Handling Small Files in dCache

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15. Mai 2014

Content

Problem

With large number of small files on tape drives the read time for one file is dominated by the seek time (tens of seconds)

Motivation

- Transparently optimise tape access for small files

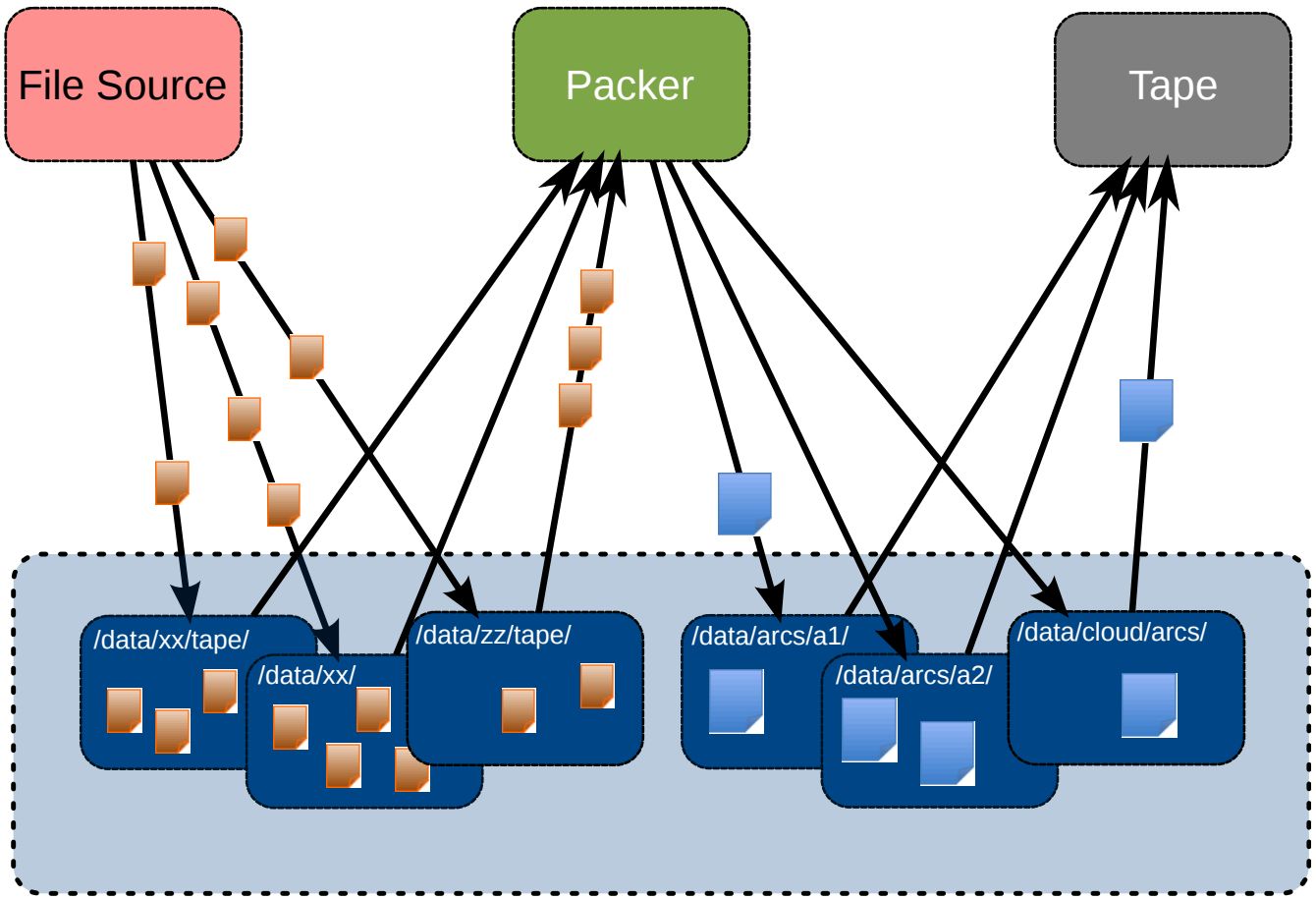
Constraints and Requests

- We have no influence on the tape system
- Use with any recent dCache system (with NFS4.1)
- Keep load on dCache (i.e., Chimera) low

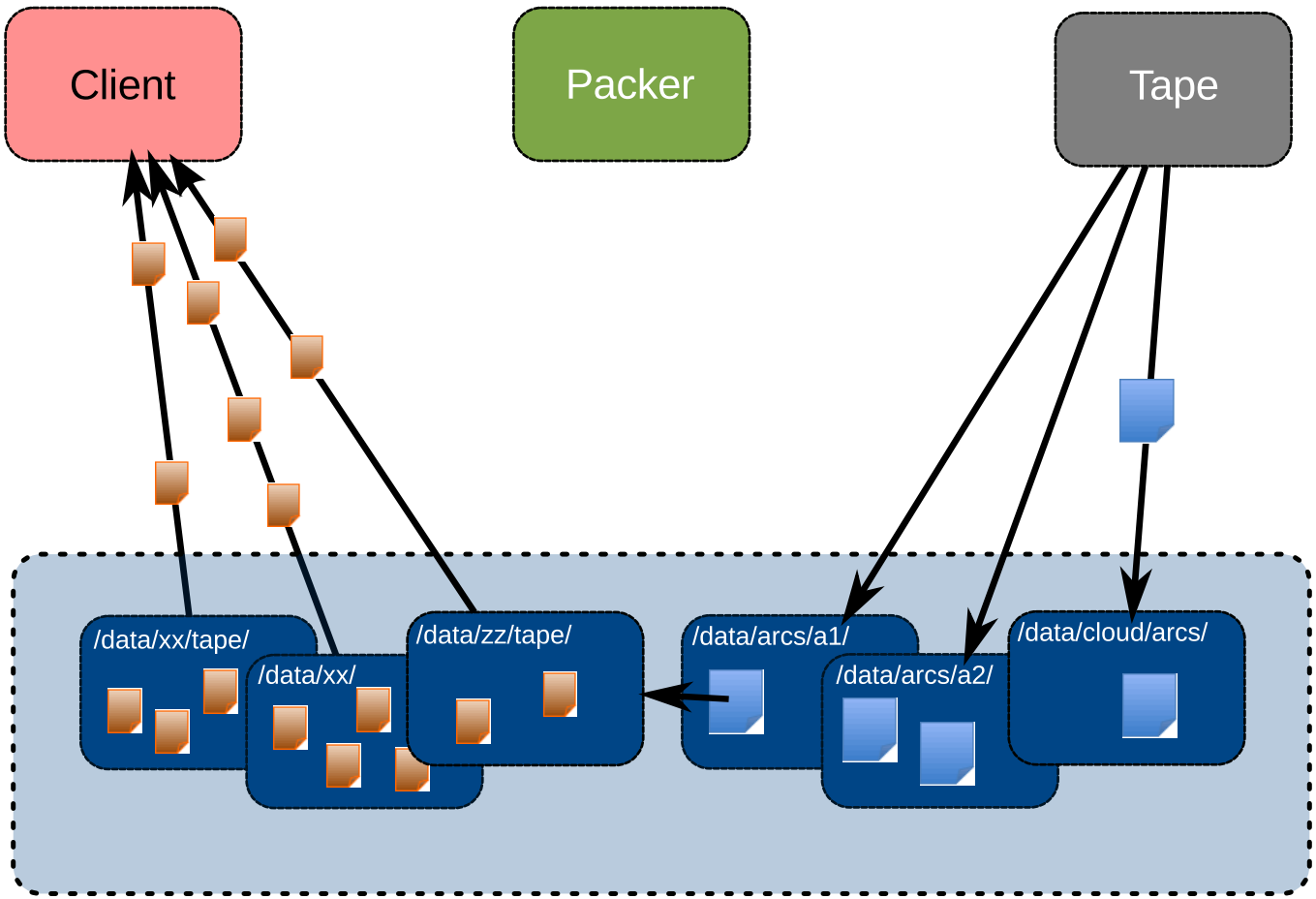
The Idea

Bundle small files into container files using dCache's already existing features.

Overview


File Source
Packer
Tape
/data/xx/tape/
/data/xx/
/data/zz/tape/
/data/arcs/a1/
/data/arcs/a2/
/data/cloud/arcs/

Overview


Client
Packer
Tape
/data/xx/tape/
/data/xx/
/data/zz/tape/
/data/arcs/a1/
/data/arcs/a2/
/data/cloud/arcs/

