
# CLIP OS 5: Beta release

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Agence nationale de la sécurité des systèmes d'information (ANSSI)

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# About the ANSSI

- *Agence nationale de la sécurité des systèmes d'information*
- French authority in the area of cyberdefence, network and information security
- Provides its expertise and technical assistance to government departments and businesses and plays an enhanced role in supporting operators of vital importance.

# CLIP OS?

- Linux distribution developed by the ANSSI
- Initially only available internally
- Now open source, mostly under the LGPL v2.1+
- Code and issue tracker hosted on GitHub[1][2]:
  - Version 4: available as reference and for upstream patch contribution
  - Version 5: currently developed version, beta released in December 2019

[1] https://github.com/CLIPOS
[2] https://github.com/CLIPOS-Archive

# CLIP OS?

## Not yet another Linux distribution

- Not a generic/multi-purpose distribution

## Targets three main use cases

- Mobile office workstation
- Remote administration workstation
- IPsec gateway

# Hardened OS

- Based on Gentoo Hardened
- Hardened Linux kernel and confined services
- No interactive `root` account available:
  $\Rightarrow$ "Unprivileged" admin, audit and update roles
- Automatic updates using A/B partition model (similar to Android 7+)
- Multilevel security:
  - Provide two isolated user environments
  - Controlled interactions between isolated environments

# 5.0 Alpha features & security

# 5.0 Alpha: Initial features

- Functional core (boot to command line shell)
- Strict split between:
  - Read Only: system executables, configuration and data
  - Read Write: runtime configuration, logs, user and application data
- Initial boot chain integrity:
  - Secure Boot (bootloader, initramfs, Linux kernel and its command line)
  - Read-only system partition protected by DM-Verity
- Initial hardware support: QEMU/KVM virtual machine

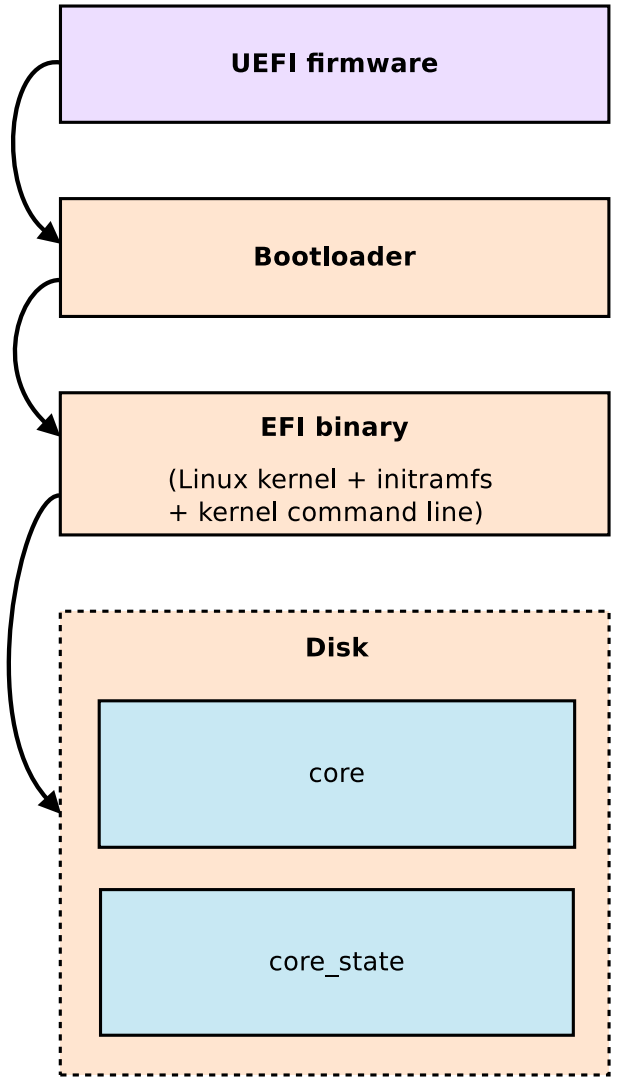
# 5.0 Beta features & security

# **5.0 Beta features & security** / TPM 2.0 Support

# TPM 2.0 Support

Goal:

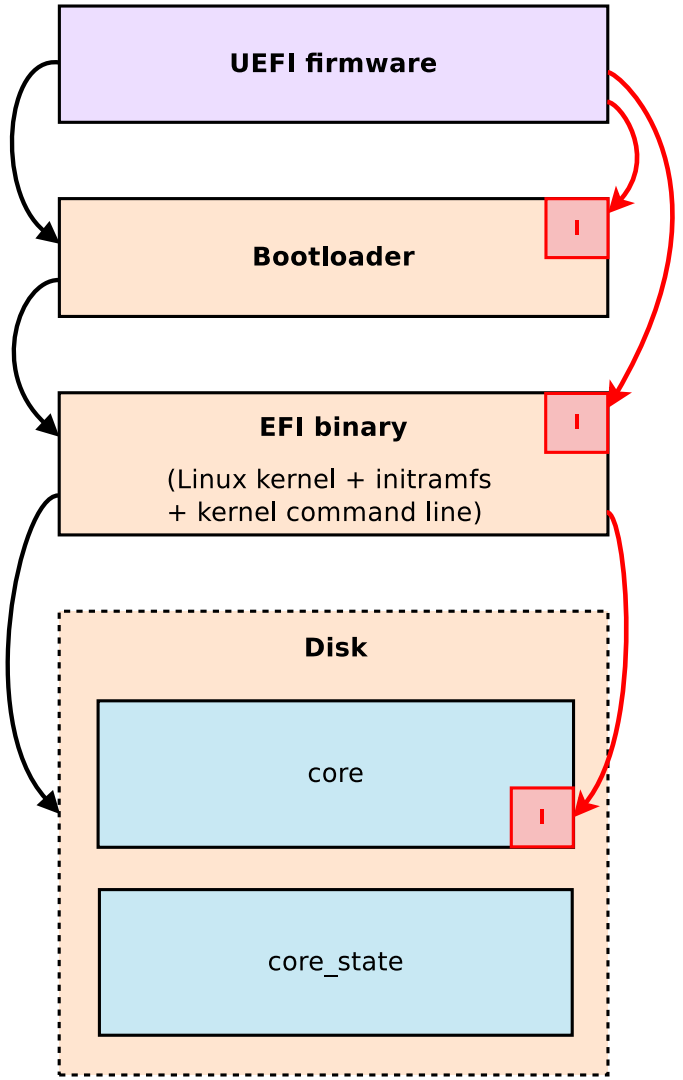
- **Transparent** (no user interaction) encryption of writable system state partition



# TPM 2.0 Support

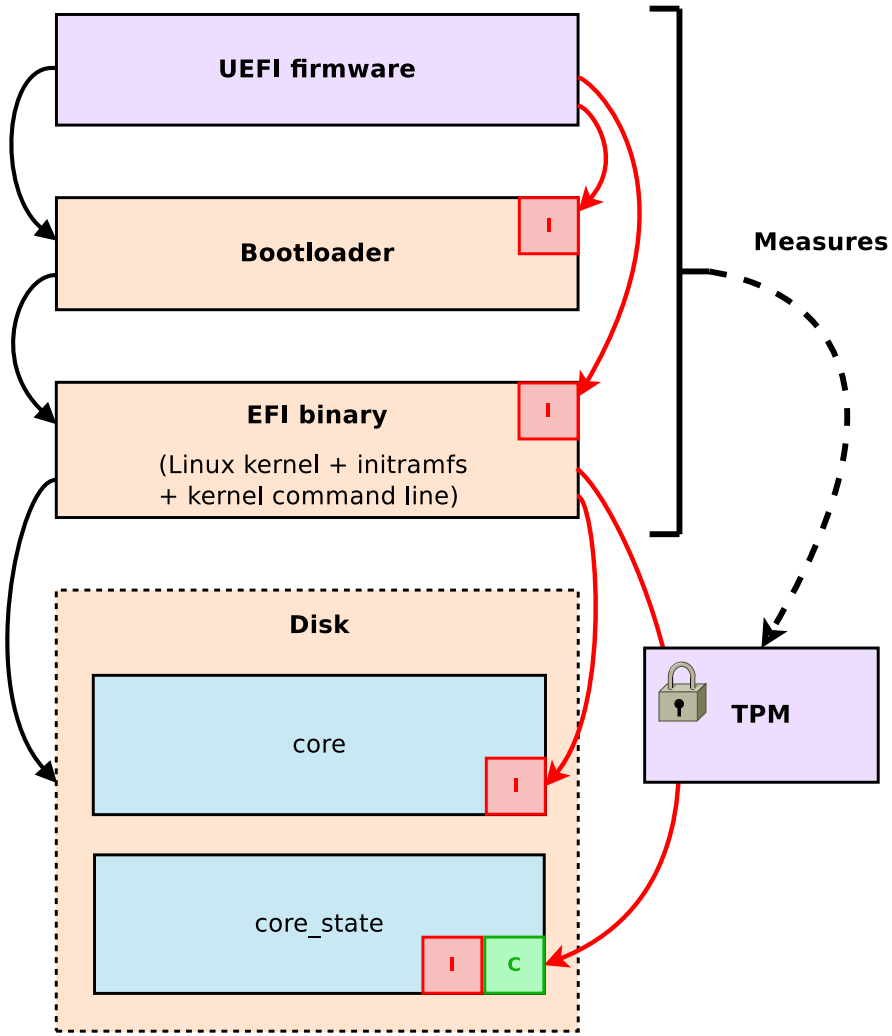
Implementation:

