Extending the Secure Boot Certificate and Signature Chain of Trust to the OS

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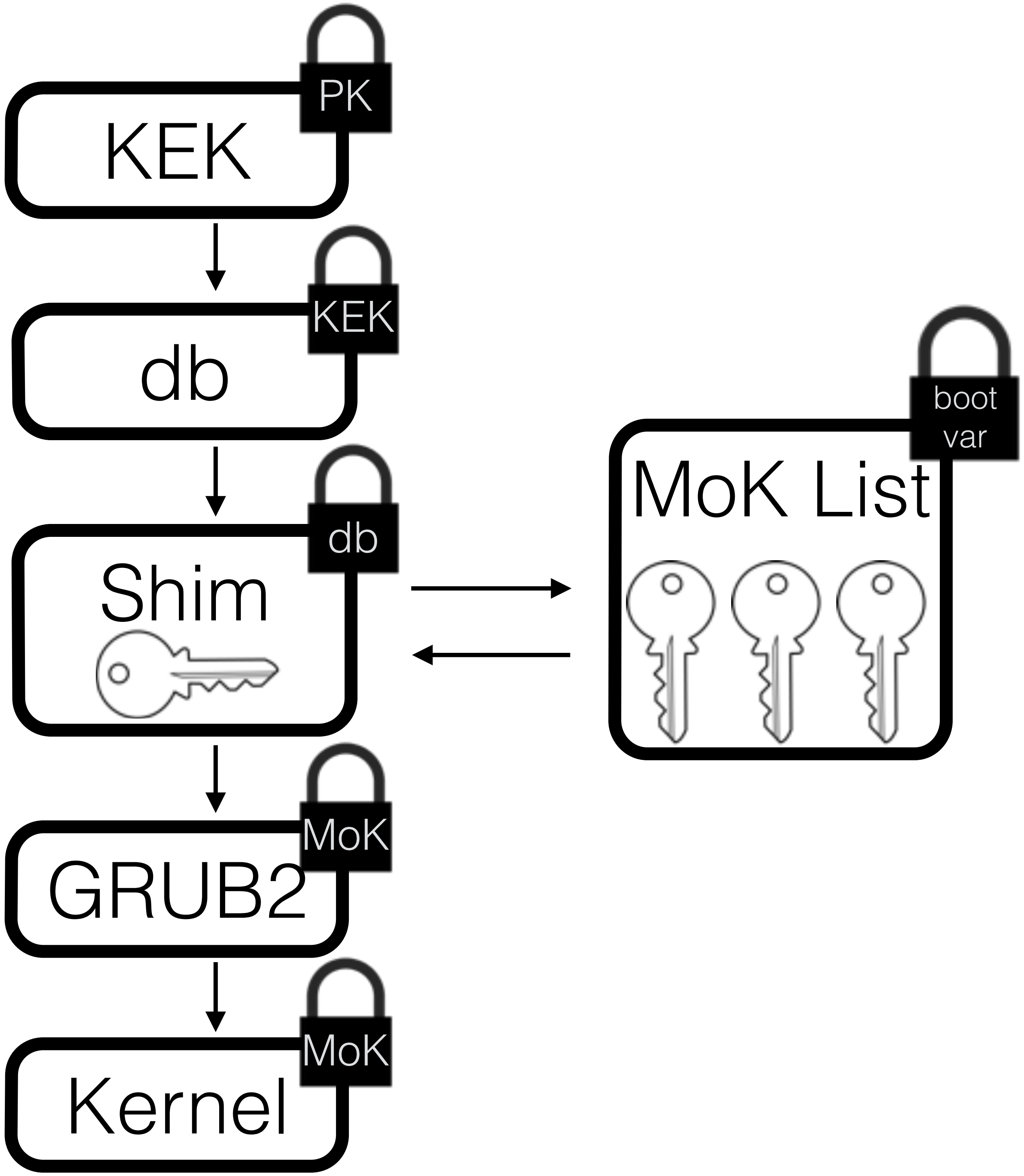
Secure Boot Chains of Trust

