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Take back control with RobinHood v3

LUG'17

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Project History

Robinhood Policy Engine

- Mature
  - Development started in 2005
  - Constantly improved since then
  - Now widely used in HPC centers of various size
  - Large contributors base (sites, vendors...)
- Open Source
  - Initially developed for internal needs
  - Open sourced in Feb. 2009 (now lives on http://github.com/cea-hpc/robinhood)
- Versatile
  - Purgeing entries on temporary filesystems
  - Conductor of Lustre/HSM installations
  - Rich reporting and near-real time monitoring
  - Powerful suite of companion tools

Robinhood 3 in a Nutshell

v2 “flavors” and their commands

robinhood-tmpfs	robinhood-lhsm	robinood-backup
robinhood	rbh-lhsm	rbh-backup
rbh-diff	rbh-lhsm-diff	rbh-backup-diff
rbh-report	rbh-lhsm-report	rbh-backup-report
rbh-du	rbh-lhsm-du	rbh-backup-du
rbh-find	rbh-lhsm-find	rbh-backup-find
		...

→ A static set of available policies per flavor

V3: a single instance to manage all “legacy” policies ...and much more!

```
robinhood

robinhood
rbh-diff
rbh-report
rbh-undelete
rbh-du
rbh-find
```

→ Policies declared in configuration

Robinhood in a Nutshell

Robinhood Policy Engine: overview

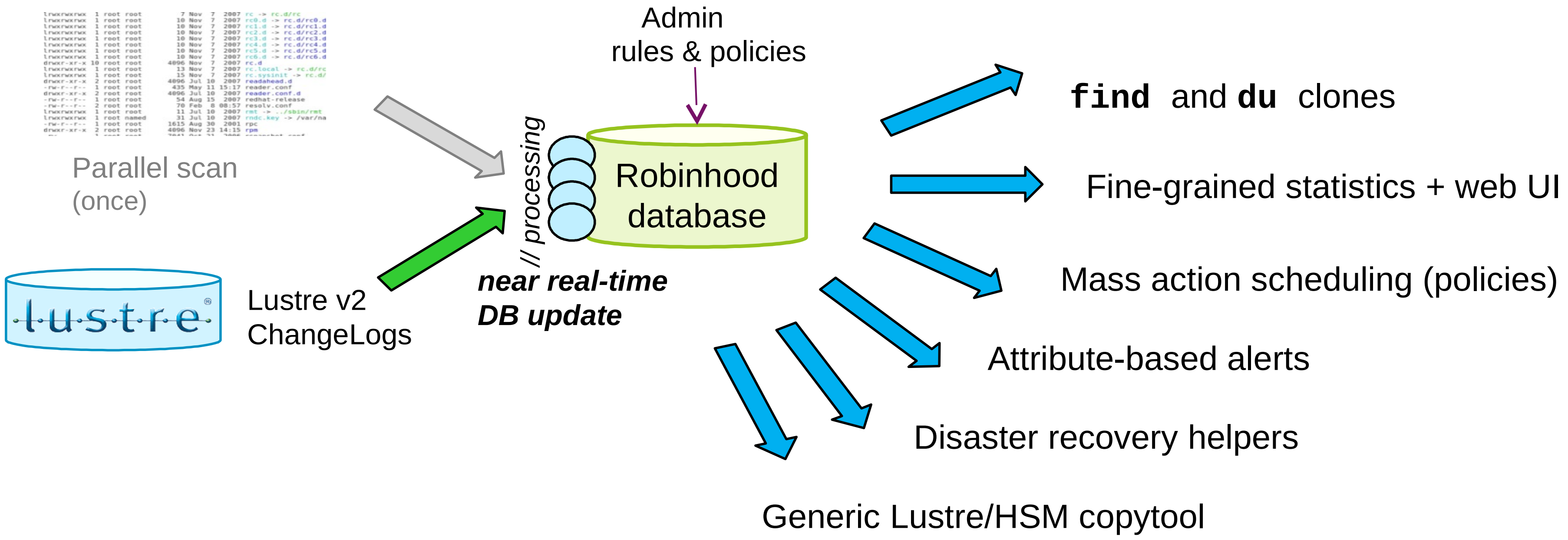
- Collects information about filesystems
  - Maintain a up-to-date image of filesystem metadata
  - Lustre: based on *MDT changelogs*
  - Posix: periodic scanning

