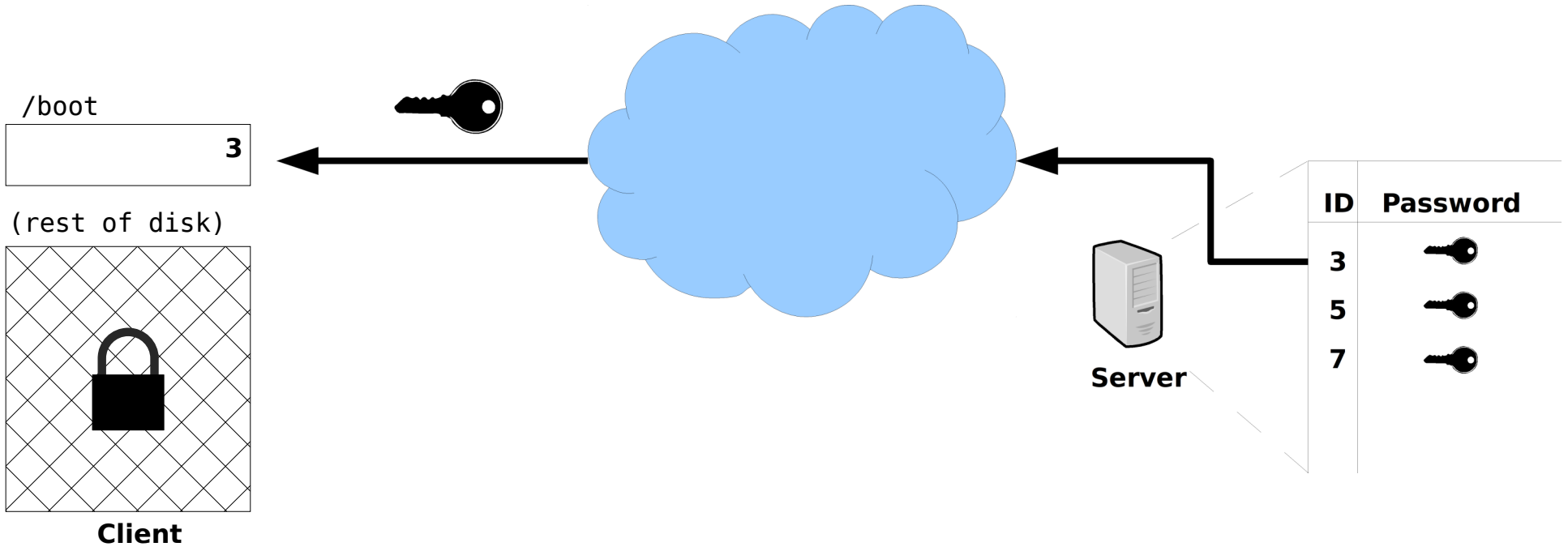

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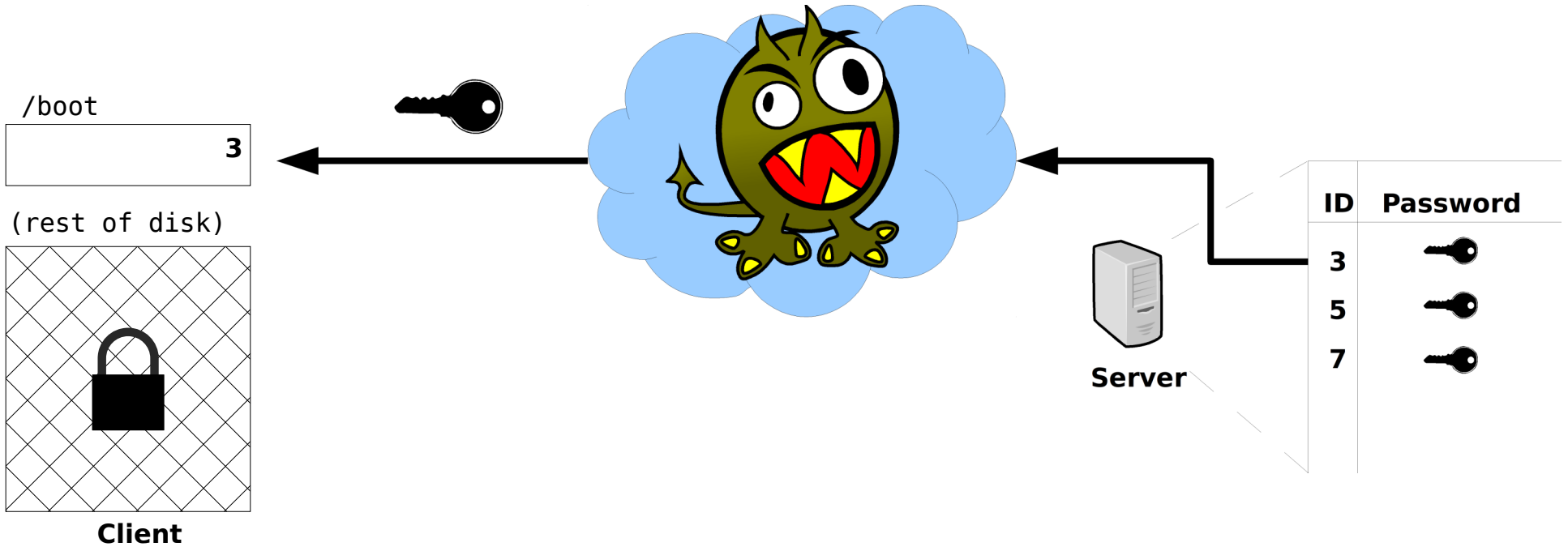


“GPG for data at rest. TLS for data in motion.”

If You're Typing The Letters A-E-S Into Your Code, You're Doing It Wrong

https://www.nccgroup.trust/us/about-us/newsroom-and-events/blog/2009/july/if-youre-typing-the-letters-a-e-s-into-your-code-youre-doing-it-wrong/

TLS has a “server” side and a “client” side, and the “server” side needs a key.

The TLS key can be a X.509 certificate

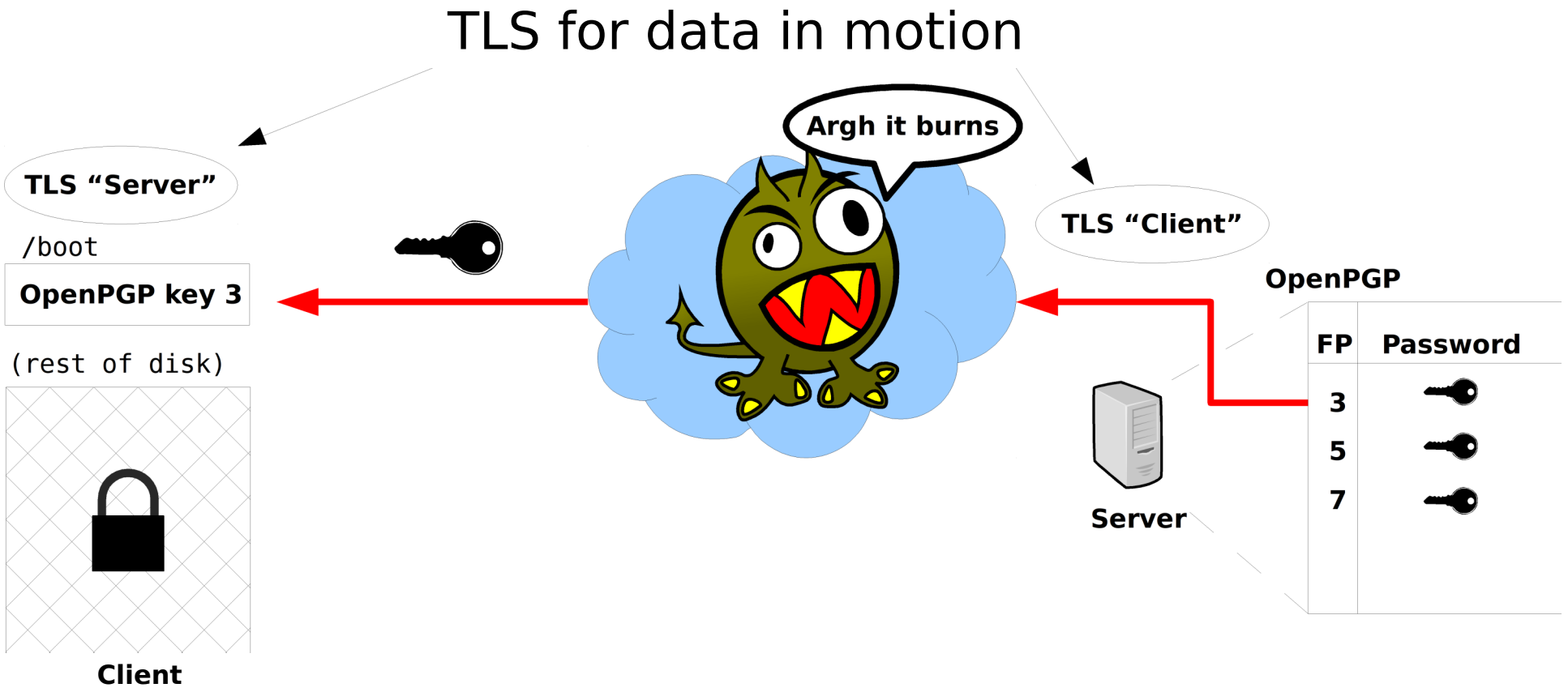
X.509:

“Someone tried to explain public-key-based authentication to aliens. Their universal translators were broken and they had to gesture a lot.”
— Peter Gutmann
Everything you Never Wanted to Know about PKI but were Forced to Find Out

Alternatively, the TLS key can be an OpenPGP key

Mandos

https://www.recompile.se/mandos

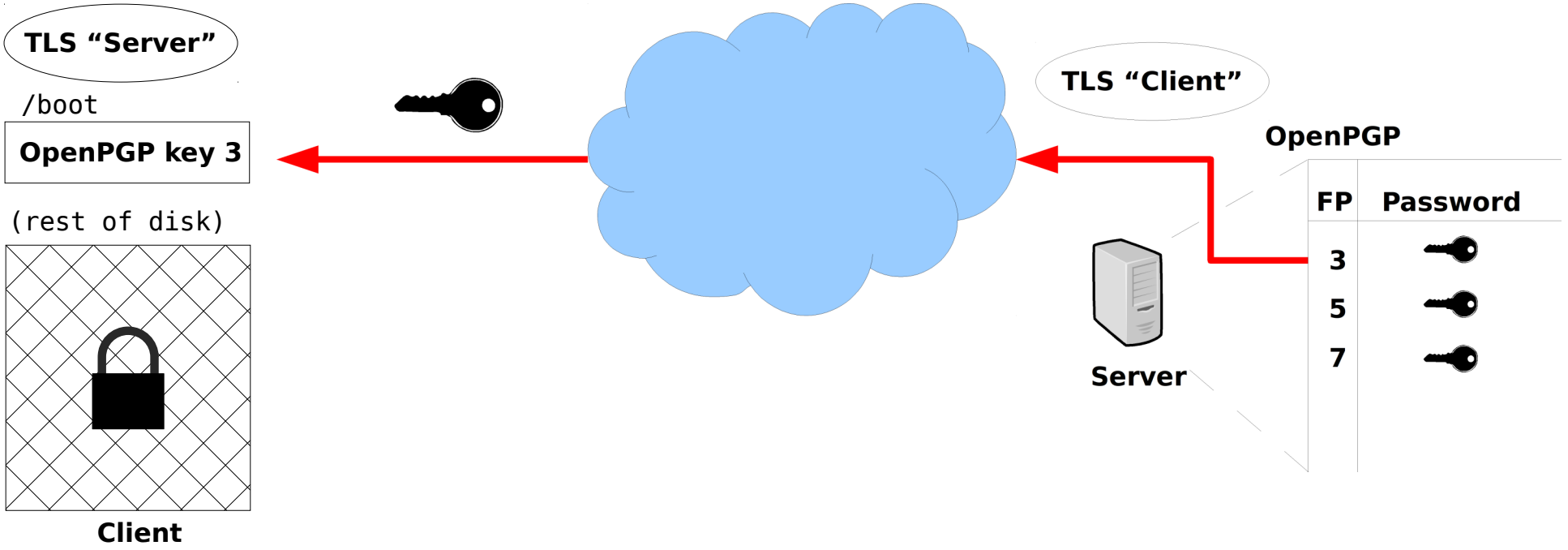


“GPG for data at rest”?

Mandos

https://www.recompile.se/mandos

TLS for data in motion



Mandos

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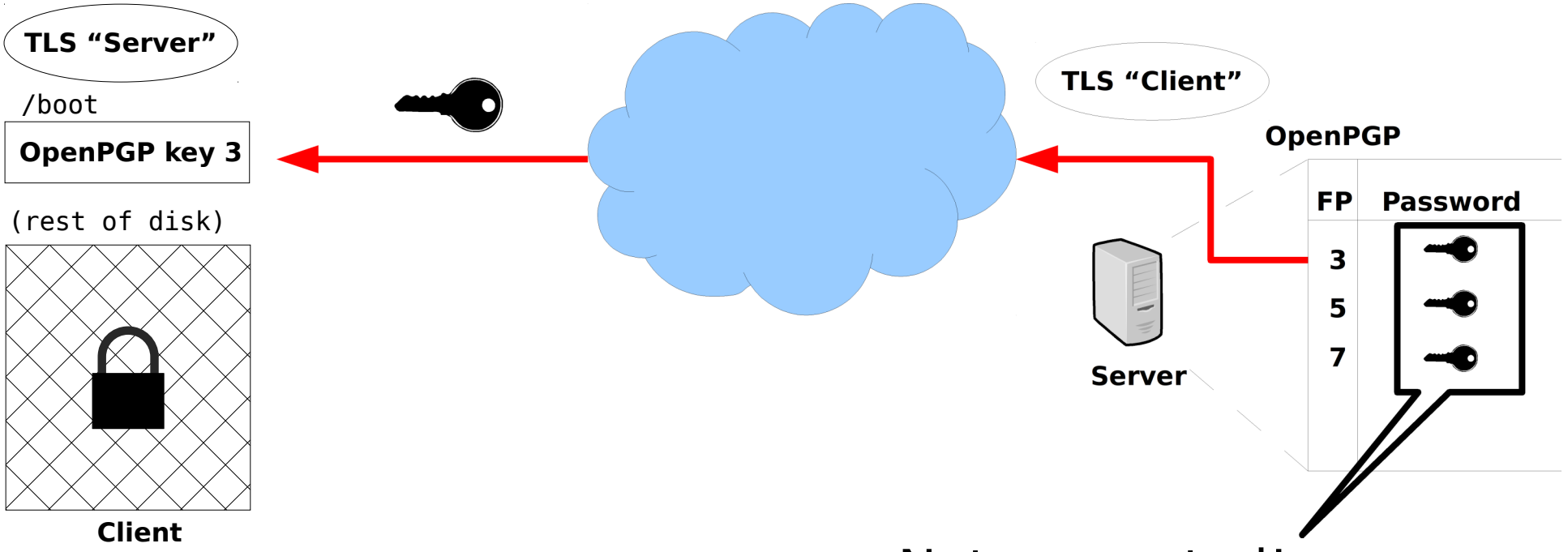
TLS for data in motion