- Secure Boot places the root of trust in hardware write protected firmware and public keys

- Public key certificates establish a chain of trust based on validating signatures

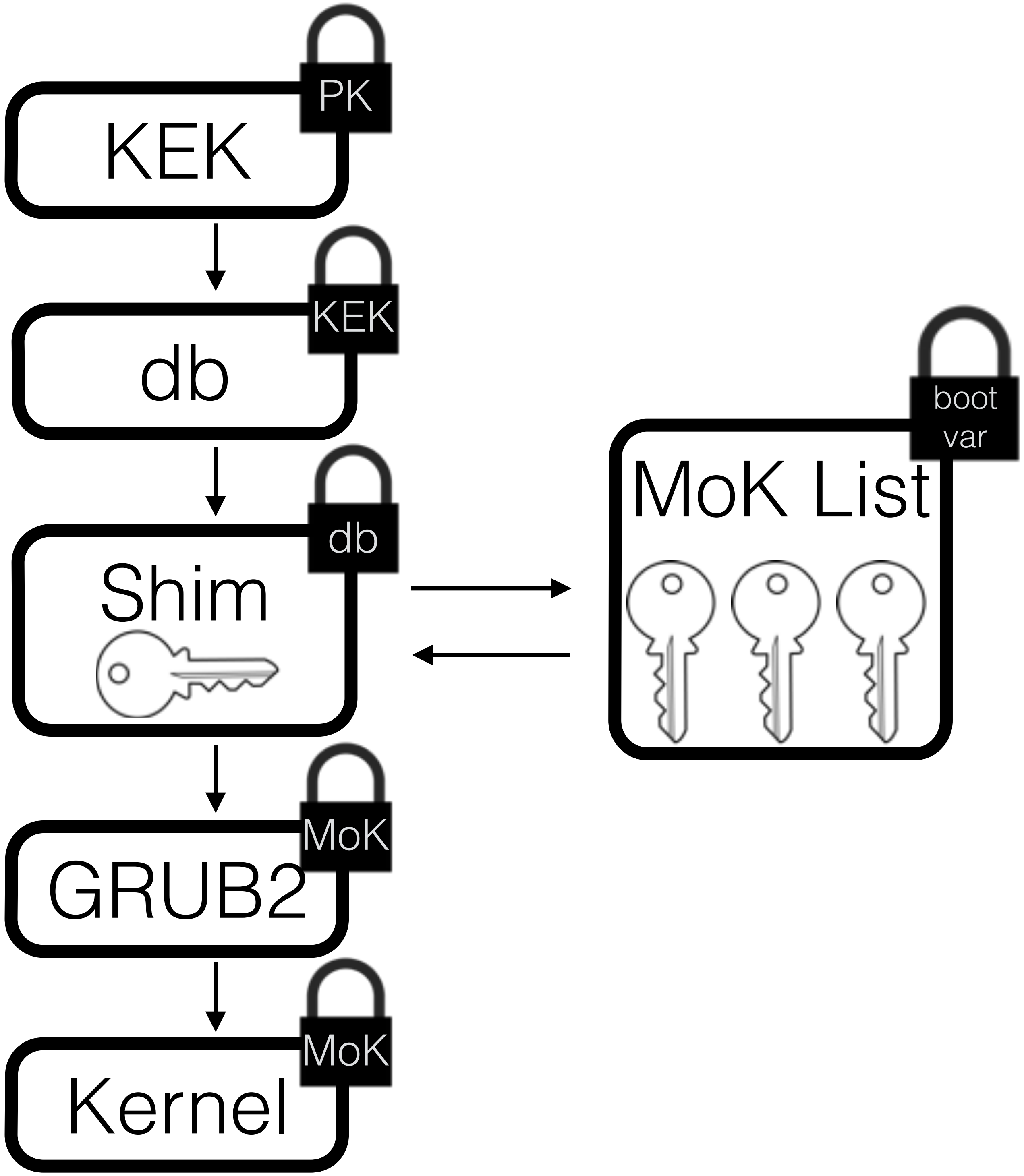
- Firmware uses public key(s) to validate the signed bootloader

