Configuration Management

Markus Raab

Institute of Information Systems Engineering, TU Wien

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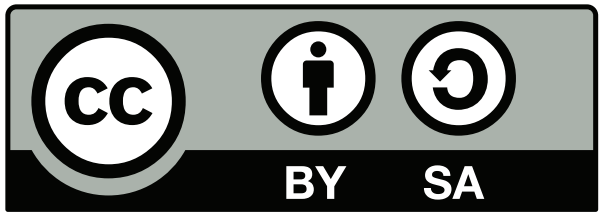


Language of the Talk?

Task

Hands up if you prefer German.

Lecture is every week Wednesday 09:00 - 11:00.

06.03.2019: topic, teams
13.03.2019: TISS registration, initial PR
20.03.2019: other registrations, Guest Lecture
27.03.2019: (HS?)
03.04.2019:
08.05.2019: (HS?)
10.04.2019: mid-term submission of exercises
15.05.2019:
22.05.2019:
29.05.2019:
05.06.2019: final submission of exercises
12.06.2019:
19.06.2019: last corrections of exercises
26.06.2019: exam

Popular Topics

14	tools
9	testability
9	code-generation
7	context-awareness
6	specification
6	misconfiguration
6	complexity reduction
5	validation
5	points in time
5	error messages
5	auto-detection
4	user interface
4	introspection
4	design
4	cascading
4	architecture of access
3	configuration sources
3	config-less systems
2	secure conf
2	architectural decisions
1	push vs. pull
1	infrastructure as code
1	full vs. partial
1	convention over conf
1	CI/CD
0	documentation

Organisation

- https://github.com/orgs/ElektraInitiative/teams/cm2019s now created
- private repo created
- first PRs created and accepted:
  - release notes often not updated
  - please set "ready to merge" if build server is happy

Talk

about anything related to configuration management.

- The duration **must be not longer** than 20 minutes (shorter is ok, content matters).
- It must be about your experience.
  - E.g., about the homework you did.
  - I.e., not only about study of literature.
  - If you extensively use some tool before, please share your experience.
- Two persons per date.
- Same topic allowed if persons coordinate their talk.

Next tasks

Task

Initial PR must be done **today**, can be trivial

Task

Registration for talk, homework, teamwork until 20.03.2019 23:59

Task

Assign yourself at least one issue or ask me to assign one to you.
(make sure to say which programming languages you know)
Deadline: 20.03.2019 23:59

learning outcome:

- Having an overview of configuration file formats.
- Understanding Elektra's abstractions that deals with the multitude of configuration file formats.

Configuration File Formats

Basic Definitions

The ***execution environment*** is information outside the boundaries of each currently running process [5].
Controlling the execution environment is essential for configuration management [4, 10], testing [24, 28], and security [8, 13, 16, 22].

Configuration Setting

Definition

A ***configuration setting***, or ***setting*** in short, fulfills these properties:

1. It is provided by the execution environment.
2. It is *consumed* by an application.
3. It consists of a key, a configuration value, and potentially *metadata*. The ***configuration value***, or ***value*** in short, influences the application's behavior.
4. It can be *produced* by the maintainer, user, or system administrator of the software.

Synonyms for Configuration Settings

User preferences [11] and ***customization*** [1] stress that users make the change although that might not always be the case. ***Variability points*** [9, 14, 15, 25–27] aim at describing the capability of software to adapt its behavior. ***Derivation decision*** [6, 7] puts the decisions to make and not the result in focus. ***Configuration parameter*** [2, 30] is easily confused with other kinds of parameters. ***Configuration item*** [3] or ***configuration option*** [21, 31, 32] are sometimes not applicable, for example, “proxy option”, or “language item”. ***Configuration data*** [10] is often used in the context of programmable gate arrays and has a different meaning in that domain.

Definition

A ***configuration file*** is a file containing configuration settings.
A Web server configuration file:

```
1 port=80 ; comment
2 address=127.0.0.1
```

Task

What are keys? What are configuration values? What is metadata?

The configuration values are 80 and 127.0.0.1, respectively.
Other information in the configuration file is metadata for the configuration settings (such as the comment).