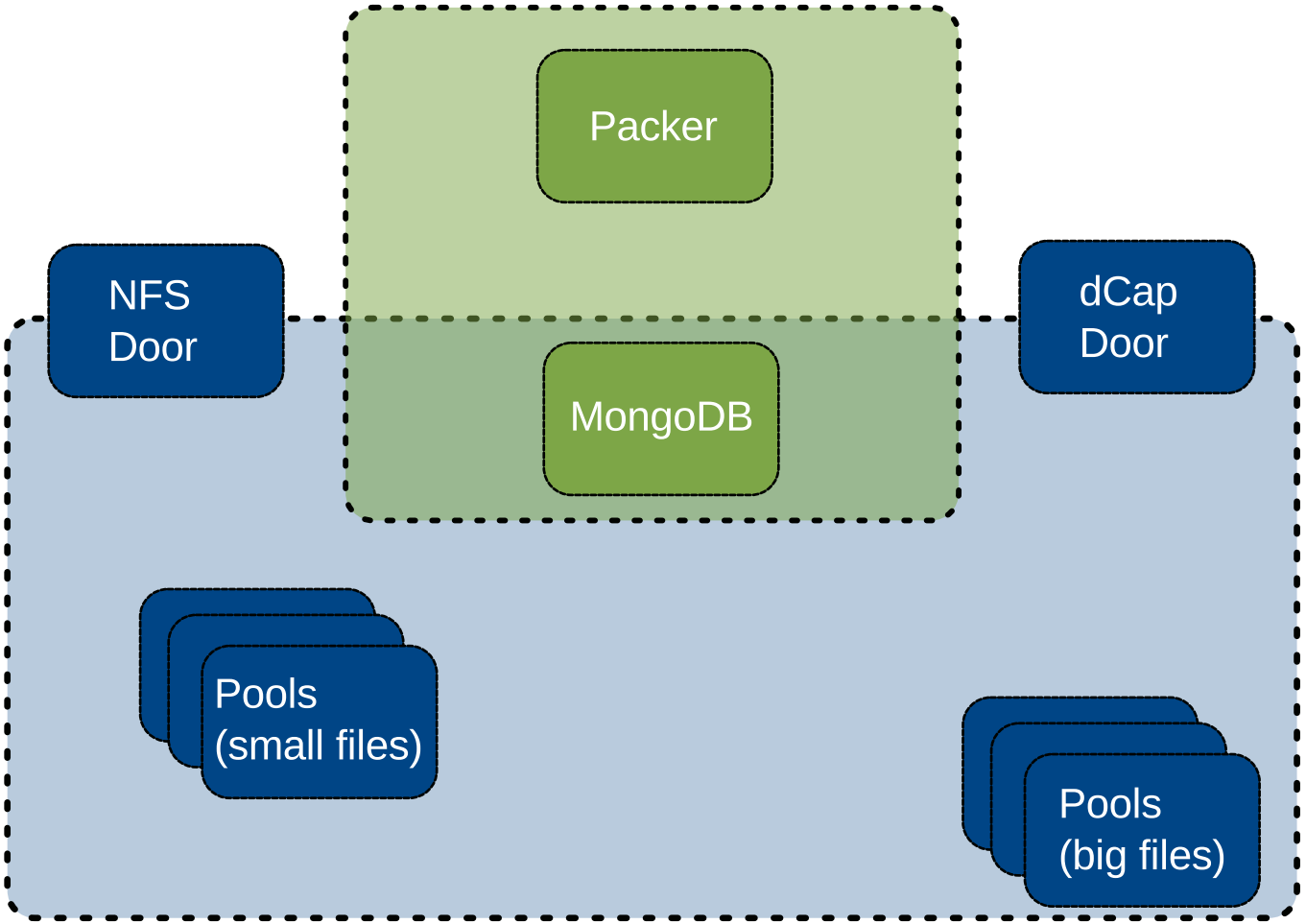
Features and Properties

- Our solution makes strong use of dCache's advantages
  - Small files are directly read from dCache, potentially coming from multiple pools
  - Container files are written into dCache, potentially being stored on multiple pools
  - dCache acts as a cache for the small files and for the containers
  - The containers are stored using dCache's regular tape connection
- The service is integrated into dCache using its HSM machanism
  $\rightarrow$ every small file triggers an hsm-script
- We use a special URI to logically connect small files with containers
- The bundling mechanism is file format agnostic, currently uses `ZIP`

A word of advice

Even though container files are regular dCache files, they should *not* be accessible by the users!

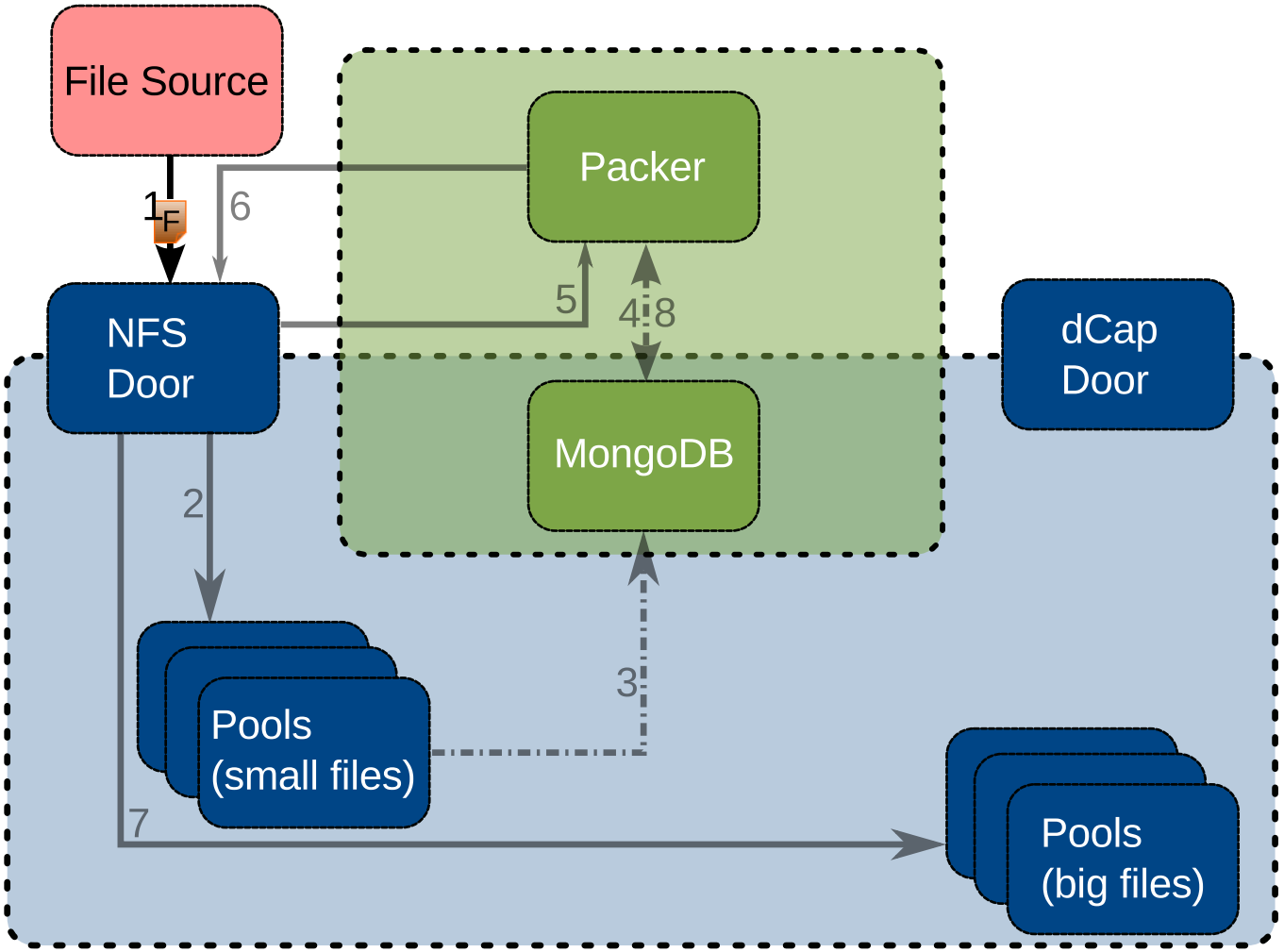
More details



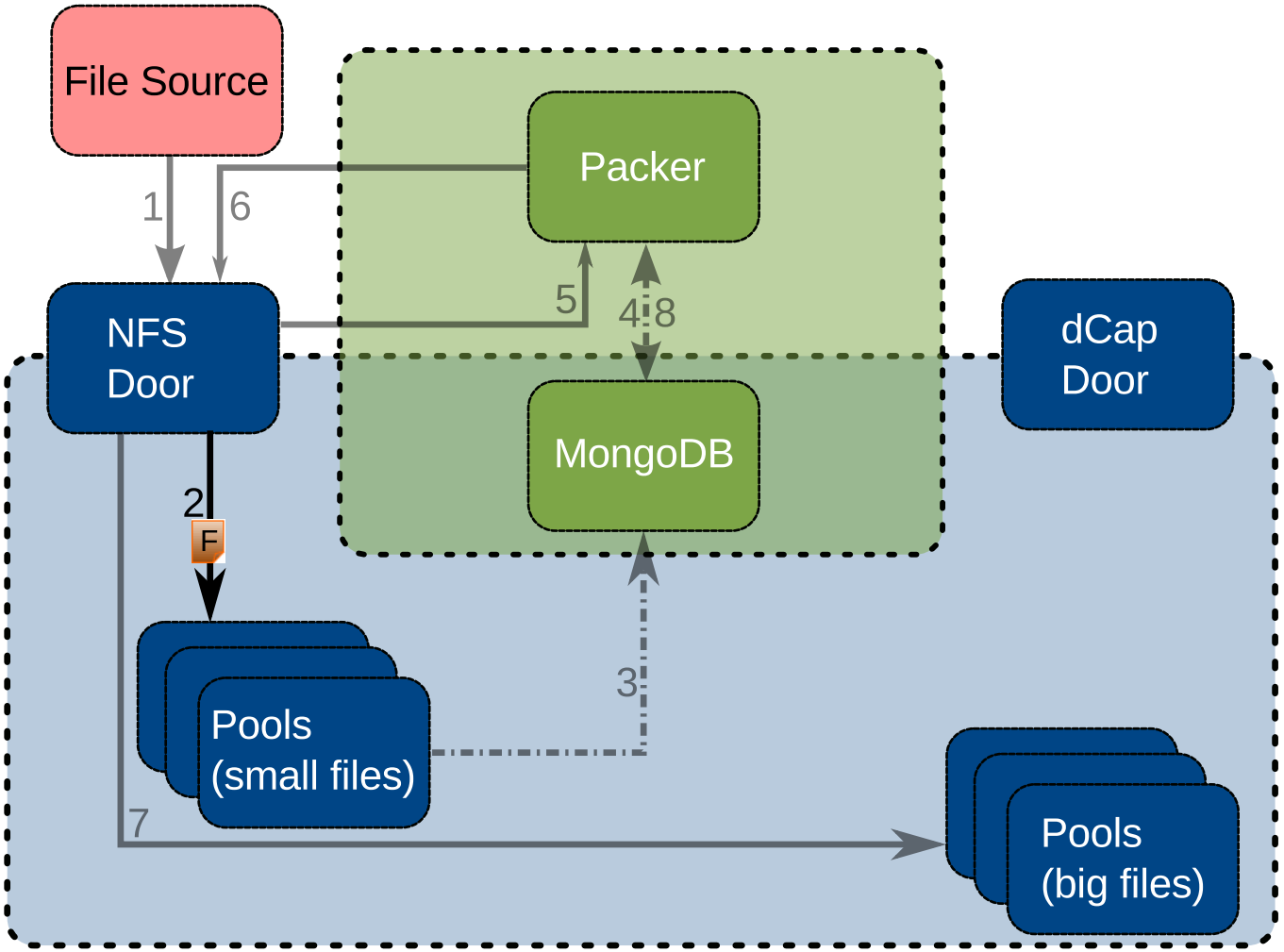
Writing a small file

What happens if a small file is written?