- Define custom policies to schedule actions on filesystems entries
  - v2.x: archiving data, purging scratch filesystems, HSM...
  - v3+: way much more!
  - Flexible, fine-grained policy rules

- Provides an overall view of filesystems contents
  - File size profile per user, per group, …
  - Classifying entries in arbitrary admin-defined sets (fileclasses)

- A set of convenient utilities to manage Lustre filesystem contents efficiently
  - rbh-find, rbh-du, rbh-diff...

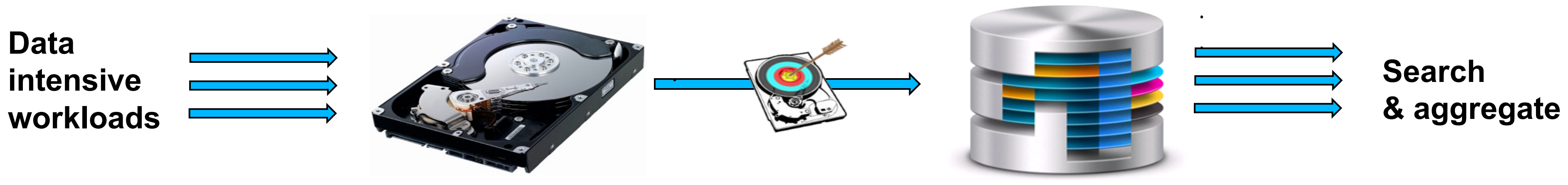
Big picture



```
lrwxrwxrwx  1 root root       7 Nov  7  2007 rc -> rc.d/rc
lrwxrwxrwx  1 root root      10 Nov  7  2007 rc0.d -> rc.d/rc0.d
lrwxrwxrwx  1 root root      10 Nov  7  2007 rc1.d -> rc.d/rc1.d
lrwxrwxrwx  1 root root      10 Nov  7  2007 rc2.d -> rc.d/rc2.d
lrwxrwxrwx  1 root root      10 Nov  7  2007 rc3.d -> rc.d/rc3.d
lrwxrwxrwx  1 root root      10 Nov  7  2007 rc4.d -> rc.d/rc4.d
lrwxrwxrwx  1 root root      10 Nov  7  2007 rc5.d -> rc.d/rc5.d
lrwxrwxrwx  1 root root      10 Nov  7  2007 rc6.d -> rc.d/rc6.d
drwxr-xr-x 10 root root    4096 Nov  7  2007 rc.d
lrwxrwxrwx  1 root root      13 Nov  7  2007 rc.local -> rc.d/rc
lrwxrwxrwx  1 root root      15 Nov  7  2007 rc.sysinit -> rc.d/
drwxr-xr-x  2 root root    4096 Jul 10  2007 readahead.d
-rw-r--r--  1 root root     435 May 11 15:17 reader.conf
drwxr-xr-x  2 root root    4096 Jul 10  2007 reader.conf.d
-rw-r--r--  1 root root      54 Aug 15  2007 redhat-release
-rw-r--r--  2 root root      70 Feb  8 08:57 resolv.conf
lrwxrwxrwx  1 root root      11 Jul 10  2007 rmt -> ../sbin/rmt
lrwxrwxrwx  1 root named     31 Jul 10  2007 rndc.key -> /var/na
-rw-r--r--  1 root root    1615 Aug 30  2001 rpc
drwxr-xr-x  2 root root    4096 Nov 23 14:15 rpm
```

Filesystems and Databases

Respective benefits



Filesystem

Goals

- Optimize data access
  - Bandwidth, data allocation
- Optimize medatada access for POSIX
  - lookup/readdir/create/unlink

```
lfs find . –user foo –size -1024 |
wc -l
```