Types of Formats

- CSV (comma-separated values)
- semi-structured
- programming language
- document-oriented
- literate

CSV formats

- passwd: 3rd November, 1971
- passwd and group use : as separator
- are difficult to extend (e.g., GECOS)
- today mostly used for legacy reasons
- are replaced one-by-one (e.g., inetd, crontab)

Trends

- away from CSV
- towards general-purpose serialization formats (INI, JSON)
- human-read/writable (YAML, HOCON, TOML)
- programming language as configuration file

Programming Language

+ very easy for developers (simply source the file)
+ above-overage quality of error message
– makes automatic change of individual values harder
– very hard to use for people who do not know the programming language
– does not separate code and data

Introduce somebody

Task

Talk with someone about your favourite configuration file format.

Task

Did you implement a configuration file parser and/or invented a new configuration file format?

Task

Explain to everyone about the other person and his/her favourite configuration file format.

Method

What do FLOSS developers say?

- *Q:* survey with 672 persons visiting, 162 persons completing the survey [18]
- *S:* source code analysis of 16 applications, comprising 50 million lines of code [18]

Why are so many formats present?

Q: "In which way have you used or contributed to the configuration system/library/API in your previously mentioned FLOSS project(s)?" [18]

- 19 % persons ($n = 251$) have introduced a configuration file format.
- 29 % implemented a configuration file parser.
- 15 % introduced a configuration system/library/API.
- 34 % used external configuration access APIs.

Multitude of Formats

- on every system a multitude of (legacy) configuration file formats exist
- the number grows fast
- thus applications usually have to deal with some legacy formats

Requirement

A configuration library must be able to integrate (legacy) systems and must fully support (legacy) configuration files.

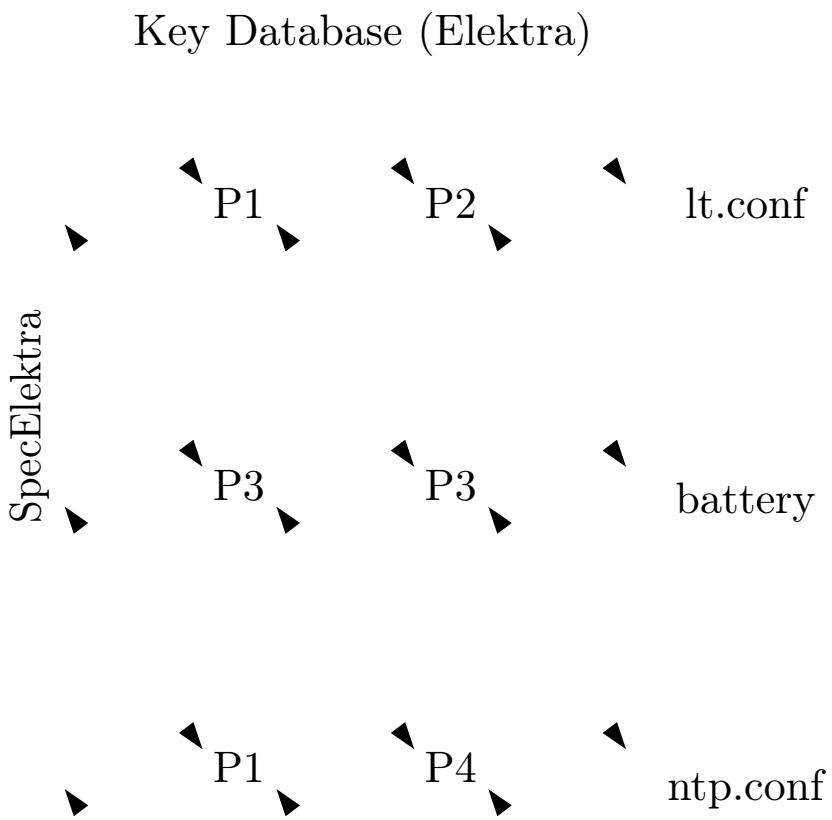
Elektra

Elektra as Virtual Filesystem

- configuration files are seen like “block devices”
- are mounted with respective filesystem drivers into the filesystem
- many tools and APIs evolved to work with files
- Idea of Elektra: establish a similar ecosystem for configuration