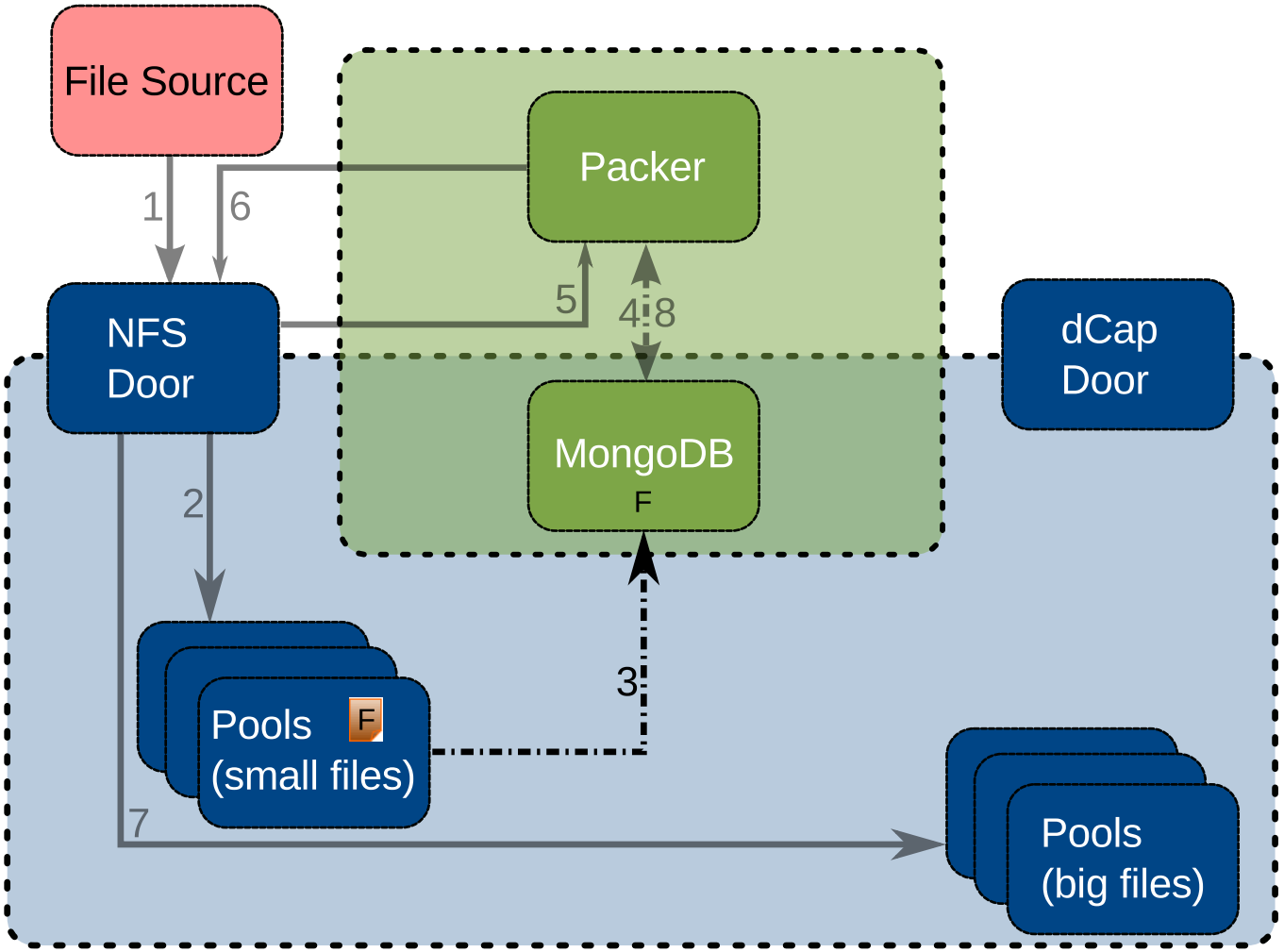
Client writes file



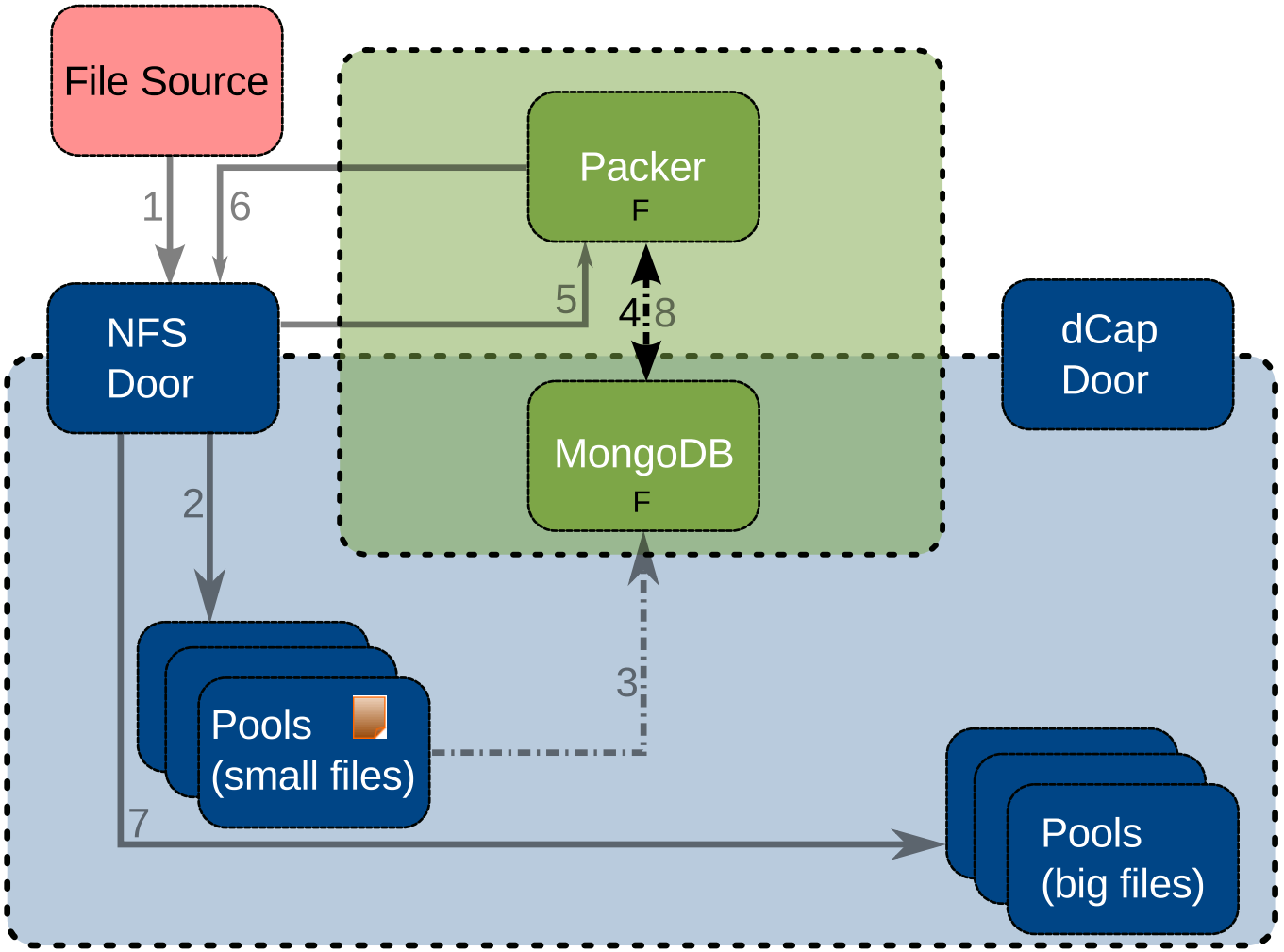
File is stored on pool



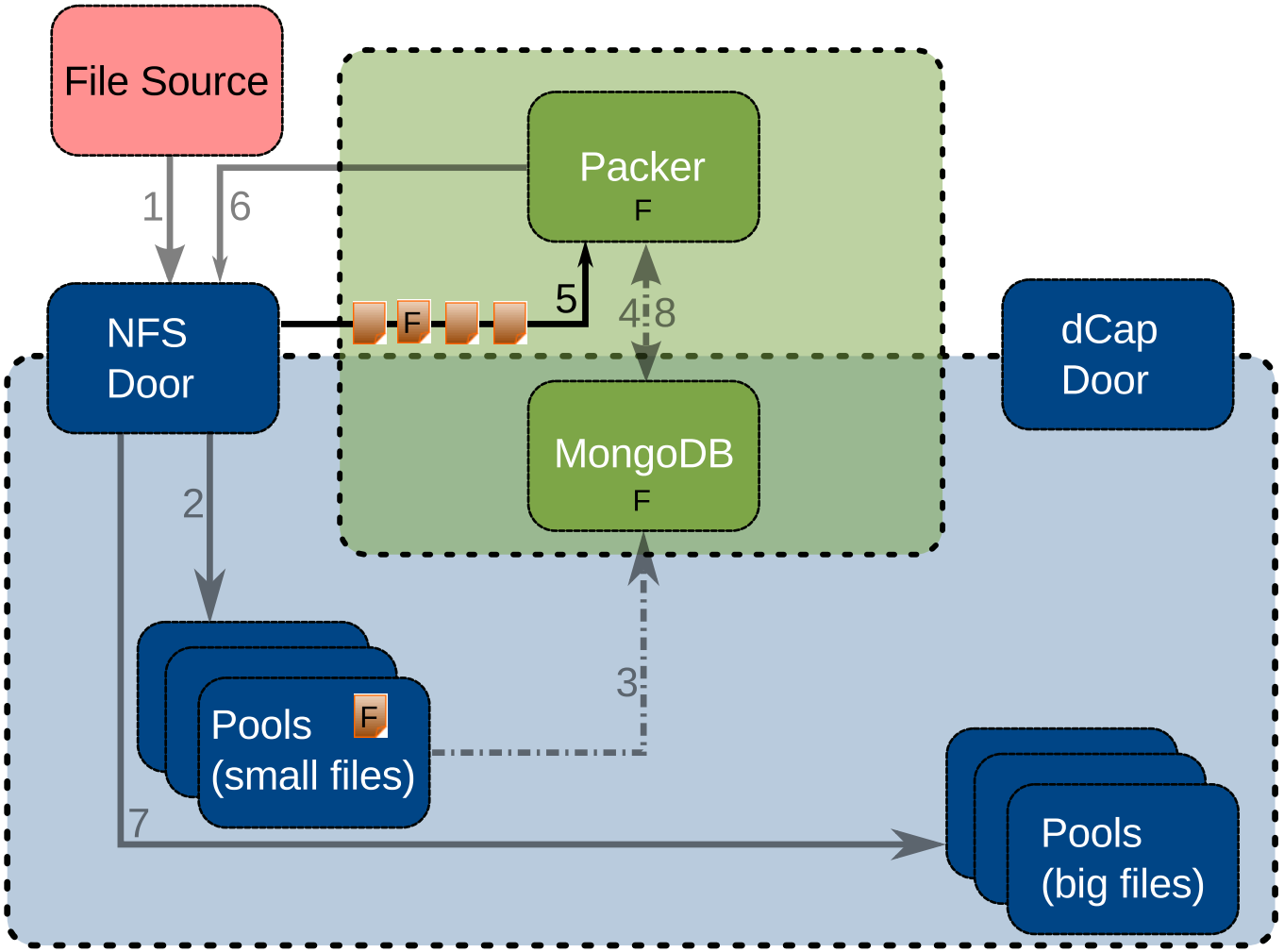
HSM script creates entry in DB



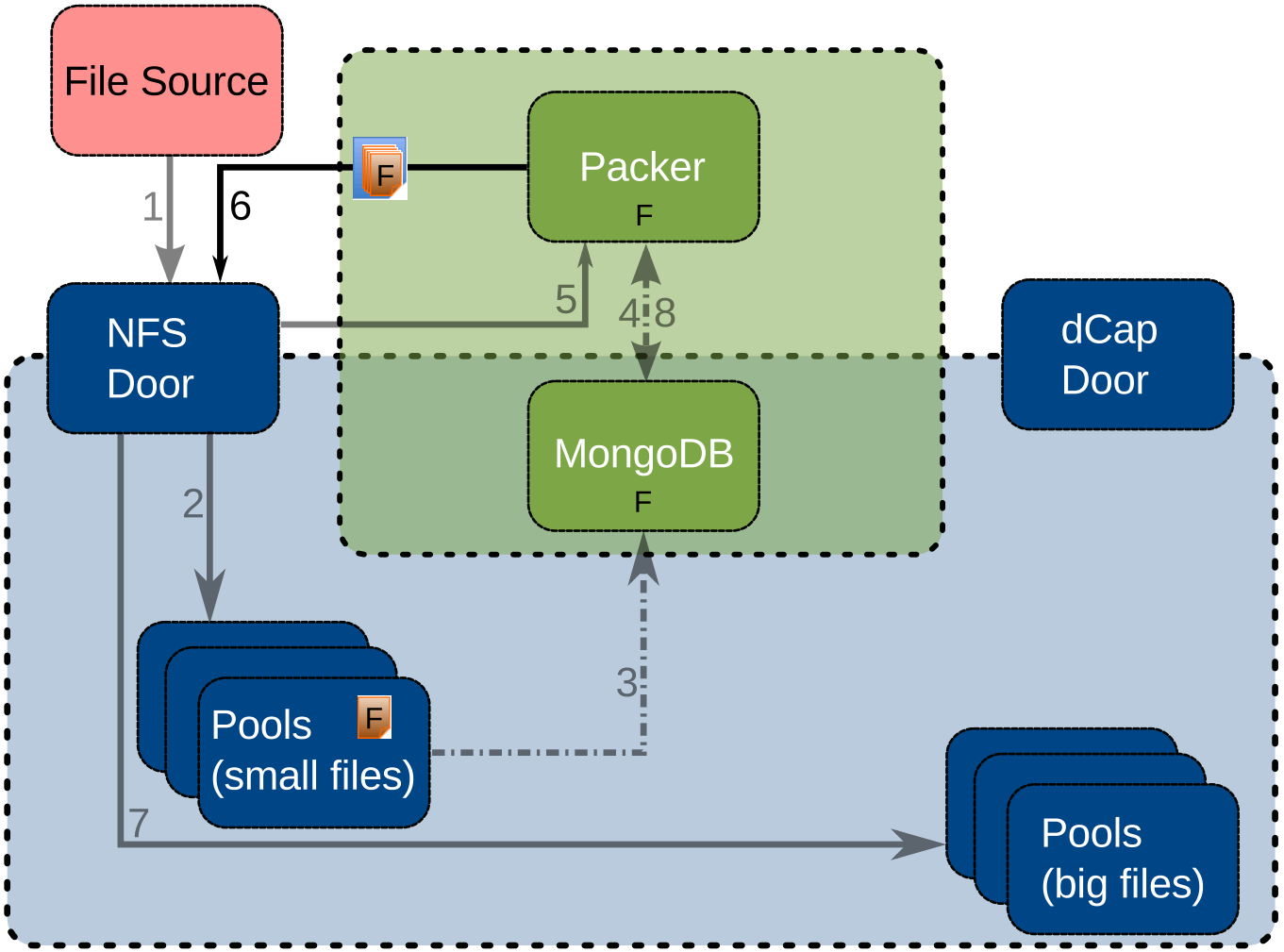
