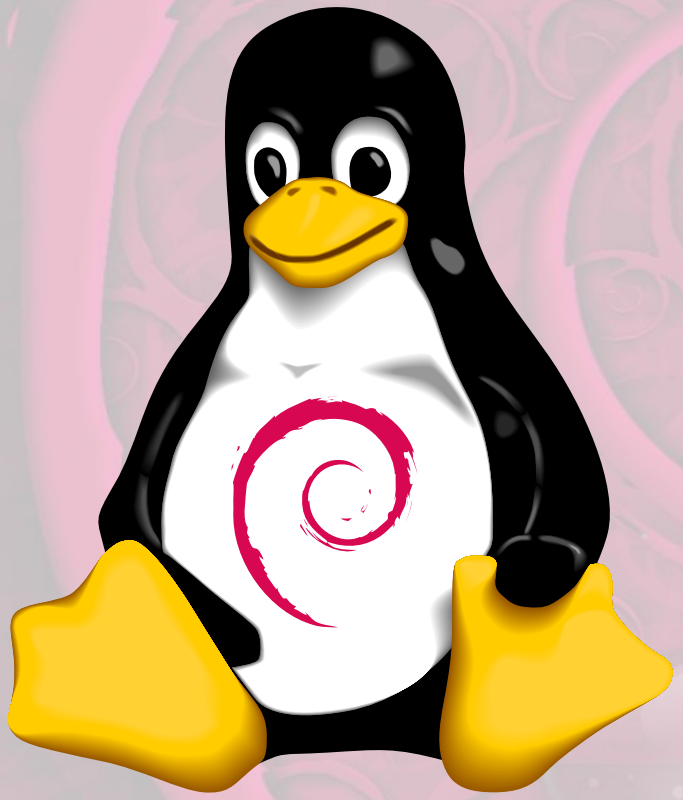
Debian's support for Secure Boot on x86 and ARM



Ben Hutchings

Kernel Recipes, Paris, 2016

debian

Ben Hutchings

- Regular Linux contributor since 2008
- Working on various drivers and kernel code in my day job
- Debian kernel and LTS team member, now doing most of the kernel maintenance aside from ports
- Maintaining Linux 3.2.y and 3.16.y stable update series on kernel.org
- Kernel maintainer for LF Civil Infrastructure Platform, aiming for super-long-term support

Secure Boot

- Optional feature in UEFI - uses certificate store to validate boot loader, UEFI drivers, system firmware updates
- Protects against persistent malware (bootkit / kernel rootkit) if implemented correctly
- Required in 'Designed for Windows' systems since Windows 8 (2012)
- Only common trusted certificates on PCs are for Microsoft signing keys
  - MS *will* sign PC boot loaders for a small fee, and the certificate store is normally editable on PCs
  - ARM-based Windows systems are completely locked down
- HPe shipping ARM64 server systems in SB setup mode, allowing installer to set trusted certificates

GNU/Linux under Secure Boot

- First stage needs MS signature – manual submission process
  - Most distributions introduced 'shim' as first stage boot loader that won't need updating often
- MS expects boot loader and kernel to validate code they load – and it's a good idea anyway
  - For later stages, we control certificates and keys – certificates can be embedded in 'shim'
  - GRUB needs to validate its modules and kernels
  - Linux kernel needs to validate its modules and any other code that runs in kernel mode

Securing the Linux kernel

- Root user, including malware running as root, can modify kernel without using any security bugs
- MS signing requires kernel to validate code it runs – and it's also a good idea in general
- Using Matthew Garrett's patchset to add 'securelevel' feature, activated when booted under SB:
  - Module signatures are mandatory
  - kexec_load() is disabled – must use kexec_file_load() instead
  - Hibernation is disabled – but images *could* be signed and validated using per-machine key
  - Other kernel APIs that allow peek/poke are disabled
- Force-loading of modules into the wrong kernel version is disabled

The signature problem

- We don't want to expose signing keys to buildds
- Reproducible builds can't depend on anything secret
- So we can't *auto-build* signed binaries in single step