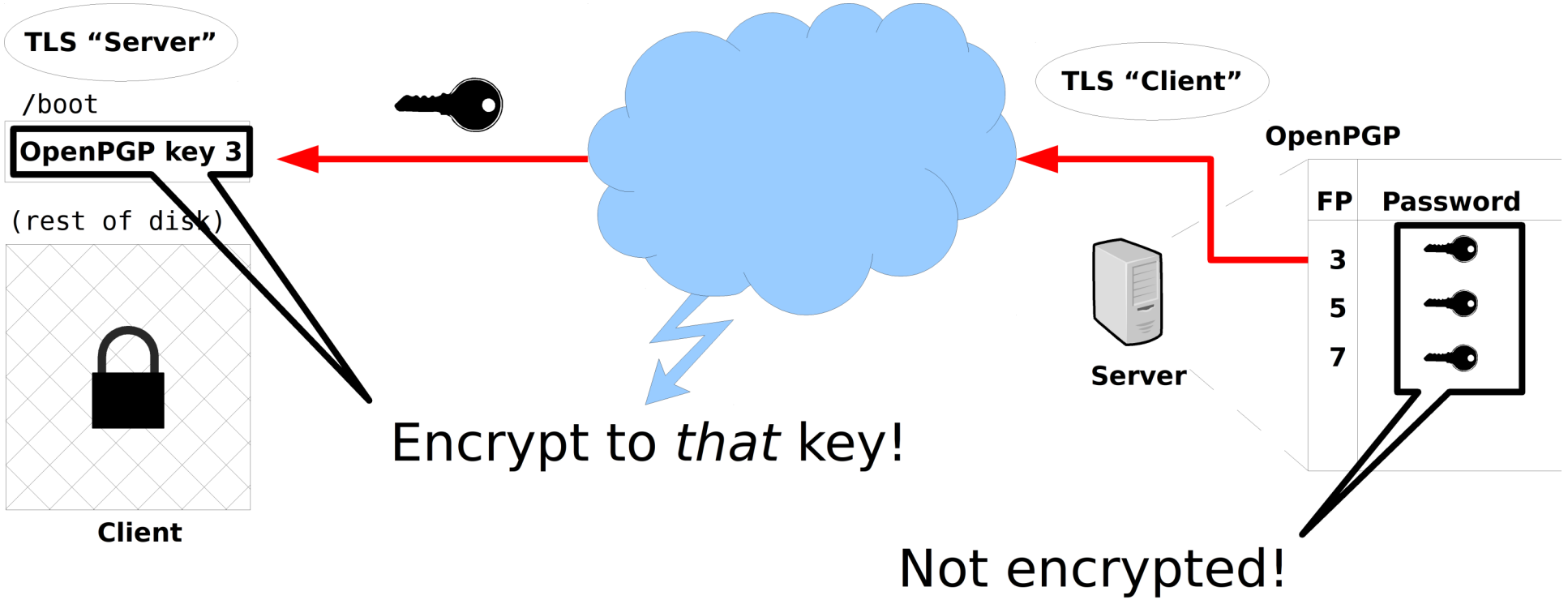


Not encrypted!

Mandos

https://www.recompile.se/mandos

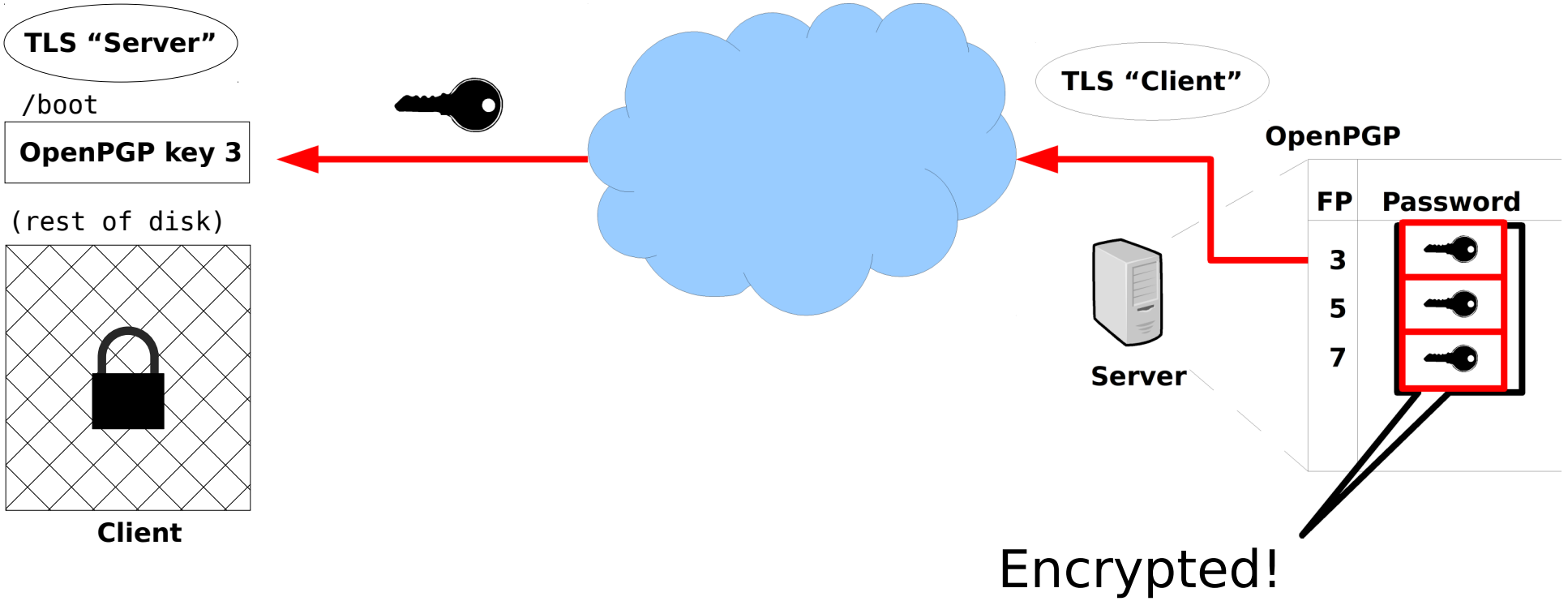
TLS for data in motion



Mandos

https://www.recompile.se/mandos

TLS for data in motion



Mandos

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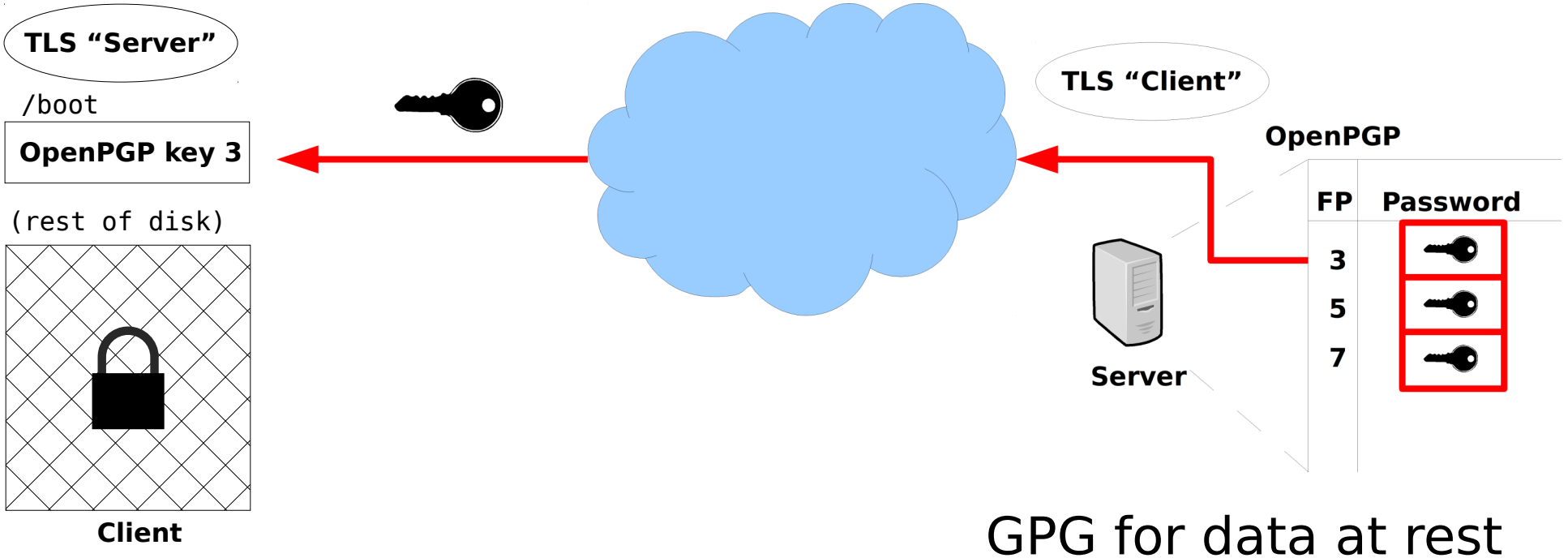
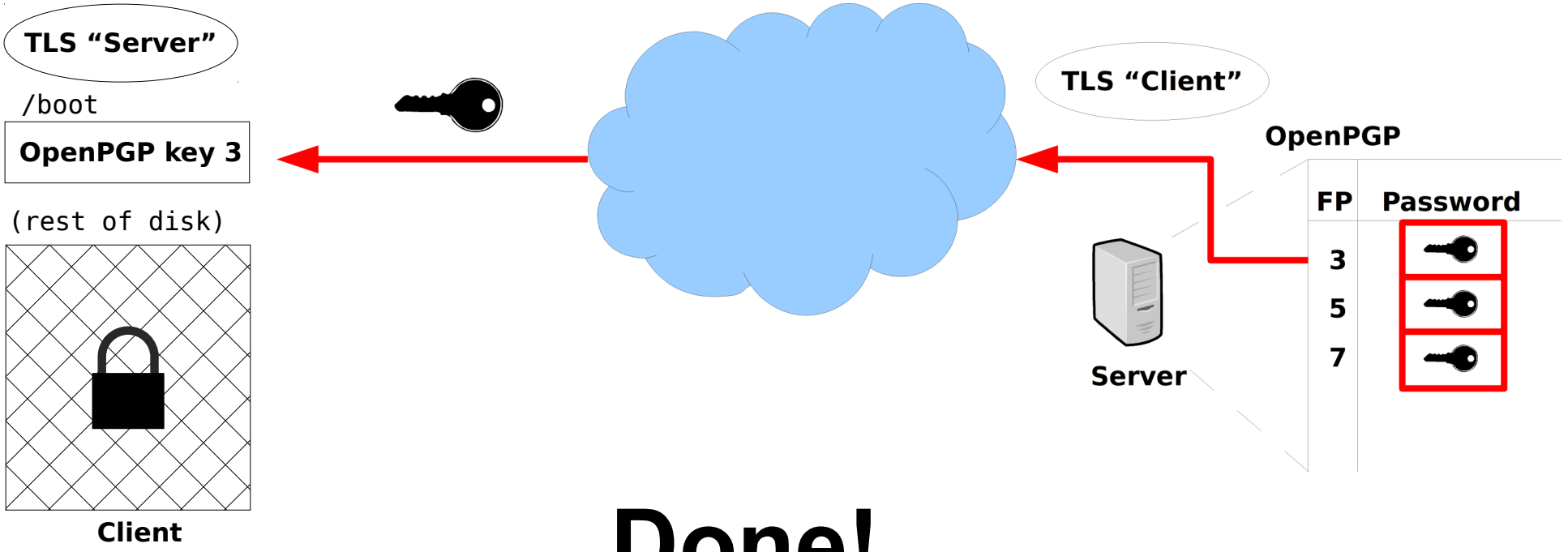
TLS for data in motion



