Configuration Management

Markus Raab

Institute of Information Systems Engineering, TU Wien

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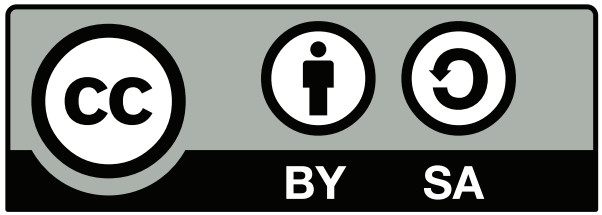


Language of the Talk?

Task

Hands up if you prefer German.

Unanimous preference of German required, otherwise English.

Organization

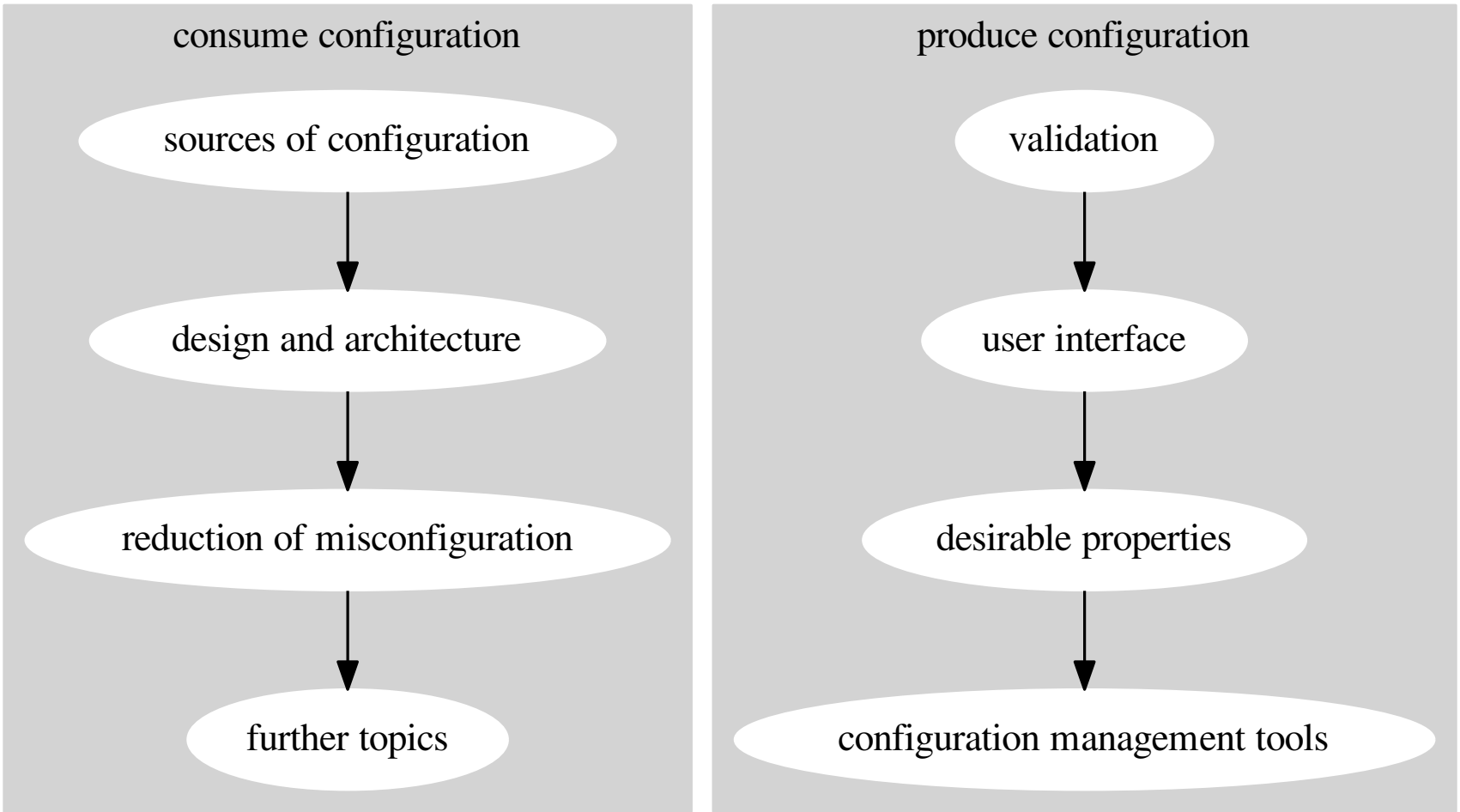
Slides now available at
`https://www.libelektra.org/ftp/elektra/slides/cm/`

