

Understanding LSST I/O patterns

status and perspectives

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LSST France calcul, Lyon, May 29th, 2015





- To understand file I/O patterns induced by LSST stack
- Ultimate goal: to identify the requirements a storage platform needs to satisfy to support LSST workflows *alternatively, to adapt LSST software to take into account the intrinsic limitations of available storage platforms*





Status

 Developed clueFS, a FUSE-based synthesised file system to intercept, trace and forward I/O operations to the underlying file system

this is the tool we use to collect the traces

 Inspired by tools such as strace, SystemTap, sysdig, dtrace, ...

• Simple to use

no super-user privileges

Linux and MacOS

easy-to-install stand-alone executable



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cluefs — a tool for tracing I/O activity at the file system level

Overview

cluefs is a lightweight utility to collect data on the I/O events induced by an application when interacting with a file system. It emits detailed, machine-parseable data on every file system-level operation.

The trace information emitted by this utility is meant to be analysed using tools not included in this package.

Motivation

The main goal of developing this utility is to observe and quantify the file I/O load induced by the software system being developed by the LSST data management team to process the data to be collected by the Large Synoptic Survey Telescope (LSST).

However, cluefs does not depend on LSST software system and can be used in several unrelated contexts. It may also be useful for other use cases, such as to get an overall understanding of how file systems work or to observe the (usually hidden and unexpected) operations performed when you mount a file system on your computer.

Although there are several tools for tracing system activity such as strace, DTrace, SystemTap or sysdig, for different reasons none of them was considered suitable for our particular use case.

How to use

Suppose you want to observe what file operations the command cat \$HOME/data/hello.txt induces

https://github.com/airnandez/cluefs



Example

Mount the file system

\$ cluefs --mount=/tmp/trace --shadow=\$HOME/data &

Observe what cat command induces:

\$ cat /tmp/trace/hello.txt

2015-03-23T10:26:35.839367864Z,2015-03-23T10:26:35.839794442Z,426578,fabio,9986,lsst,1021,/usr/bin/cat,23161,/home/fabio/data/hello.txt,stat

2015-03-23T10:26:35.840322045Z,2015-03-23T10:26:35.840364156Z,42111,fabio,9986,lsst,1021,/usr/bin/cat,23161,/home/fabio/data/hello.txt,openfile,O_RDONLY,0000

2015-03-23T10:26:35.840556082Z,2015-03-23T10:26:35.840572507Z,16425,fabio,9986,lsst,1021,/usr/bin/cat,23161,/home/fabio/data/hello.txt,read, 15,0,4096,15

2015-03-23T10:26:35.841009818Z,2015-03-23T10:26:35.901634332Z,60624514,fabio,9986,lsst,1021,/usr/bin/cat,23161,/home/fabio/data/hello.txt,flush

2015-03-23T10:26:35.90204842Z,2015-03-23T10:26:35.902054482Z,6062,root,0,root,0,,0,/home/fabio/data/hello.txt,close

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Analysis

- Currently developing the Python notebooks to summarise the traces collected by executing the LSST demo
 - example of preliminary findings: a single index file of astrometry.net is open 210 times when executing the stack demo
 - not necessarily an anomaly, but an interesting fact we could exploit
- Once this is done, we will do the same exercise with more realistic workflows developed by Dominique Boutigny, using the stack and CFHT data



Analysis (cont.)

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Import data into Pandas

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In this step we use Pandas to read the CSV-formatted raw data and create a data frame.

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In [7]: # Import the data file and show its first entries
         column names=[
              "Start", "End", "Duration",
              "UserName", "UserId", "GroupName", "GroupId", "ProcessName", "ProcessId",
              "Path", "ObjType",
              "Operation", "OpArg1", "OpArg2", "OpArg3", "OpArg4", "OpArg5"
         frame = pd.read csv("./ubuntu-14.04-lsst dm stack demo.csv", header=None, names=column names, parse dates=False)
         frame.head(10)
Out[7]:
                    End
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                                           Duration UserName
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                                                                                          /bin/bash
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         23080675Z 28T13:49:29.423091724Z
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         23374836Z 28T13:49:29.423381097Z
```



 PhD student from IHEP (Beijing, China) just started working on building a model for simulating I/O activity at the scale required by LSST, based on the observed activity

will stay at CC-IN2P3 for one year

Simulator to be built on top of SimGrid <u>http://simgrid.gforge.inria.fr</u>

co-supervised by Frédéric Suter, one of the main developers of SimGrid, and myself



comments & questions