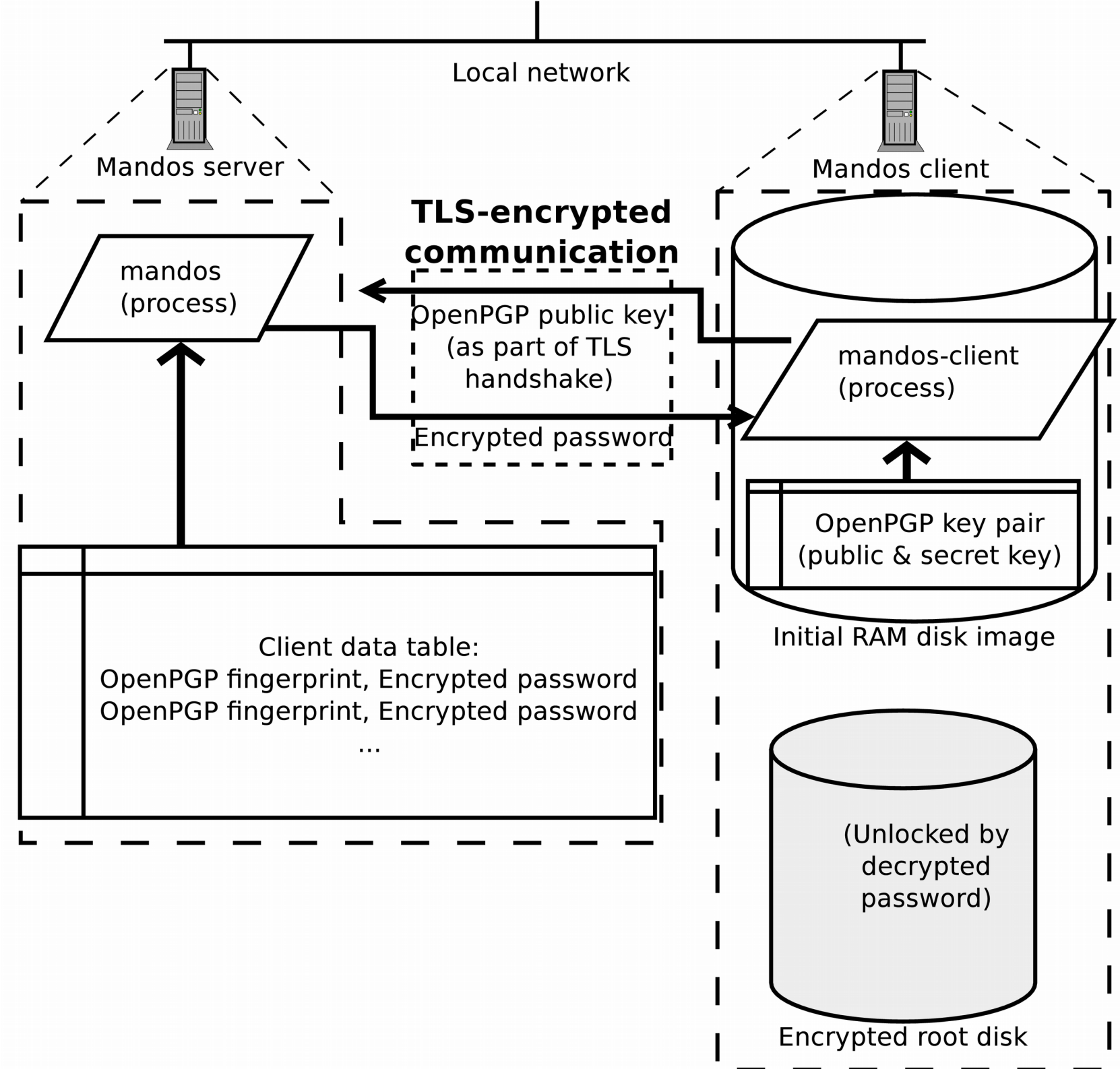
GPG for data at rest

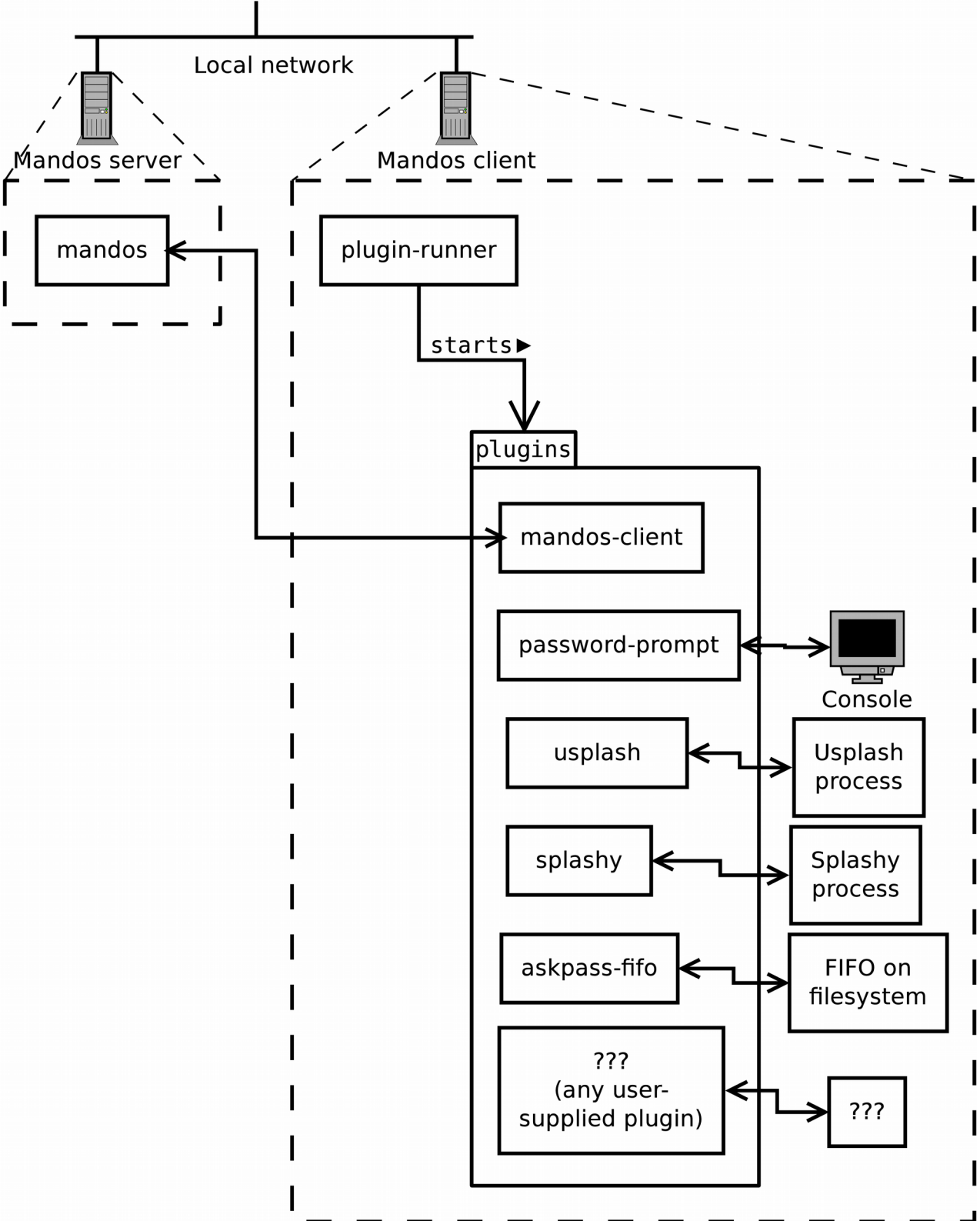
Mandos

https://www.recompile.se/mandos



Done!


Local network
Mandos server
Mandos client
TLS-encrypted communication
mandos (process)
OpenPGP public key (as part of TLS handshake)
Encrypted password
mandos-client (process)
OpenPGP key pair (public & secret key)
Initial RAM disk image
Client data table:
OpenPGP fingerprint, Encrypted password
OpenPGP fingerprint, Encrypted password
...
(Unlocked by decrypted password)
Encrypted root disk


Local network
Mandos server
Mandos client
mandos
plugin-runner
starts
plugins
mandos-client
password-prompt
Console
usplash
Usplash process
splashy
Splashy process
askpass-fifo
FIFO on filesystem
??? (any user-supplied plugin)
???

FAQ

Grabbing the Mandos client key from the `/boot` partition's `initramfs` image really quickly?

Mandos

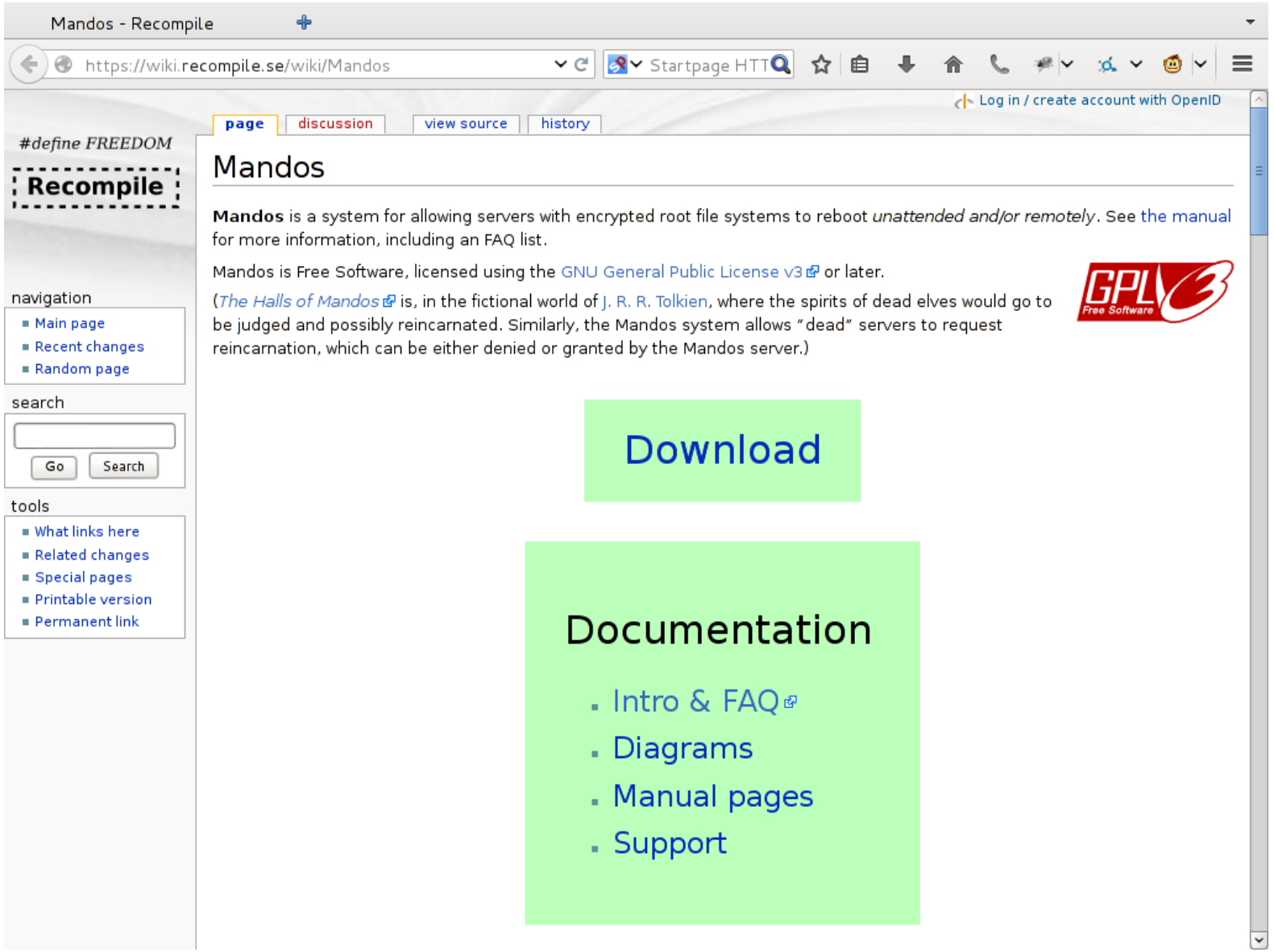
https://www.recompile.se/mandos

- **In Ubuntu “universe” since 2009**
- **In Debian since 2011**

```
aptitude install mandos
aptitude install mandos-client
```

Mandos

https://www.recompile.se/mandos



Mandos

https://www.recompile.se/mandos

https://ftp.recompile.se/pub/mandos/misc

Mandos

https://www.recompile.se/mandos

Disk encryption is essential for physical computer security, but seldom used due to the trouble of remembering and typing a password at every restart. We describe Mandos, a program which solves this problem, its security model, and the underlying concepts of its design.

Any security system must have a clear view of its intended threat model – i.e. what threats it is actually intended to protect against; the specific choices and tradeoffs made for Mandos will be explained. Another danger of security system design is the risk of its non-use; i.e. that the system will not be used for some real or perceived drawbacks, such as complexity. The deliberate design choices of Mandos, involving low-interaction, “invisible” and automatic features, will be covered.

```
pub   4096R/CA34C2C4 2013-10-05
      Key fingerprint = 153A 37F1 0BBA 0435 987F  2C4A 7223 2973 CA34 C2C4
uid                  Mandos Maintainer Team <mandos@recompile.se>
```

Introductory text for people to read before the talk starts

Mandos

https://www.recompile.se/mandos

TL;DL

```
aptitude install mandos
aptitude install mandos-client
```

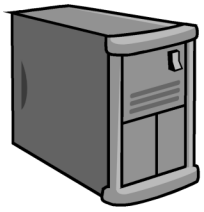
If you don’t have time to listen to this talk, here is how you install Mandos.

To continue with configuration, read `/usr/share/doc/mandos-client/README.Debian.gz`

Threat Model

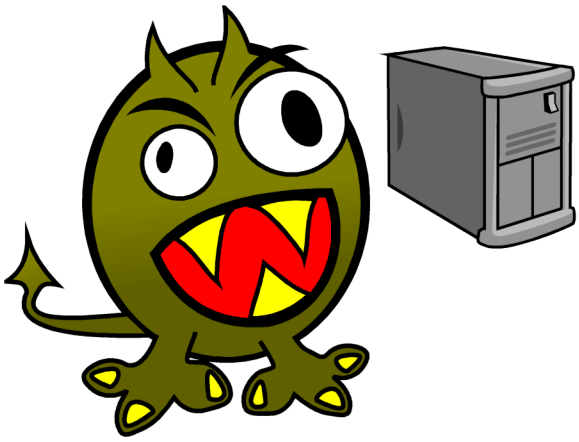
What is the threat model?