Time Line:

- 9.3.2018: **TISS registration**
- 16.3.2018: **topic homework and talk** (GitHub account!)
- 23.3.2018: teams found together
- 13.4.2018: homework submitted, topics of team exercise
- 20.4.2018: **no lecture**
- 18.5.2018: guest lecture
- 25.5.2018: team exercise submitted
- 22.6.2018: last corrections of team exercise

Popular Topics

- 4 validation
- 4 user interface
- 3 tools (benefits?)
- 3 testability
- 3 complexity reduction (when conf. needed?)
- 3 architectural decisions
- 2 Puppet
- 2 modularity
- 2 environment variables
- 2 documentation
- 2 configuration specification
- 2 command-line args
- 2 code generation
- 1 variability
- 1 self-description
- 1 round-tripping
- 1 introspection
- 1 early
- 1 dependencies
- 1 context-awareness
- 1 auto-detection
- 1 administrators


consume configuration
sources of configuration
design and architecture
reduction of misconfiguration
further topics
produce configuration
validation
user interface
desirable properties
configuration management tools

Configuration File Formats

Basic Definitions

The ***execution environment*** is information outside the boundaries of each currently running process [6].
Controlling the execution environment is essential for configuration management [5, 11], testing [24, 28], and security [9, 14, 17, 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 [12] and ***customization*** [2] stress that users make the change although that might not always be the case. ***Variability points*** [10, 15, 16, 25–27] aim at describing the capability of software to adapt its behavior. ***Derivation decision*** [7, 8] puts the decisions to make and not the result in focus. ***Configuration parameter*** [3, 30] is easily confused with other kinds of parameters. ***Configuration item*** [4] or ***configuration option*** [21, 31, 32] are sometimes not applicable, for example, “proxy option”, or “language item”. ***Configuration data*** [11] 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
- especially made (easy to use vs. easy to implement)

CSV formats

- passwd: 3rd November, 1971
- passwd and group use : as separator
- are difficult to extend (e.g., GECOS)
- only 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

Introduce somebody

Task

Talk with someone else 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

S: source code analysis of 16 applications, comprising 50 million lines of code [18]

Q: survey with 672 persons visiting, 162 persons completing the survey [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 ($n = 251$) claim to have introduced a configuration file format.
- 29 % implemented a configuration file parser.
- 15 % introduced a configuration system/library/API.
- used external configuration access APIs (34 %).

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?

