Configuration Management

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Talk: JIRA/Confluence/Bitbucket

Configuration Management in JIRA/Confluence/Bitbucket (Server). Configuration approach of my personal software for staging to production cloning of JIRA/Confluence/Bitbucket

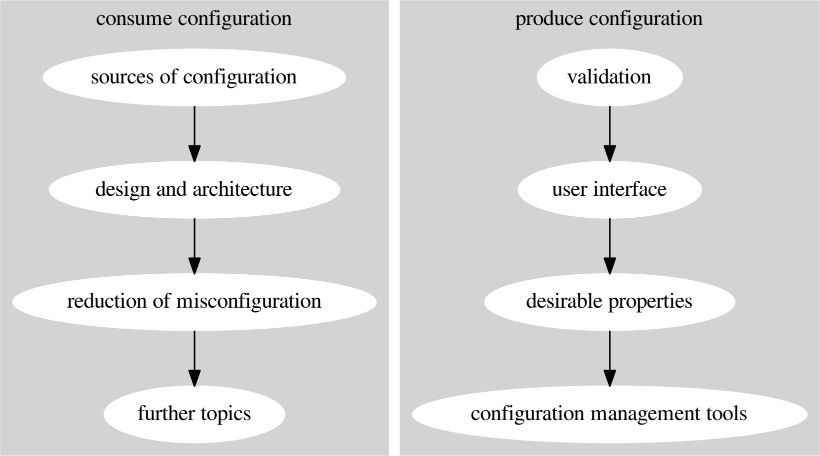
Organization

Next dates:

- 13.4.2018: **homework submitted, topics of team exercise**
- 27.4.2018: lecture
- 4.5.2018: lecture
- 18.5.2018: guest lecture
- 25.5.2018: team exercise submitted
- 1.6.2018: lecture
- 8.6.2018: lecture
- 15.6.2018: last corrections of team exercise
- 22.6.2018: test

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 early
- 1 introspection
- 1 dependences
- 1 auto-detection
- 1 context-awareness
- 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 Access (Recapitulation)

Configuration access is the part of every software system concerned with fetching and storing configuration settings from and to the execution environment. There are many ways to access configuration [2, 3, 6]. ***Configuration access APIs*** are APIs that enable configuration access.

Within the source code the ***configuration access points*** are configuration access API invocations that return configuration values.

Trend (Recapitulation)

- alarming trend in number and complexity of configuration settings
- sharing, visibility and default value calculation often helps
- needs abstraction: configuration specification
- but also more courageous decisions and periodical reevaluation
- different ways to reduce configuration space

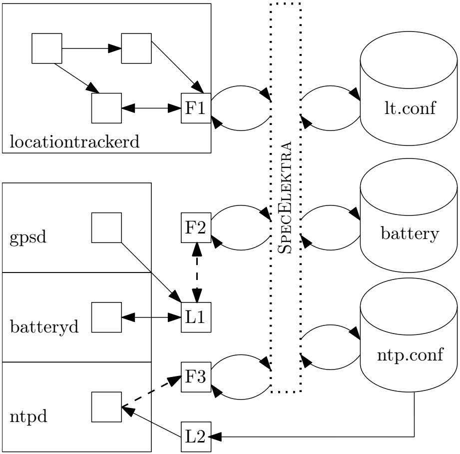
SpecElektra (Recapitulation)

SpecElektra is a modular ***configuration specification language*** for configuration settings. In SpecElektra we use properties to specify configuration settings and configuration access. SpecElektra enables us to specify different parts of Elektra.

Modularity (Recapitulation)

Vertical modularity describes how strongly separated the configuration accesses of different applications is. *Horizontal modularity* describes how strongly separated modules implementing configuration access for a single application is.

Vertical Modularity (Recapitulation)



Plugins (Recapitulation)

Plugins are filters, sinks, and sources processing a key set. We aim at SpecElektra to be as modular as possible and make extensive use of plugins:

1. SpecElektra does not have any built-in feature, all features are (or can be) implemented as plugins.
2. Elektra works completely without SpecElektra's specifications.
3. Configuration specifications are present within the execution environment. Thus any tool and plugin can introspect and use the specifications.