Solution requires an extra source package:

1. Build unsigned binaries from first source package
2. Sign 'offline' and put detached signatures in second source package
3. Build signed binaries from second source package

Introducing linux-signed

- The second source package for linux
- Contains detached signatures for specific kernel version and script to update them for a new kernel version
- linux builds binary packages like linux-image-4.7.0-1-amd64-unsigned
- linux-signed clones those packages, attaches signatures, and builds packages like linux-image-4.7.0-1-amd64
- Signing currently done with my personal key, which will not be trusted by shim or GRUB

Signing in dak - background

- Debian archive software (dak) signs archive metadata using keys trusted by Debian systems
  - Separate keys for stable releases, security updates, rolling releases
  - Keys managed by 'FTP' team
- We want dak to also sign code from linux, grub, etc. and publish detached signatures
  - Keys also managed by FTP team, possibly similar split between releases
  - Mustn't publish complete binaries at this stage - need reproducibility, and might have an embargoed fix
- dak supports uploads with non-standard file types (byhand) and configured handlers (auto-byhand!)

Signing in dak - implementation

- Add auto-byhand script that converts tarball of EFI binaries and/or kernel modules to tarball of corresponding signatures
- Enable auto-byhand for all source packages that need code signing
- Include signature tarballs in signed archive metadata
- Change each first source package to include a suitable tarball in uploaded files (dpkg-distaddfile)
- Add preparation script to each second source package to download and unpack published signature tarball

Didn't Ubuntu already do this?

Yes, but:

- Launchpad has a different hook mechanism
- Signing script only covers EFI binaries, not kernel modules
- Signing script produces signed binaries, not detached signatures
- Kernel is only signed on amd64
- linux packages in Debian and Ubuntu have >10 years of divergence

We'll still share shim, grub-signed, sbsigntool, etc.

Secure Boot on ARM?

- Upstream kernel has EFI stub for ARM32 and ARM64
- We have out-of-tree kernel patches for securelevel on ARM64
- sbsigntool works for ARM32 and ARM64 (although the test cases only cover x86)
- GRUB EFI code runs on ARM32 and ARM64
- shim runs on ARM64
- So we should be able to support Secure Boot on ARM64

Securing the signing keys

- Julien Cristau is working on signing with a PKCS#11 hardware security module – some model of Yubikey
- Signing with Yubikey is slow so we plan to use it for EFI binaries only; kernel modules will be signed with a file

Current status

- Bug #820036 tracks work to be done
  - dak support for signed packages – *in progress*
  - shim package – *in review*
  - GRUB signed build and validation of next stage
  - Linux signed build – *ready to go when dak is*
  - fwupdate signed build
  - Signed binaries in installer and live images
- More information at https://wiki.debian.org/SecureBoot
- Aiming for stretch release (freeze in Jan 2017)

Credits

- Linux 'Tux' logo © Larry Ewing, Simon Budig.
  - Modified by Ben to add Debian open-ND logo
- Debian open-ND logo © Software in the Public Interest, Inc.
- Debian slide template © Raphaël Hertzog
- Background image © Alexis Younes

Debian's support for Secure Boot on x86 and ARM

Ben Hutchings
Kernel Recipes, Paris, 2016

debian

Ben Hutchings

- Regular Linux contributor since 2008
- Working on various drivers and kernel code in my day job
- Debian kernel and LTS team member, now doing most of the kernel maintenance aside from ports
- Maintaining Linux 3.2.y and 3.16.y stable update series on kernel.org
- Kernel maintainer for LF Civil Infrastructure Platform, aiming for super-long-term support

debian

Secure Boot

- Optional feature in UEFI - uses certificate store to validate boot loader, UEFI drivers, system firmware updates
- Protects against persistent malware (bootkit / kernel rootkit) if implemented correctly
- Required in 'Designed for Windows' systems since Windows 8 (2012)
- Only common trusted certificates on PCs are for Microsoft signing keys
  - MS *will* sign PC boot loaders for a small fee, and the certificate store is normally editable on PCs
  - ARM-based Windows systems are completely locked down
- HPe shipping ARM64 server systems in SB setup mode, allowing installer to set trusted certificates