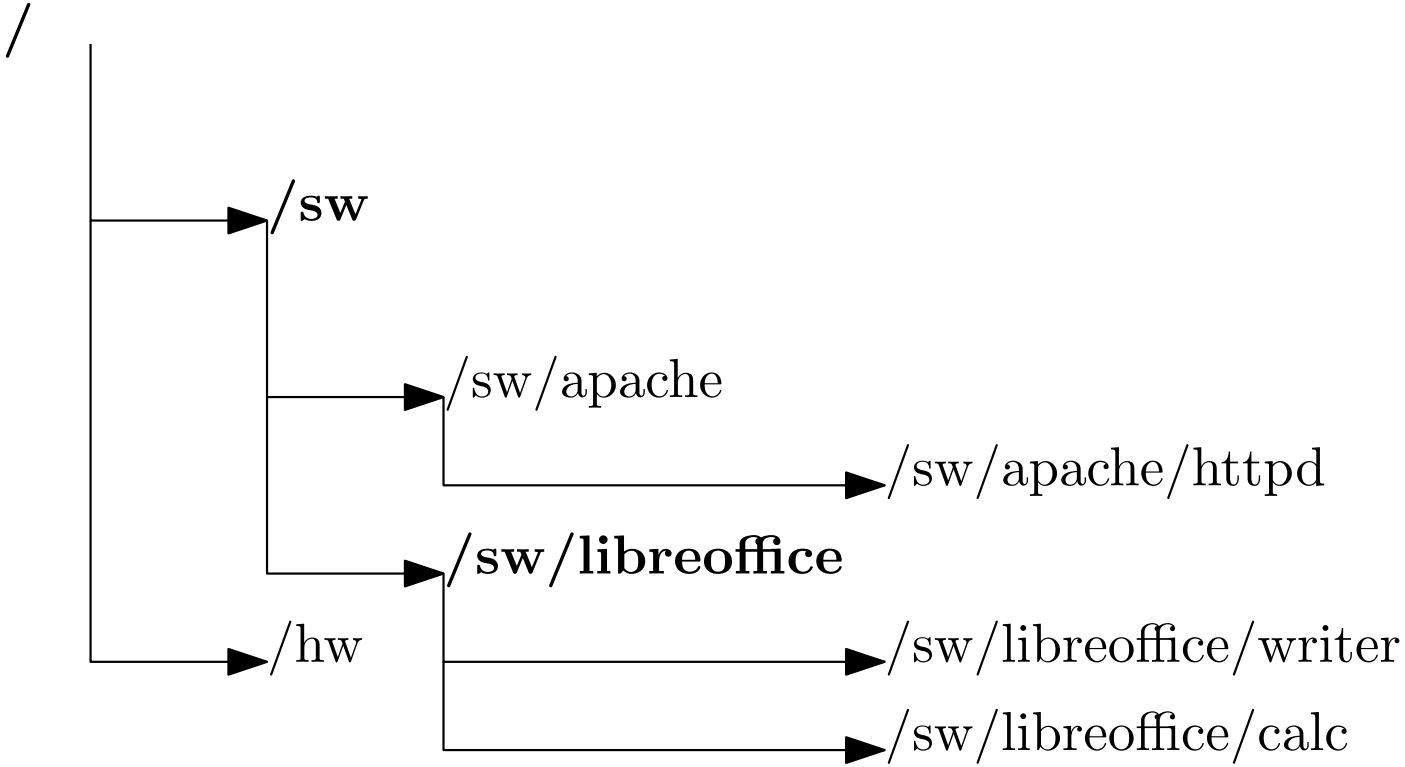
Key-Value

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*** [12, 13, 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.