Introspection (Recapitulation)

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

Code Generation

1. Code Generation
   - Why?
   - How?
2. Introspection vs. Generation

Task

How to ensure that configuration access points match with present configuration settings?

Rationale (Partly Recapitulation)

Configuration Specification:

- without specification you and others do not even know which settings are available
- needed for any further techniques we will discuss:
  - code generation guarantees that configuration access points match with specification
  - validation guarantees that configuration settings match with specification
- essential for ***no-futz computing*** Holland et al. [1]
- the foundation for any advanced tooling like configuration management tools
- needed as communication of producers and consumers of configuration

Task

Brainstorming: Which artefacts can we produce with code generation?

Artefacts:

- examples (e.g., defaults)
- documentation
- auto-completion/syntax highlighting/IDE support
- tooling (GUI, Web UI)
- validation code
- configuration management tool code
- configuration access APIs

Current Challenges

Configuration access code usually has:

- code duplications
- hard-coded default values
- unexpected transformations
- no introspection facilities

Example

```
if (!strcasecmp(token, "on")) {
        *var = 1;
} else {
        *var = 0;
} /* src/cache_cf.cc from Squid */
```

Goal

Goal

Configuration settings should adhere the specification from source to destination.

Requirement

The specification must enable code generation and inconsistencies must be ruled out during compilation.

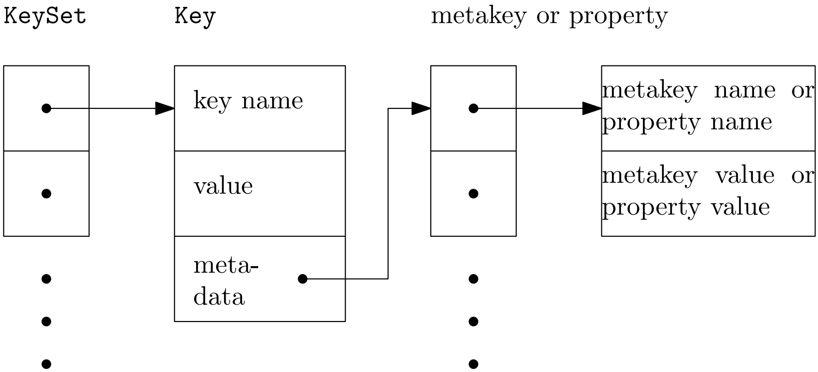
Code Generation

The code generator GenElektra reads SpecElektra specifications and emits high-level APIs to be used in applications. GenElektra facilitates the key names to generate unique API names.

But how?

KeySet (Recapitulation)

The common data structure between plugins:



KeySet Generation

Question

Idea: What if the configuration file format grammar describes source code?

⟨*KeySet*⟩ ::= 'ksNew'␣(' { ⟨*Key*⟩ ', ↩' } { '␣' } 'KS_END);'

⟨*Key*⟩ ::= 'keyNew ␣(" ' ⟨*key name*⟩ '"' , ↩' [⟨*Value*⟩]
⟨*properties*⟩ 'KEY_END)'

⟨*Value*⟩ ::= { '␣' } 'KEY_VALUE, ␣" ' ⟨*configuration value*⟩ '"' ,
↩'

⟨*properties*⟩ ::= { { '␣' } ⟨*property*⟩ ', ↩' }

⟨*property*⟩ ::= 'KEY_META, ␣ ' <property name> ' ,
␣ ' <property value> ' '

Example

Given the key `spec:/slapd/threads/listener`, with the configuration value 4 and the property default $\mapsto$ 1, GenElektra emits:

```
ksNew (keyNew ("spec:/slapd/threads/listener",
               KEY_VALUE, "4",
               KEY_META, "default", "1",
               KEY_END),
          KS_END);
```

Finding

We have source code representing the settings. And if we instantiate it, we have a data structure representing the settings. Plugins emitting such "configuration files" are code generators.