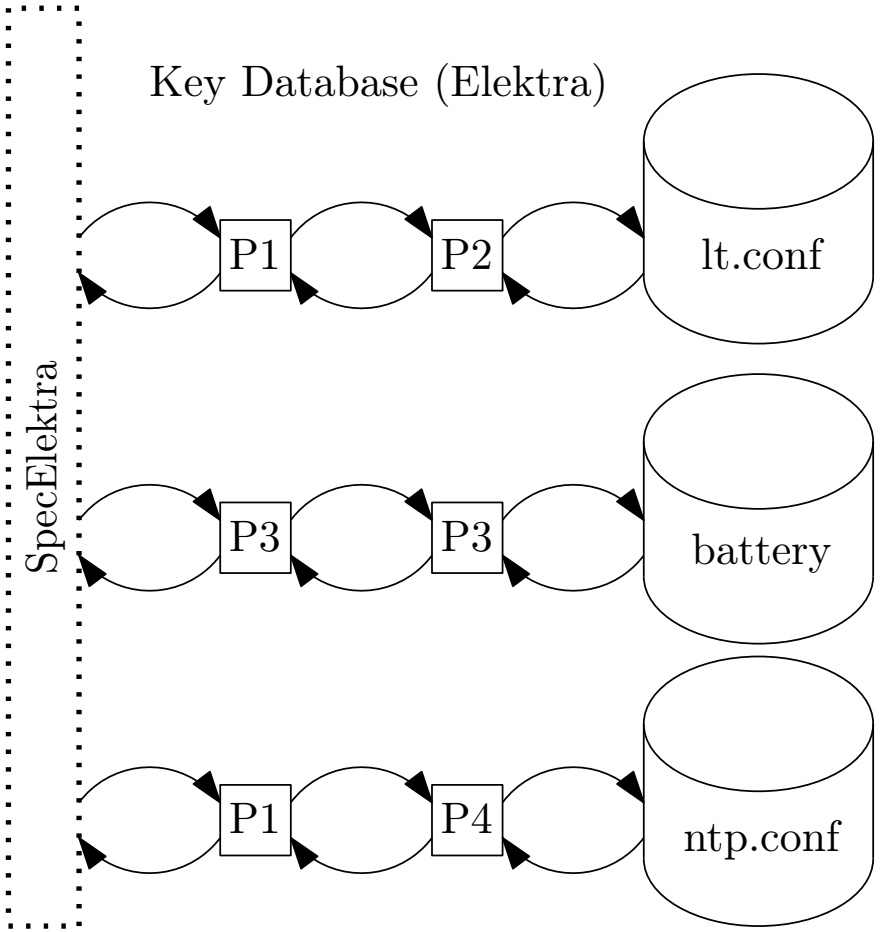
Why is Elektra not a Filesystem then?

- API semantics: key/value get/set
- namespaces: based on established semantics
- many features essential for misconfiguration hardening:
  - validation
  - visibility
  - defaults
  - ... (extensible specification)



Cylinders are configuration files, P? are plugins [17].
Key ideas:

- all work is done by plugins
- central data structure implements semantics



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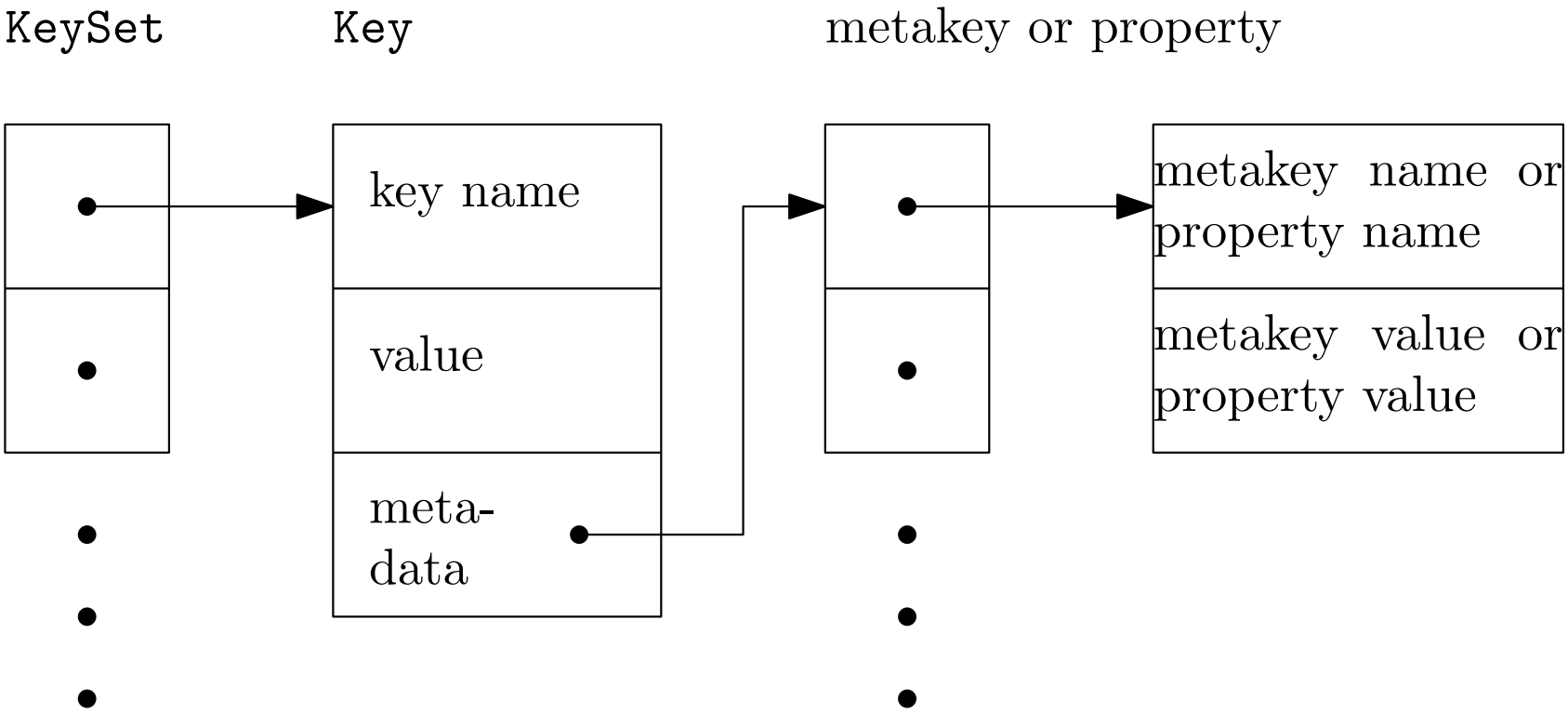
KeySet

The common data structure between plugins:



Task

Is meta-data separated from or included in the data structure?

kdb.open(): The first step is to bootstrap into a situation where the necessary plugins can be loaded.

kdb.get(KeySet): The application (initially) fetches and (later) updates its configuration settings as a key set of type `KeySet` from the execution environment by one or many calls to `kdb.get`.

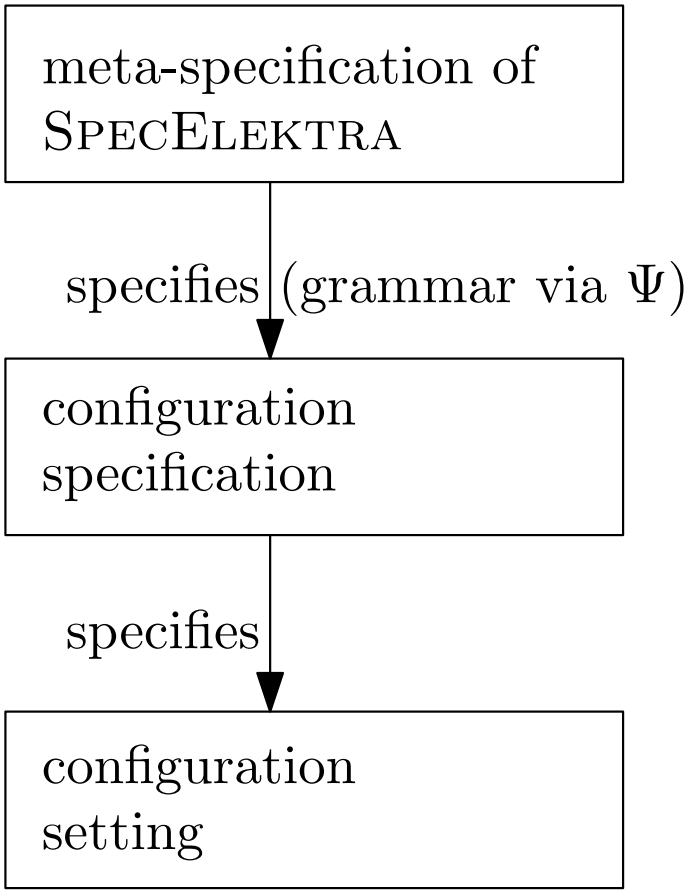
kdb.set(KeySet): When a user finishes editing configuration settings, `kdb.set` is in charge of writing all changes back to the key database.

kdb.close(): The last step is to close the connection to the key database.