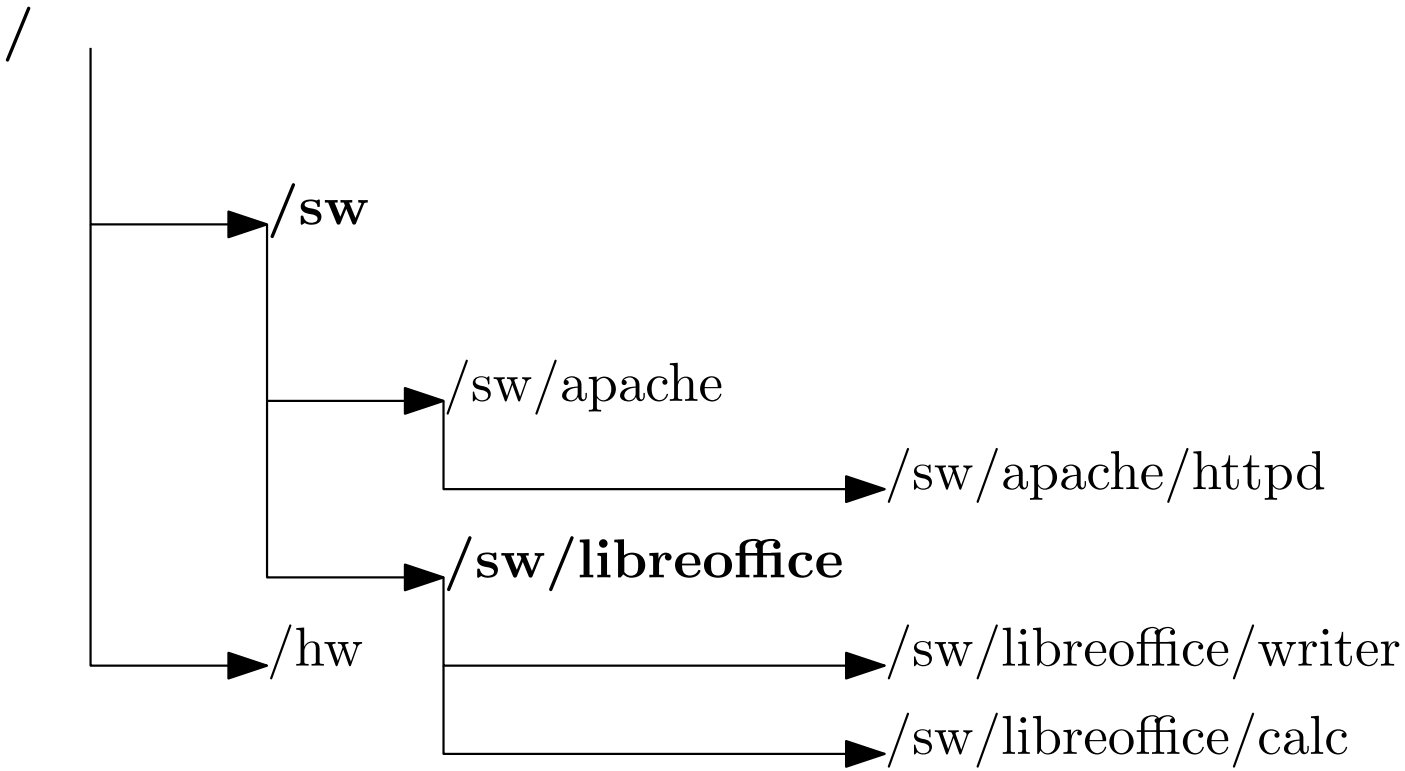


Plugins

Different backends can use different plugins:

`/sw` in the INI file config.ini

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



Task

Possible Homework: Implement a storage plugin with existing parser.

Task

Explain your neighbor what mounting is.

Command-line Arguments

Is there something else?

- configuration files are the most researched of all configuration sources [12]
- but it is neither the most used nor most popular [18]

Q: "Which configuration systems/libraries/APIs have you already used or would like to use in one of your FLOSS project(s)?"

- command-line arguments (92 %, $n = 222$)
- environment variables (79 %, $n = 218$)
- *S:* API `getenv` is used omnipresently with 2,683 occurrences
- configuration files (74 %, $n = 218$))

Q: "What is your experience with the following configuration systems/libraries/APIs?"

- `getenv` (10 %, $n = 198$)
- configuration files (6 %, $n = 190$)
- command-line options (4 %, $n = 210$)
- X/Q/GSettings (41 %, 14 %, 35 %)
- KConfig (21 %)
- dconf (42 %)
- plist (32 %)
- Windows Registry (69 %)

Task

Which configuration source do you use most?

Task

Possible talk: About one of these sources.

- passed by main for a new process via (`int argc, char ** argv`)
- visible from other processes (e.g., via `ps aux`)
- could be passed along to subprocesses but hardly done
- need to be parsed by process
- portability: differences in parsing
- cannot be changed from outside (requires restart, no IPC)

Environment Variables

Semantics

- are also per-process (`/proc/self/environ`)
- are not visible from other processes
- are automatically inherited by subprocesses
- need to be parsed by process (`[extern] char **environ`) but API is provided (`getenv`)
- cannot be changed from outside (requires restart, no IPC)

Task

What is wrong with the code in the book?

getenv

- is widely standardized, including SVr4, POSIX.1-2001, 4.3BSD, C89, C99 [1],
- is supported by many programming languages, and
- enforces `key=value` convention.