Packer sees entry in DB



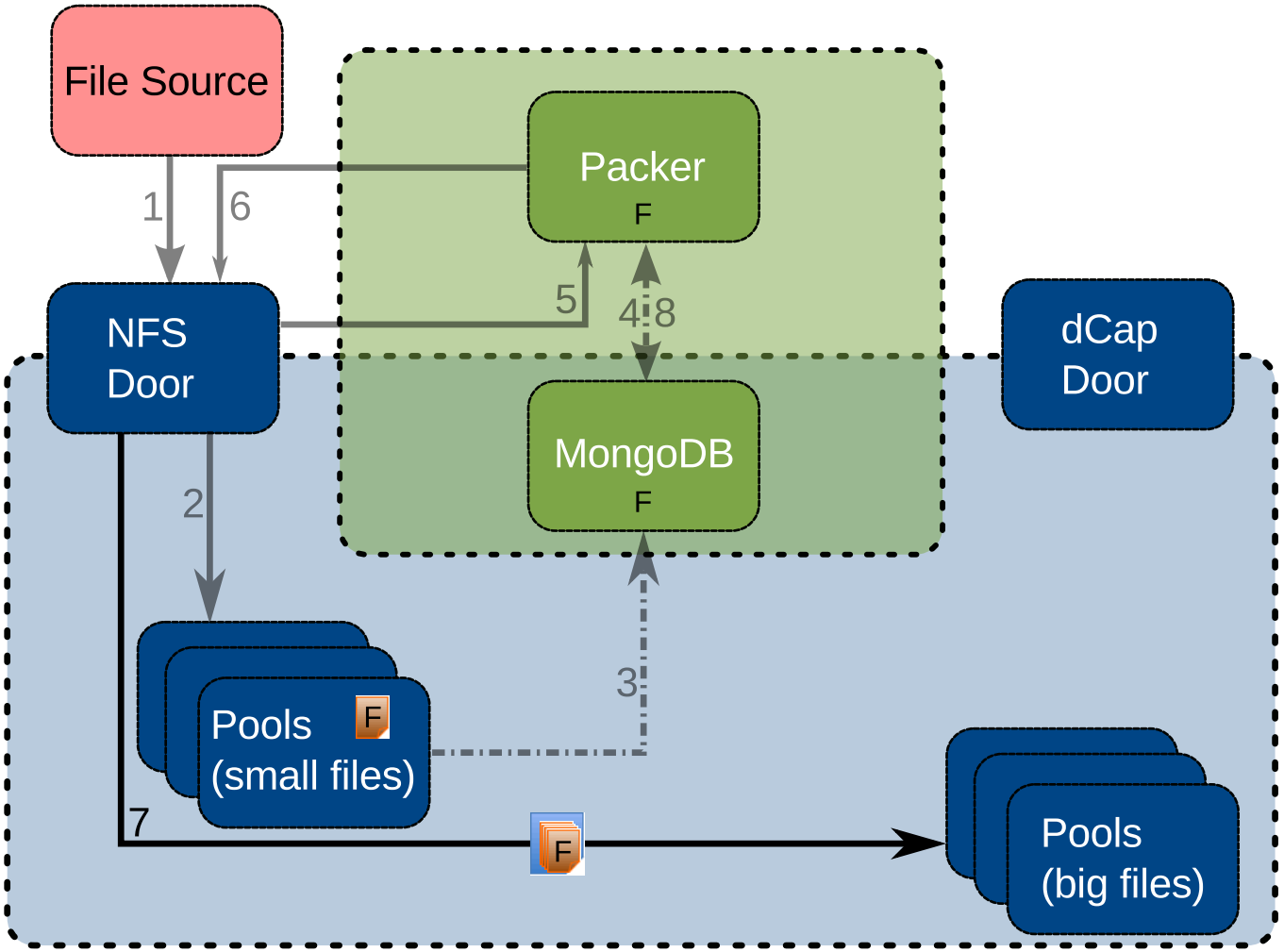
Packer adds file to file container



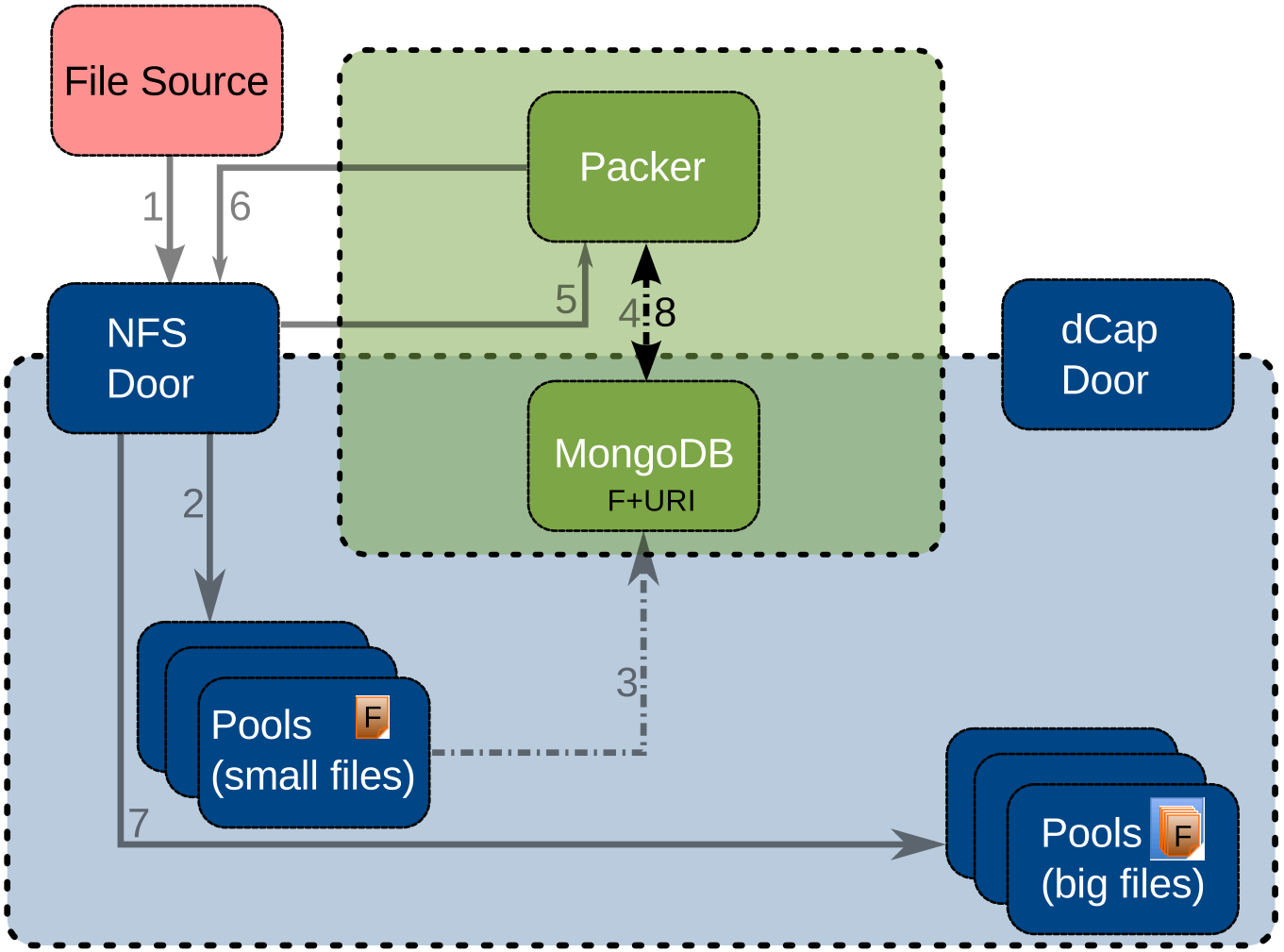
File container is written into dCache



File container is stored on pool

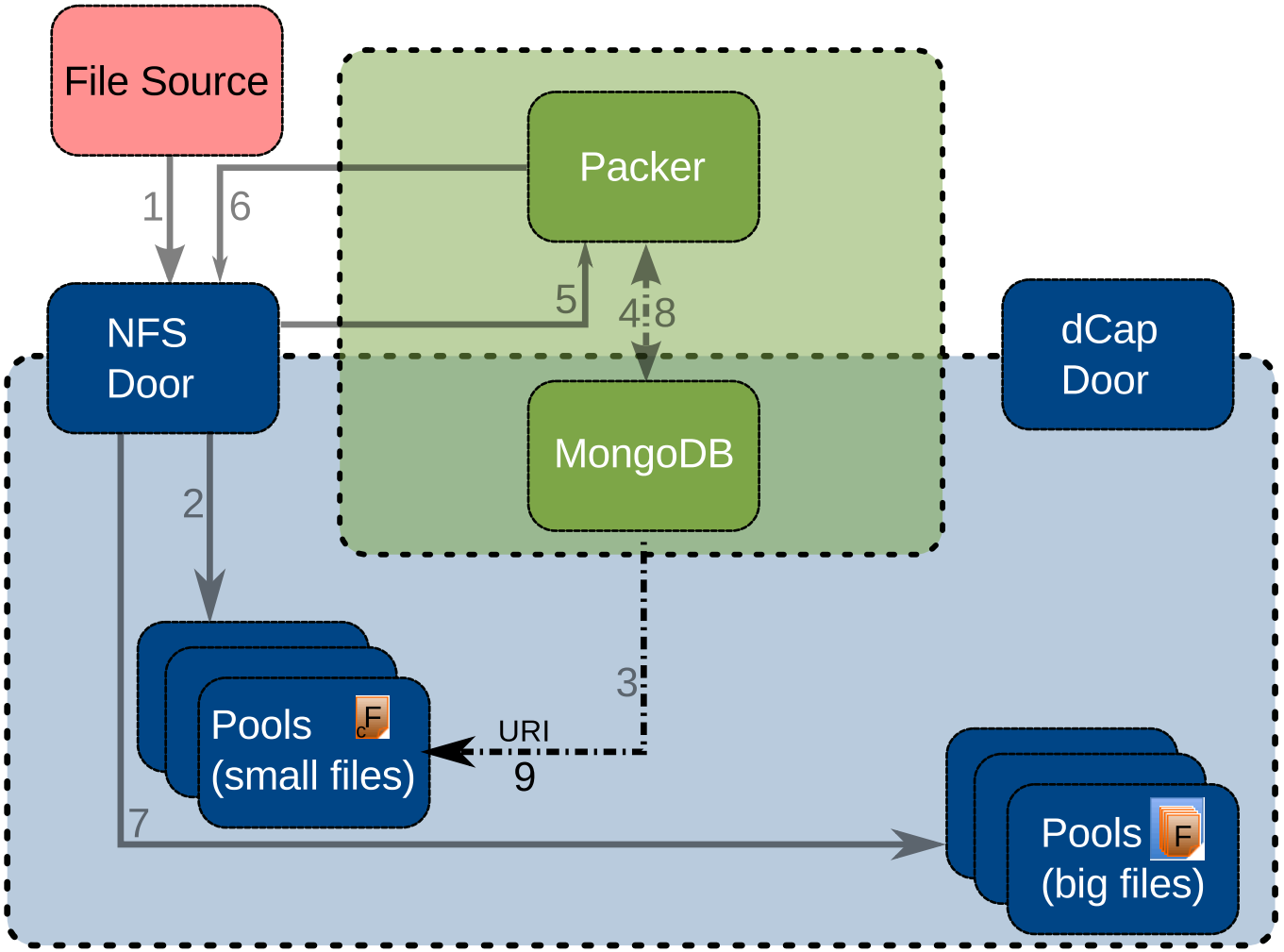