- The signed bootloader can then validate the signed kernel, and so on



Secure Boot Chains of Trust

- PK - Platform Key (OEM key)
- KEK - Key Exchange Keys Database (OS vendor keys)
- db - Signature Database
- MoK - Machine Owner Key (the machine owner can replace boot components using mokutils tool)



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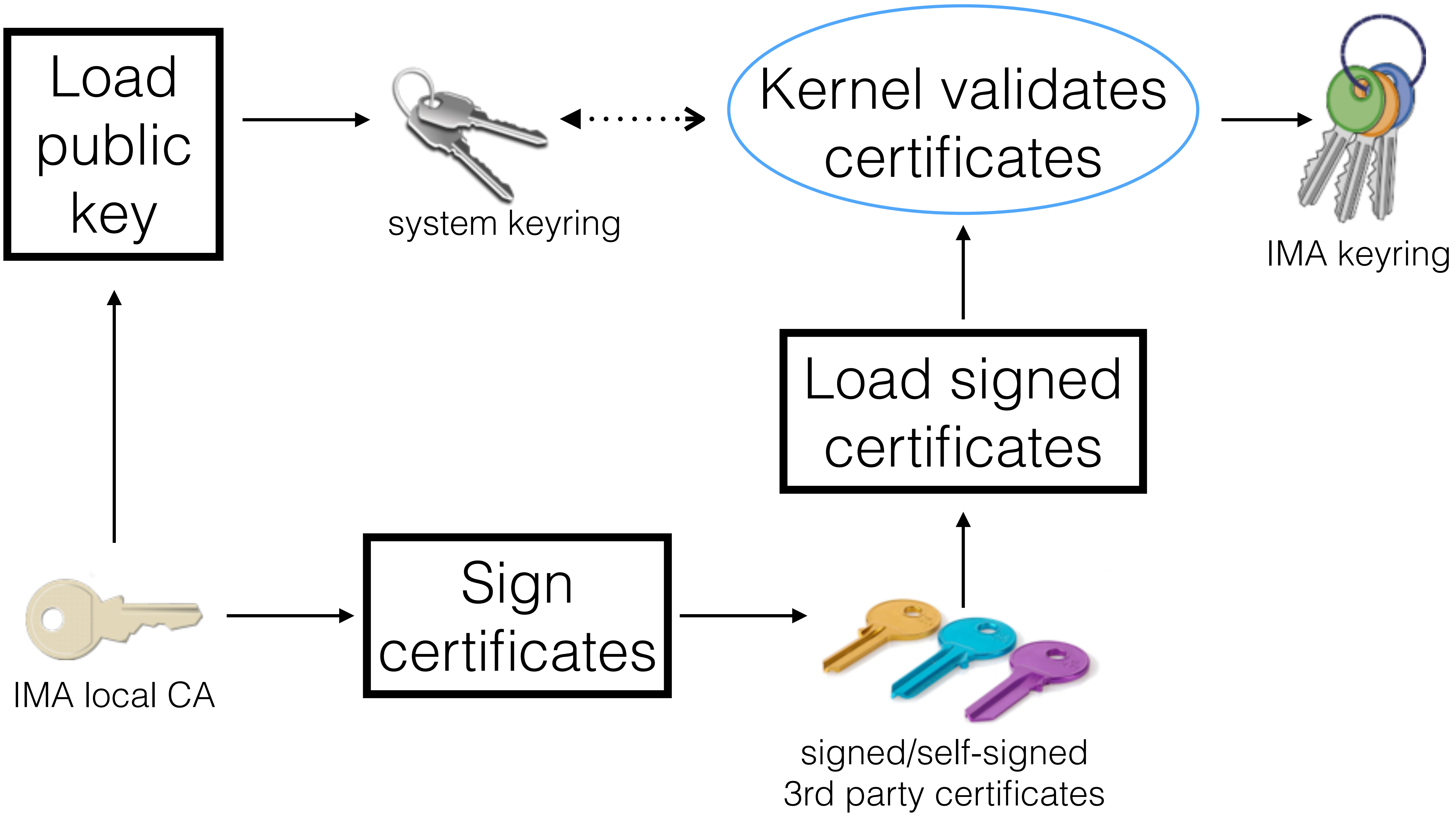