Task

Break.

Metalevels



We will now walk through metalevels bottom-up.

Configuration Settings

A configuration file may look like:

```
1       a=5
2       b=10
3       c=15
```

We apply these configuration settings imperatively using:

```
1       kdb set /a 5
2       kdb set /b 10
3       kdb set /c 15
```

And we list them with `kdb ls /`.

Specifications

For specifications such as:

```
1       [slapd/threads/listener]
2         check/range :=1,2,4,8,16
3         default :=1
```

We apply the specifications imperatively using:

```
1       kdb setmeta /slapd/threads/listener\
2           check/range 1,2,4,8,16
3       kdb setmeta /slapd/threads/listener\
4               default 1
```

(automatically uses spec namespace)

Meta-Specifications

For meta-specifications such as:

```
[visibility]
type:=enum critical important user\
      advanced developer debug disabled
description:=Who should see this\
     configuration setting?
```

We apply the meta-specifications imperatively using:

```
kdb setmeta /elektra/meta/\
    visibility type enum ...
kdb setmeta /elektra/meta/\
    visibility description "Who ...
```

(see doc/METADATA.ini, disclaimer: 1.0 not yet released)

Task

Brainstorming: Ideas for (meta-)specifications.

Introspection

- unified get/set access to (meta*)-key/values
- access via applications, CLI, GUI, web-UI, ...
- GUI, web-UI can semantically interpret metadata
- access via any programming language
- access via any configuration management system

Users of Elektra

- Embedded systems
  - OpenWRT (distribution)
  - Broadcom (blue-ray devices)
  - Kapsch (cameras)
  - Toshiba (TVs)
- Server
  - Allianz (insurance)
  - TU Wien
  - puppet-libelektra
  - Other Universities
- Desktop
  - Oyranos
  - LCDproc (in progress)
  - KDE

Conclusion

- goals:
  - make simple configuration management tasks simple
  - improve robustness
  - improve extensibility (reusable plugins operating on key/value)
  - improve performance
  - good defaults
  - system-wide introspection
  - system-level dependency injection
- Elektra has no dependence to other libraries but only concrete plugins introduce dependences.

Abstractions

Abstraction

Requirement

A configuration library must be able to integrate (legacy) systems and must fully support (legacy) configuration files.

How can we deal with the many formats?