Packer adds container URI to file entry in MongoDB



dCache

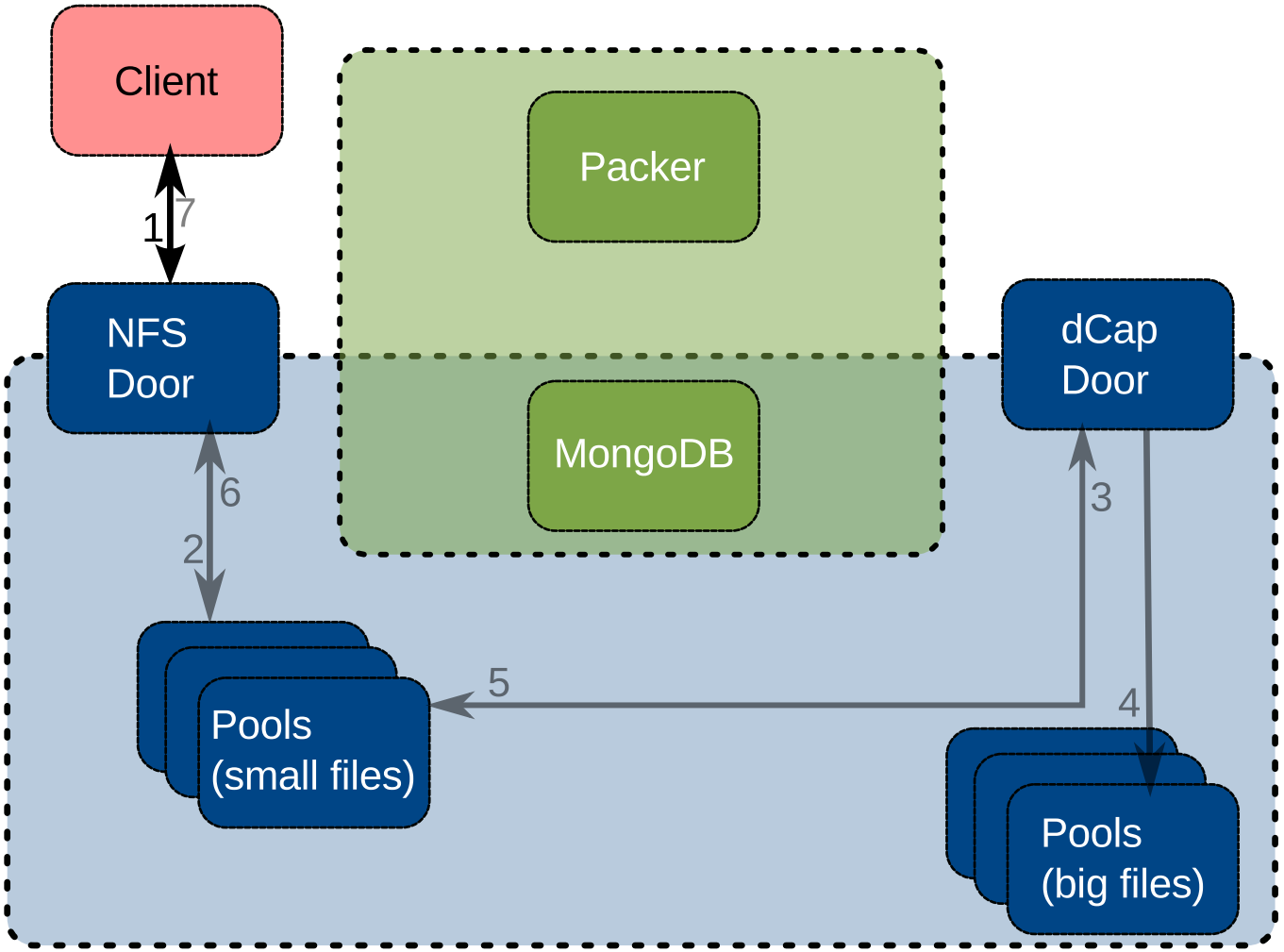
HSM script returns URI to dCache



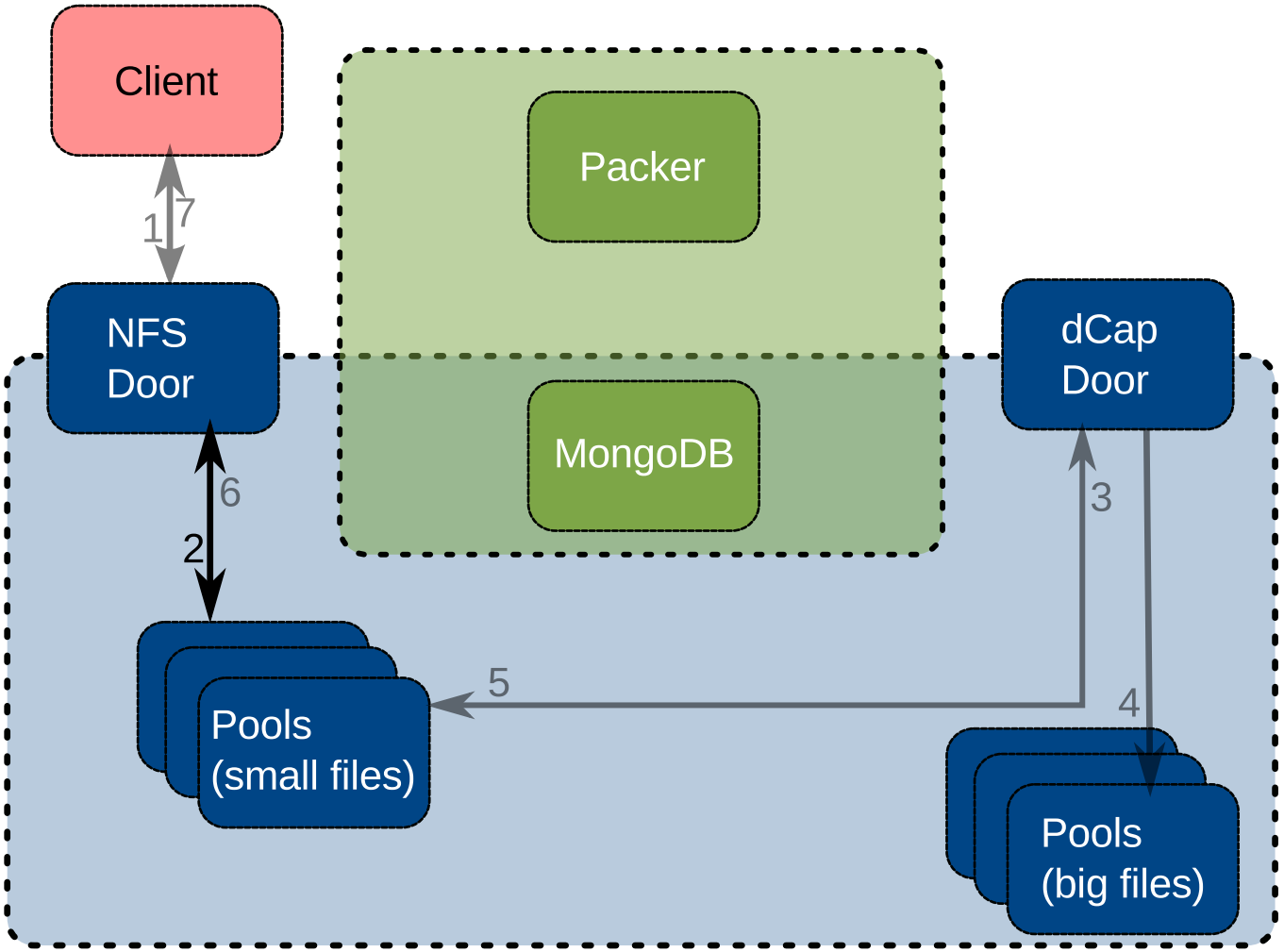
Reading a small file

What happens if a small file is read back?

