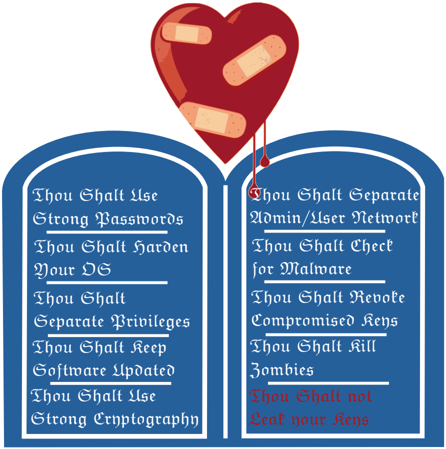
Thou Shalt not Leak your Keys:
Practical Key Privilege Separation Using Caml Crush



FOSDEM'15

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ANSSI

February 1st, 2015

Context

- Bob hosts a service, wants Alice to access it safely:
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    - Bob is authenticated
    - Data integrity and confidentiality
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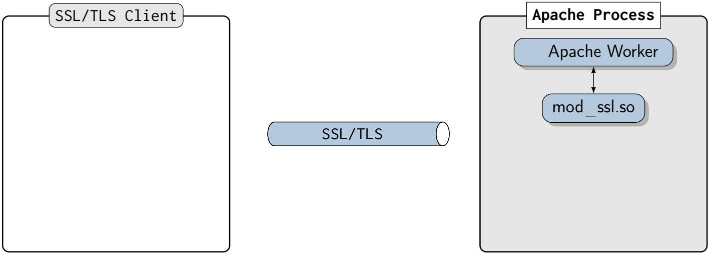
- But how safe is she?
- Heartbleed was a painful reminder:
  - Using TLS is not enough
  - Vulnerabilities in TLS stack can lead to private key leakage

Heartbleed

- Heartbleed is a security bug that affects an implementation of a TLS protocol extension



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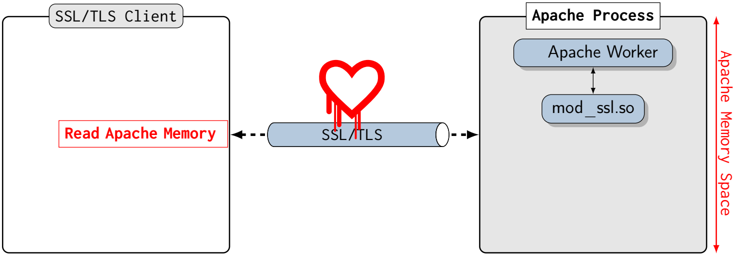
- Simply put: using a ping feature results in a buffer over-read allowing more data than expected to be read



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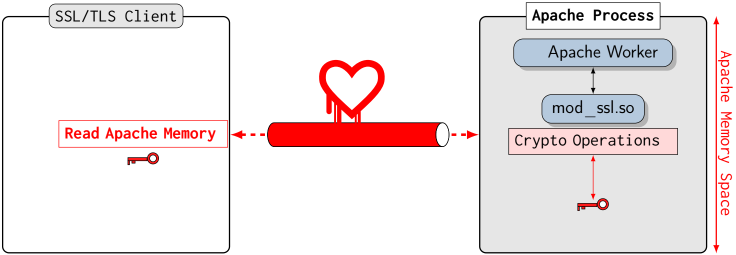
- Simply put: using a ping feature results in a buffer over-read allowing more data than expected to be read
- Memory from the server process can be retrieved
  - Application data
  - TLS symetric session keys
  - Private key of the server



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- Massive renewal of enterprise and private credentials
  - Costly (think thousands of X.509 certificates to renew)
  - Painful

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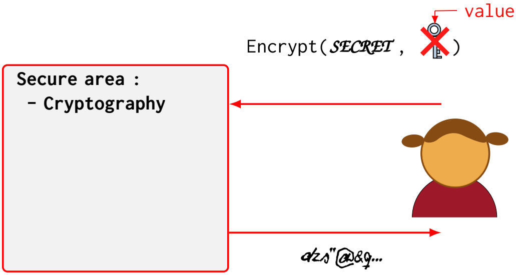

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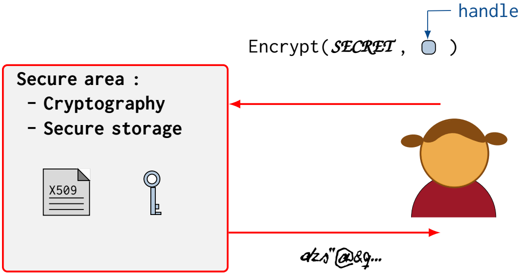