GNU/Linux under Secure Boot

- First stage needs MS signature – manual submission process
  - Most distributions introduced 'shim' as first stage boot loader that won't need updating often
- MS expects boot loader and kernel to validate code they load – and it's a good idea anyway
  - For later stages, we control certificates and keys – certificates can be embedded in 'shim'
  - GRUB needs to validate its modules and kernels
  - Linux kernel needs to validate its modules and any other code that runs in kernel mode

debian

Securing the Linux kernel

- Root user, including malware running as root, can modify kernel without using any security bugs
- MS signing requires kernel to validate code it runs – and it's also a good idea in general
- Using Matthew Garrett's patchset to add 'securelevel' feature, activated when booted under SB:
  - Module signatures are mandatory
  - kexec_load() is disabled – must use kexec_file_load() instead
  - Hibernation is disabled – but images *could* be signed and validated using per-machine key
  - Other kernel APIs that allow peek/poke are disabled
- Force-loading of modules into the wrong kernel version is disabled

The signature problem

- We don't want to expose signing keys to buildds
- Reproducible builds can't depend on anything secret
- So we can't *auto-build* signed binaries in single step

Solution requires an extra source package:

1. Build unsigned binaries from first source package
2. Sign 'offline' and put detached signatures in second source package
3. Build signed binaries from second source package

Introducing linux-signed

- The second source package for linux
- Contains detached signatures for specific kernel version and script to update them for a new kernel version
- linux builds binary packages like linux-image-4.7.0-1-amd64-unsigned
- linux-signed clones those packages, attaches signatures, and builds packages like linux-image-4.7.0-1-amd64
- Signing currently done with my personal key, which will not be trusted by shim or GRUB

debian

Signing in dak - background

- Debian archive software (dak) signs archive metadata using keys trusted by Debian systems
  - Separate keys for stable releases, security updates, rolling releases
  - Keys managed by 'FTP' team
- We want dak to also sign code from linux, grub, etc. and publish detached signatures
  - Keys also managed by FTP team, possibly similar split between releases
  - Mustn't publish complete binaries at this stage - need reproducibility, and might have an embargoed fix
- dak supports uploads with non-standard file types (byhand) and configured handlers (auto-byhand!)

Signing in dak - implementation

- Add auto-byhand script that converts tarball of EFI binaries and/or kernel modules to tarball of corresponding signatures
- Enable auto-byhand for all source packages that need code signing
- Include signature tarballs in signed archive metadata
- Change each first source package to include a suitable tarball in uploaded files (dpkg-distaddfile)
- Add preparation script to each second source package to download and unpack published signature tarball

Didn't Ubuntu already do this?

Yes, but:

- Launchpad has a different hook mechanism
- Signing script only covers EFI binaries, not kernel modules
- Signing script produces signed binaries, not detached signatures
- Kernel is only signed on amd64
- linux packages in Debian and Ubuntu have >10 years of divergence

We'll still share shim, grub-signed, sbsigntool, etc.

Secure Boot on ARM?

- Upstream kernel has EFI stub for ARM32 and ARM64
- We have out-of-tree kernel patches for securelevel on ARM64
- sbsigntool works for ARM32 and ARM64 (although the test cases only cover x86)
- GRUB EFI code runs on ARM32 and ARM64
- shim runs on ARM64
- So we should be able to support Secure Boot on ARM64

Securing the signing keys

- Julien Cristau is working on signing with a PKCS#11 hardware security module – some model of Yubikey
- Signing with Yubikey is slow so we plan to use it for EFI binaries only; kernel modules will be signed with a file

Current status

- Bug #820036 tracks work to be done
  - dak support for signed packages – *in progress*
  - shim package – *in review*
  - GRUB signed build and validation of next stage
  - Linux signed build – *ready to go when dak is*
  - fwupdate signed build
  - Signed binaries in installer and live images
- More information at https://wiki.debian.org/SecureBoot
- Aiming for stretch release (freeze in Jan 2017)