Threat Model



Your server

Threat Model

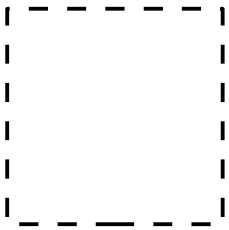


Monster comes

Threat Model

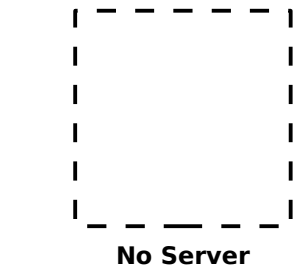
Monster takes your server

Threat Model



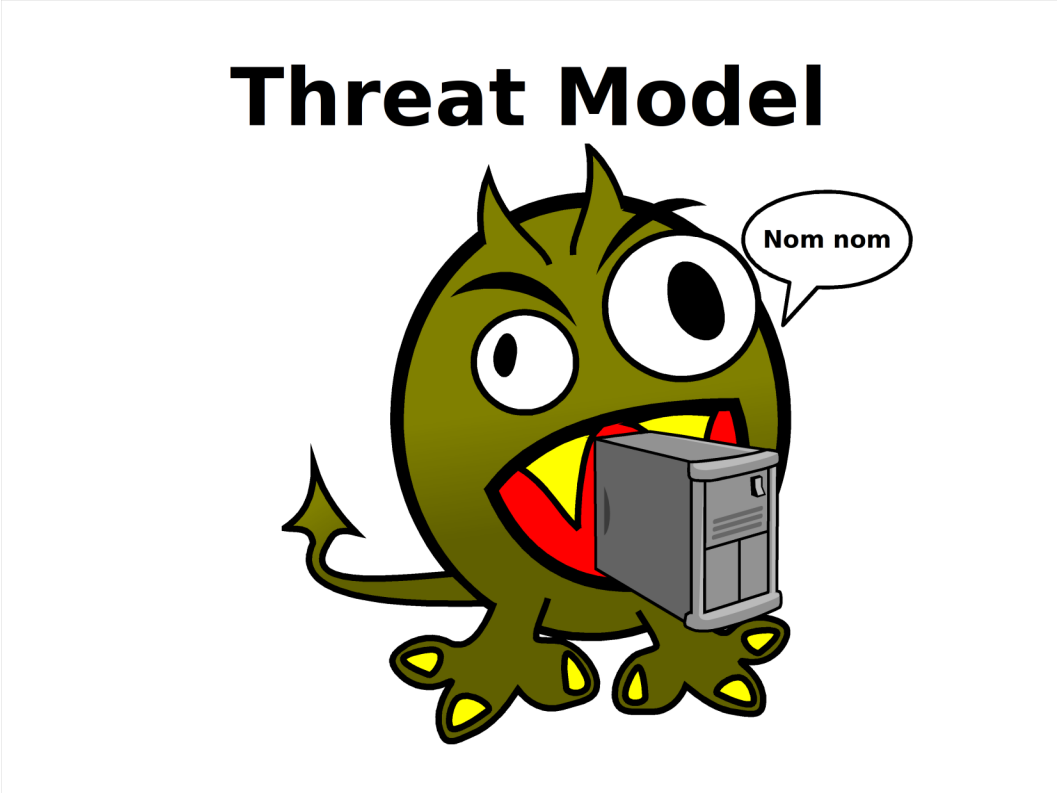
Now you have no server

Threat Model

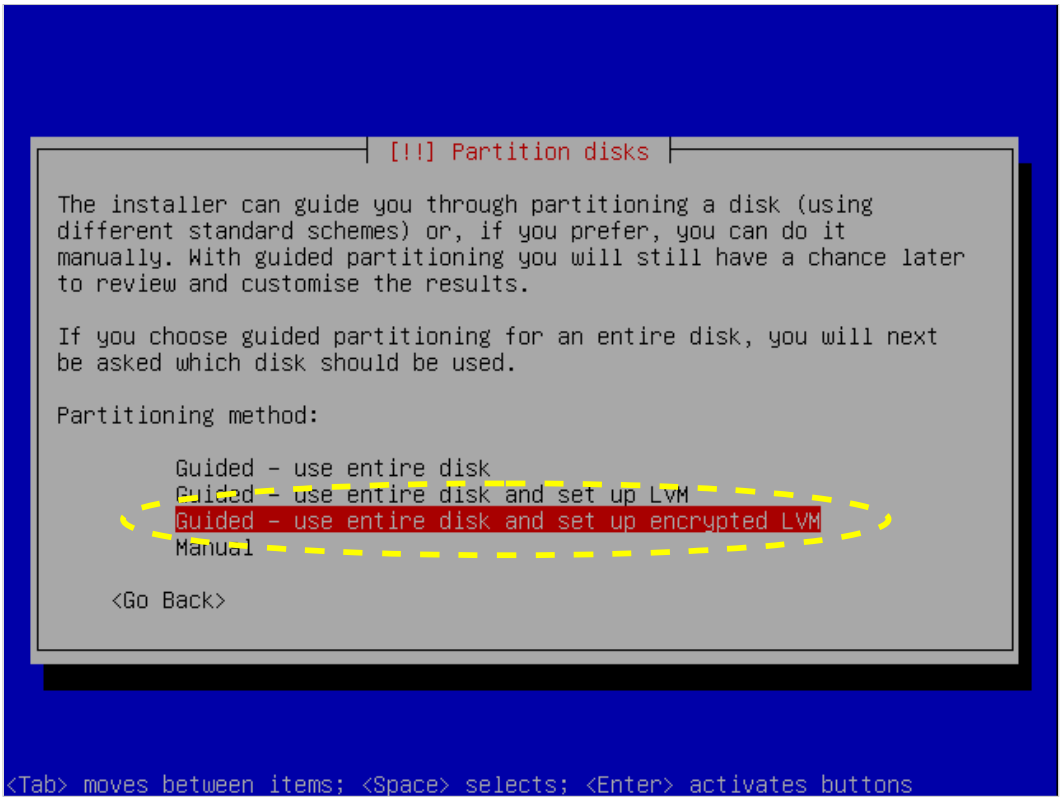


☹☹☹

You and your users are sad

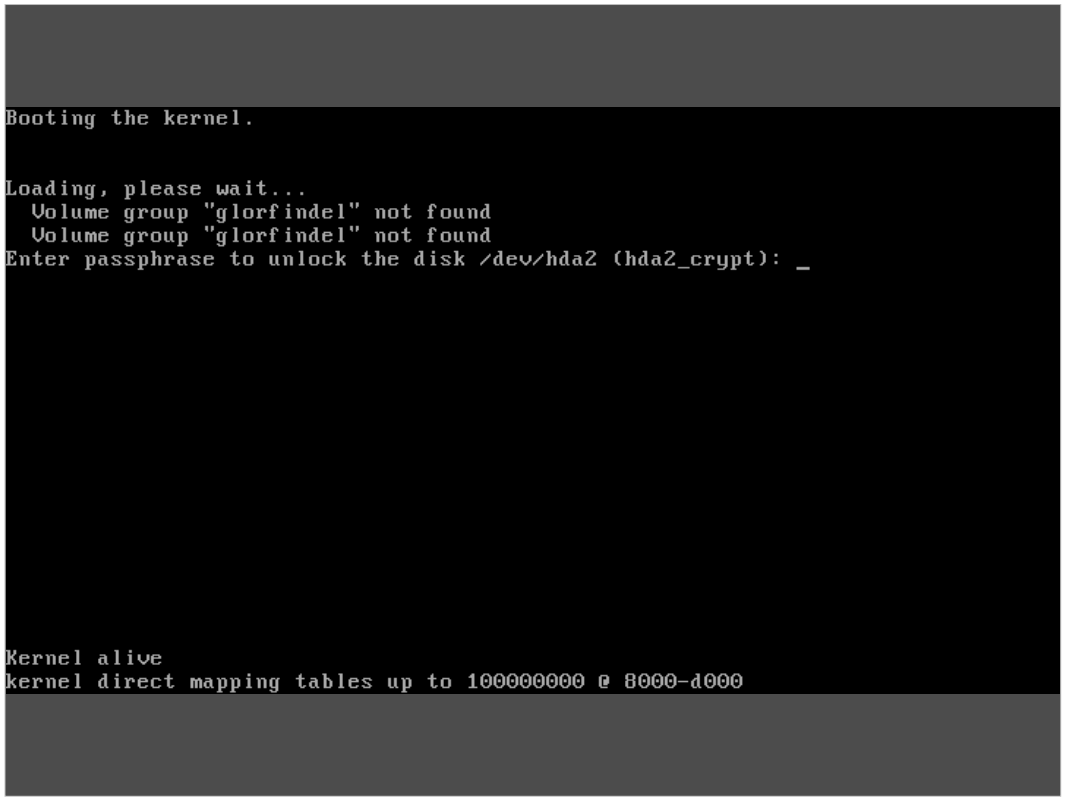


Monster eats your server’s data

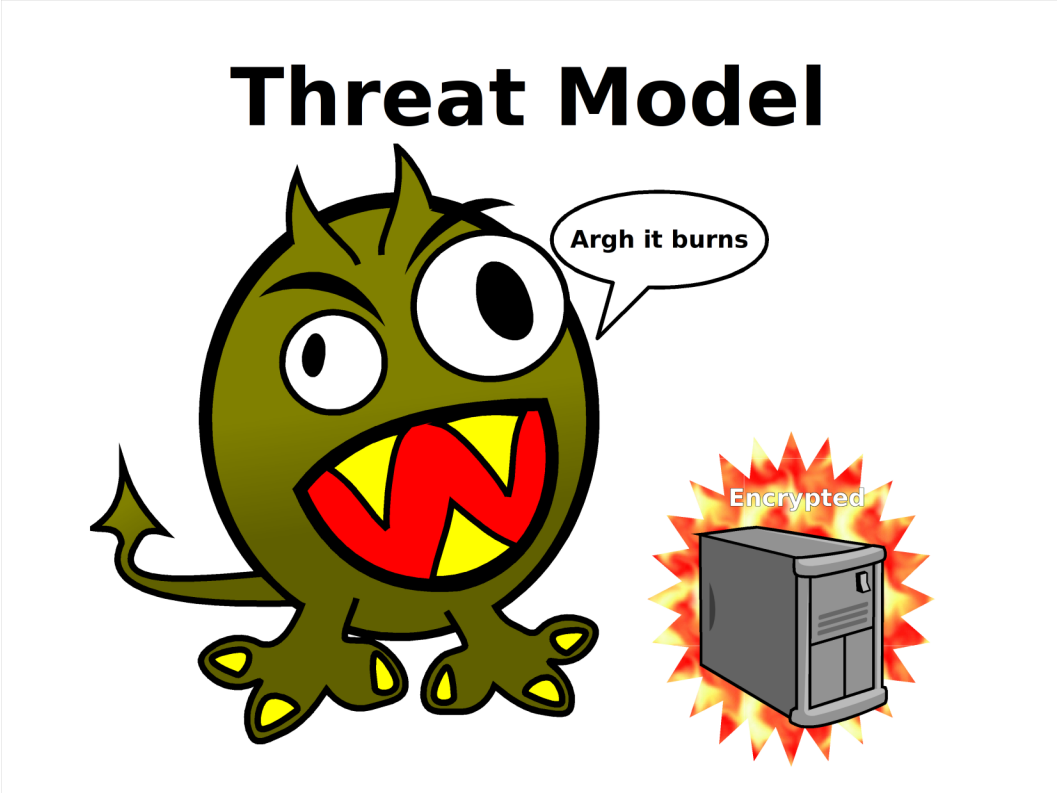


Obvious solution: Use full-disk encryption

Debian installer shown



Prompted for password at boot



Data is now encrypted – Monster can still steal your server, but is now burnt by encrypted data

New threat: non-use

Inconvenient
Burdensome
“I’ll do it some day”

Mail servers especially common to not be encrypted. Co-location make passwords inconvenient.

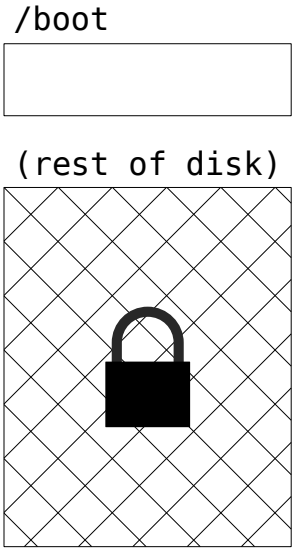
New threat:

Passwords are hard to remember, especially if you seldom use them, like when rebooting a server

Security needs to be transparent

Model after IPsec.
User behavior can stay unchanged.

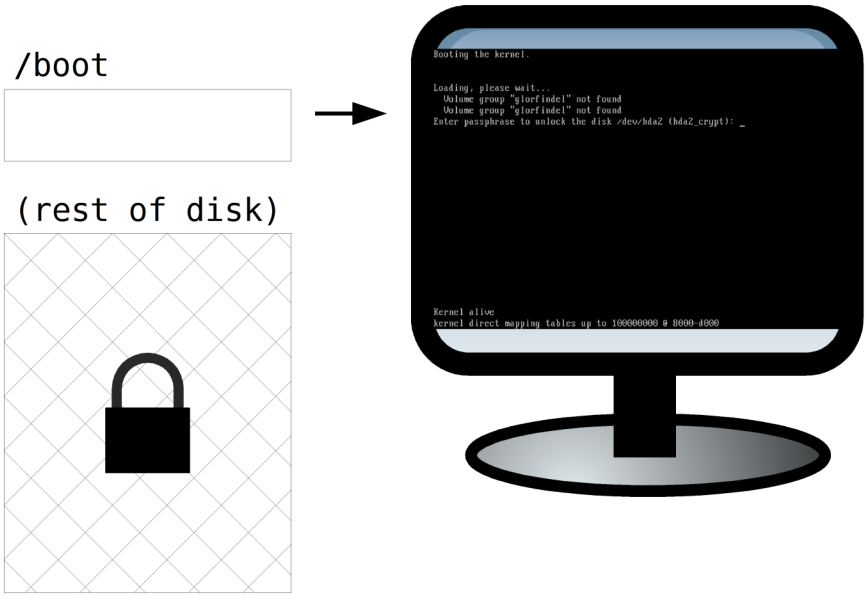
Full Disk Encryption



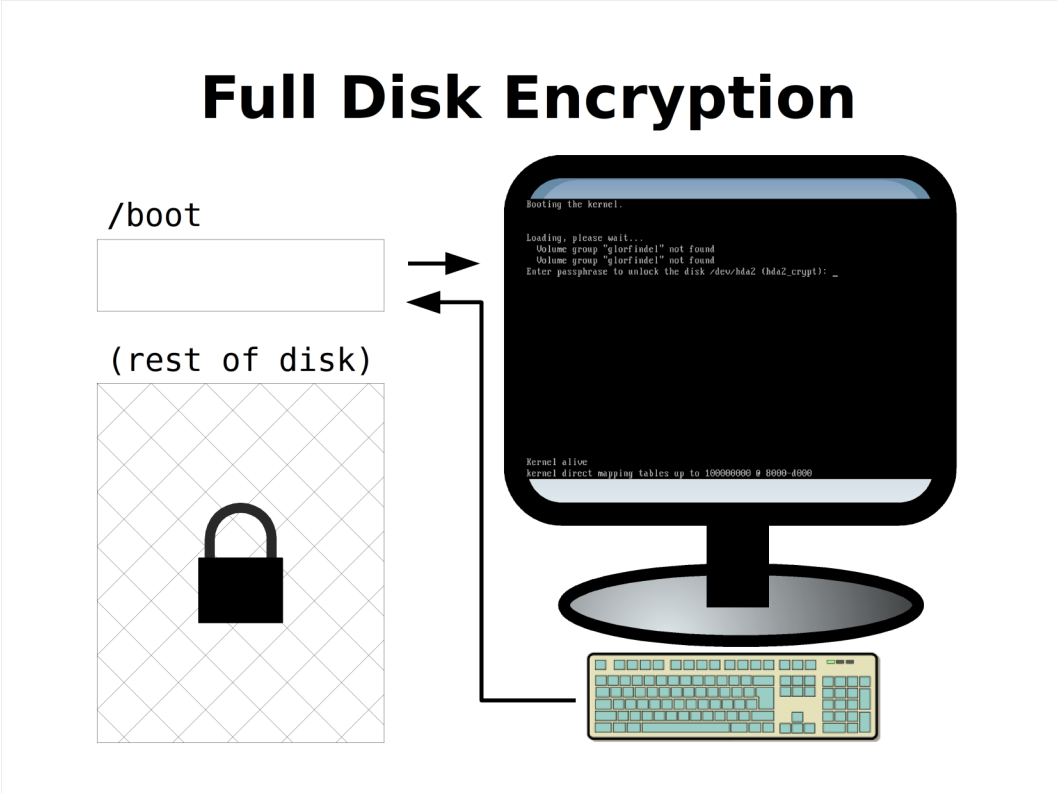
A brief overview of how full disk encryption works.