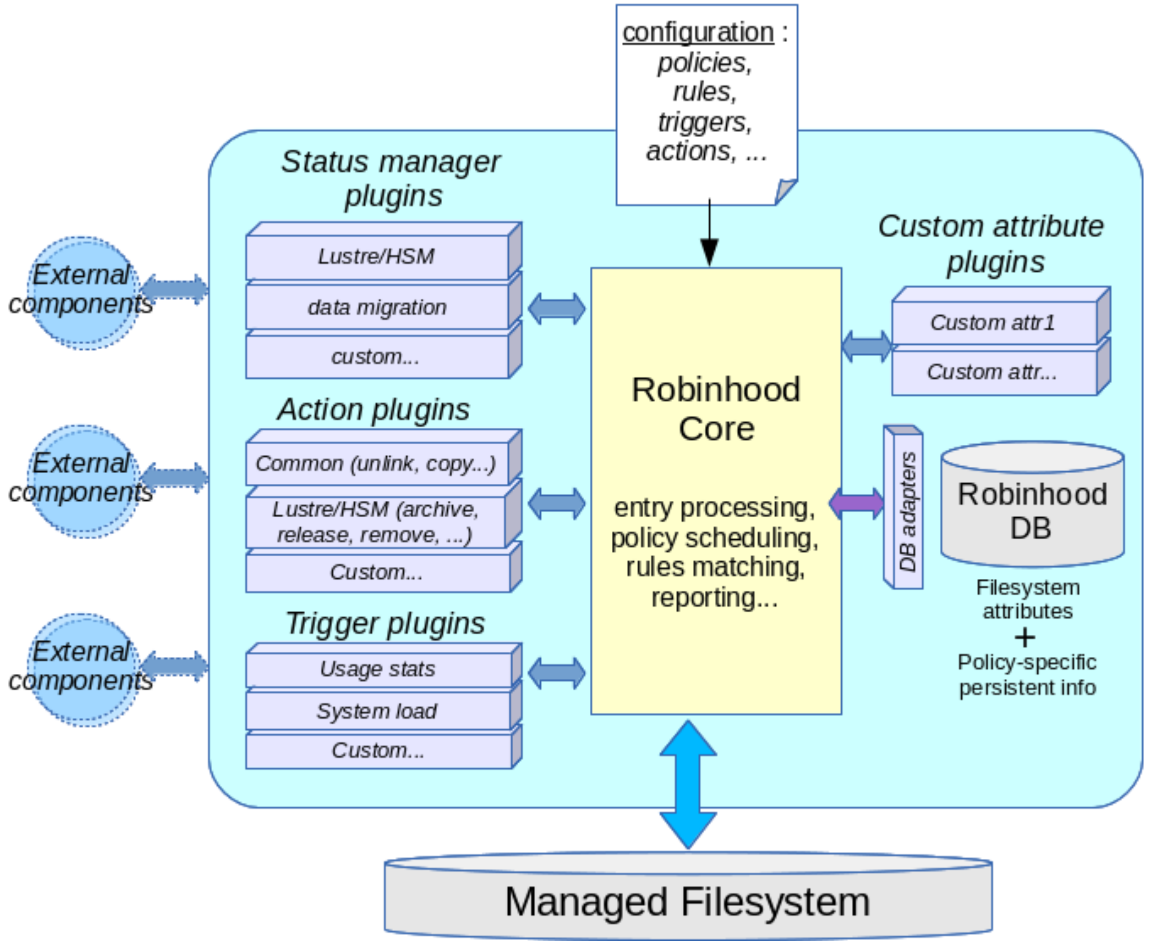
Database

Goals

- Optimize per-record access
  - select/insert/update
- Optimize multi-criteria searches
- Optimize aggregating/sorting information

```
select count(*) from ENTRIES where
user='foo' and size<1024
```

Robinhood v3 Plugin-Based Architecture



Robinhood core made generic

- Purpose-specific code moved out of robinhood core: now dynamic plugins loaded at run-time
- All policy behaviors made configurable
- Vendors/users can write their own plugins for specific needs

