Query-FS: Integrating with UNIX from Common Lisp via FS API

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Disclaimer

Query-FS is a virtual POSIX FS, implemented using FUSE;
Lisp is used as a great tool, not something defining *every* choice

- Why I care and why you might care probably differ
  … but I want to find other use-cases and add support!
- I like Common Lisp where it fits, even if nothing is perfect
  … but the same for Bash and SQL and UNIX process boundaries
- I even use Vim not Emacs
  … but Vim, Firefox, Emacs — FS API is universal

For me, something flexible enough for SQL as FS,
for you, exporting functionality in CL to whatever speaks POSIX FS API

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Overview

- Virtual filesystem
- File layout created by code — on the fly
- Queries in pluggable DSLs
- «A Lisp data structure as a directory»
- «SQL SELECT as a directory»

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Demo

Install some native stuff...

```
$ package-manager install gcc libfuse-development
```

Get the latest update and dependencies

```
$ cd ~/quicklisp/local-projects
$ git clone https://gitlab.common-lisp.net/cl-fuse/query-fs
* (ql:quickload :query-fs)
```

Run it!

```
* (query-fs:run-fs :target "query-fs-test")
```

You now have `query-fs-test/results`

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Demo (pointless)

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Run it!

```
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```

You now have `query-fs-test/results`
... it is empty: no queries to represent

Demo: more than a boring FS

+1 filesystem, with large numbers handled on the fly:

```
(mk-pair-generator x
  (let ((xn (ignore-errors (parse-integer (first x)))))
    (if xn `((,(first x) ,(1+ xn)))
        (loop for k from 1 to 10
              collect `(,(format nil "~a" k) ,(1+ k)))))
  (mk-file (first x) (format nil "~a" (second x))))
```

```
$ ls query-fs-test/results/1plus/
1  10  2  3  4  5  6  7  8  9
$ cat query-fs-test/results/1plus/3
4
$ cat query-fs-test/results/1plus/33
34
$ cat query-fs-test/results/1plus/no
cat: /home/raskin/queries/plus1/no: No such file or directory
```

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cat: /home/raskin/queries/plus1/no: No such file or directory
```

Demo (SQL)

SQL means a DB... I use PostgreSQL (and I have a local server)
Let's prepare a playground

```
$ echo "…" > /home/test/psql-pass
$ createdb test_queryfs
$ psql -d test_queryfs -c \
    "create table test_table (
        name varchar,
        content varchar
     );"
```

Demo (SQL)

Now let's install some stuff for Query-FS

```
$ package-manager install postgresql-client
* (ql:quickload :clsql-postgresql :esrap-peg)
```

And start filling `query-fs-test/queries/db.sql2`

```
set db-server="127.0.0.1"
set db-name="test_queryfs"
set db-type="postgresql"
set db-user="test"

read db-password < "/home/test/psql-pass"
```

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```

Demo (SQL)

Now some actual query

```
mkdir "all" do
  for x in "select name, content from test_table"
    with-file $name do
      on-read $x[1]
      on-write data "update test_table
                     set content = ${data}
                     where name = ${name}"
      on-remove "delete from test_table
                 where name = ${name}"
    done
  on-create-file name "insert into test_table
                       (name) values (${name})"
done
```

Demo (SQL)

It works

```
$ echo qwe > query-fs-test/results/db/all/123
$ echo asd > query-fs-test/results/db/all/12345
$ cat query-fs-test/results/db/all/123
qwe
```

Demo: more than a boring FS

Extend the query

```
mkdir "silly" do
  for x in "select ${x[0]},
                   'Indeed, we have '|| ${x[0]} ||' here!'
              where ${x[0]} is not null"
    with-file $name do
      on-read $x[1]
    done
done
```

And now...

```
$ ls query-fs-test/results/db/silly/
$ cat query-fs-test/results/db/silly/code
Indeed, we have code here!
```

Demo: more than a boring FS

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```

And now...

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$ cat query-fs-test/results/db/silly/code
Indeed, we have code here!
```

Structure

- CL-FUSE
  - CFFI bindings for FUSE
  - Direct use of FUSE medium-level API
  - A slightly lispy wrapper on top
- CL-FUSE-Meta-FS
  - Produce list-based layout instead of callbacks
  - A set of macros to define layouts
    Used in `1plus.cl`
  - Missing: CLOS-based API
- Query-FS
  - Plugins to parse queries
  - For each query, plugin outputs lisp code
    CL-FUSE-Meta-FS layout descriptions
  - Complete FS definition composed of translated queries
  - Queries can be updated while FS is mounted

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PEG parsing

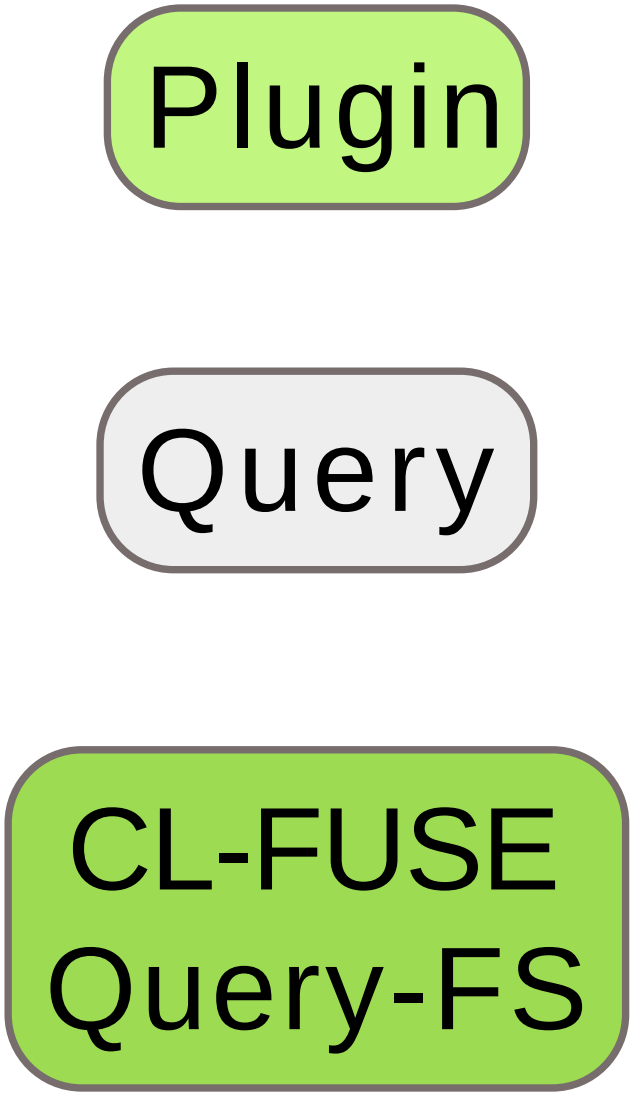
Esrap-PEG: frontend for Esrap
An abstract grammar