The disk is divided into two parts, an encrypted main part, and a small unencrypted part, where the code to run at boot resides.

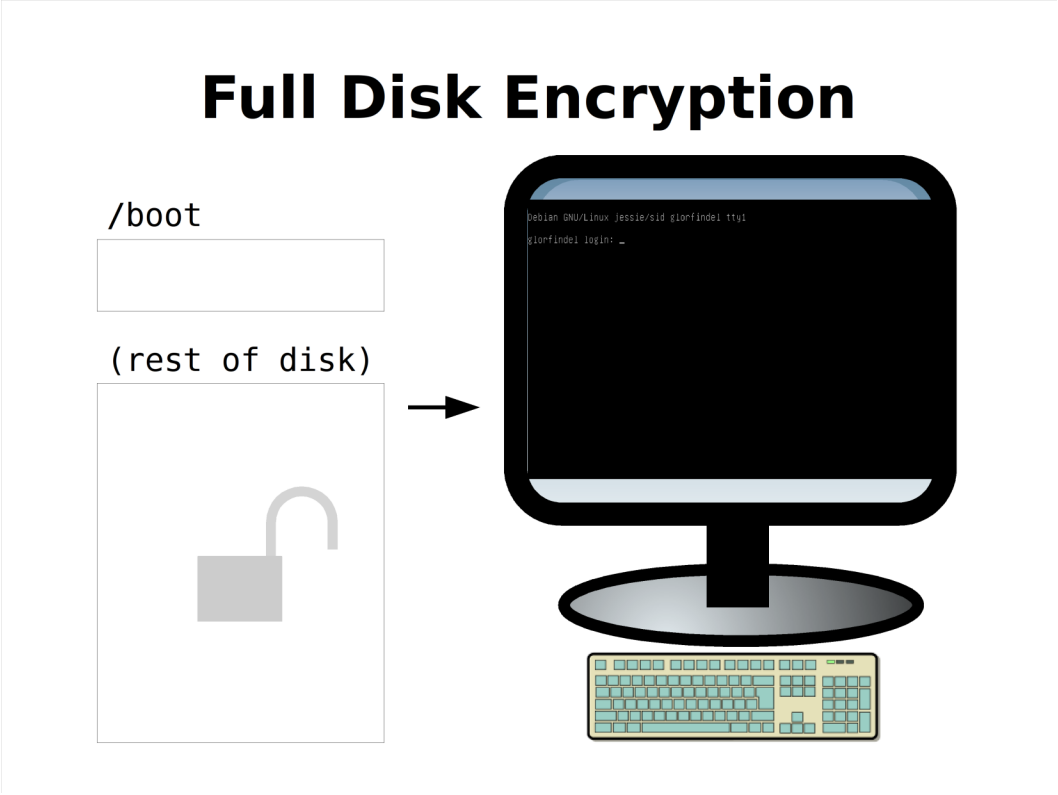
Full Disk Encryption



The code which runs at boot prompts for the password on the display.



The password is typed on the keyboard.



The password is used to unlock the encrypted part, and the code there is started to run the main system.

This is the *normal* full disk encryption procedure, and as you can see, it requires some manual work at the keyboard at each boot.

Mandos

http://www.recompile.se/mandos

Servers provide passwords to each other

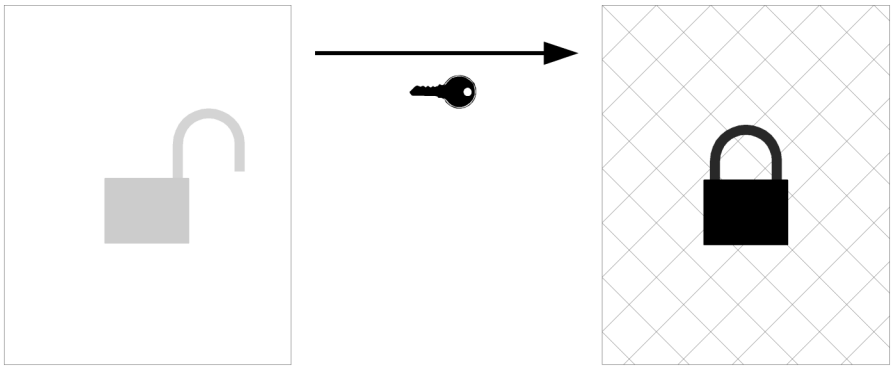
What does Mandos do to make this better?

It makes the servers provide the passwords to *each other*.

Mandos

https://www.recompile.se/mandos

Normal operation

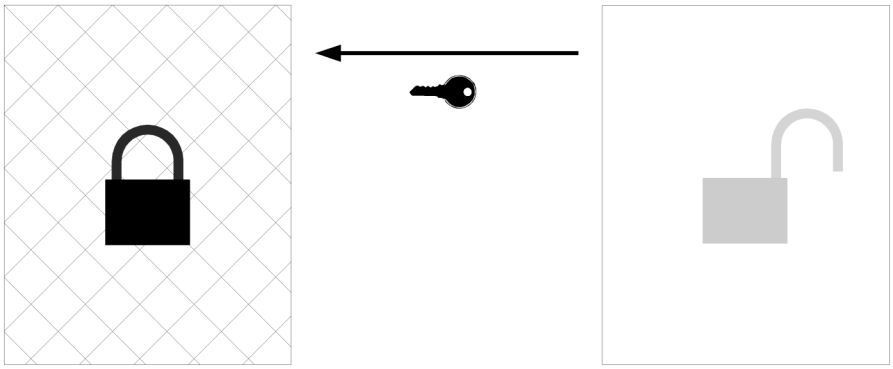


An unlocked and running server provides the password needed by a locked server when the latter boots.

Mandos

https://www.recompile.se/mandos

Normal operation



If the *other* server is up, that server can in turn provide the password for the first one.

Mandos

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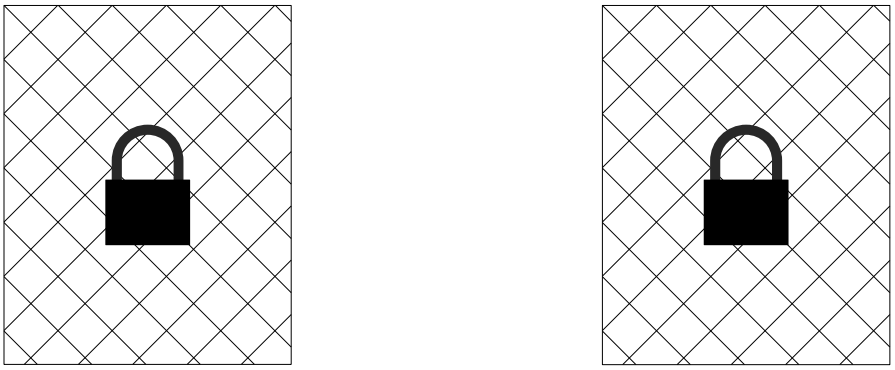
Lockdown state

Administrator attention required



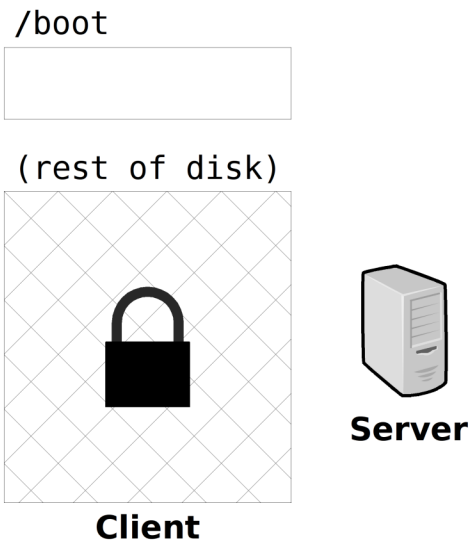
If both servers are down, like when the Monster has taken them, they are both locked – no server can provide the password for the other.

This deadlock / bootstrap problem is a security feature!

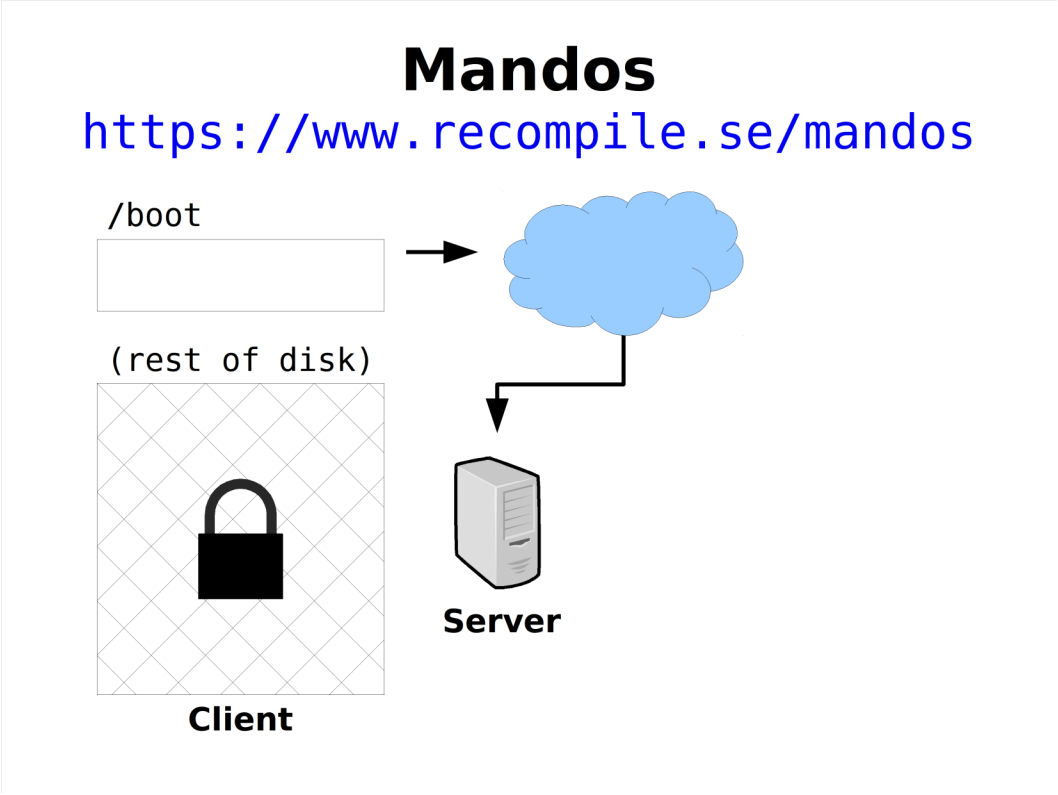
This is the usual state when you really need encryption.

Mandos

https://www.recompile.se/mandos

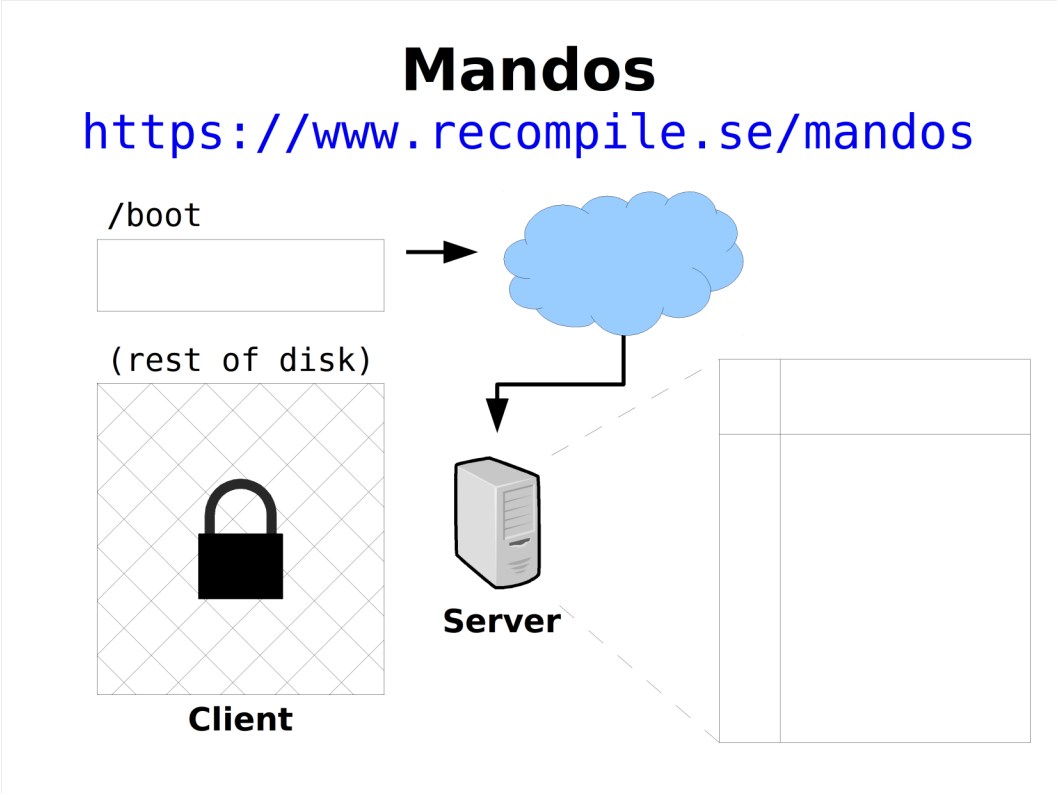


Let’s look at the communication in detail. We call the left computer – the one needing a password – the “client”, and reduce the right server to an icon to make room.