Generic Policies (v3.0): Motivation

Before v3

- Static set of policies, statically defined
- 1 mode = 1 robinhood instance = 1 set of commands
- Instances can't coexist on the same filesystem

Package	"migration" policy	"purge“ policy	"hsm_remove" policy	"rmdir" policy
robinhood-tmpfs lustre/posix	-	rm (old files)	-	rmdir, rm –rf
robinhood-backup	Copy to storage backend	-	rm in storage backend	-
robinhood-lhsm	Lustre HSM archive	Lustre HSM release	Lustre HSM remove	-

Robinhood v2.x packages and policies

- E.g. Lustre/HSM purpose
  - Package: robinhood-lhsm
  - Commands: rbh-lhsm-*
  - Only implements HSM-related policies (*archive*, *release*, *remove*)
  - Cannot manage other actions (delete old files, …)

Generic Policies (V3.0): Overview

Robinhood v3

- A single Robinhood instance for all purposes:

Lustre filesystems:

Package	Generic policies
robinhood-lustre	Fully configurable

Other filesystems:

Package	Generic policies
robinhood-posix	Fully configurable

- Robinhood core: **generic** policy implementation
- Specific aspects:
  - Specified by **configuration** (policy templates)
  - Possibly as specific **plugins** (dynamic libraries)
- Policies at will
  - Schedule any conceivable action
  - Just by writing a few lines of configuration

Generic Policies (V3.0): Example

Example: configurable pool migration with just a few lines of config

- Declare policy

```
declare_policy move_pool {
    scope { type == file and status != ok }
    default_action = cmd("lfs migrate -p {pool} -c {count} {path}");
    status_manager = basic ; # manages ok/failed status
}
```

- Specify rules

```
move_pool_rules {
    rule migr_movies {
        target_fileclass = movie_types;
        action_params { pool = "pool1"; count = 2; }
        condition { last_mod > 6h }
    }
    rule migr_hpc_data {
        target_fileclass = big_hpc_files;
        action_params { pool = "pool2"; count = 16; }
        condition { last_mod > 6h }
    }
}
```

Rbh-report: see what is going on

Examples of reports

- Inode count and volume usage

```
$ rbh-report –u foo* -S
user , group,    type,   count, spc_used, avg_size
foo1 , proj001, file, 422367, 71.01 GB, 335.54 KB
…
Total: 498230 entries, 77918785024 bytes used (72.57 GB) 00
```

- File size profiles per user, per group…

```
$ rbh-report --szprof –i|-u 'foo*'|-g 'bar*'
```

- Printf option to rbh-find (contributed by Cray)

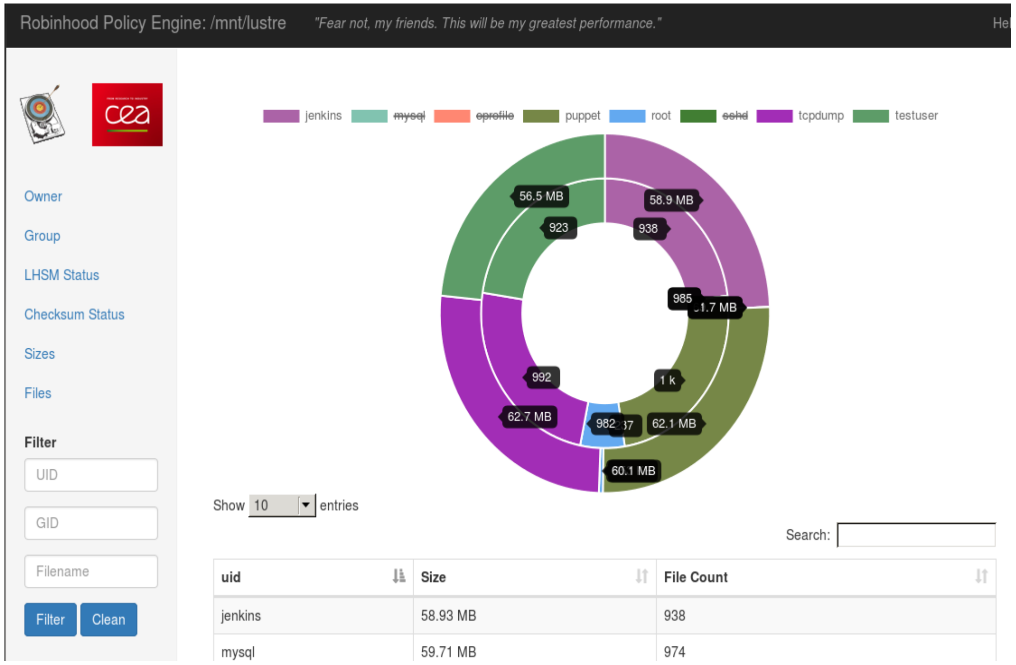
```
 $ rbh-find -status lhsm:released -printf "%p %Rm{lhsm.archive_id}\n"
```