- Complements existing **Secure Boot** support and **Boot Chain Integrity**



# TPM 2.0 Support

- **Seal the encryption key** and provide it at boot time if machine in known-good state:
  - Rely on **PCR 7**: records measure of Secure Boot state
  - Expected Secure Boot state ⇒ we booted a trusted EFI binary (kernel + initramfs + cmdline)



# TPM 2.0 Support

- Using other PCRs is easy (e.g. PCR 0 to measure firmware integrity), but requires some care to handle updates
- Use Intel's implementation of the TPM2 Software Stack, from the initramfs: `tpm2-tss` library *via* `tpm2-tools` binaries (may change)

**5.0 Beta features & security** / Update support

# Update model

Goals:

- Client side:
  - **safe**: applied while the system is online and in use
  - **in-background**: happen transparently to the user
  - **atomic**: list only valid options during boot
  - **rollback**: temporary fallback to a working version

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  - client identification and version reporting
  - update channels

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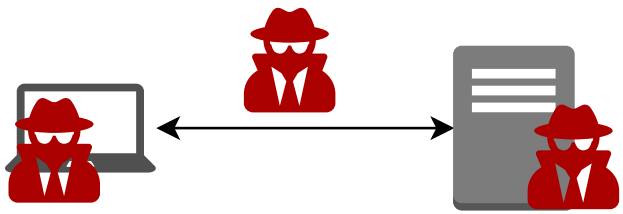
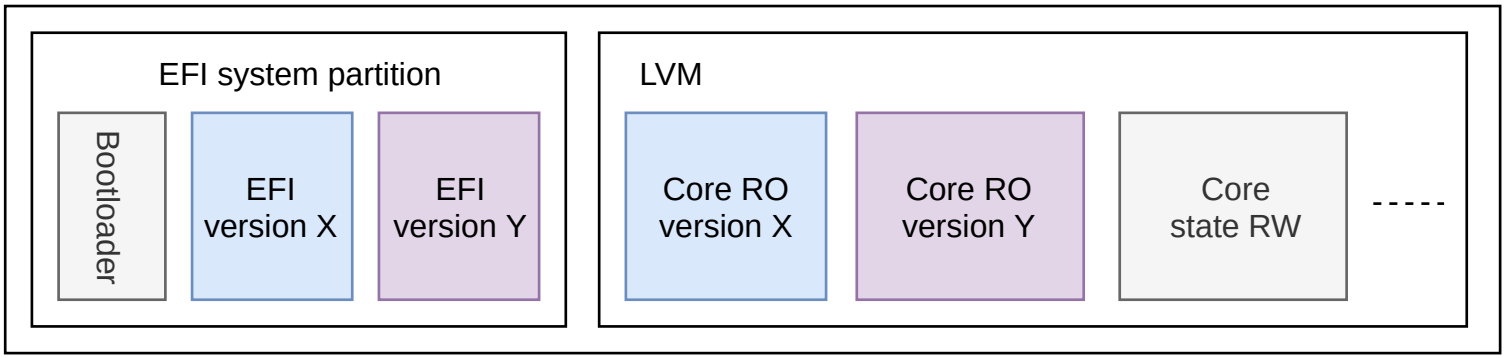
Threats:

- Compromised update server
- Active man-in-the-middle attacker
- Active local attacker



# Update support: Client




CLIP OS system layout:

- UEFI boot only, following the Boot Loader Specification
- A/B partition setup using Logical Volumes for system Read-Only partitions (for example: Core)
- Single partition setup for stateful partitions

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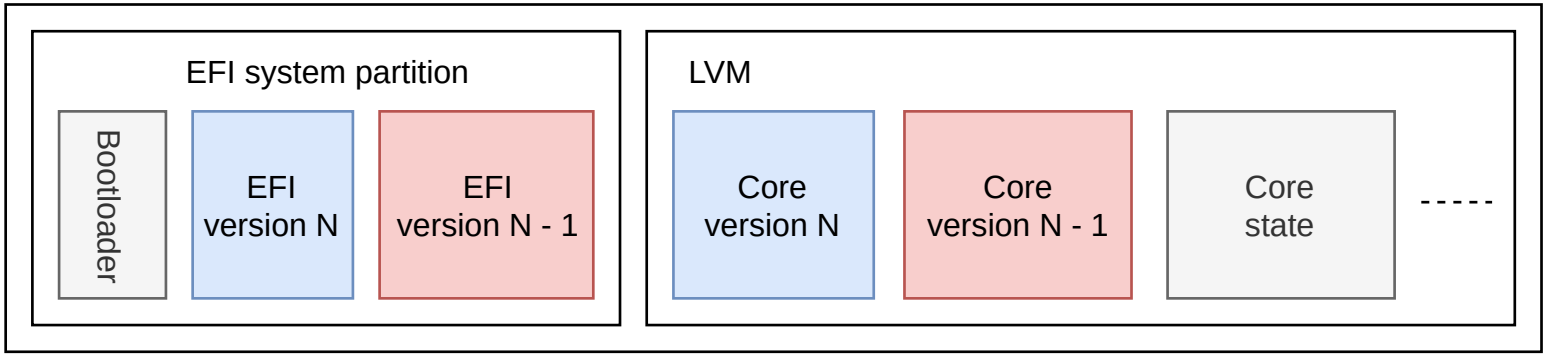


Implementation:

- Download the latest Core partition and EFI binary from the update server

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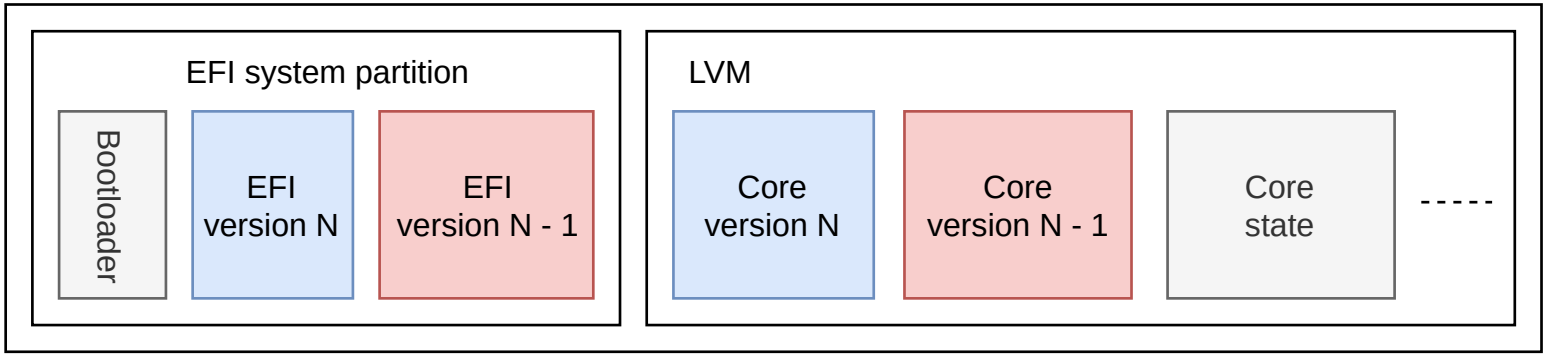