Load public key

system keyring

Kernel validates certificates

IMA keyring

Load signed certificates

IMA local CA

Sign certificates

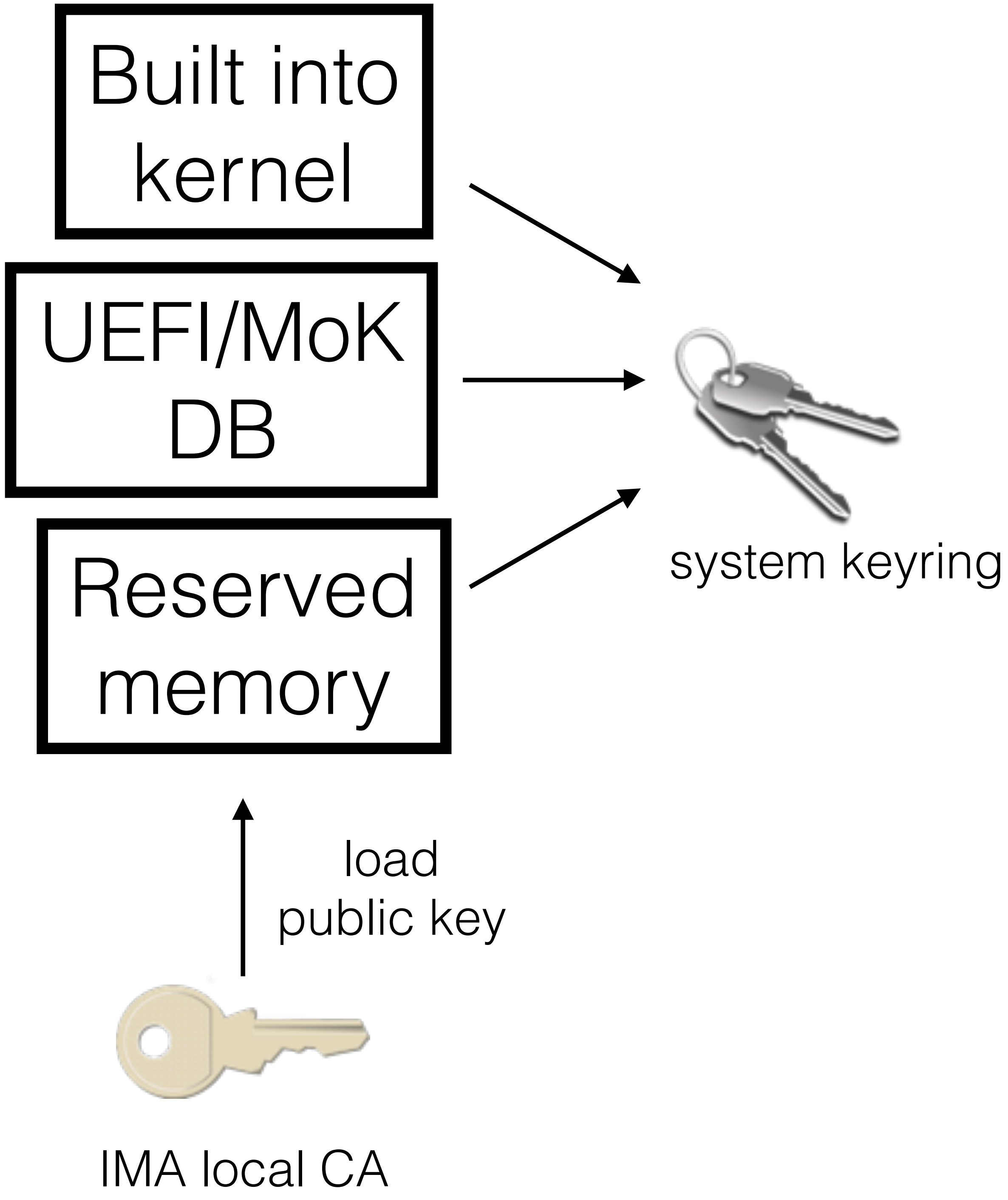
signed/self-signed
3rd party certificates