```
WhiteSpace <- " " / "\r" / "\n" / "\t"
S <- WhiteSpace +
OnWrite                  <- "on-write" S Identifier S SQLCommand
```

And pattern-matching to process the AST

```
…
  (OnWrite
    ((_ _ ?var _ ?body)
     `(:on-write
        (,(! ?var)
        ,(! ?body)))))
…
```

Query-FS request



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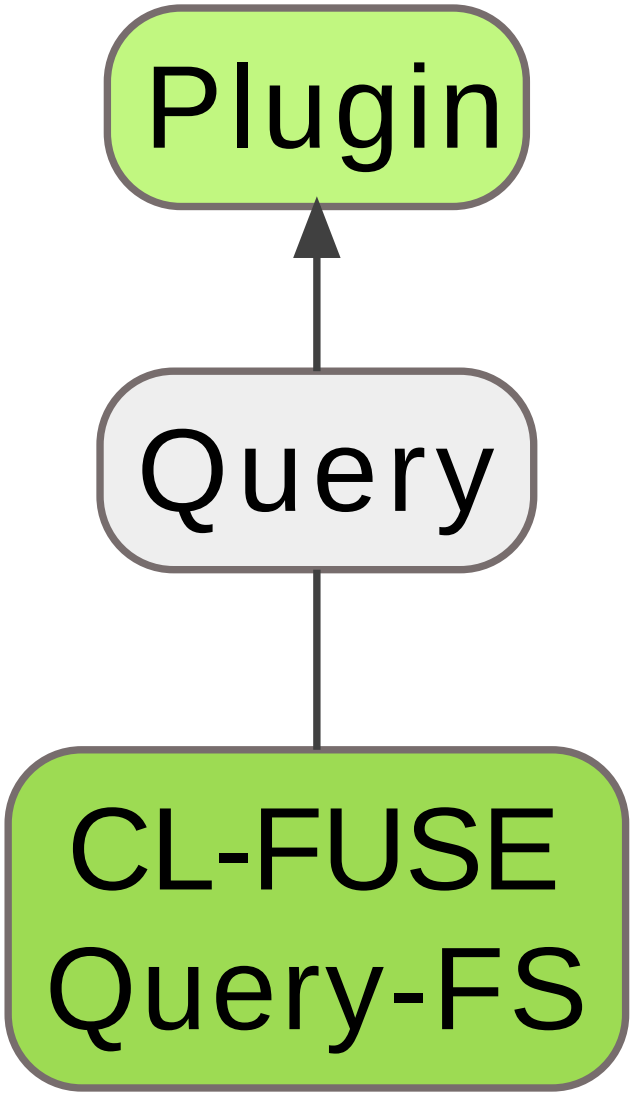