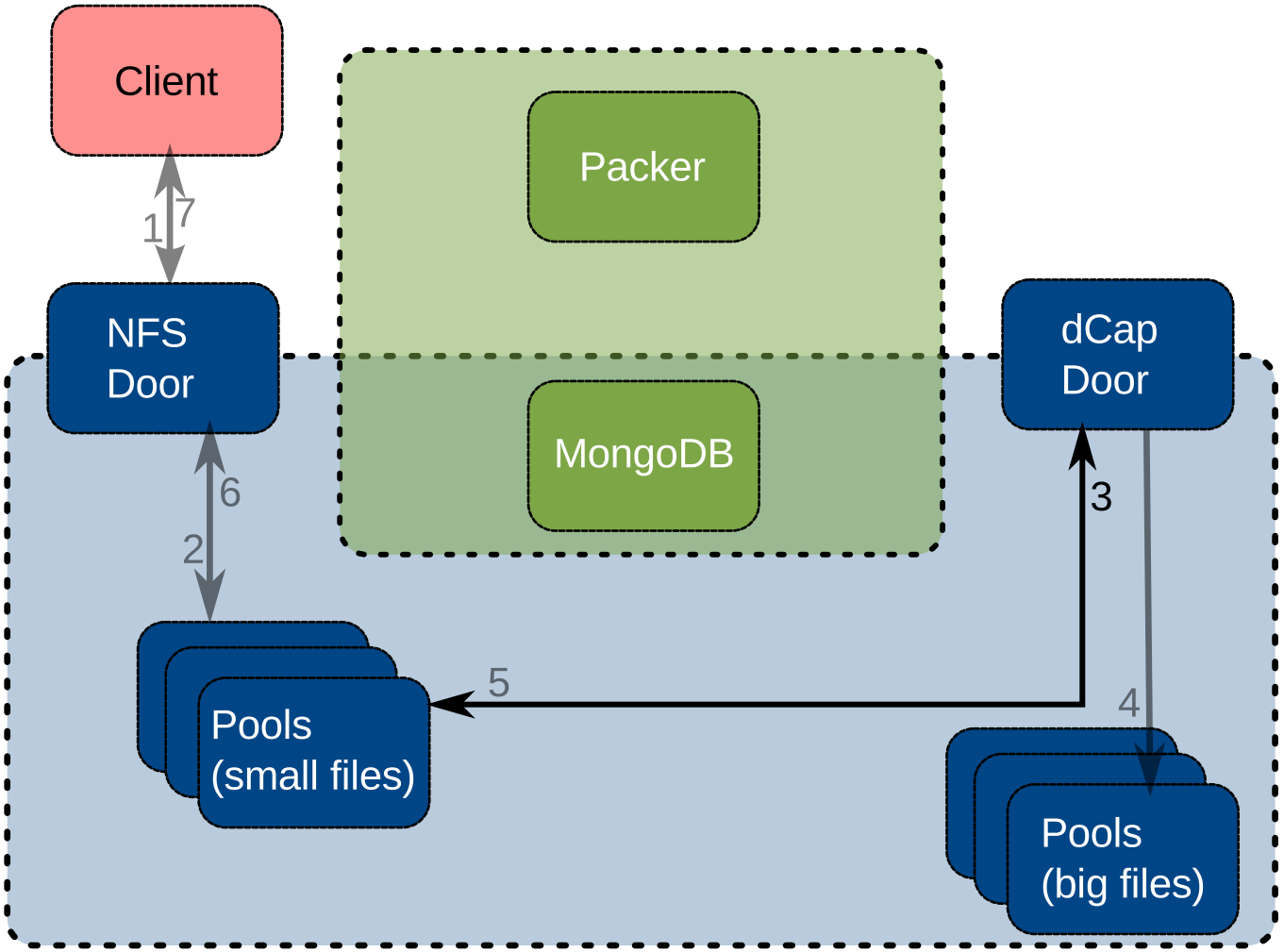
Client requests small file



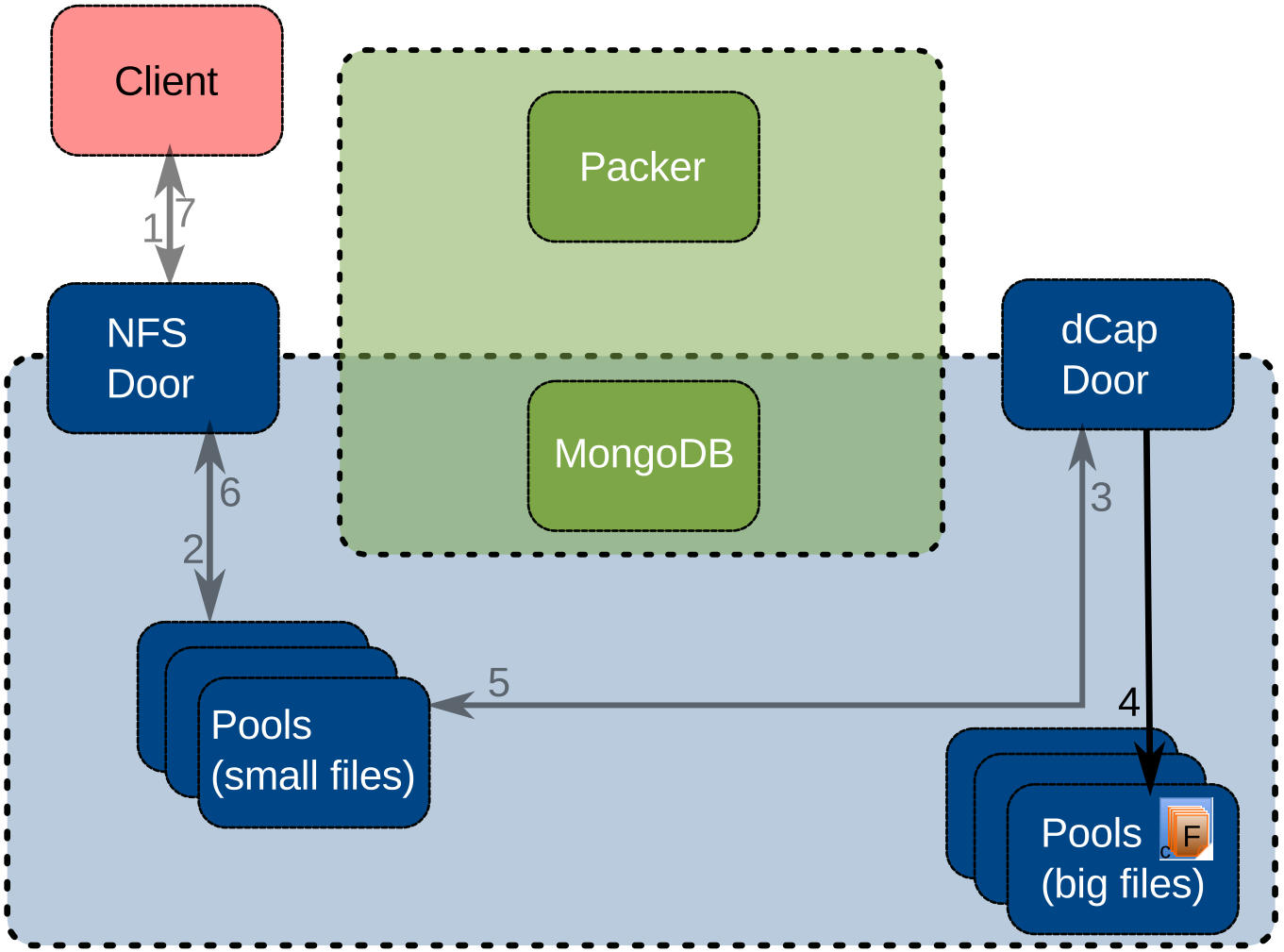
Small file pool is triggered to deliver small file