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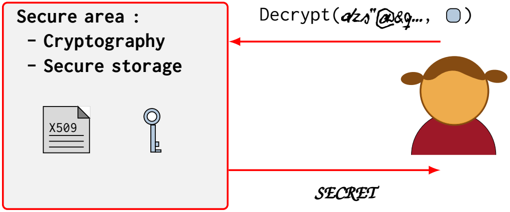

The PKCS#11 security API

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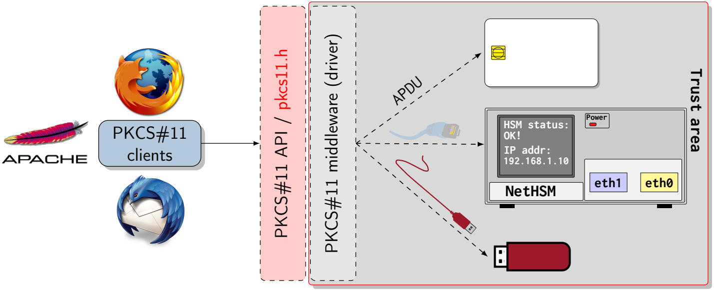

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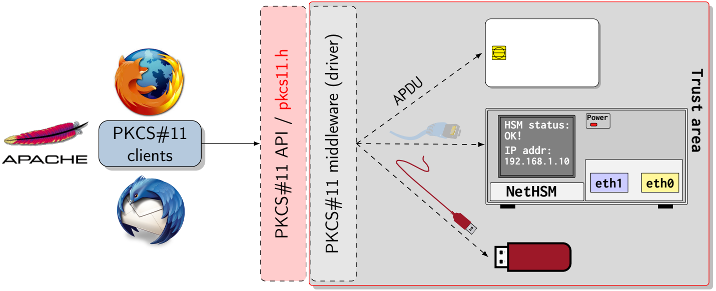

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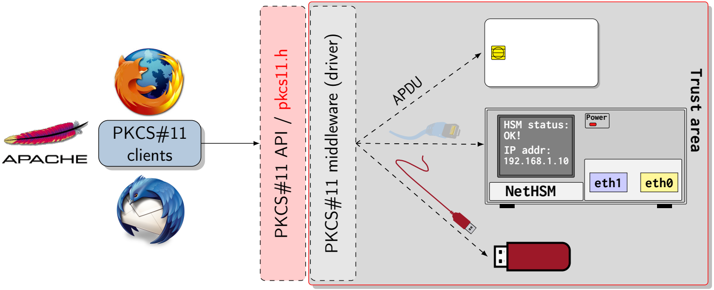
- The shared library handles the hardware:
  - Sends APDU sequences to smartcards (via USB, ...)
  - Sends network packets to network HSMs
  - Sends frames to USB dongles



Scenario: a TLS enabled HTTP web server

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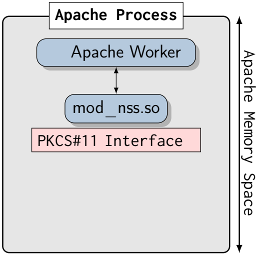

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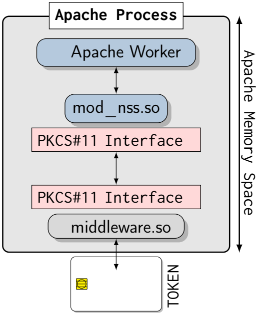

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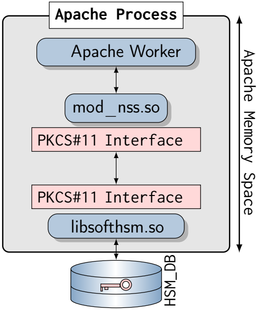
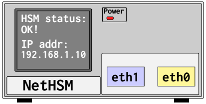
- Software PKCS#11 devices offer:
  - Convenient to deploy and some are open-source
  - Keys are mapped in memory



Let's sum up

	Cost	Security	Performance
HSM	✗	✓	✓



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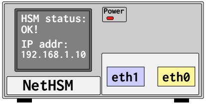

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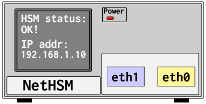

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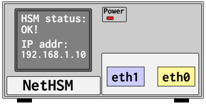

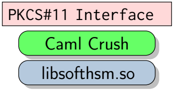

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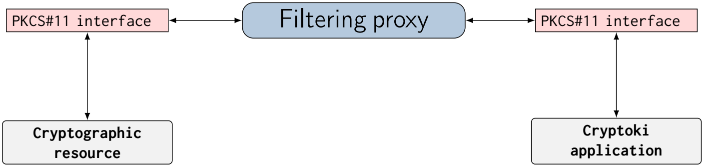
- What if we leverage process isolation?
- Caml Crush is a PKCS#11 filtering proxy