- Top users, top groups, top file sizes, top directories…
- Changelog statistics: operations rate (create, mkdir, setattr...)

Nice new features since last year

New web interface (in 3.0)

- New WebUI, compatible with robinhood 3 DB schema
- Modern widgets and layout
- Fine-grained authentication
- Compatibility with newer MySQL versions


Robinhood Policy Engine: /mnt/lustre *"Fear not, my friends. This will be my greatest performance."*

uid	Size	File Count
jenkins	58.93 MB	938
mysql	59.71 MB	974

Nice new features since last year

REST interface (in 3.0)

- Makes it possible to query robinhood DB through a standard protocol (HTTP)
- 3 possible output format:
  - Classic JSON (key-value) http://server/api/**native**/...
  - Datatables.js: http://server/api/**data**/...
  - GraphJS: http://server/api/**graph**/...

```
{
    "uid": "root",
    "gid_set": "root",
    "type_set": "dir,file",
    "lhsm_status_set": ",new",
    "checksum_status_set": ",ok",
    "size": "975872",
    "blocks": "1912",
    "count": "237",
    "sz0": "0",
    "sz1": "0",
    "sz32": "0",
    "sz1K": "237",
    "sz32K": "0",
    "sz1M": "0",
    "sz32M": "0",
    "sz1G": "0",
    "sz32G": "0",
    "sz1T": "0"
}
```

- Simple and convenient query language:

  > Returns usage stats about all users and status (as JSON)

  http://rbh/api/native/acct/...

  > Returns usage stats about a given user (as JSON)

  http://rbh/api/native/acct/**uid.filter/foo**

Advanced querying. Example: split user's info by gid

  http://rbh/api/native/acct/**uid.filter/foo/gid.group**

- Allow querying robinhood stats from scripts, dashboards, …
  - E.g: take usage stats into account for job scheduling

Plugins: extending robinhood

Example of plugin: “checker” (v3.0)

“Checker” policy plugin

- Executes admin-defined commands and stores their output to rbh's DB
- Saves OK/failed status
- Manages specific attributes: last execution time and last success time
- Example applications:
  - **Detecting silent corruption**: run “md5” on files at regular interval, and check the output is unchanged.
  - **Audit filesystem contents**: run “file” utility on all files, then generate a report by file type

```
SELECT … GROUP BY file_output
```

Example of plugin: “modeguard”

Community-contributed policy plugin

- Enforces mode on selected entries
- Maintains OK/Invalid status on entries
- Two parameters: “set mask” and “clear mask”

- Example applications:
  - **Force user directories to be setgid**: set_mask=02000
  - **Remove executable bits on files:** clear_mask=0111

- Again: the scope of the policy is defined in the configuration

Developers: how to write a policy plugin? (1/2)

Anatomy of a robinhood plugin

- Plugins are Shared Object Libraries
  - Loaded on demand
  - Cached by the application
  - Can be included within the project or distributed separately

- Expose a clearly defined interface
  - `mod_get_name()`
  - `mod_get_version()`
  - `mod_get_{satus_manager, action, scheduler}()`

Developers: how to write a policy plugin? (2/2)

Exposed methods (details)

- Pick a name
- Define the parameters of your module
- Define the status manager
  - Set of all possible states of an entry
  - How to store them in the DB (type, default value...)
  - A couple callbacks for rbh to operate the state machine
- Define the exposed actions
  - Core functions of the policy
  - Set mode, rename file, delete directory, archive file...