Small file pool requests container file

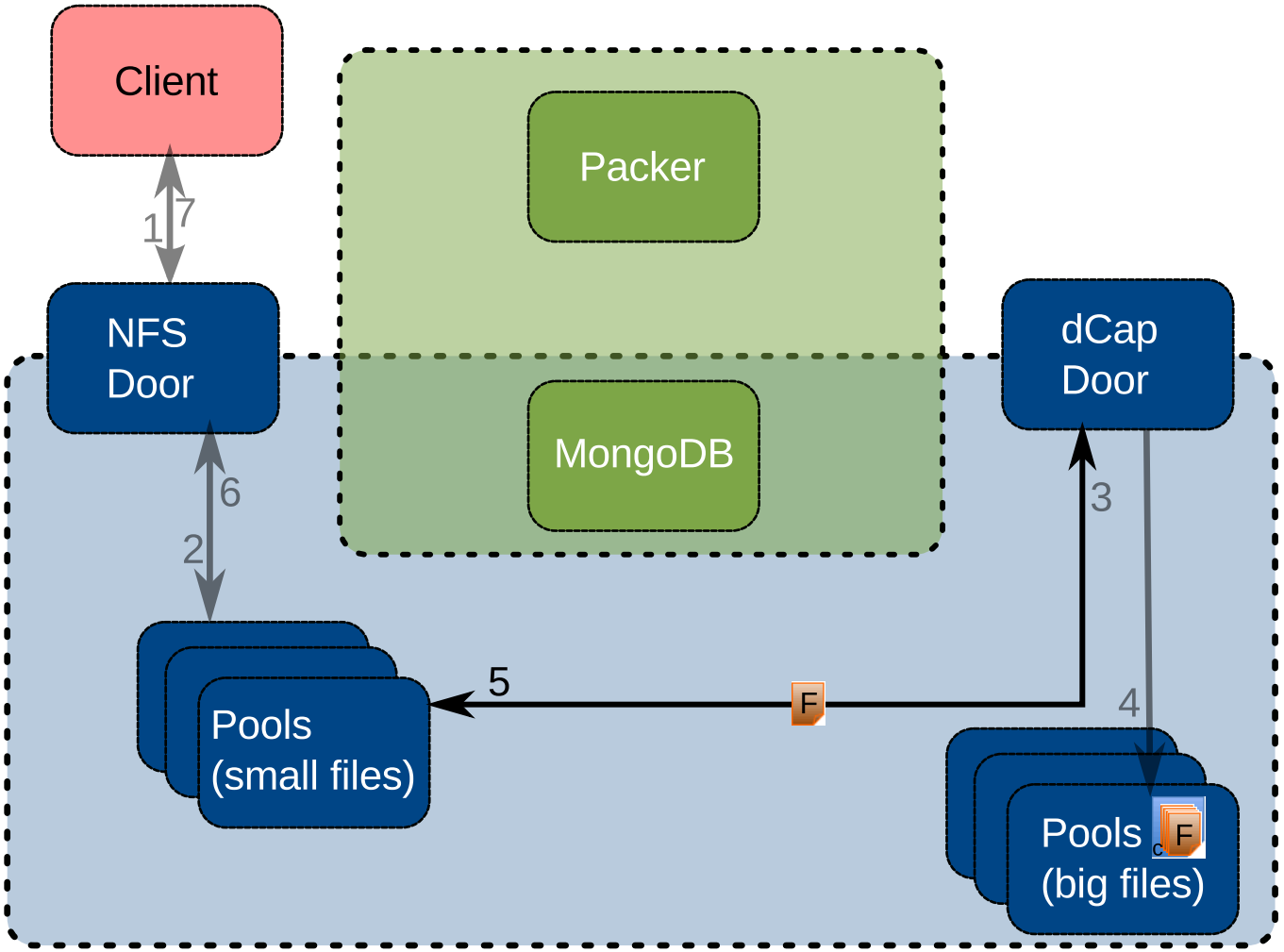


Big file pool is triggered to deliver container file

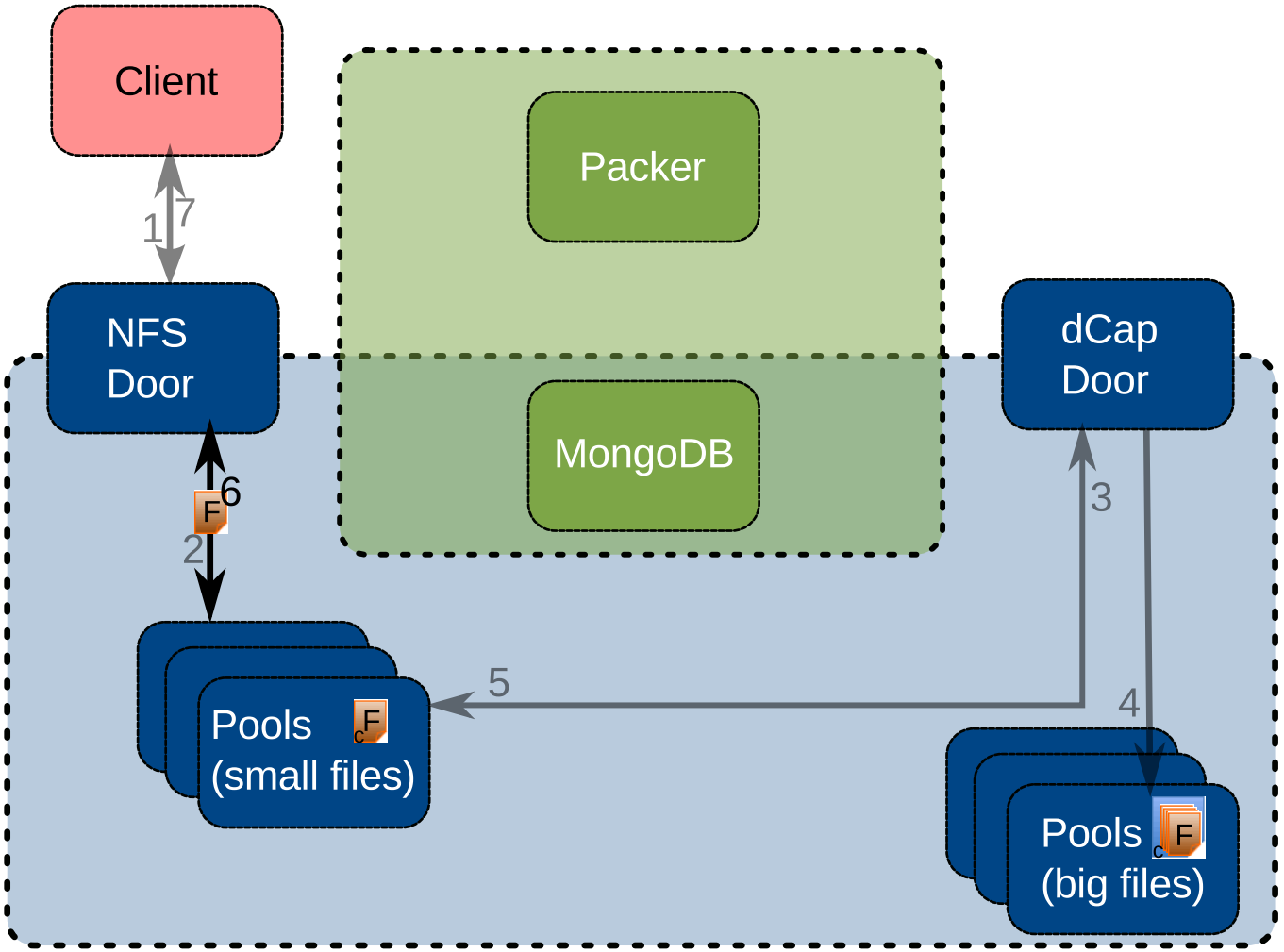


dCache

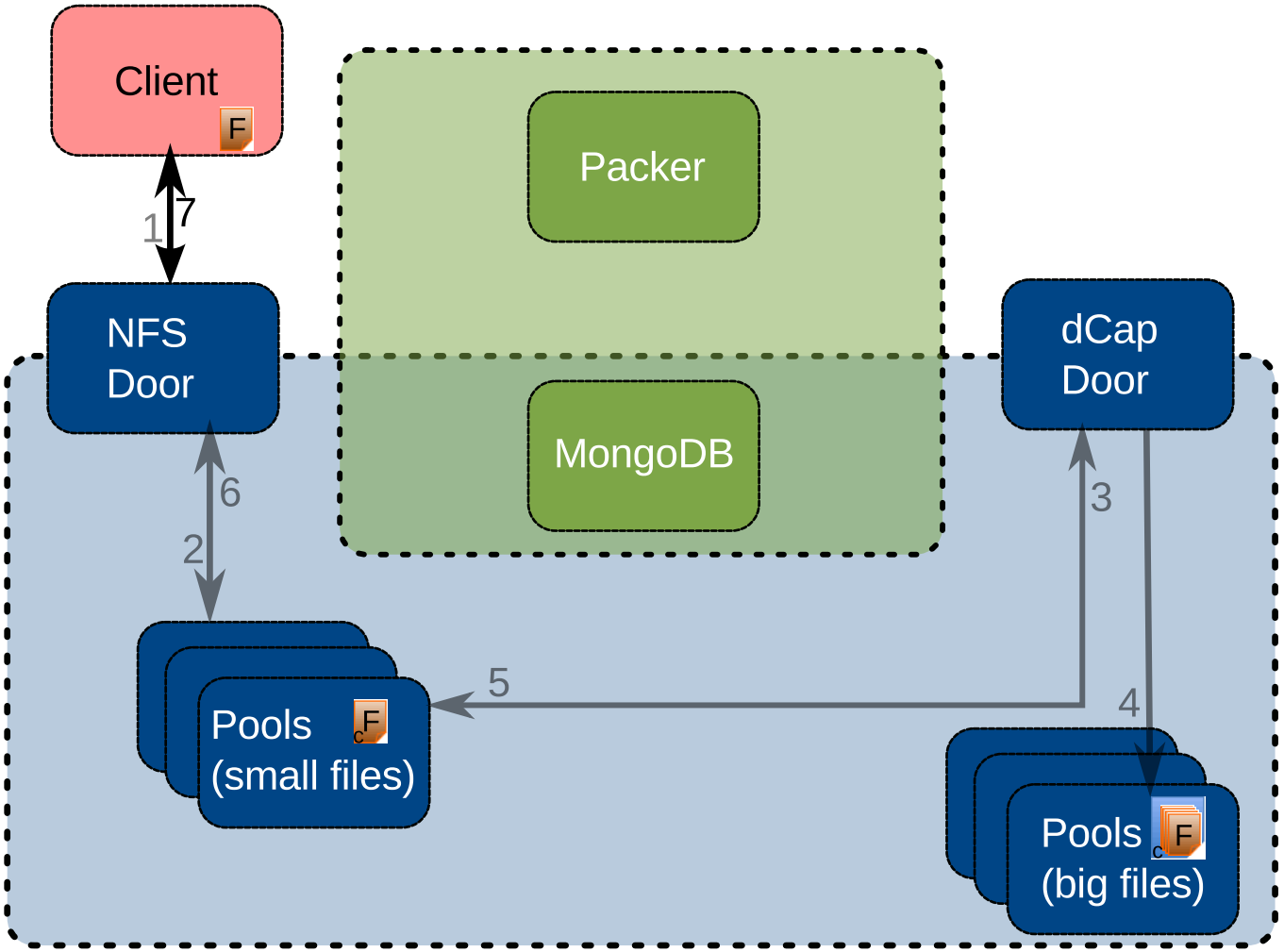
Small file pool extracts small file from container



Small file is delivered to door



Small file is delivered to client



Configuration

What can be configured?

Configuring Packaging Classes

Define one or more *Packaging Classes*. A Packaging Class defines a group of small files that should be handled the same way and end up on the same tape set.

Matching Attributes:

- path and file pattern
- sGroup and storeName pattern
- Minimum file age
- Maximum file age

Storage Attributes:

- Maximum container file size
- Container target directories

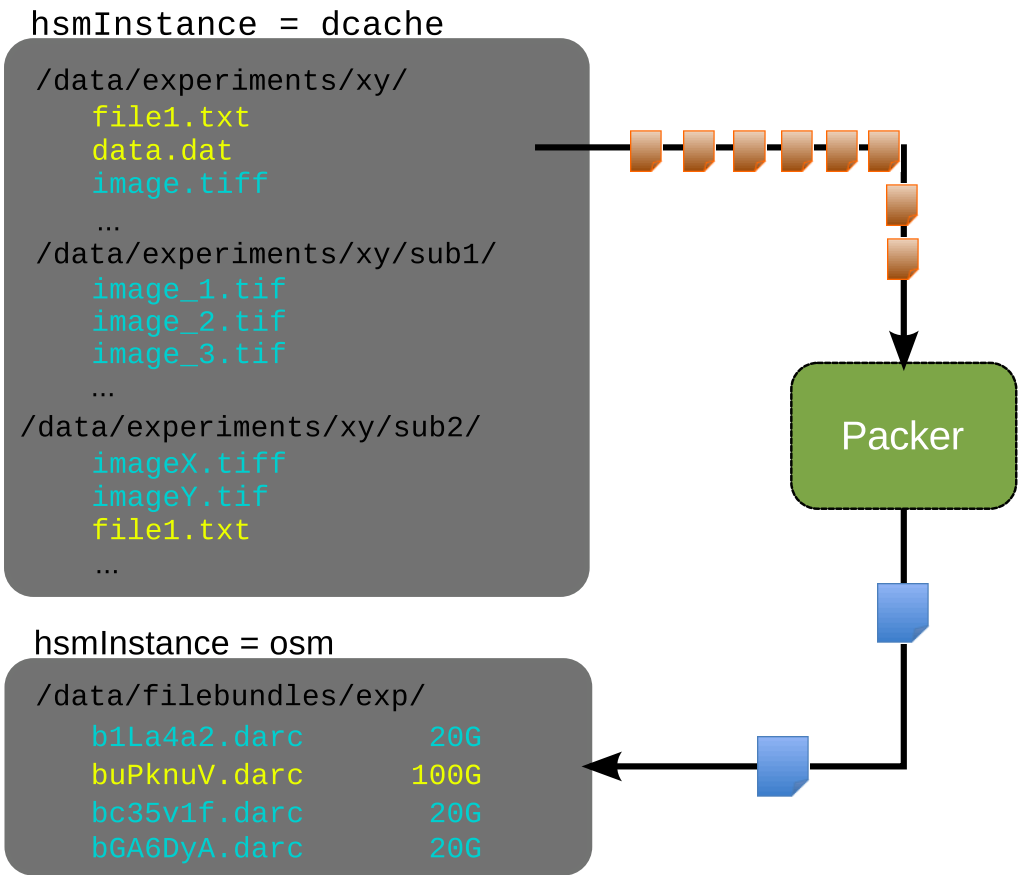
Packaging Class Configuration Example

```
[Experiment-Tiffs]
pathExpression=^/data/experiments/xy/
fileExpression=.*\.tiff?
archiveSize=20G
archivePath=filebundles/exp/

[Experiment-Others]
pathExpression=^/data/experiments/xy/
fileExpression=.*\.(?!(tiff?))
archiveSize=100G
archivePath=filebundles/exp/
```

Please note: You have to make sure *every* small file is matched by exactly one Packaging Class!

Packaging Class Packing Example



Scaling

How does it scale?

Bottlenecks

- The packing script creates one archive at the time
- Stacked up pending small file entries in MongoDB might slow down the packing system

- use multiple instances of the script working on distinct sets of files

(Multiple instances of the script can run on the same machine or on different machines)

Current Status

- Deploying the system for evaluation in a pre-production environment at DESY

Future Plans

- Will be made available after successful evaluation
- Implement to expand the whole container if one file from it is requested

Questions?