Methods for Loading IMA Local-CA Public Key on the System Keyring

1. Compile key into Linux kernel

2. Load the UEFI/MoK database keys (RedHat's patches)

3. Pre-allocate space in the kernel image for IMA local-CA public key. Post build, install key and resign kernel image.



Sign Certificates with IMA Local-CA Private Key

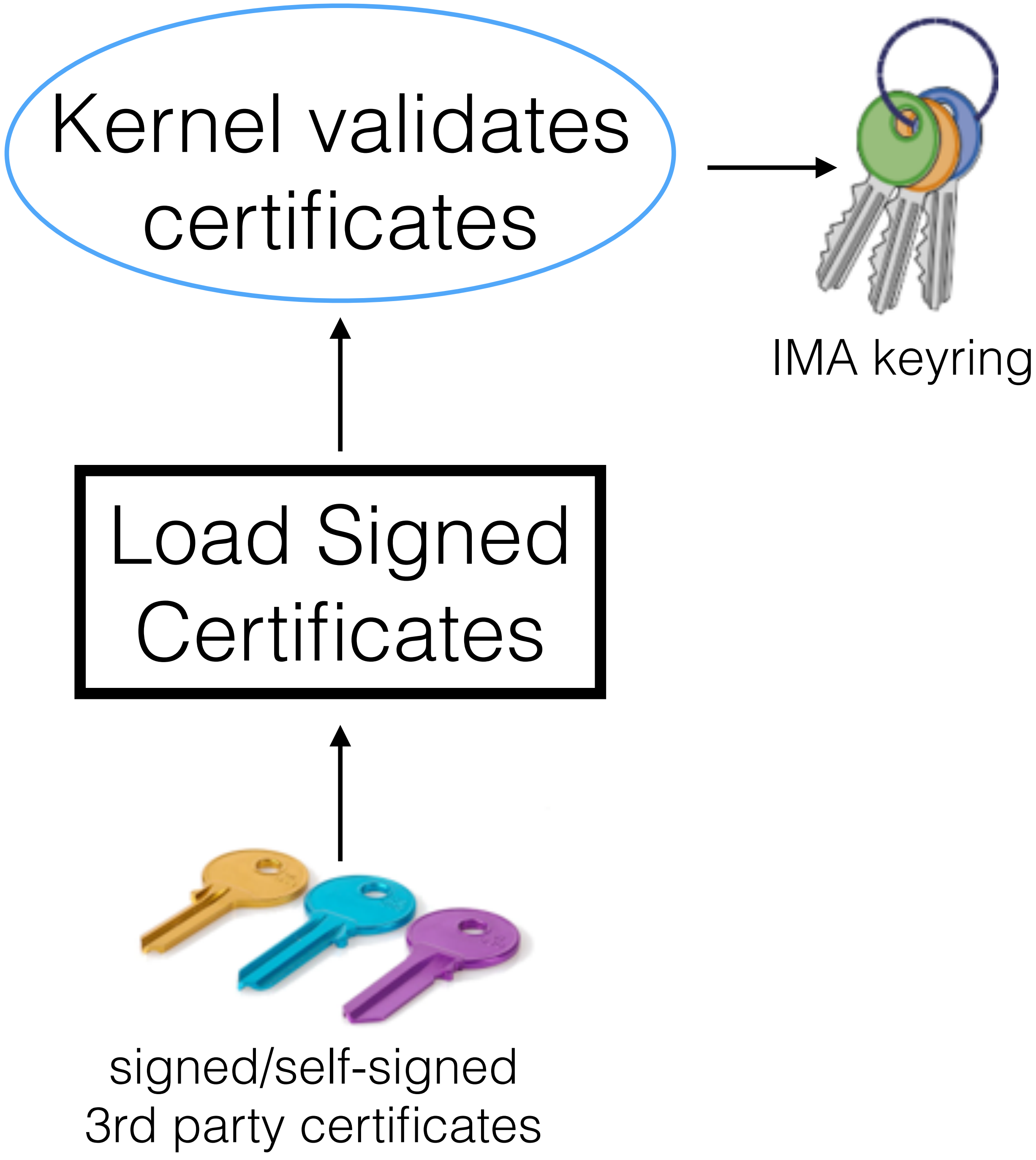
- Which certificates and why?