APACHE

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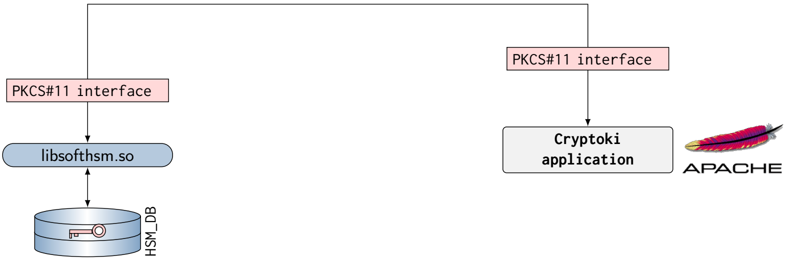

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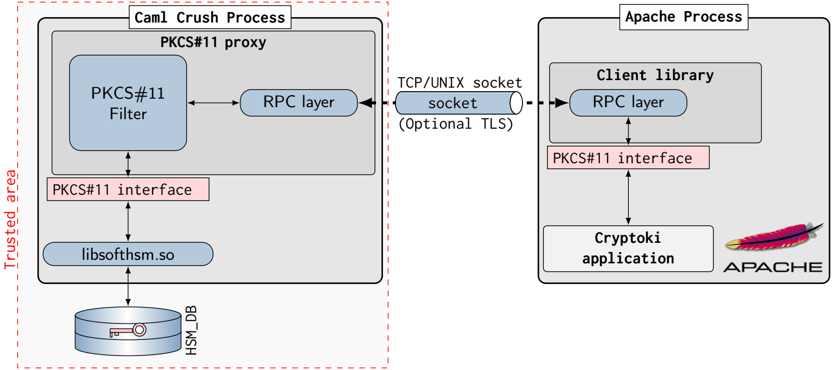

Scenario: a TLS enabled HTTP web server

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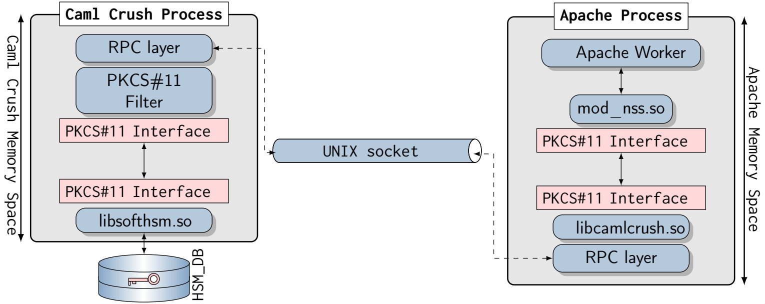

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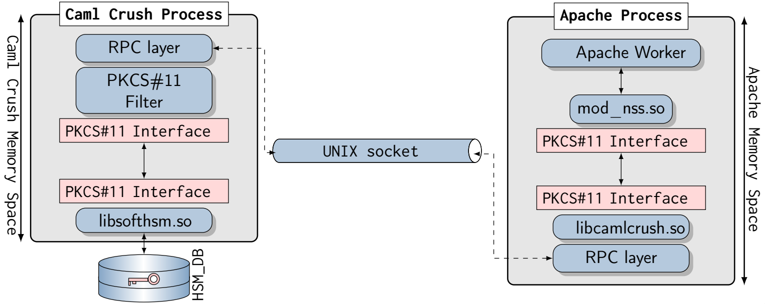

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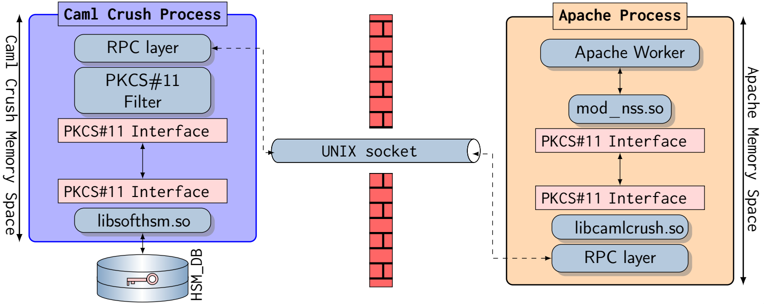