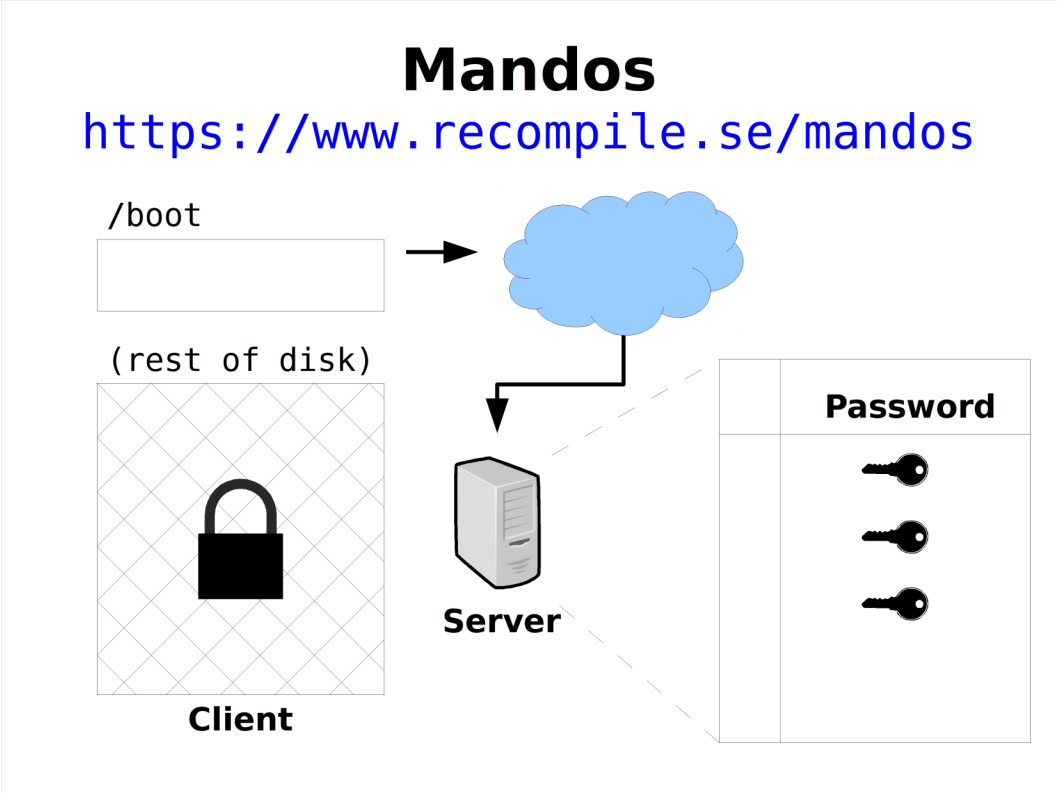


The encrypted server's unencrypted part runs code which locates a server on the network, and connects to it.

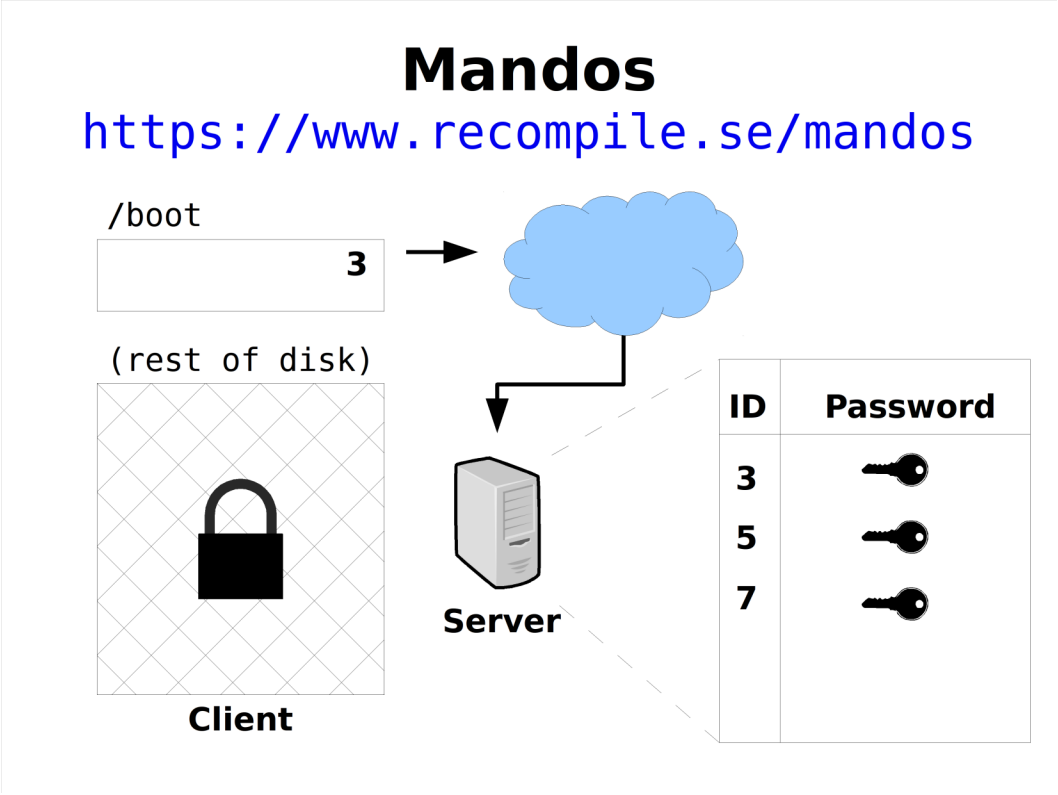
(Using either Zeroconf to find it automatically on the local network, or by pre-specified IP address and port number.)



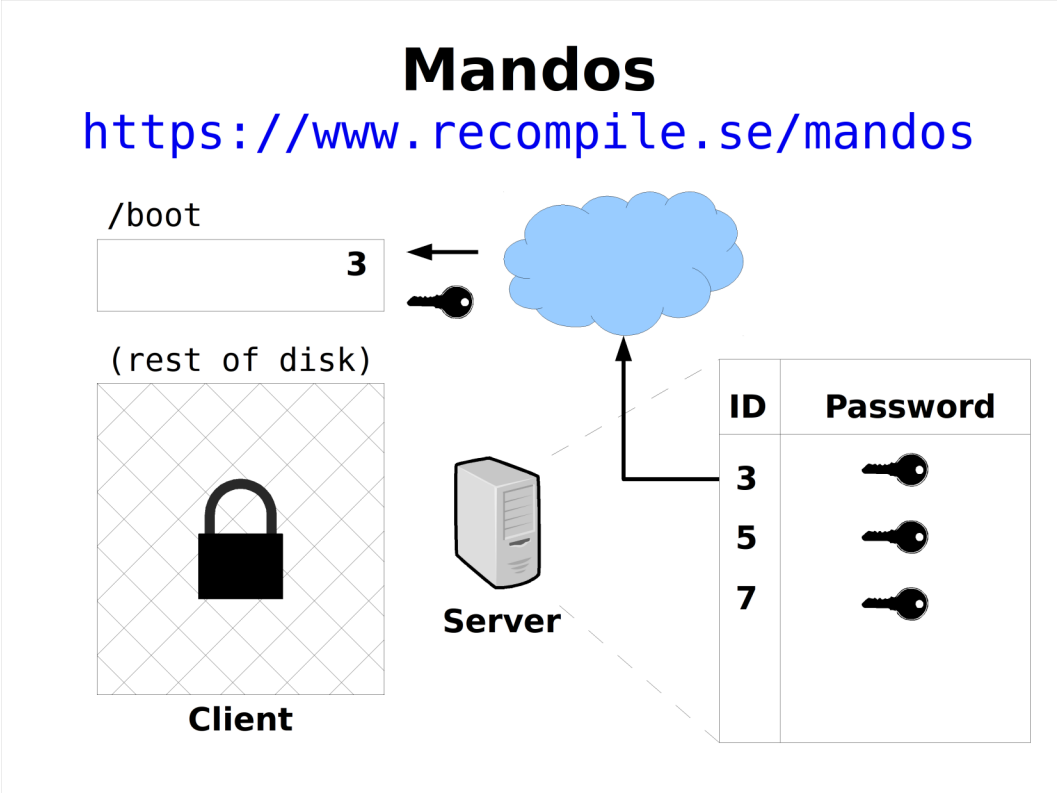
The server contains a table of data.



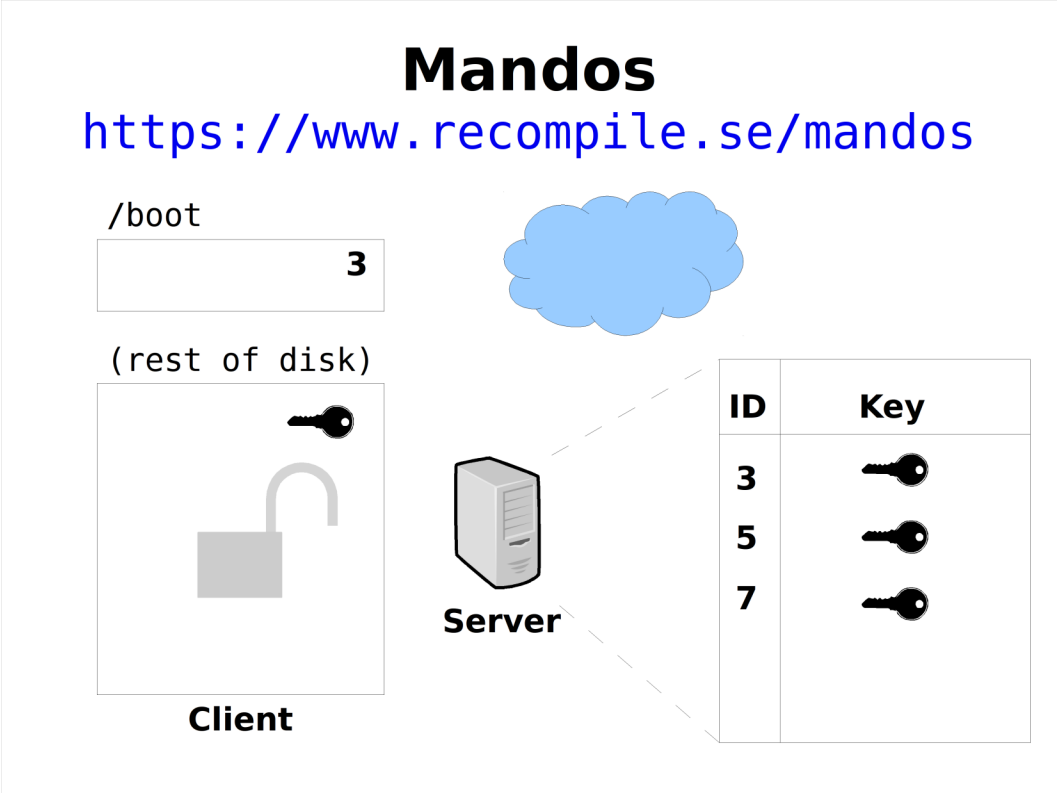
The table is a table of passwords, since the server can serve passwords for many clients.



Since there are many clients, we need some sort of identifier to uniquely identify them to map them to their corresponding key.



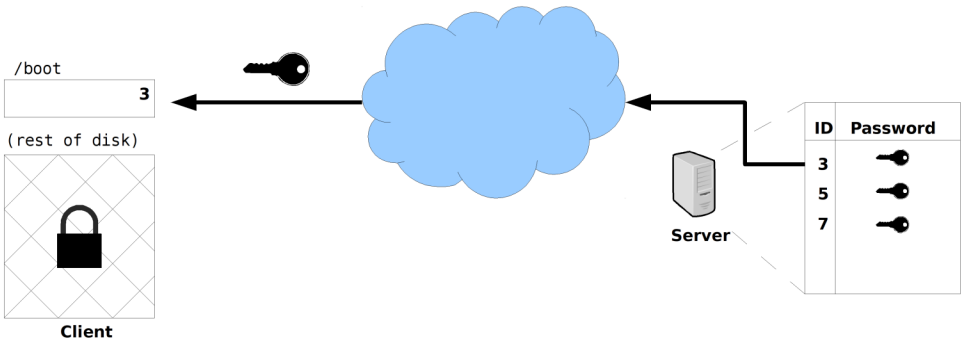
The ID is looked up in the table and the correct password is sent to the client.



The password is used to unlock the client's encrypted disk, and it can continue to boot up normally.

Mandos

https://www.recompile.se/mandos

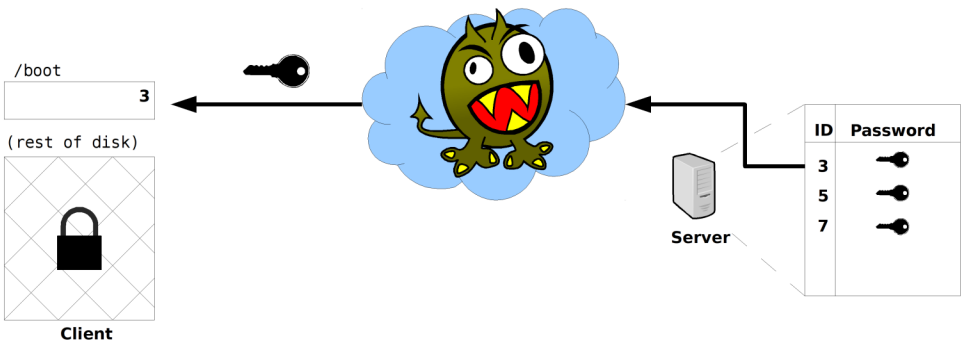


Let’s look at it in more detail.

The key is sent from the server to the client over the network.

Mandos

https://www.recompile.se/mandos



But in the network there be monsters.

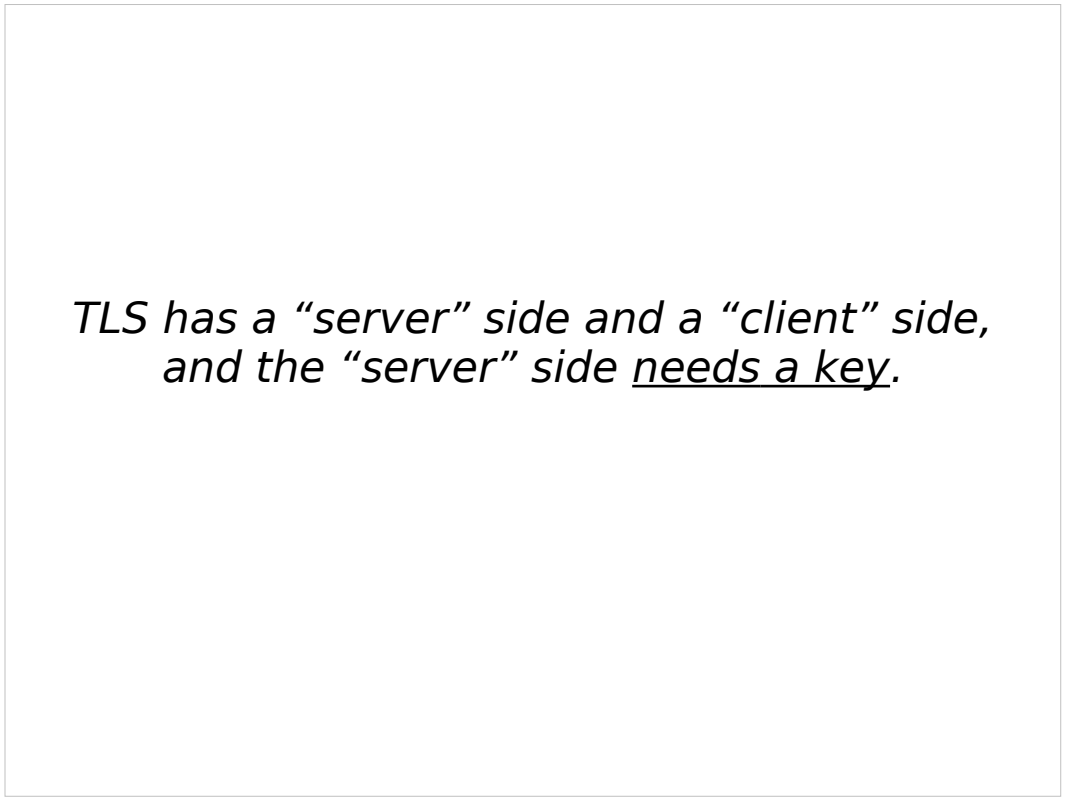
“GPG for data at rest. TLS for data in motion.”