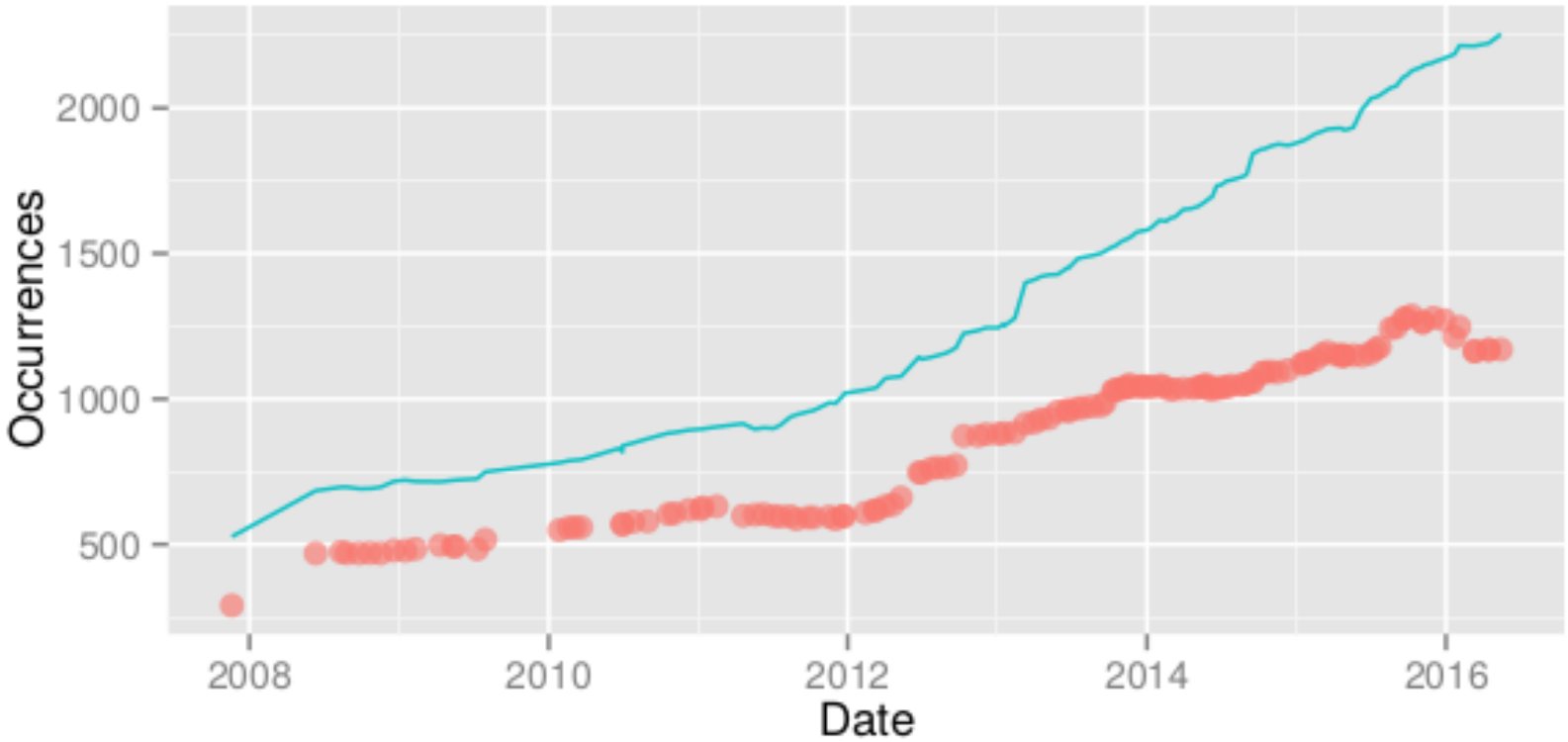
Usage

1. bypassing other configuration accesses (*Q:* 45 %)
2. locating configuration files
3. debugging and testing (*Q:* 55 %, *S:* 1,152, i. e. 43 %)
4. sharing configuration settings across applications (*Q:* 53 %, *S:* 716, i. e. 47 %)
5. for configuration settings unlikely to be changed by a user (*Q:* 20 %)
6. *"even when it is used inside a loop"* (*Q:* 2 %)