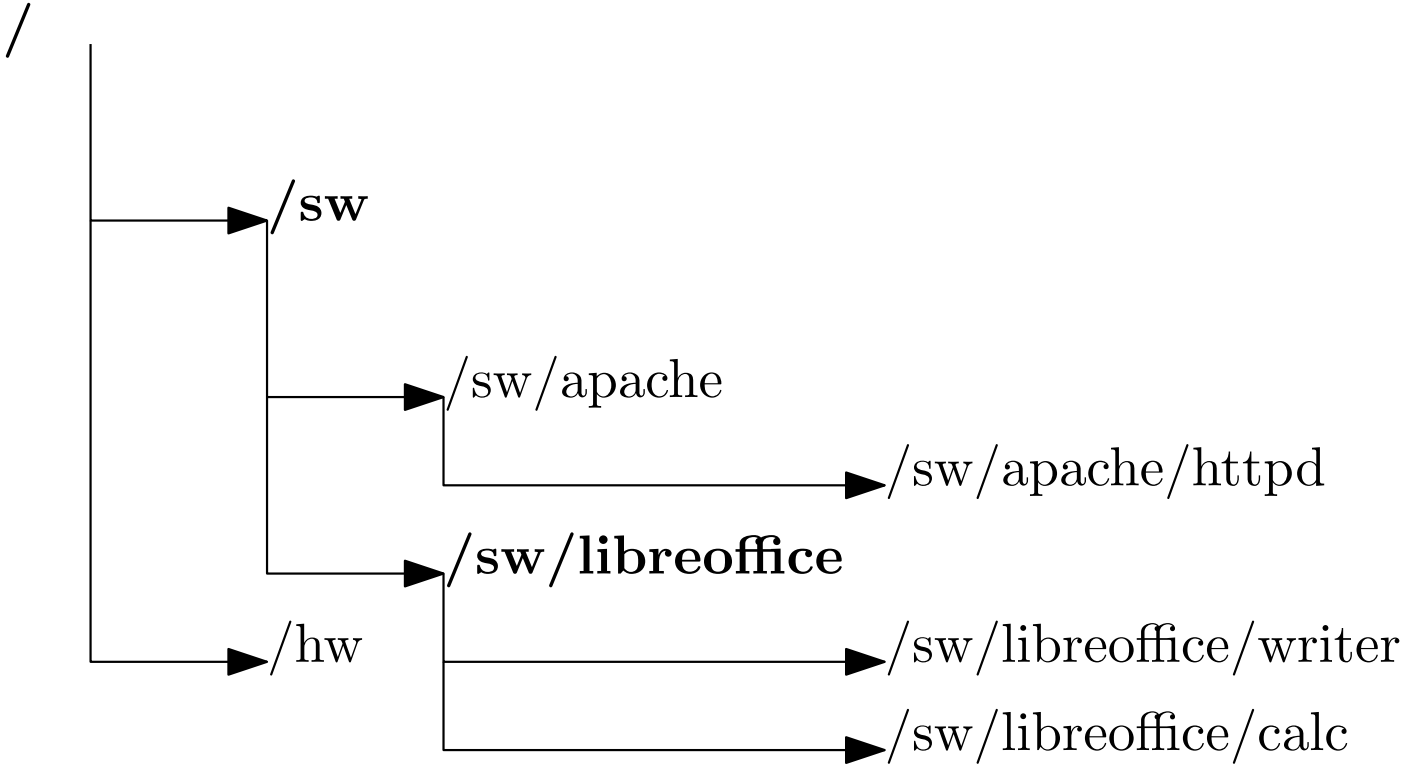
Key-Value

A key-value pair is the simplest generic data structure [23]. While all these formats above have many differences, all of them represent configuration settings as ***key-value pairs*** [11, 12, 21, 29].

For configuration as program you need to execute them first.

Mounting

Mounting integrates a backend into the key database [20]. Hence, Elektra allows several backends to deal with configuration files at the same time. Each backend is responsible for its own subtree of the key database.