Implementation:

- Download the latest Core partition and EFI binary from the update server
- Verify download integrity

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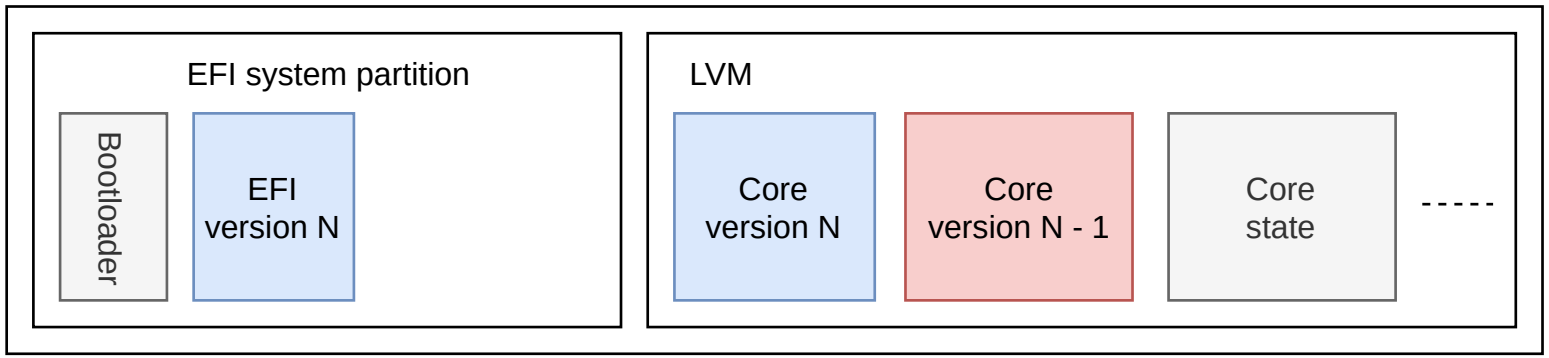


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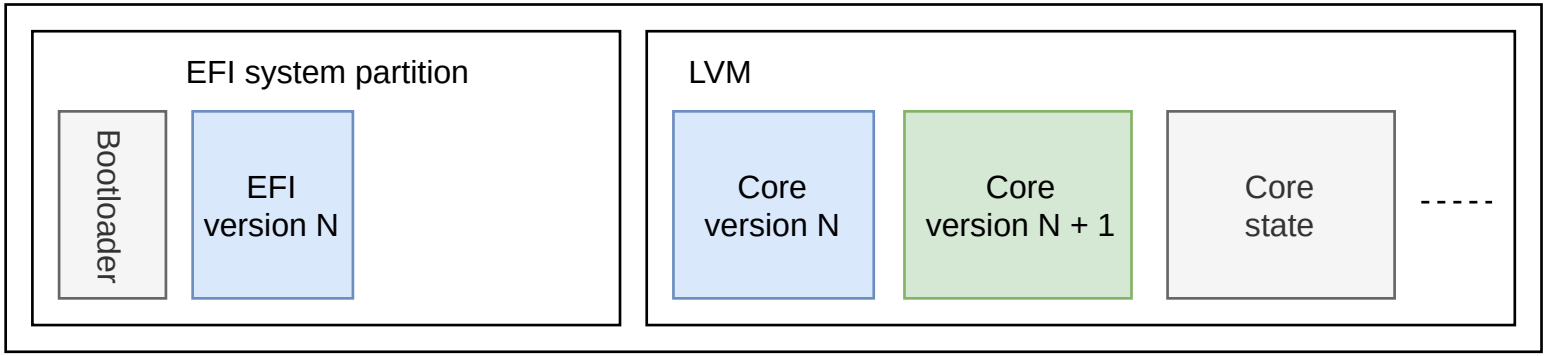