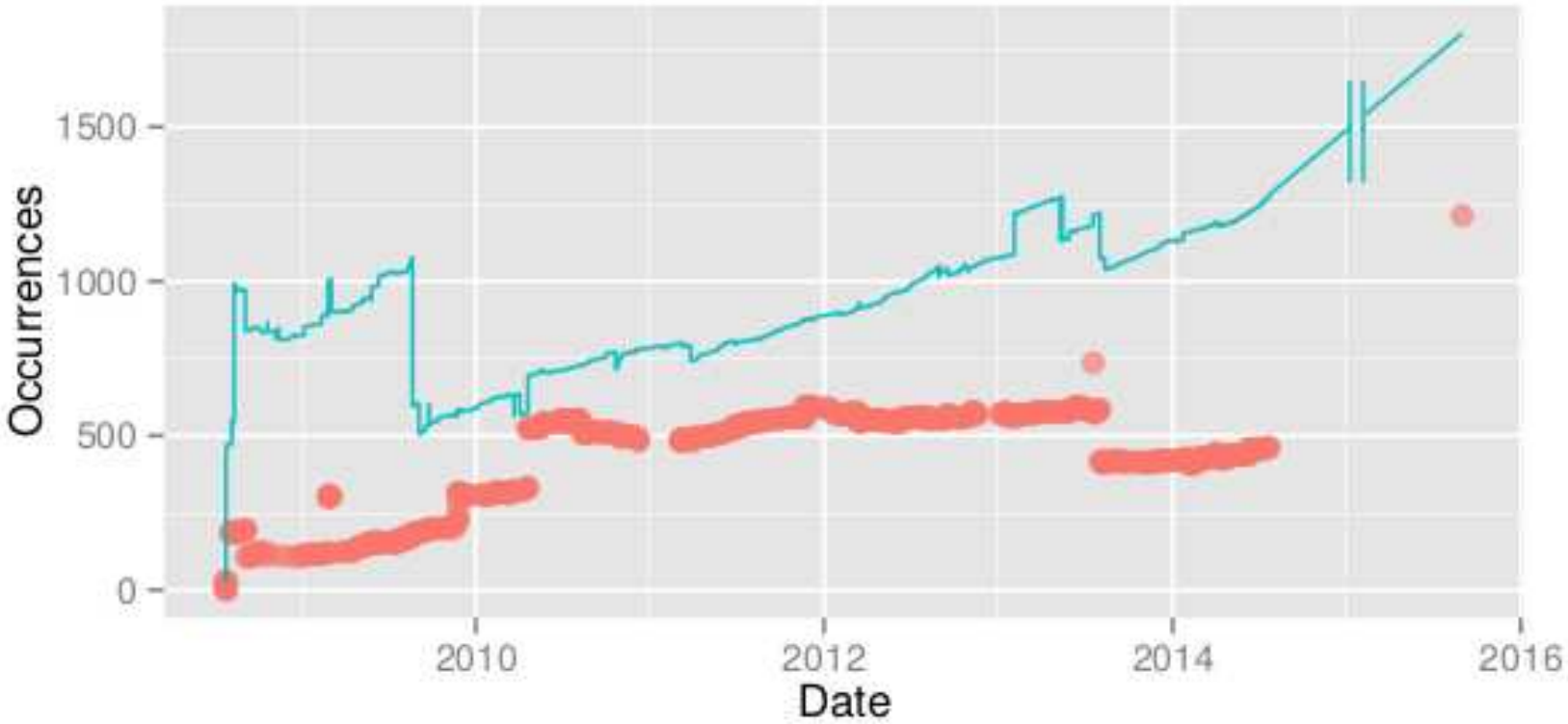
Portability

- no separators for values defined
- case sensitivity problems
- often many environment variables for the same purpose: TMP, TEMP, or TMPDIR
- sometimes one environment variable for different purposes: PATH