Implementation Strategies

- Using print (only for very small generators)
- Using generative grammars

```
query = '{' >> *(pair) > '}';
pair = '{' >> key_name > '=' >> key_value >>
          *('{' >> metakey_name > '=' >> metakey_
          > '}';
```

- Using template languages (RubyERB, Cheetah, GNU AutoGen)

```
@for n in hierarchy.name.split('/')[1:-1]
namespace $support.nsnpretty($n)
{
class ${hierarchy.prettyclassname(support)}
{
typedef $support.typeof($hierarchy.info) type;
@if $support.typeof($hierarchy.info) != "kdb::none_t"
static type get(kdb::KeySet &ks, kdb::Key const& spec)
{
    type value $support.valof($hierarchy.info)
    Key found(ckdb::ksLookup(ks.getKeySet(), *spec,
              ckdb::elektraLookupOptions::KDB_O_SPEC));
    return found.get<$support.typeof($hierarchy.info)>();
}
```

Possible Properties

For example, SpecElektra has following properties:

type represents the type to be used in the emitted source code.

opt is used for short command-line options to be copied to the namespace proc.

opt/long is used for long command-line options, which differ from short command-line options by supporting strings and not only characters.

readonly yields compilation errors when developers assign a value to a contextual value within the program.

default enables us to start the application even if the backend does not work.

With the specification:

```
[foo/bar]
  default := Hello
  type := string
  opt := b
  readonly := 1
```

GenElektra gives the user read-only access to the object `env.foo.bar`:

```
1     std::cout << env.foo.bar;
2     env.foo.bar = "Other world"; // comp. error
```

Line 1 prints the configuration value of `/foo/bar` or `"Hello"` (without quotes) by default. When invoking the application with `application -b "This world"`, the application would print `"This world"` (without quotes). Line 2 leads to a compilation error because of the property readonly.

Which Configuration Access API?

First approach, one class (or function) per configuration setting:

```
class SlapdThreadsListener : public Value<long,
    WritePolicyIs<ReadOnlyPolicy>> {
    ... keyNew ("/slapd/threads/listener",
            KEY_META, "type", "long",
            KEY_META, "readonly", "1",
            KEY_END) ...
};
```

Which Configuration Access API?

Bad idea, manual instantiation and long names necessary:

```
KeySet config;
Context c;
long foo ()
{
    SlapdThreadsListener slapdThreadsListener (con
    slapdThreadsListener++;
    return slapdThreadsListener;
}
```

Which Configuration Access API?

Use hierarchy with namespaces or nasted classes:

```
namespace slapd
{
namespace threads
{
class Listener : public Value<long> {};
} // <continues on the next page>
class Threads : public Value<none_t>
{threads::Listener listener;};
} // end namespace slapd
class Slapd : public Value<none_t>
{slapd::Threads threads;};
class Environment {Slapd slapd;};
```

Which Configuration Access API?

Much easier to use:

```
long foo(slapd::Threads const & threads)
{
    threads.listener++;
    Context & c = threads.context (); // access co
    return threads.listener;
}

int main()
{
    KeySet config;
    Context c;
    Environment env (config, c);
    long x = foo (env.slapd.threads);
}
```

Which Configuration Access API?

In C, we use identifiers to be passed to the API:

```
elektraGetString (elektra, ELEKTRA_TAG_X);
```

Where `ELEKTRA_TAG_X` is a struct for that type.

Guarantees by code generation:

- Every configuration setting is specified.
- Configuration access with defaults is always successful.
  Reason: We compile in a KeySet and use it if everything else fails.

Missing Guarantee: Is every specified setting actually used?