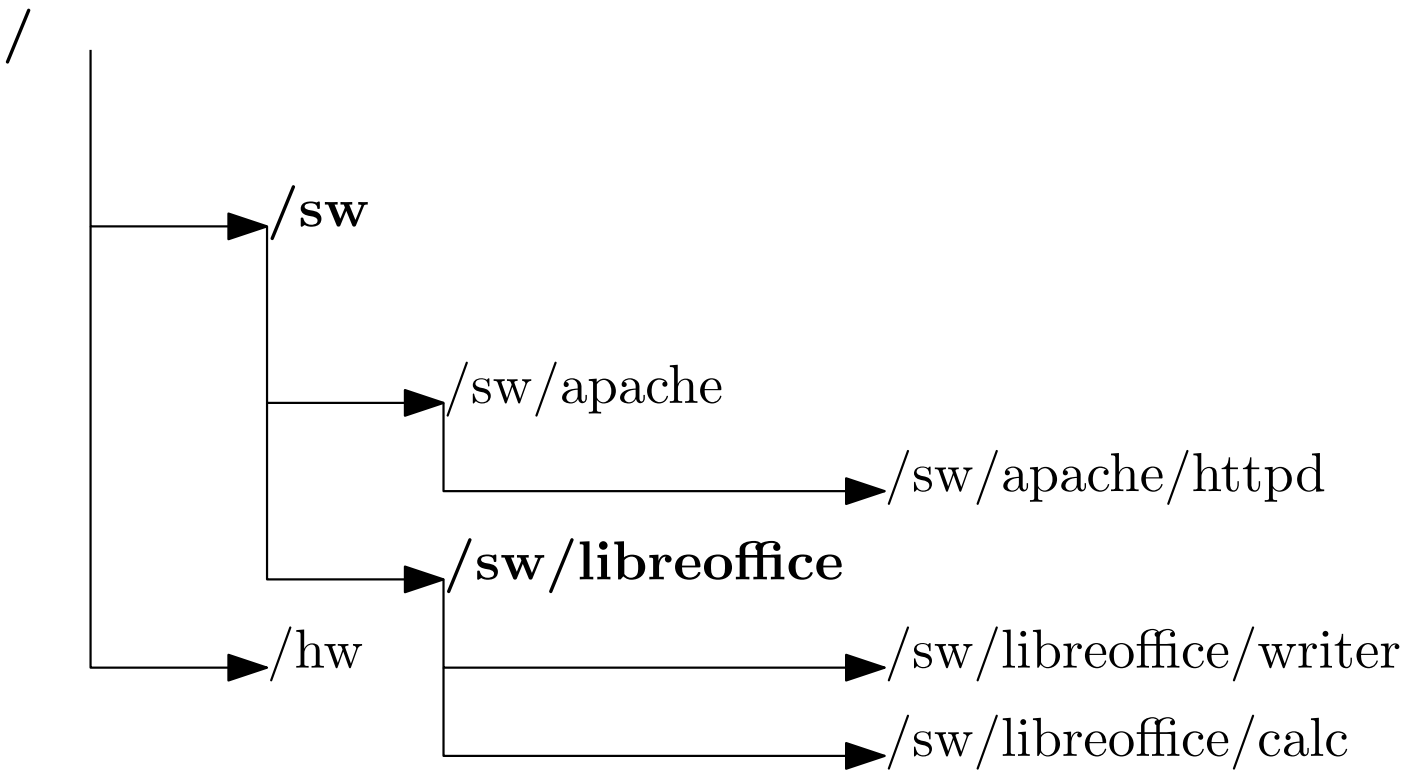


Plugins

Different backends can use different plugins:

`/sw` in the INI file config.ini

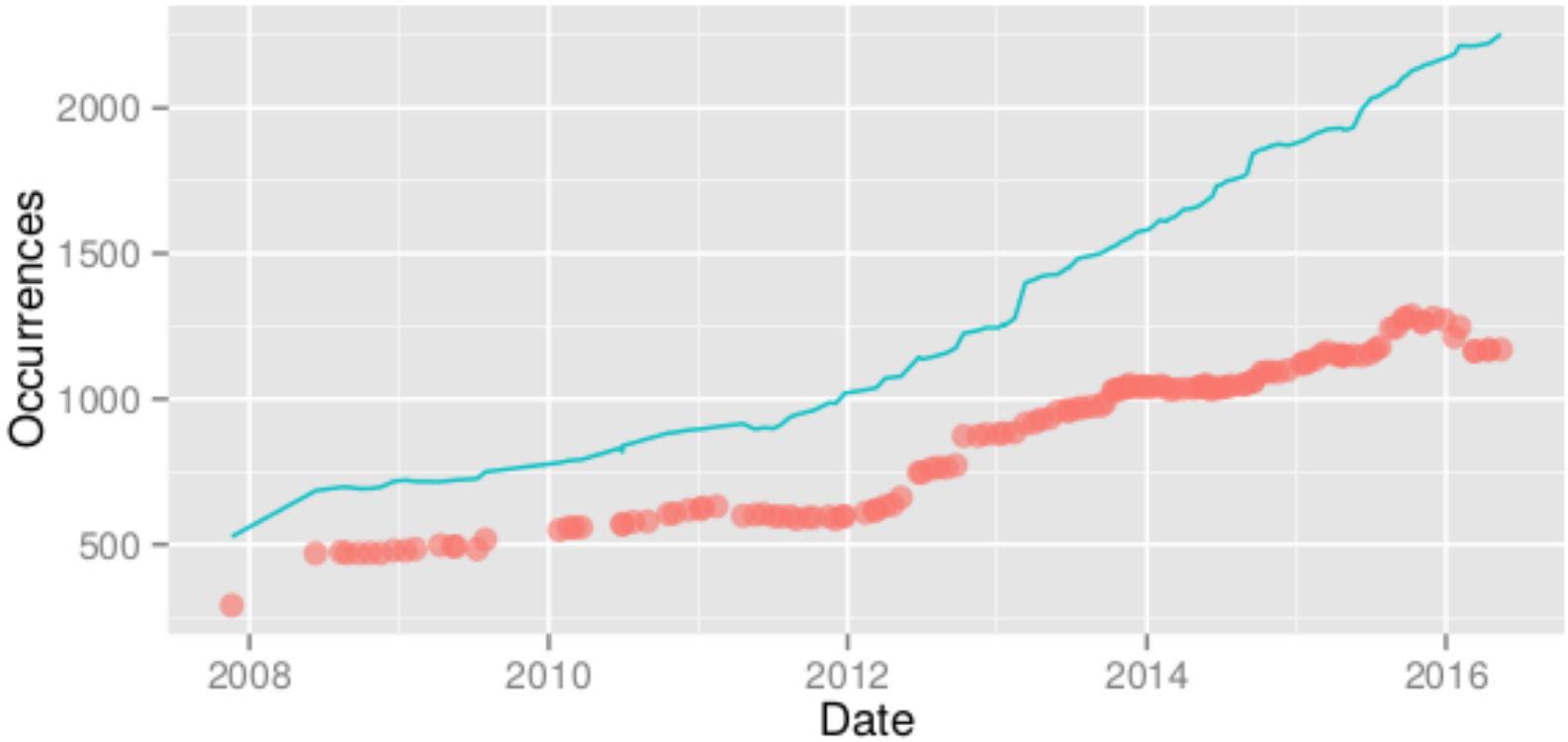
`/sw/libreoffice` in the XML file libreoffice.xml