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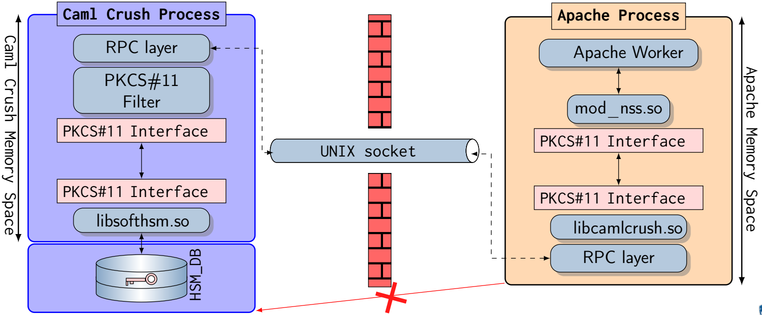

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- I heard about other PKCS#11 proxies, why use yours ?
- Caml Crush is security oriented
  - OCaml programming language
  - Able to sandbox itself
  - Blocks known cryptographic attacks
  - Restricts cryptographic mechanisms
  - Object filtering capabilities
  - Token read-only mode
  - . . .

Beyond Heartbleed

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  - Use the PKCS#11 stack as an oracle
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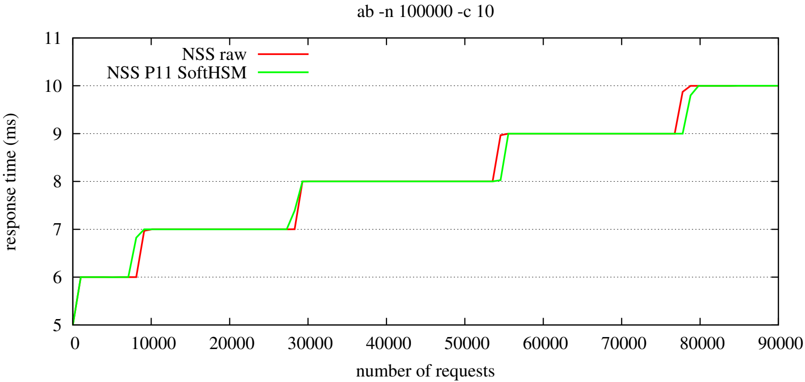
- Caml Crush filtering engine protects from such attacks
- Other deployments
  - Transform local cryptographic tokens (PCI HSM, smartcard) into network devices
  - . . .

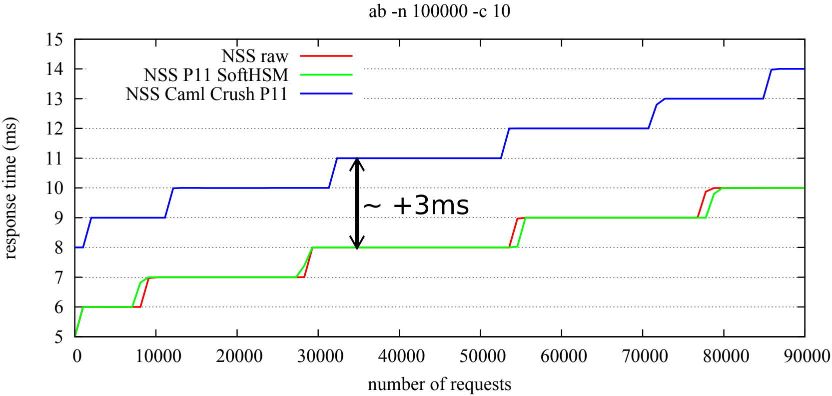
Performances

- No overhead when using plain SoftHSM



Performances

- **Reasonable** overhead with Caml Crush



Server compatibility

- Web server:
  - Apache (mod_nss[1], mod_gnutls[2])
  - NGINX (since 1.7.9[3])
- Other server applications:
  - Ex: LDAPS for OpenLDAP
  - Should work transparently if linked to GnuTLS

[1] PFS is not supported
[2] requires a patch from Nikos
[3] using OpenSC engine_pkcs11

Conclusion

- Caml Crush has benefits applicable to TLS stacks
- Caml Crush is also useful in a variety of other scenarios
- Soon in Debian Sid
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Thou Shalt Ask Questions!

Compatibility Matrix

	C client		OCaml client		pkcs11proxyd		SSL/TLS
	Unix	TCP	Unix	TCP	Unix	TCP	
Linux	✓	✓	✓	✓	✓	✓	✓
FreeBSD	✓	✓	✓	✓	✓	✓	✓
Mac OS X	✗	✓	✓	✓	✓	✓	✓
Win32 (native)	✗	✓	✗	✗	✗	✗	
Win32 (cygwin)							

- Caml Crush works on Little/Big Endian platforms (even with hybrid architectures between client and server)