If You're Typing The Letters A-E-S Into Your Code, You're Doing It Wrong

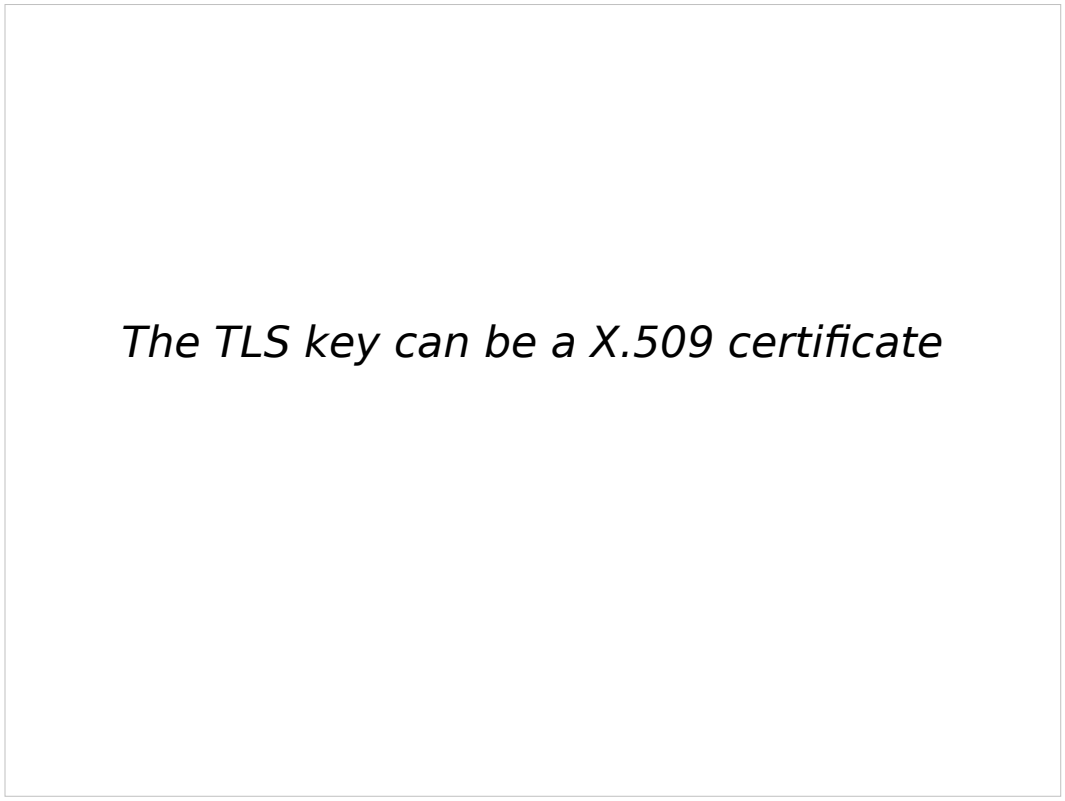
https://www.nccgroup.trust/us/about-us/newsroom-and-events/blog/2009/july/if-youre-typing-the-letters-a-e-s-into-your-code-youre-doing-it-wrong/

There is a good quote and principle to follow in this informative dialogue.

We should therefore use TLS for the client-server communication.



A fundamental property of TLS is the the server side absolutely needs a key, and the client side key is merely optional.



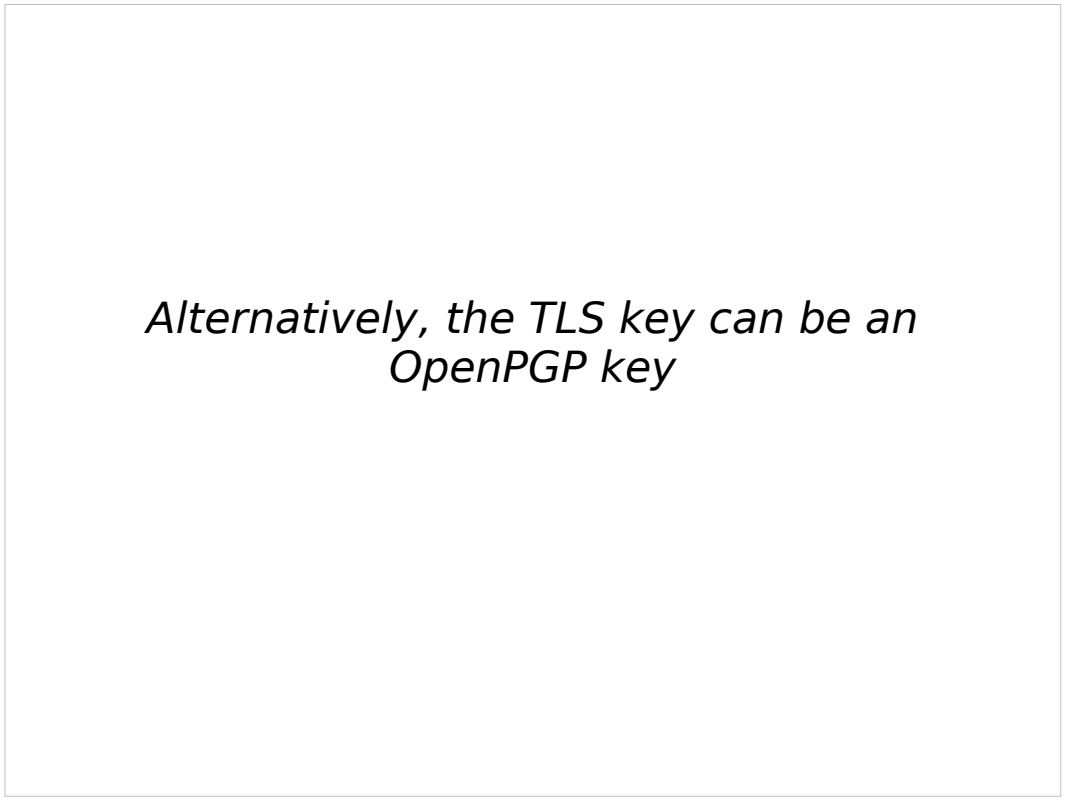
The X.509 system is most commonly used.

X.509:

“Someone tried to explain public-key-based authentication to aliens. Their universal translators were broken and they had to gesture a lot.”
— Peter Gutmann
Everything you Never Wanted to Know about PKI but were Forced to Find Out

But we really don’t want to use X.509 if we don’t have to.

There have been multiple security bugs in various TLS implementations resulting from the sheer complexity of the X.509 specification alone.

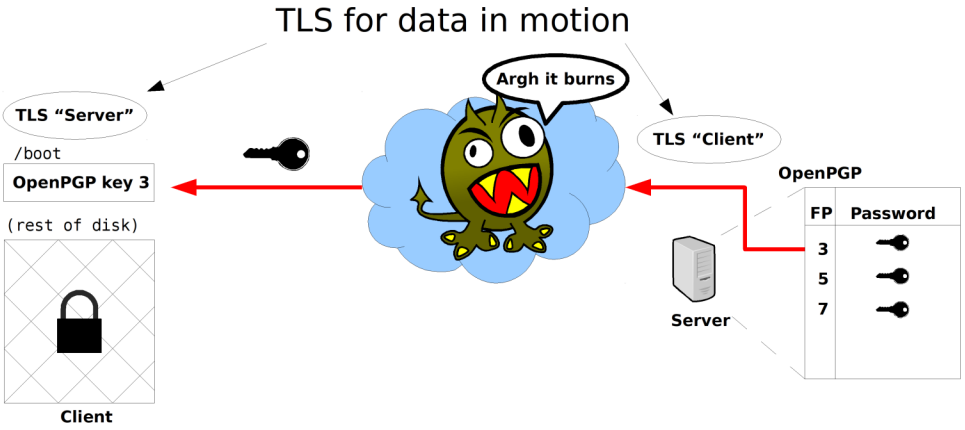


A seldom-used feature of TLS comes to the rescue.

(RFC 6091: *Using OpenPGP Keys for Transport Layer Security (TLS) Authentication*)

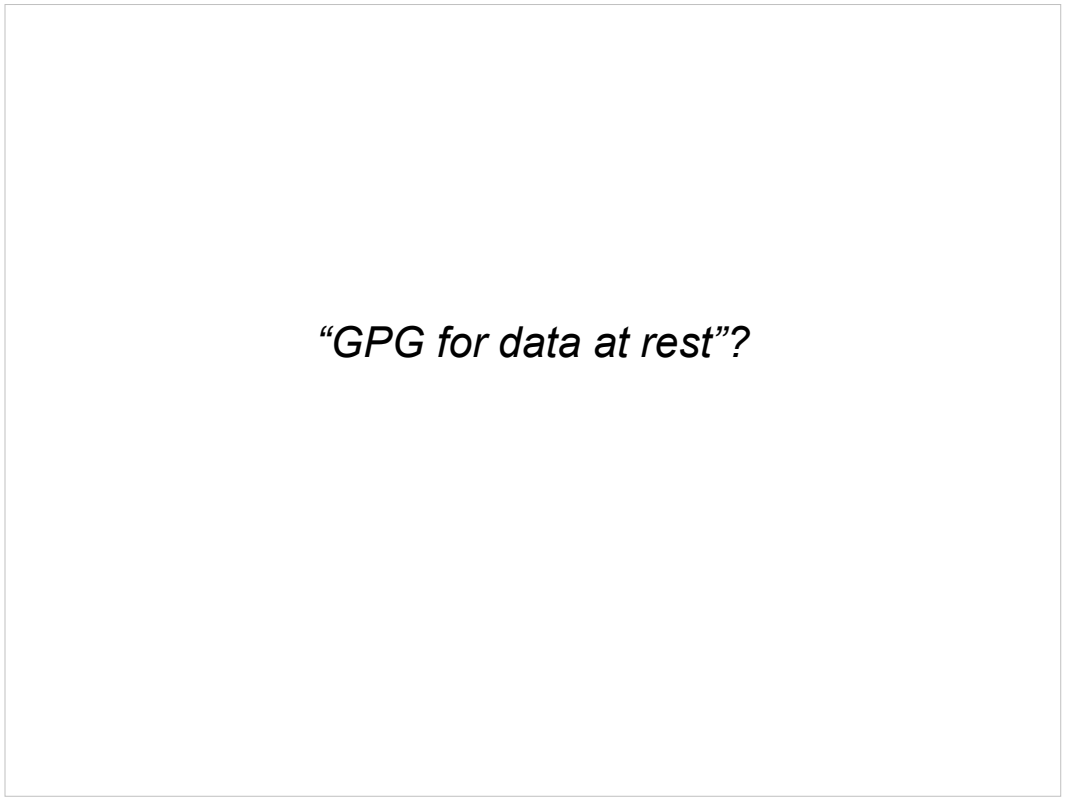
Mandos

https://www.recompile.se/mandos



There are several things going on here.

- The client has an OpenPGP key, and the fingerprint of that key is used as the ID into the table of passwords. (“FP” means fingerprint)
- The TLS handshake is done “backwards”, since the client has an OpenPGP key, but the Mandos server doesn’t. So the Mandos client is the TLS server, and vice versa.
- The fingerprint of the client is *proven* by the TLS handshake, i.e. the client does have access to the secret portion of the OpenPGP key, and this can *not* be faked by the client. This means clients cannot ask for any other password than its own.

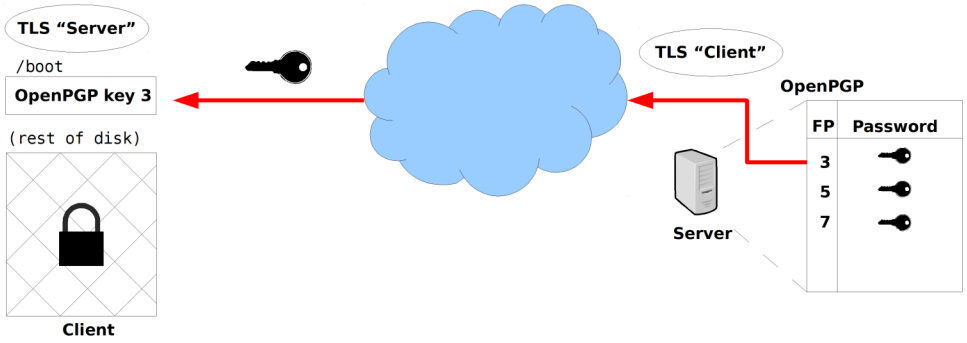


But what about the other part of that quote?

Mandos

https://www.recompile.se/mandos

TLS for data in motion

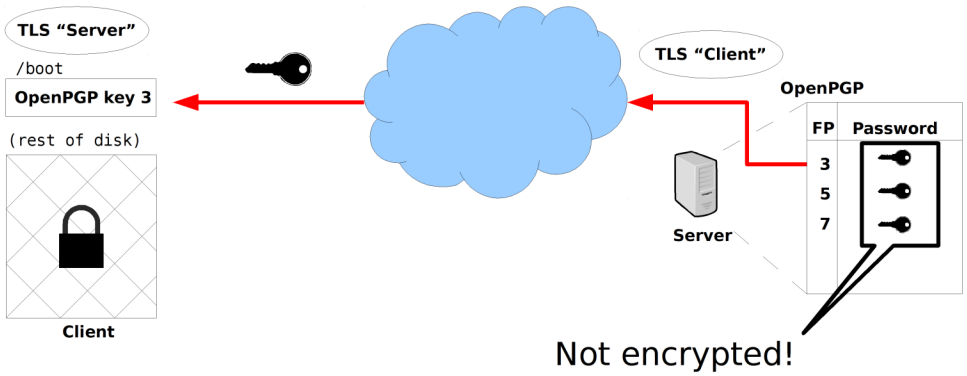


What data do we have at rest?

