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EVANGELIZE

Data at rest: ZFS & Ioffe crypto

Darren J Moffat

Senior Staff Engineer, Solaris Security

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Topics

- Raw block device crypto – lofi(7D)
- ZFS terminology review
- ZFS Crypto & Key Management

Lofi Encryption

- <http://opensolaris.org/os/project/loficc>
- lofi(7D)
 - File as a block device
 - Originally created for mounting ISO CD images
- Extend lofi(7D) and lofiadm(1M)
 - Specify crypto algorithm & provide key
 - Includes support for encrypted swap space
 - PAM module for mounting encrypted “disks” at user login

Lofi issues

- Current implementation uses AEC_CBC
- No integrity protection
 - Considering other AES modes to help
- lofiadm(1m) changes need to be cleaner.
 - Desirable to have crypto framework extensions for userland admin commands seeing kernel provider info.
 - Smartcard integration via PKCS#11

ZFS Terminology

- Pool
 - Collection of disks in a RAID layout
- Data set
 - File system or ZVOL
- ZVOL
 - Reserved part of a pool acting as block device
- COW
 - All of ZFS is Copy on Write
- All data & metadata checksummed/hashed

ZFS Crypto high level goals

- Support software only solution
- Support keys & crypto ops in hardware
- Support local (HSM, TPM, smart card, password)
 - or remote key manager
- Don't break COW semantics
- Support secure delete – by “key destruction”
- Need ability for delegation of key management to a Solaris Zone
- Need ability to keep data set keys away from a Solaris Zone

Decisions

- Set encryption policy at the ZFS data set
 - Most systems have only one pool
 - This allows zones/TX labels to have different keys and algorithms, eg AES-128 vs AES-256
- Will support encrypted zvol as well
 - Gives encrypted swap and raw database
- Ultimately support for encrypted root file system
 - /var/tmp could be a separate file system
 - /tmp is backed by swap

Decisions

- Data set encryption set at create time
 - Avoids encrypt later problem
 - Avoids old clear text due to COW
 - In future
 - ♦ may have “scrub behind” - early discussions
 - ♦ Rekey – deadline?
 - Rekey could take a VERY long time for a large pool/dataset and WILL hurt performance
- send & receive
 - Hope to support encrypted & clear

The Crypto bit

- Integrity protection of data & metadata
 - Fletcher
 - SHA256
- Data and file system metadata confidentiality
 - AES 128,192,256
 - Production – CCM/GCM
 - Prototype is using CBC
- No direct use of asymmetric crypto in file system
 - Maybe used in remote key manager protocols

What is encrypted ?

Yes

All “application”
data

POSIX layer data

Permissions, owner
etc

Directory structure

All ZVOL data

Snapshots

Take parent policy

No

Pool metadata

Disks, mount time,
raid, etc.

Open issue

Data set names

Data set properties

Where do we store things ?

- Every dnode has compress/checksum/encrypt alg
- Never write unwrapped keys to disk
 - Issues with suspend/resume
 - Issues with Xen migration

Delivery

- Phased delivery of key management
- Phase 1:
 - Per file system keys encrypted with per pool key
 - Pool key in hardware token or software
- Phase 2:
 - Remote key manager
 - Zones / TX Labels with keys unavailable to them.
 - Per user key delegation
 - Depends on ZFS user delegation – in progress

Delivery

- Phase 3:
 - Secure Deletion
 - Key escrow/recovery
- Phase 4:
 - Encrypted root file system
 - HA ZFS & encrypted data sets

Where & When

- First Draft of design doc went to OpenSolaris early 2006
- Prototype in development
- <http://opensolaris.org/os/project/zfs-cryp>
- zfs-crypto-discuss@opensolaris.org
- At least Phase 1 for Solaris.next

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Darren.Moffat@Sun.COM

<http://blogs.sun.com/darren/>

<http://opensolaris.org/os/project/zfs-crypto/>

<http://opensolaris.org/os/project/loficc/>

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