Trend Firefox



Trend Chromium

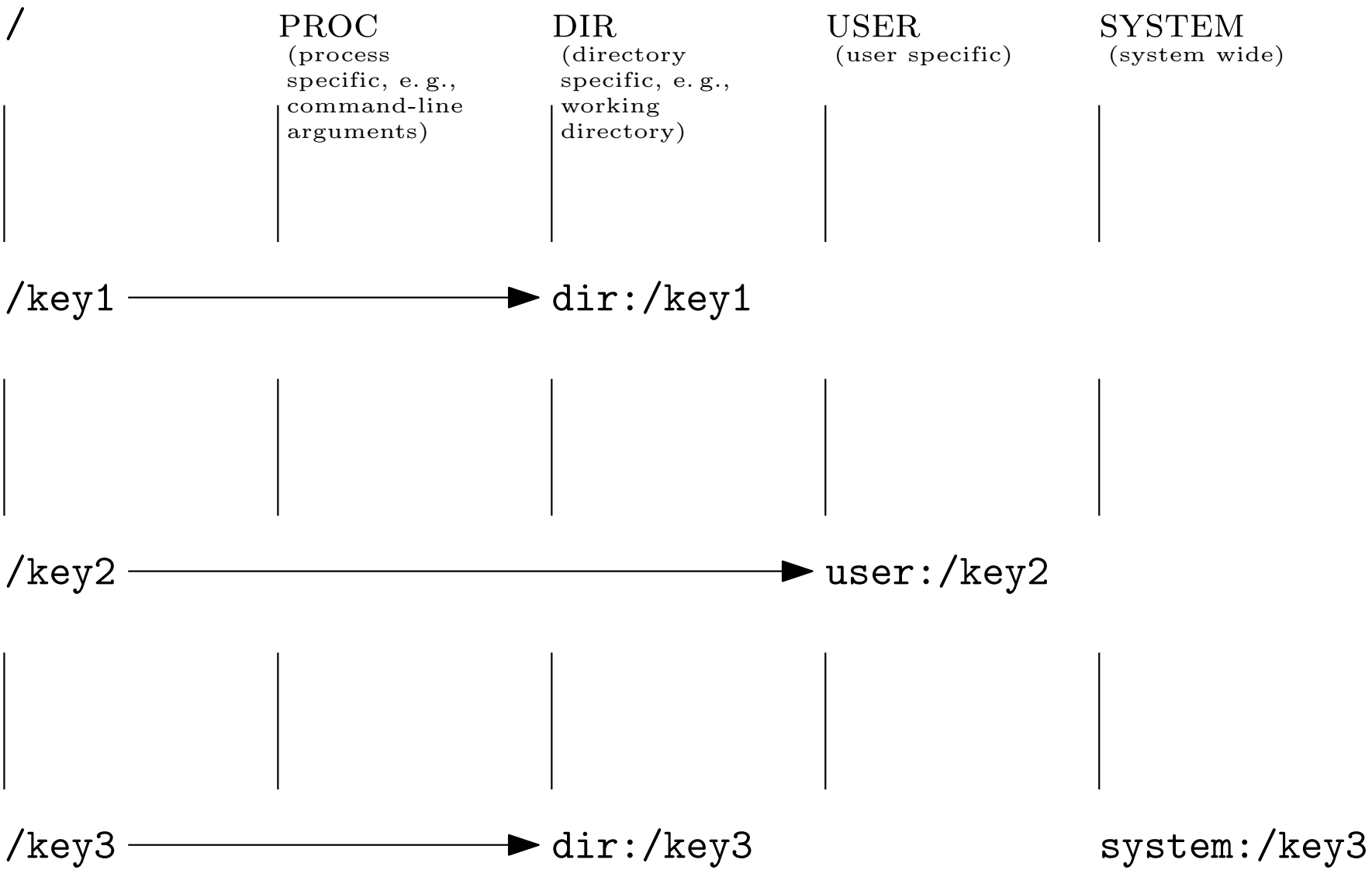


How can we deal with the many sources?

Requirement

A configuration library must support all three popular ways for configuration access: configuration files, command-line options, and environment variables.

Cascading


/
PROC
(process specific, e. g., command-line arguments)
DIR
(directory specific, e. g., working directory)
USER
(user specific)
SYSTEM
(system wide)
/key1
dir:/key1
/key2
user:/key2
/key3
dir:/key3
system:/key3

Task

Discuss the differences of mounting and cascading with your neighbor.

User View

- command-line for trying out configuration settings
- environment variables for configuration settings within a shell
- configuration files for persistent configuration settings

Conclusion

- three different configuration sources widely used
- all three used for different reasons but often for the same configuration settings
- many different configuration file formats
- abstractions: key-value, mounting, and cascading

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