Mandos

https://www.recompile.se/mandos

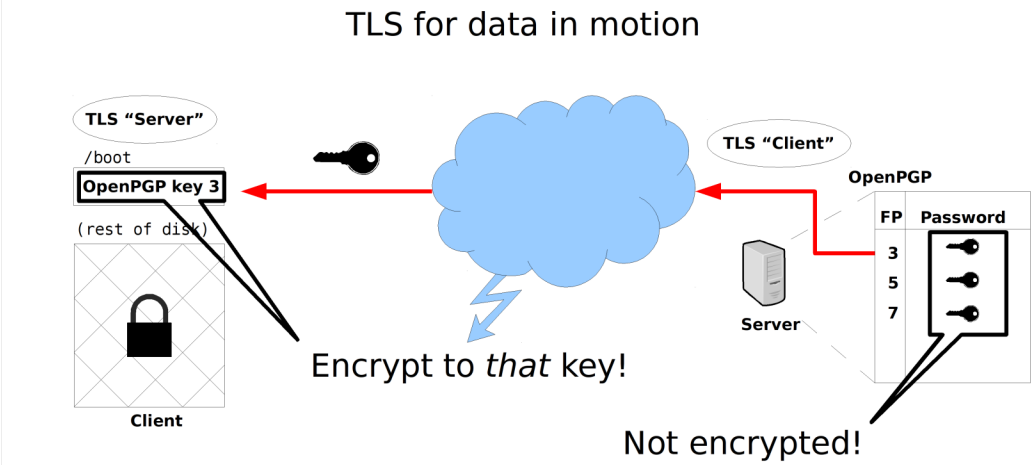
TLS for data in motion



The passwords in the table are unencrypted, i.e. any admin on the server can read them.

Mandos

https://www.recompile.se/mandos

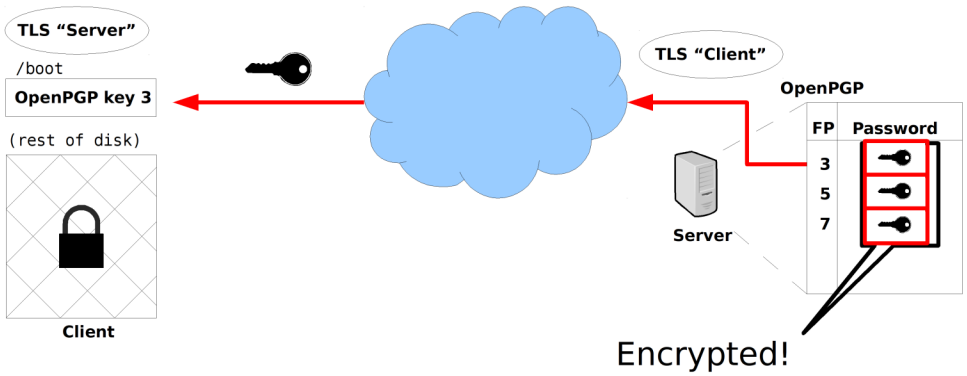


Flash of insight: We have an OpenPGP right there in the client; we can encrypt the passwords with *that* key!

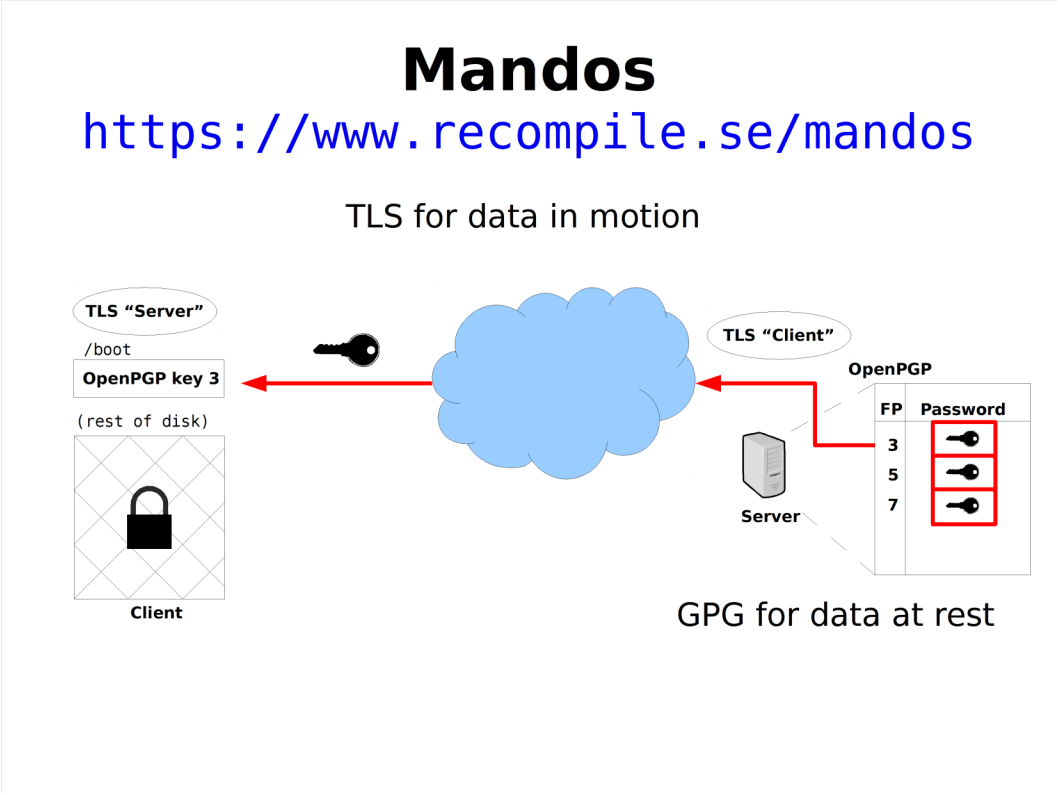
Mandos

https://www.recompile.se/mandos

TLS for data in motion



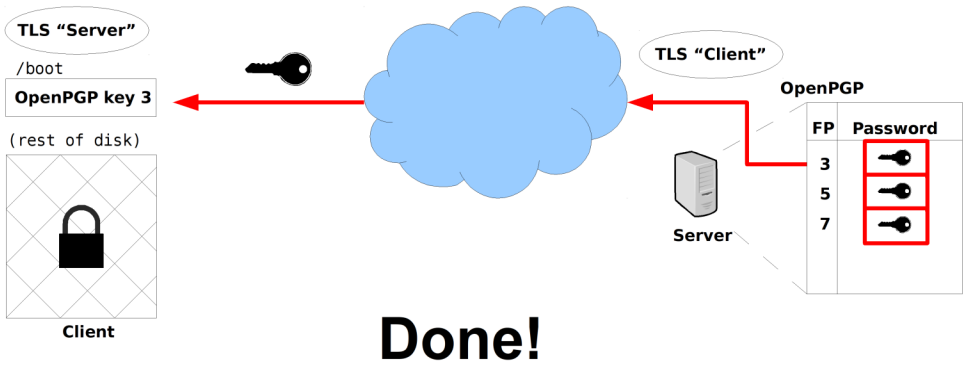
Now the passwords are encrypted.



And we can fulfill the other part of the quote.

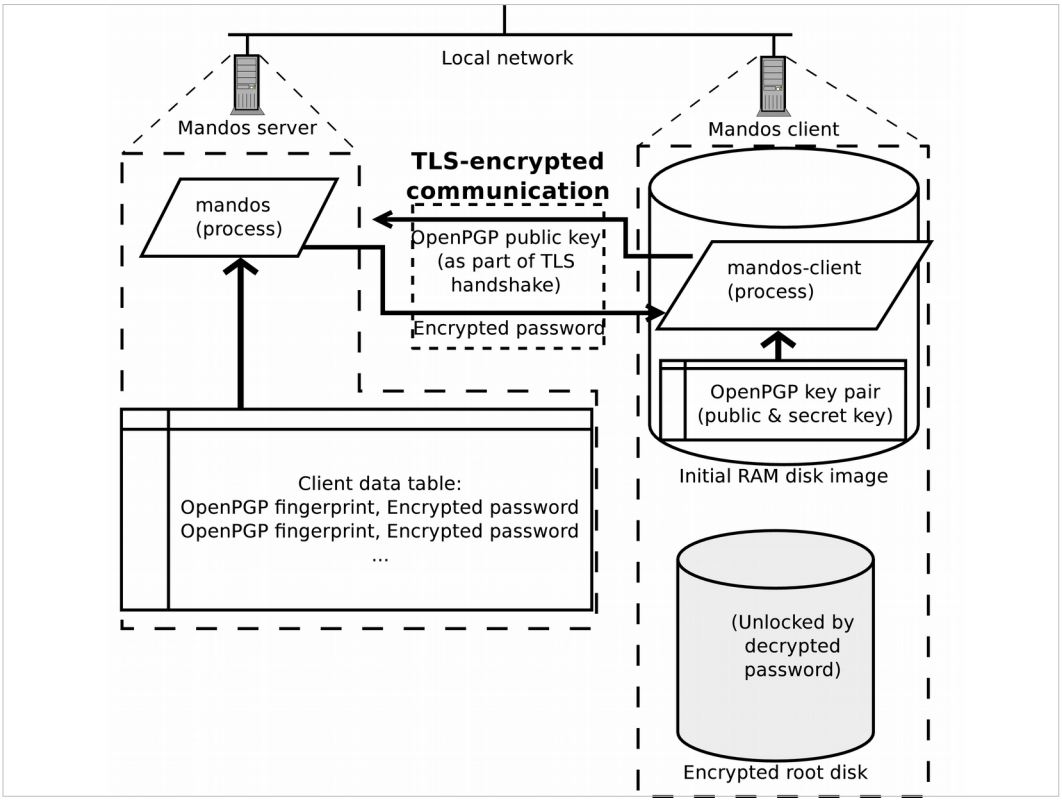
Mandos

https://www.recompile.se/mandos

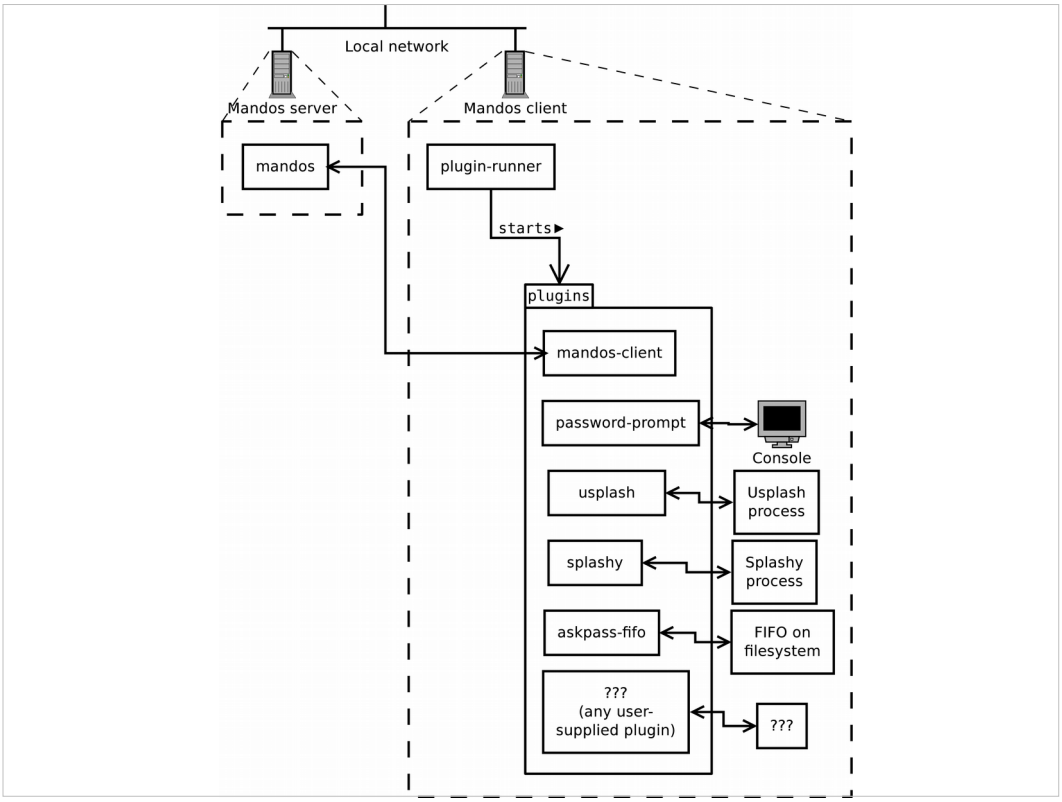


Done!

This is actually the finished design; this is how the Mandos network protocol works.



Older diagram attempting to show the same thing



Client-side process model with plugins for various input methods, etc.

FAQ

Grabbing the Mandos client key from the `/boot` partition's `initramfs` image really quickly?

Threat model: people grabbing servers fast. Sophisticated attackers can and will do cold-boot.

Mandos shrinks the window of opportunity to default 5 minutes, customizable

Mandos

https://www.recompile.se/mandos

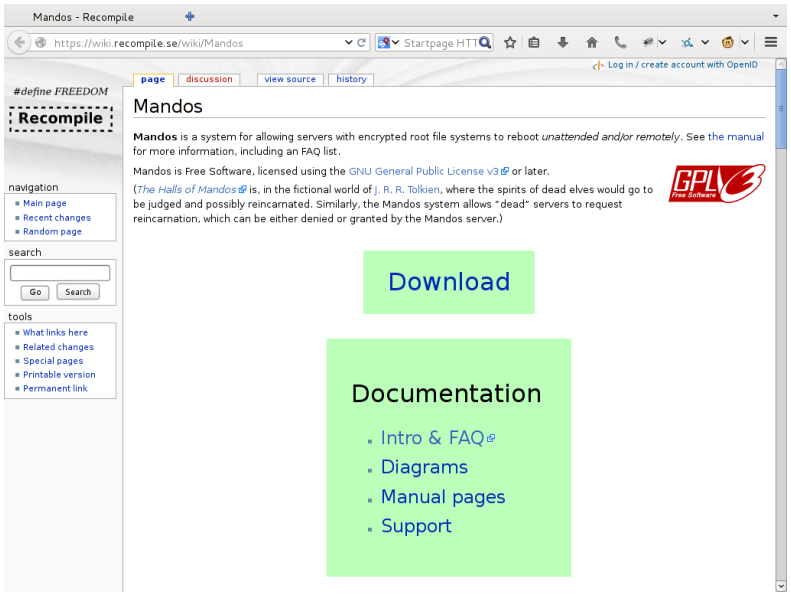
- **In Ubuntu “universe” since 2009**
- **In Debian since 2011**

```
aptitude install mandos
aptitude install mandos-client
```

This is mature, well-used code, and has been available and in use for many years.

Mandos

https://www.recompile.se/mandos



The Mandos home page has more information.

Mandos

https://www.recompile.se/mandos

https://ftp.recompile.se/pub/mandos/misc

Link to these slides (and more)