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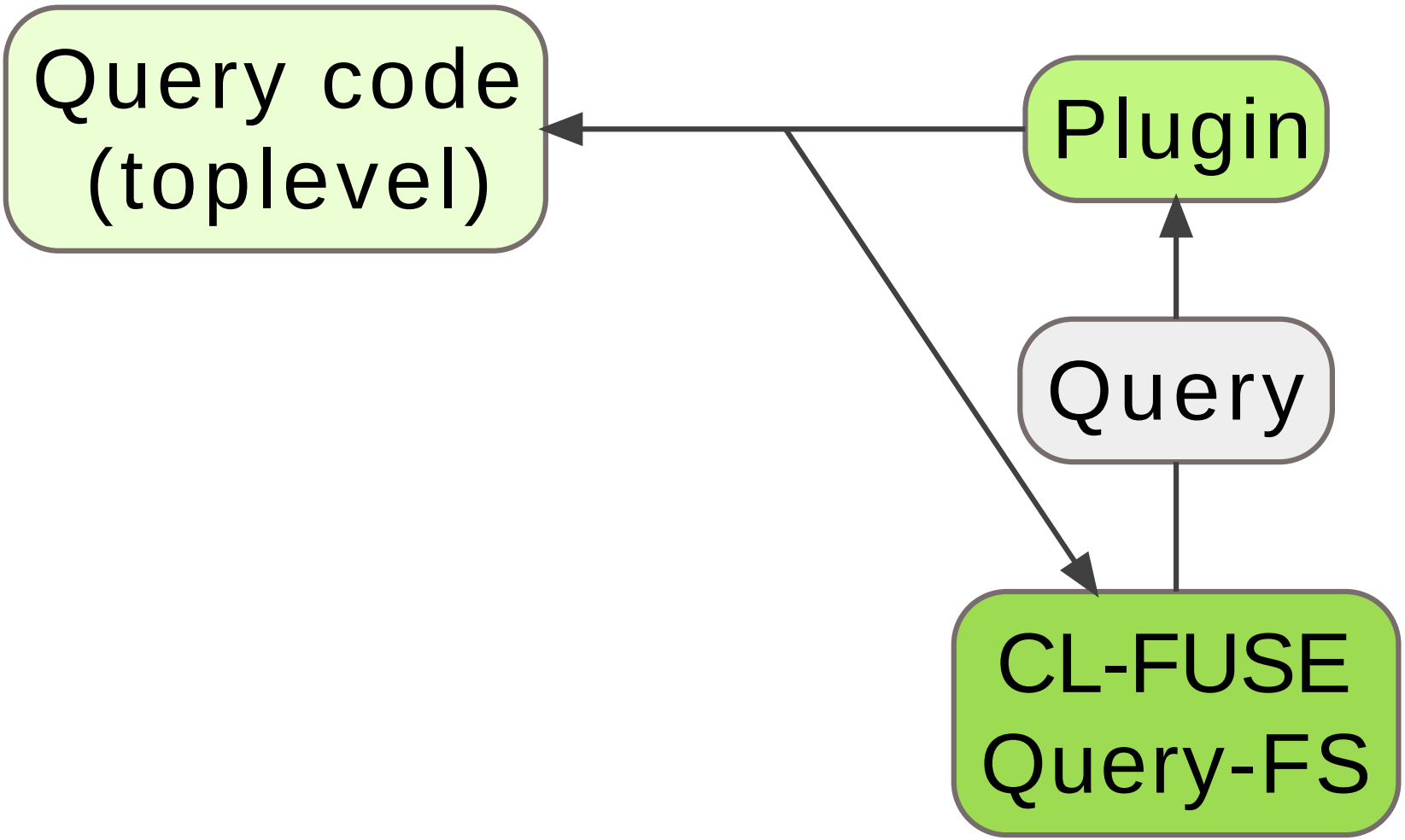

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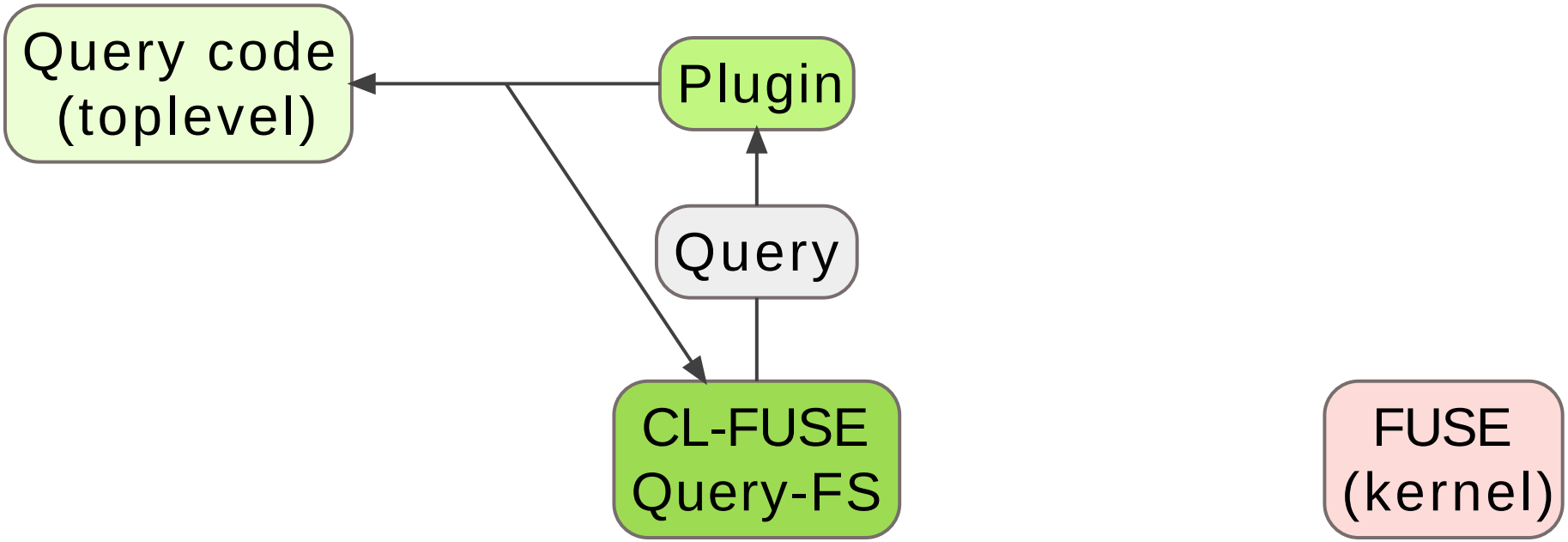

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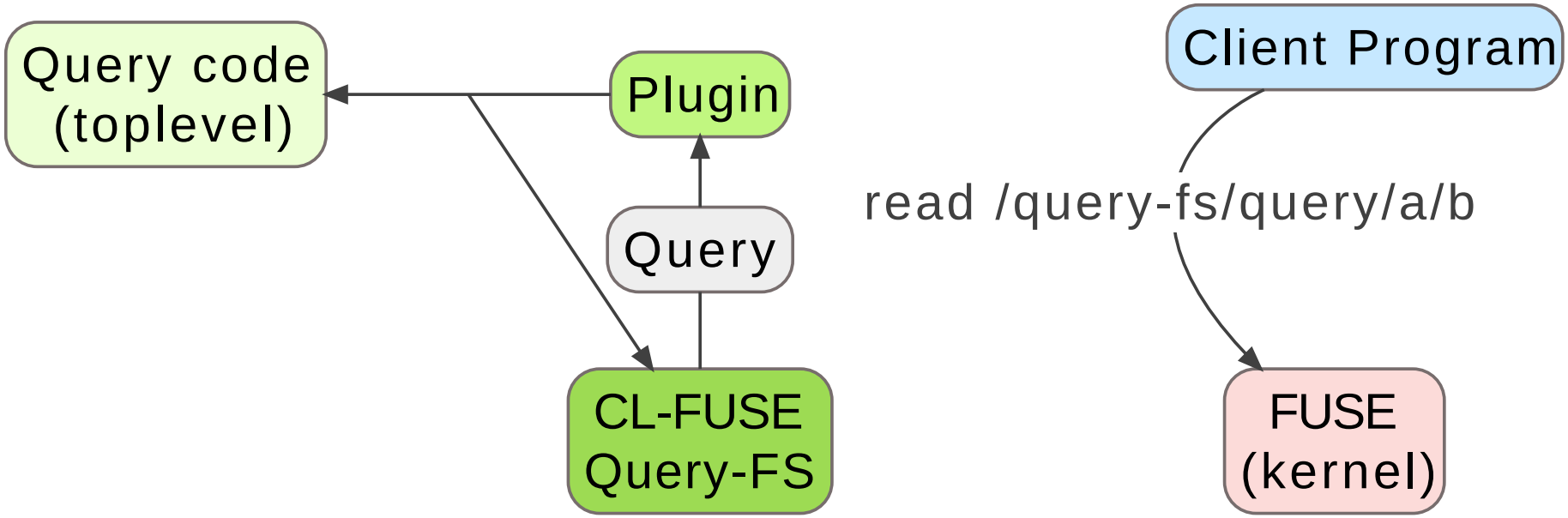

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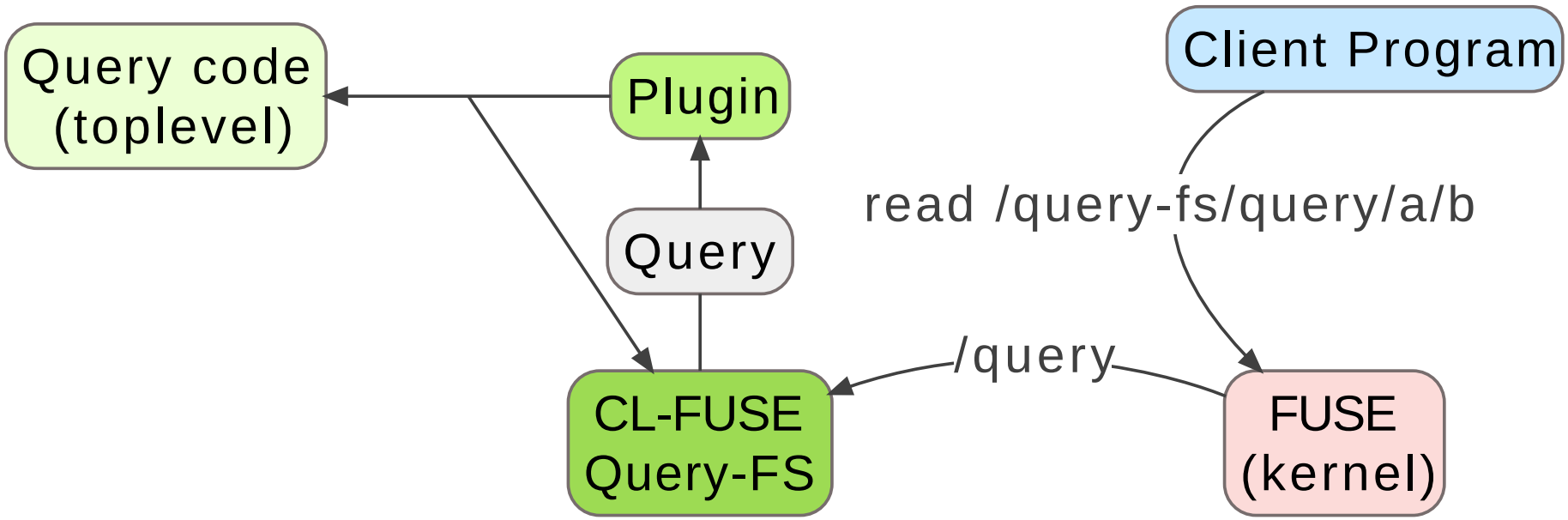

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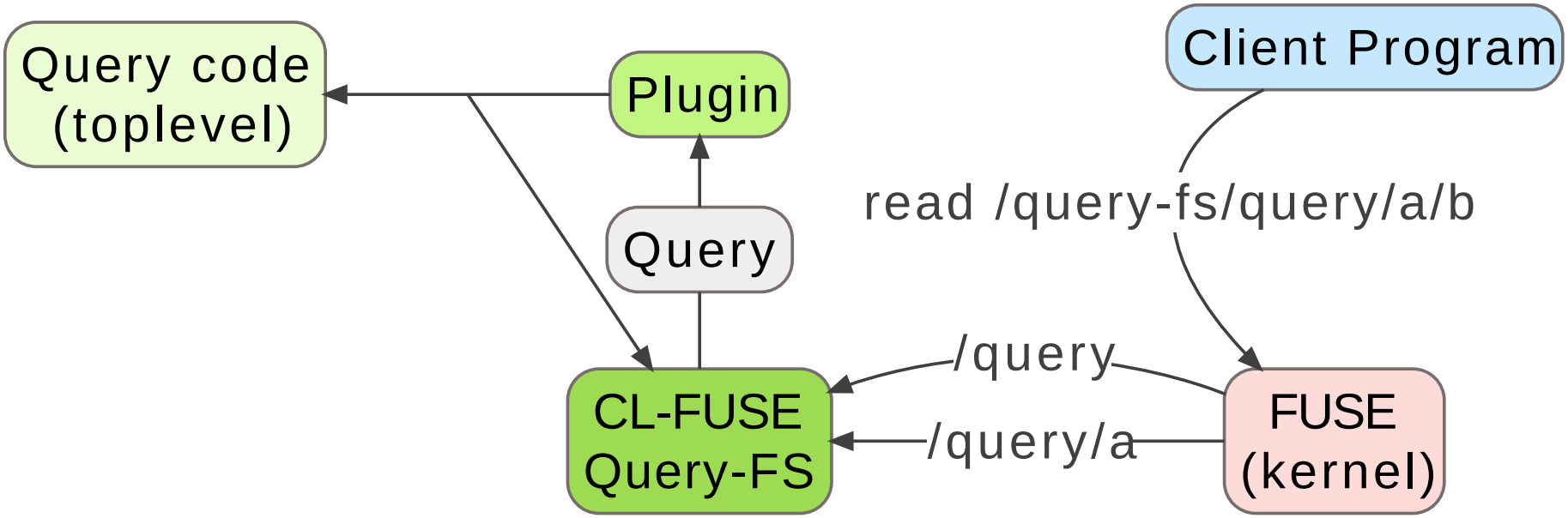