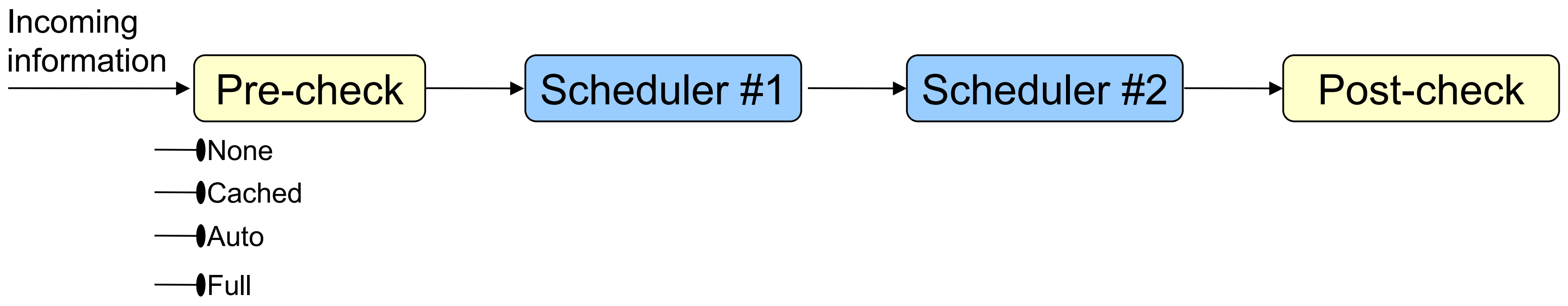
- See the existing ones in: http://github.com/cea-hpc/robinhood/src/modules

Development status and roadmap

New in v3.1: schedulers

Problem: how to regulate the pace of actions and order them properly?

- 1st example: avoid overwhelming the coordinator with archive requests
  - No existing feedback mechanism from MDT to Robinhood
- 2nd example: archive into a rate-limited system
  - Interleave big and small files to maximise rate and throughput



Schedulers

Implemented as plugins

- Enabled and parametrized from configuration files
- Stackable
- Entry handling function can decide to:
  - Take the entry (forward it to the next level of processing)
  - Skip the entry for this run
  - Pause the handling of new entries for a while
  - Stop the handling of new entries for this run
  - Stop and cancel in-flight entries in the other schedulers

Upcoming features

Robinhood v3.1 (1H2017)

- Fixes from 3.0
- Schedulers
  - TBF rate limiting
  - Per run-limitations
- New policy plugins
  - Modeguard
  - Deferred purges
- Performance improvements
- Improved GUI