- Signing distro/3rd party certificates without a certificate signing request (CSR)

```
openssl ca -ss_cert cert.pem
```

Load Signed Certificates onto IMA Keyring

- Certificates containing a key used to verify file signatures need to be signed by a system trusted key
- This extends the signature chain of trust to the OS
- The dracut integrity module loads signed certificate keys onto the trusted .ima keyring



Kernel validates certificates

IMA keyring

Load Signed Certificates

signed/self-signed
3rd party certificates

Labeling Filesytems with Signatures

- The Linux kernel’s integrity subsystem verifies and appraises file integrity based on file signatures

- Files are currently signed, post install, by walking the filesystem

- A better, more complete solution is to include file signatures in software packages

- This enables files to be automatically labeled with signatures during installation

RPM File Signatures

- Extended the existing rpm signing tool to include file signatures in packages

- RPM plugin installs file signatures using post transaction element hook (psm_post)

- Expected in rpm-4.13.0

RPM Including File Signatures

- New Command

  ```
  rpmsign –addsign –signfiles PACKAGE_FILE
  ```

- Sign Files Options

  ```
  –fskpath and –fskpass
  ```

RPM Including File Signatures

- The new option signs all the file digests included in the package with libimaevm v1.0
- File signatures are stored in the package header under the tag RPMTAG_FILESIGNATURES
- After including file signatures, the packages are signed normally

RPM Installing File Signatures

- When a package is installed, rpmfilesPopulate extracts file signatures from the package header and stores them in rpmfiles struct
- The RPM plugin instantiates the post transaction element hook (psm_post) and writes the file signatures to security.ima xattr

deb Including File Signatures

- Control.tar.gz in the .deb packages contains a md5sums file

- Include digest sums file in package (eg. sha256sums)

- Append file signatures

  ```
  cat sha256sums | evmctl sign_hash -a
  sha256 -key “${PRIVKEY}” > sha256sums
  ```

deb Installing File Signatures

- debhelper script and autoscript install ELF file and script signatures stored in the sha256sums file
- debhelper script: dh_installfile-sigs
- autoscript: postinst-file-sigs

Next Steps

- Upstream deb file signature extensions - feature request #766267
- Linux software distributors ship packages with file signatures

References

- https://wiki.ubuntu.com/SecurityTeam/SecureBoot
- https://www.suse.com/documentation/sles11/book_sle_admin/data/sec_uefi_secboot.html
- http://blog.hansenpartnership.com/the-meaning-of-all-the-uefi-keys/