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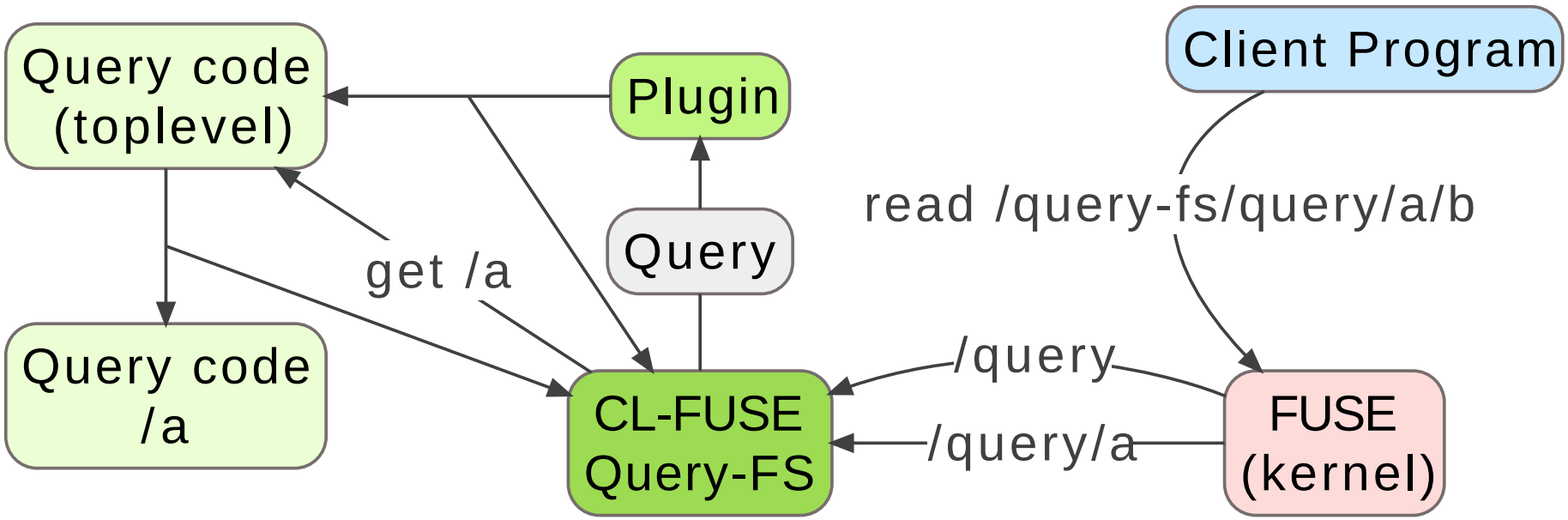

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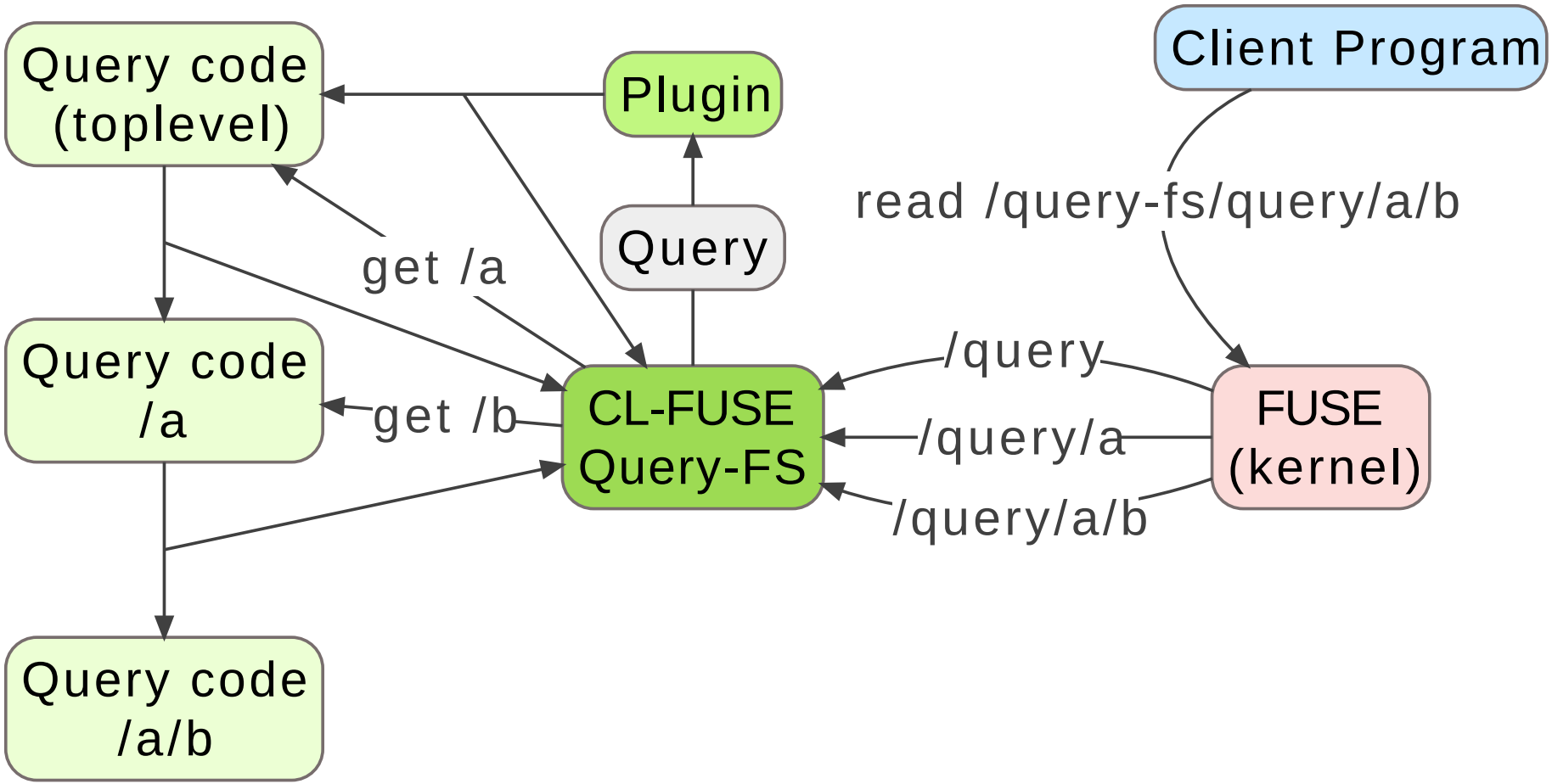

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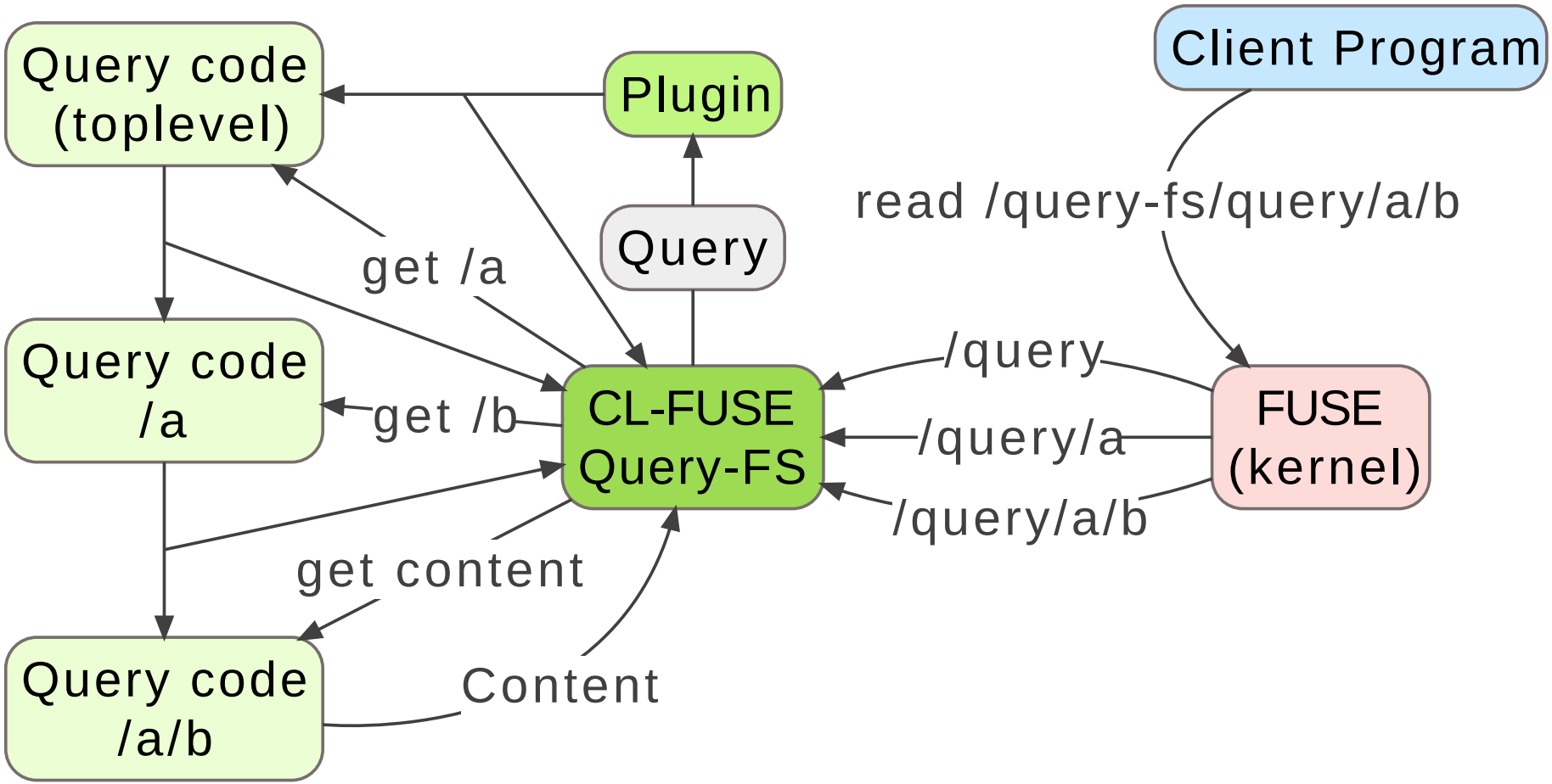

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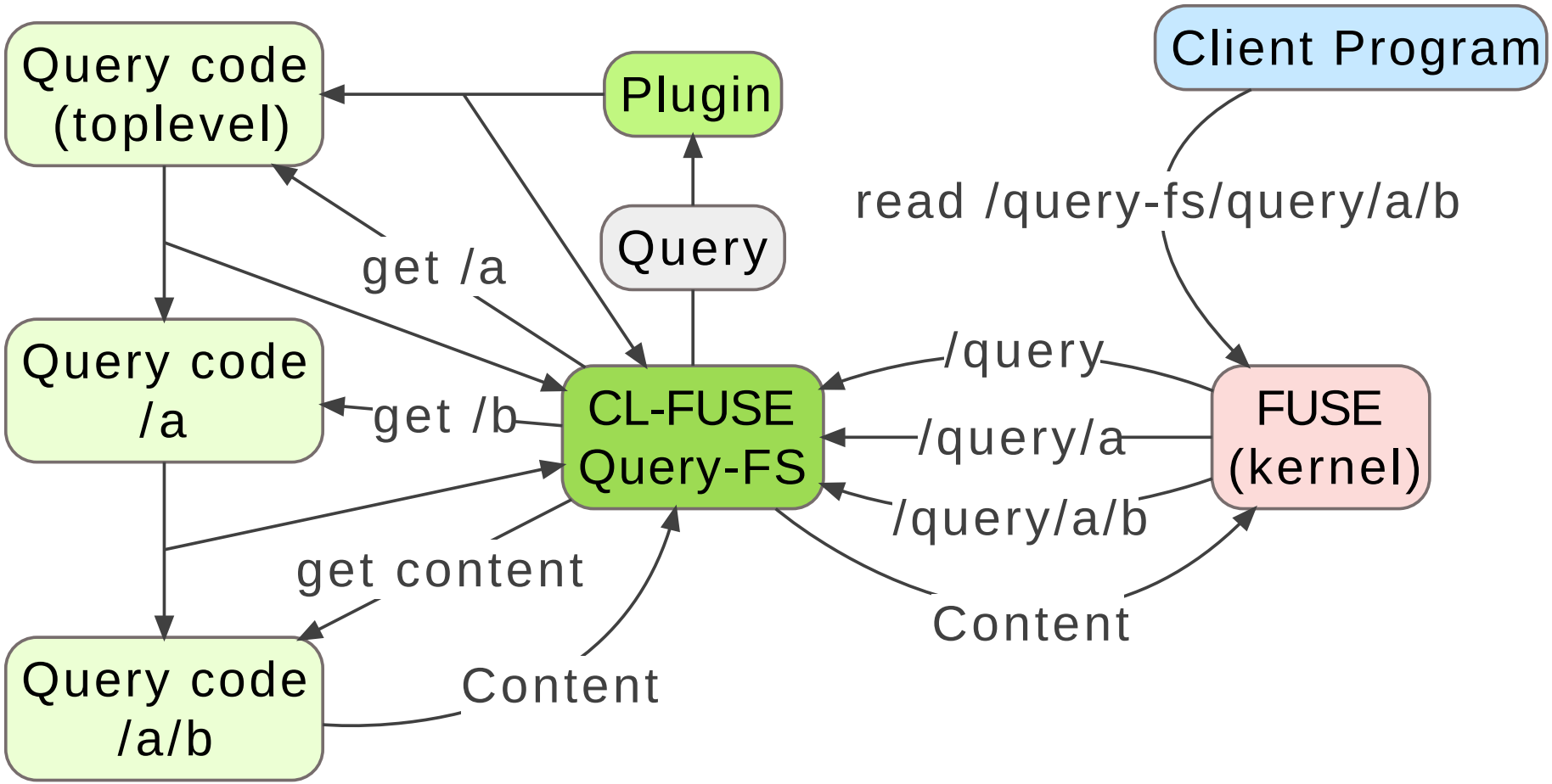

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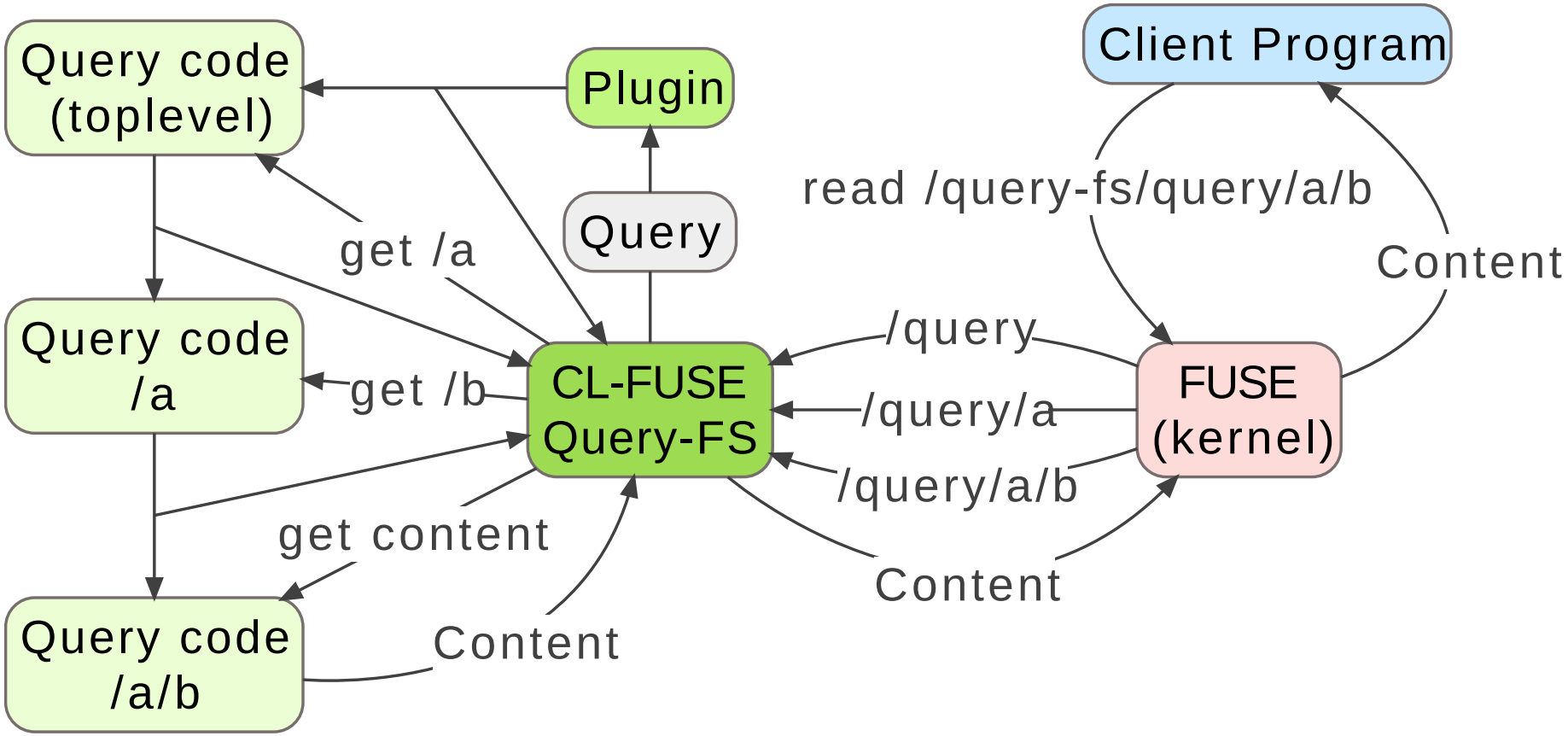