Robinhood v3 Roadmap

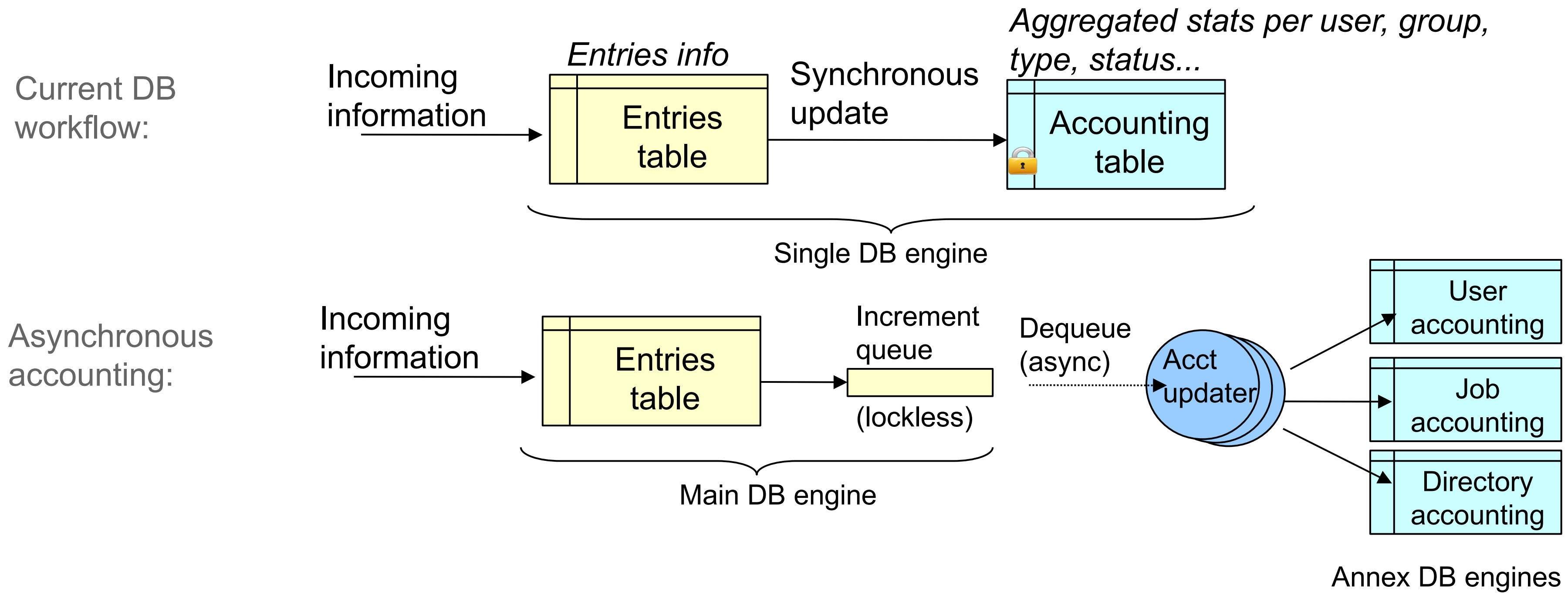
Candidate features for v3.2 (2H2017)

- **Asynchronous 'stat' of entries**: higher ingest rate
  - No 'stat' performed synchronously when processing changelogs
  - Changelog are ingested directly to the DB (high throughput!)
  - Background (asynchronous) update of entry metadata in DB
- **Asynchronous accounting**: more information, reduced impact on performance
  - Reduce the impact of 'accounting' on DB performance

    - Can possibly be offloaded to a 2nd server
  - Allows implementing much more aggregated stats (track users activity, jobs activity...)

Next Plans: Asynchronous Accounting

- Asynchronous accounting
  - Goal: reduce the impact of accounting on ingest rate.
  - Make it possible to distribute the accounting processing and its DB.



Lustre contributions from the robinhood project

Misc. performance and stability enhancements

- **New changelog distribution interface**
  - Character device to efficiently deliver records from kernel to userland
  - Orders of magnitude faster than the venerable “KUC” pipe
  - Landed for 2.10 (LU-7659)

- **QoS for HSM requests on the coordinator**
  - Reduce the impact of massive archiving campains on Lustre/HSM
  - Target 2.10 (LU-9482)

- **New LustreAPI**
  - Work by Cray tracked by LU-5969
  - Optimize massive entry handling
    - Avoid continuous open/close of FS root and “fid” directory for IOCTLs

Getting involved

What can robinhood do for you?

- **Administrators**
  - Install (or upgrade to) v3
  - Give us feedback on the mailing lists (robinhood-support@sf.net)
  - Tell us about the limitations you encounter, the features you would need
- **Developers**
  - Implement new plugins and make people happy
  - Help experimenting with alternative DBMS
  - Get in touch on robinhood-devel@sf.net
- **Vendors**
  - Consider the added value of solution-specific plugins

Thank you for your attention !

Questions ?

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