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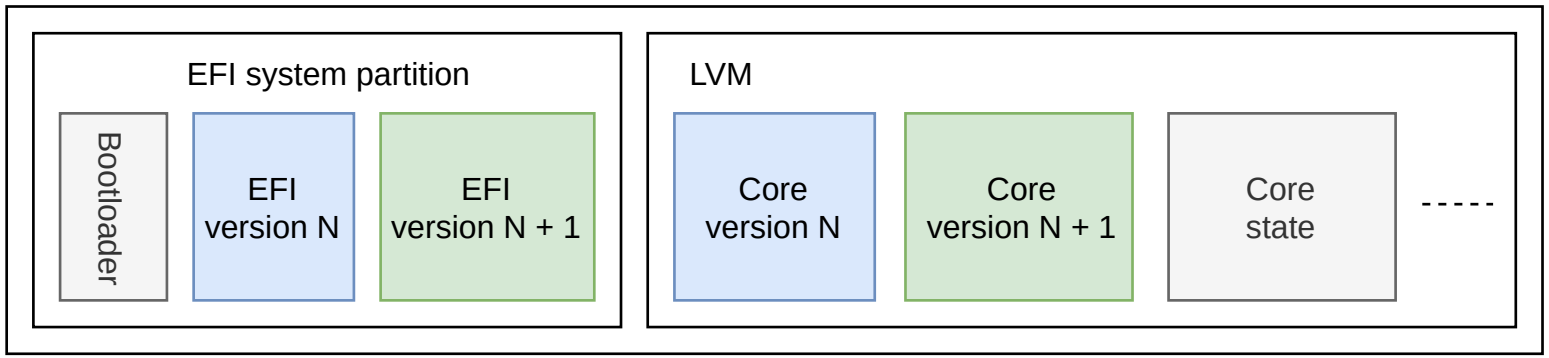


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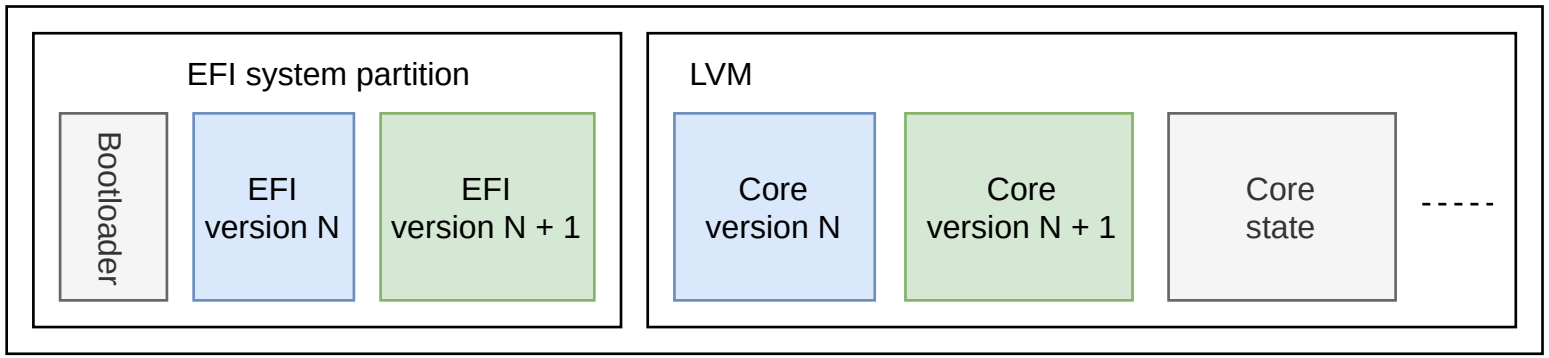


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- Verify download integrity
- Remove the EFI binary associated with previous and soon unavailable version
- Install the Core partition in the currently unused Logical Volume or create a new one if only one exists
- Install the EFI binary with a name following the Boot Loader Specification
- Reboot the system to automatically boot the new version

# Update support: Server

Initial version:

- Static files served over HTTPS
- Versioned directory layout

```
https://update.clip-os.org/
        +-- dist
        |   +-- 5.0.0-alpha.2
        |       +-- clipos-core, clipos-core.sig
        |       +-- clipos-efiboot, clipos-efiboot.sig
        +-- update
            +-- v1
                +-- clipos
                    +-- version
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Planned:

- Client statistics and version reporting
- Channel support

# Update support: Security

Implemented:

- Client in Rust
- HTTPS with TLS 1.2+ only
- Root CA pinning
- Payload signatures using minisign
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Unaddressed issues:

- Offline rollback resistance
- Update signing key compromise

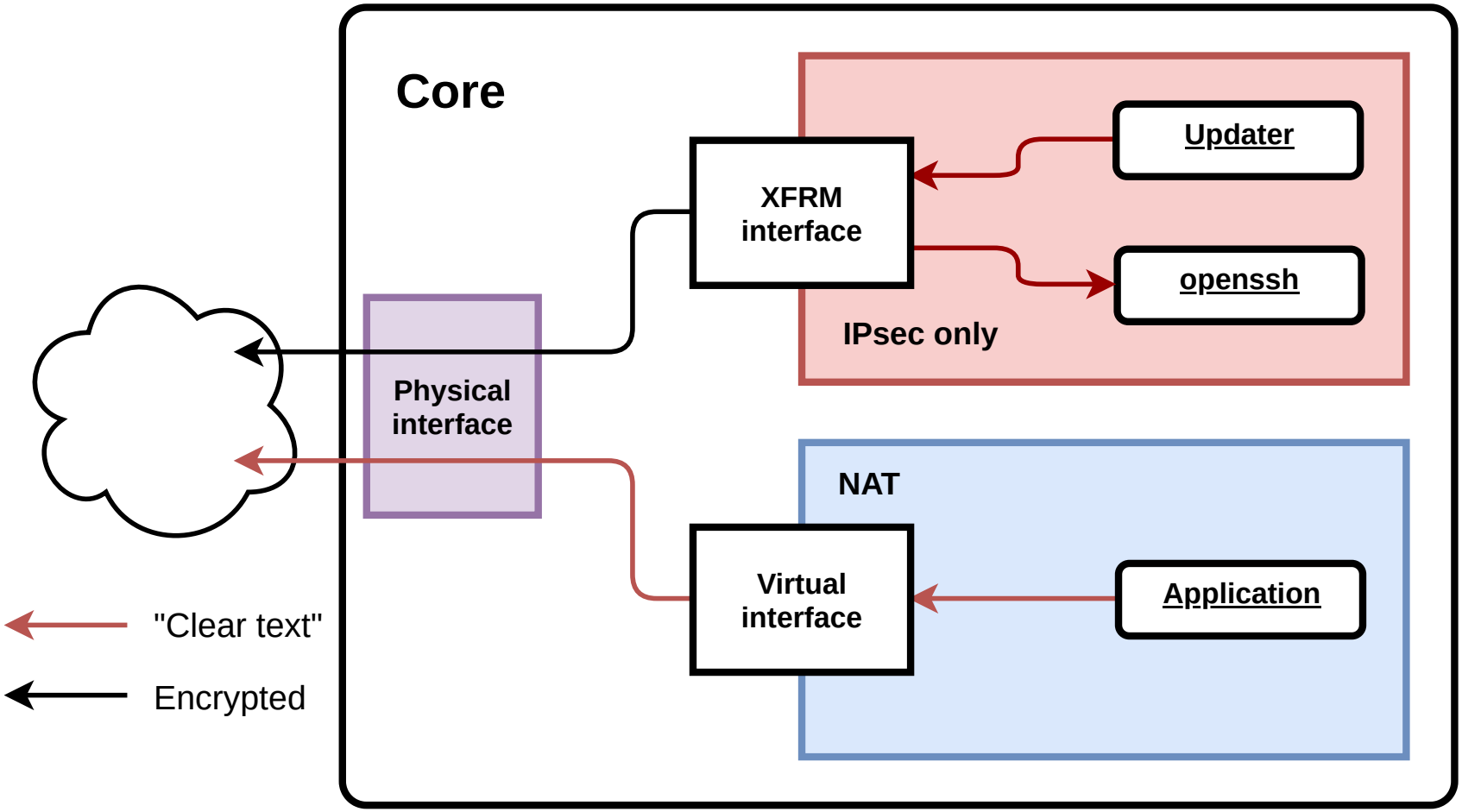
# Update support: Planned improvements

- Reduce client privileges (unprivileged network procecessing, etc.)
- Incremental updates using casync
- Bootloader update
- Free disk space checks

# 5.0 Beta features & security / IPsec support

# IPsec support

- Isolation using network namespaces
- IPsec access using XFRM interfaces (similar to Wireguard)



# IPsec support

- Latest strongSwan release (5.8.1):
  - Strict compile time configuration
  - Strict default strongSwan configuration
  - Confined unprivileged strongSwan daemon
- IPsec DR conformity in progress:
  - All available compile time and runtime configuration changes applied
  - All items requiring code changes and code review postponed to 5.0 stable
- IPsec aware nftables based firewalling:
  - Currently static rules generated at install time
  - Dynamically generated / template based rules postponed to 5.0 stable

**5.0 Beta features & security** / Linux kernel maintenance

# linux-hardened

- Set of hardening patches initially maintained by Daniel Micay, many of them extracted from grsecurity/PaX
- Now maintained internally, in collaboration with Arch Linux
- Tends to shrink due to *upstreamization*, but some features regularly require time-consuming adaptations
- ASLR improvements, memory sanitizing, slab cookies, a bit more `__ro_after_init`, etc.

# Patches merged upstream

Former out-of-tree patch sets merged and maintained in CLIP OS but now available upstream:

- Lockdown (in v5.4, as an LSM)
- STACKLEAK (since v4.20)

# Running a recent kernel

Pros:

- Quickly benefit from new features
  - Kernel hardening (e.g. `init_on_free`, `STRUCTLEAK_BYREF_ALL`)
  - Security mechanisms (e.g. `dm_verity`, `nf_tables`)
- Receive more stable backports, especially security fixes
- Constant but easier (and less error-prone) work to keep in sync
  - As opposed to CLIP OS v4: massive work required once upon a time to jump from one LTS to another