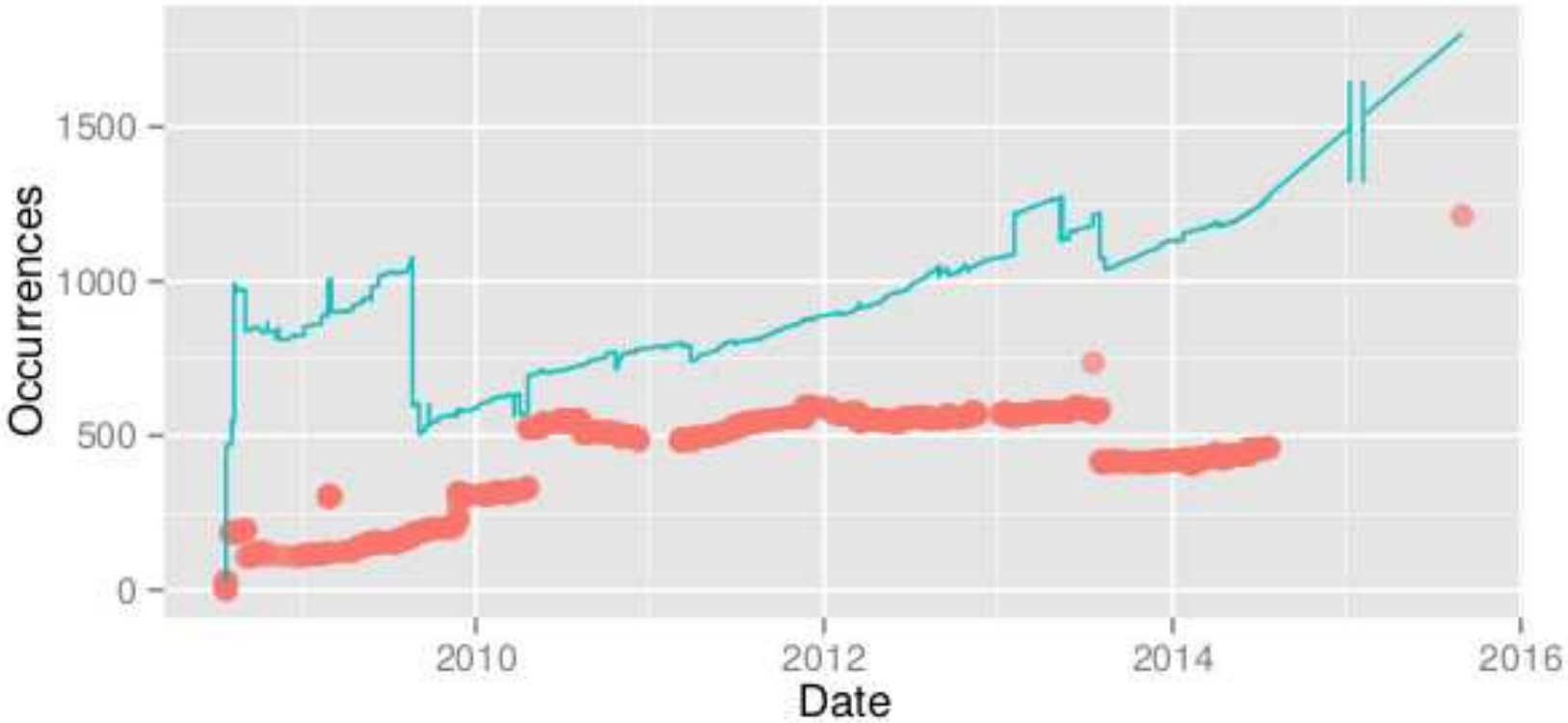
Task

Explain your neighbor what mounting is.

Trend Firefox



Trend Chromium



Outlook

- Environment Variables
- Command-line options
- Complexity

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