Introspection vs. Generation

1. Code Generation
   - Why?
   - How?

2. Introspection vs. Generation

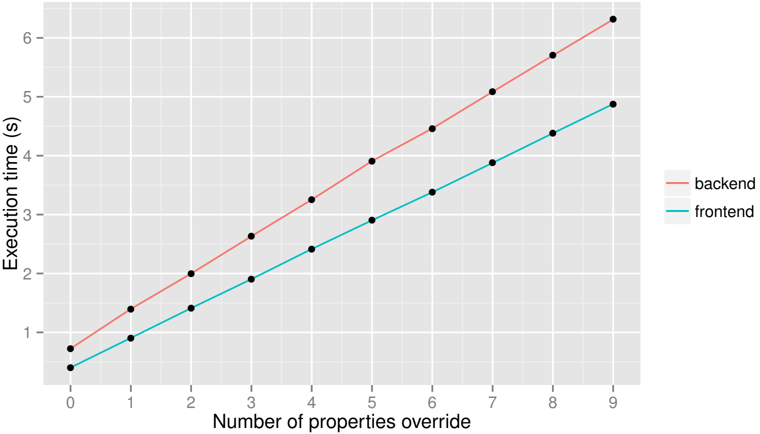
Question

Introspection vs. Code Generation?

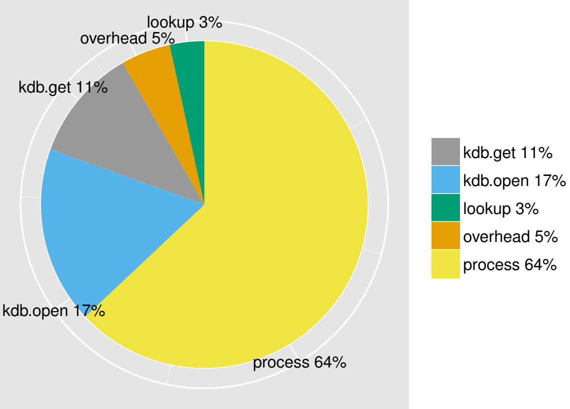
Limitations of introspection:

- no static checks
- no whole-program optimizations (API barriers)

Overhead without code generation (=backend) is 1.8x higher [4]:



But it might not matter because configuration access might not be a bottleneck [4], for example, a word counting application:



But: Configuration access points within loops might be a bottleneck.

Advantages of introspection:

- specification can be updated live on the system without recompilation
- tooling has generic access to all specifications
- new features the key database (e.g., better validation) are immediately available consistently

Implication

We generally prefer introspection, except for a very thin configuration access API.

Requirement

Configuration settings and specifications must be introspectable.

Talk: Puppet-Libelektra

Preview

- Testing
- Early Detection of Misconfiguration

[1] David A. Holland, William Josephson, Kostas Magoutis, Margo I. Seltzer, Christopher A. Stein, and Ada Lim. Research issues in no-futz computing. In *Hot Topics in Operating Systems, 2001. Proceedings of the Eighth Workshop on*, pages 106–110. IEEE, May 2001. doi: 10.1109/HOTOS.2001.990069.

[2] Dongpu Jin, Xiao Qu, Myra B. Cohen, and Brian Robinson. Configurations everywhere: Implications for testing and debugging in practice. In *Companion Proceedings of the 36th International Conference on Software Engineering*, ICSE Companion 2014, pages 215–224, New York, NY, USA, 2014. ACM. ISBN 978-1-4503-2768-8. doi: 10.1145/2591062.2591191. URL `http://dx.doi.org/10.1145/2591062.2591191`.

[3] Emre Kiciman and Yi-Min Wang. Discovering correctness constraints for self-management of system configuration. In *International Conference on Autonomic Computing, 2004. Proceedings.*, pages 28–35. IEEE, May 2004. doi: 10.1109/ICAC.2004.1301344.

[4] Markus Raab. Sharing software configuration via specified links and transformation rules. In *Technical Report from KPS 2015*, volume 18. Vienna University of Technology, Complang Group, 2015.

[5] Markus Raab and Gergö Barany. Introducing context awareness in unmodified, context-unaware software. In *Proceedings of the 12th International Conference on Evaluation of Novel Approaches to Software Engineering - Volume 1: ENASE,*, pages 218–225. INSTICC, SciTePress, 2017. ISBN 978-989-758-250-9. doi: 10.5220/0006326602180225.

[6] Tianyin Xu, Jiaqi Zhang, Peng Huang, Jing Zheng, Tianwei Sheng, Ding Yuan, Yuanyuan Zhou, and Shankar Pasupathy. Do not blame users for misconfigurations. In *Proceedings of the Twenty-Fourth ACM Symposium on Operating Systems Principles*, pages 244–259. ACM, 2013.