Cons:

- "Stable" kernels are far from being stable (but neither are LTS ones)
  - We uncover bugs, either in new features or due to uncompromising combinations and configurations that nobody seems to use nor test
  - Several bugs reported to upstream, as well as missing backports

# **5.0 Beta features & security** / Other features

# Other features

- Virtual testbed using Vagrant:
  - Includes test support for updates and IPsec
- Initial admin & audit roles (available over SSH)
- X260 hardware profile
- etc.

# Project infrastructure

# **Project infrastructure** / Code review (Gerrit)

# Code review (Gerrit)

Gerrit:

- Powerful, Git-based, code review web application
- Deployed at: review.clip-os.org

# **Project infrastructure** / Continuous Integration (GitLab CI)

# Continuous Integration (GitLab CI)

Why GitLab?

- Lots of features (Git LFS, container registry, artifact storage, etc.)
- Compatible with offline development environment requirements (DR/CD)
- Gerrit deployment now optional
- Good documentation, lots of high profile users
- GitLab CI integration

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Why GitLab CI?

- Jobs described with simple YAML file & (Bash) scripts
- Container based:
  - mostly Docker for now
  - podman support in GitLab 12.6 (expected on 2019-12-22)
- Scheduler / worker split

# Continuous Integration (GitLab CI)

Public CI with GitLab.com (gitlab.com/CLIPOS/ci):

- Weekly "from scratch" builds
  - Build Debian based work container
  - Build everything else from scratch
  - Takes approximately 2 hours 20 min
- Daily "incremental" builds
  - Re-use container image
  - Re-use SDKs from latest successful build
  - Re-use binary packages from latest successful build
  - Takes approximately 35 min
- Build results (artifacts) available at files.clip-os.org
- Now very easy to try the latest version of CLIP OS in QEMU: docs.clip-os.org/toolkit/quick-try.html

# 5.0 stable: Roadmap

# Roadmap: 5.0 stable

- Confined user environments (GUI)
- Multilevel support (Vserver-like LSM)
- Automated installation using PXE
- Fix all remaining issues required for qualification

# Conclusion

CLIP OS 5 Beta:

- All the building blocks to create an IPsec gateway are now available
  - IPsec DR compatibility in progress, planned for final 5.0
- All the building blocks to create a server are now available
  - Update, IPsec client, Remote administration over SSH, etc.

Focus is now on user environments (GUI) and multi-level support:

- Use case 1: Mobile office workstation
- Use case 2: Remote administration workstation

# Thanks!

✉ clipos@ssi.gouv.fr

- Website: clip-os.org
- Docs: docs.clip-os.org
- Sources: github.com/CLIPOS
- Bugs: github.com/CLIPOS/bugs