Remarks on FS interface

Many of us value stability and flexibility

- C FFI integration needs support from both sides
- FFI is fragile: memory layout of arguments, ABIs
  that's before the unavoidable meaningful part
- In-process compatibility: threads, signals, allocations

- Maybe their file browsing/loading is enough?
  ...better chances than supporting HTTP just right
- Still need serialisation; at least breaking FS API is discouraged
- Different processes, diferent rules
- Well, some overhead; not so bad compared to SQL DB request
  for large files, generate symlinks to them

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Filesystem API in general

- Encodings: decide whether (or when) filenames must be valid UTF8...

FUSE

- The simple way to use FUSE: a framework
  - Makes assumptions about threads...
  - FUSE-managed threads + callbacks + GC... no good
- One step below: actual functions... and tons of callbacks
  - Works fine with CFFI
- You do want to exit once the FS is unmounted
- Symbol versioning in `libfuse.so`
  - Hard to handle
  - One-function shared library just to wrap this

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Query-FS: my usage

- Email: indexed in PostgreSQL DB, read in Vim using Query-FS
- Planet.Lisp.org (and many other feeds): same
- Password manager: same, with master key to encrypt entries
  Probably wasn't a very good idea...
- File tagging: implemented... but I don't use it

Not there (yet?):

- Security model
  by kernel default only same UID allowed
- Advanced FS functionality: inotify, mmap, etc.
- Smarter caching based on lower-level FUSE API
- In-Lisp FUSE protocol parsing instead of libfuse
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