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Team Work
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Context-Awareness
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Configuration Management

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22.05.2018

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: PR for first issue done, second started

03.04.2019: first issue done, PR for second

10.04.2019: mid-term submission of exercises

08.05.2019: different location: Complang Libary

15.05.2019:

22.05.2019: all 5 issues done

29.05.2019:

05.06.2019: final submission of exercises

12.06.2019:

19.06.2019: last corrections of exercises

26.06.2019: exam

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Tasks for today

(until 22.05.2019 23:59)

Task

All issues done.

Tasks for next week

(until 29.05.2019 23:59)

Task

Continue teamwork and homework.

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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

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Goals for today

learning outcome:

- remember how to use configuration specification as documentation
- remember requirement for synchronization
- remember example of 3-way merge
- remember types of configuration

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.

Introspection (Recapitulation)

Task

What is internal and external specification? What is introspection?

- internal: within applications' source code
- 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
- needed as communication of producers and consumers of configuration
- essential for *no-futz computing* Holland et al. [4]

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Guarantees (Recapitulation)

Question

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

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

Testing (Recapitulation)

Question

What do we want to test? What do we ask ourselves?

- That settings do what they should (devs and admins)
- That settings are properly validated (devs [13])
- Regression tests [11]

- Are all settings implemented?
- Are all settings used in tests?
- Are there unused settings in the code?

When are settings used? (Recapitulation)

Implementation-time configuration accesses are hard-coded
settings in the source code repository. For example,
architectural decisions [3] lead to
implementation-time settings.

Compile-time configuration accesses are configuration accesses
resolved by the build system while compiling the code.

Deployment-time configuration accesses are configuration accesses
while the software is installed.

Load-time configuration accesses are configuration accesses
during the start of applications.

Run-time configuration accesses are configuration accesses
during execution not limited to the startup procedure.

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Latent Misconfiguration (Recapitulation)

Phases when we can detect misconfigurations:

- Compilation stage in configuration management tool
- Writing configuration settings on nodes
- Starting applications (load-time)
- When configuration setting is actually used (run-time)

Problem

More context vs. easier to detect and fix.

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Q: In detail, persons found it very important that (multiple choice, $n \geq 150$, *"You want to configure a FLOSS application. How important are the following ways for you?"*):

- 48 % documentation is shipped with the application
- 36 % configuration examples are shipped with the applications
- 17 % *"google, stackoverflow... (looking for my problem)"*
- 14 % looking at the website of the application
- 14 % use UIs that help them
- 14 % look into the source code
- 11 % *"wiki, tutorials... (looking for complete solutions)"*
- 5 % look into the configuration specification
- 2 % ask colleagues and friends

There are at least two forms of documentation necessary:

- Explanations
- Examples

Generation helps to avoid duplication:

Requirement

There must be a support for shipping correct documentation and examples generated from the configuration specifications.

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Question

How to avoid duplication between description text and other parts?

- Render type and defaults into the documentation
- Render requirements and rationale into the documentation
- Use visibility to only show relevant configuration settings

Example

```
1 [slapd/threads/listener]
2    check/range := 1,2,4,8,16
3    default := 1
4    description := adjust to use more threads
5    rationale := needed for many-core systems
6    requirement := 1234
7    visibility := user
```

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Reevaluate specifications (Recapitulation)

In which situations should you reevaluate if a configuration setting (specification) is needed?

1. a requirement,
2. an architectural decision,
3. a technical need, and
4. an ad hoc decision.

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Synchronization

Problem: transient and persistent configuration settings might be out-of-sync [6]

Requirement

Configuration libraries must provide ways to keep transient and persistent views consistent.

Solutions:

- Often write out configuration settings.
- Many conflicts can be resolved with a semantic 3-way merge.

Semantic 3-way merge

We can resolve many conflicts automatically, if we consider:

- the key/value structure (vs. line-based)
- the origin of both files
- the type of settings

For example, when upgrading slapd:

- System administrator changed the file (Ours).
- Package maintainer changed the file (Theirs).

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Conflicts Example

Ours:

```
1  slapd/threads/listener=4
2
3  abc= \
4       def
```

Theirs:

```
1  abc = def
2  slapd/threads/listener=8
```

Origin:

```
1  slapd/threads/listener=8
2  abc=def
```

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Steps

1. Familiarize yourself with the description of the proposed configuration system. (5 min)
2. Find a group and decide who will create flip chart, moderate, and present. (1 min)
3. Give yourselves roles (admin, dev, user) and split the goals among them. (1 min)
4. Create together an architecture that fulfils the goals. (ca. 40 min)
5. Present that architecture. (5 min)

Goals

1. configuration-management friendly
2. early detection of misconfiguration
3. transient and persistent configuration consistent
4. correct documentation
5. reuse software as much as possible but integrate them nicely

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Requirements

Design a camera system:

1. that is able to take single pictures and streams
2. pluggable camera modules (lenses, image sensor, ...)
3. should have camera profiles for different vendors
4. a Web-UI that shows all configuration settings
5. support yet-unknown remote configuration protocol (Web, SNMP, CMs, ...)

Tasks

1. design the architecture of configuration settings
2. design the architecture of configuration access
3. design how the CM tools should look like
4. tracer bullet [5]: explain for one configuration setting the whole way from source to destination
5. make decisions (which languages, which software, how to achieve the goals)
6. explain how to ensure smooth configuration upgrades
7. explain how to provide documentation for operators
8. explain how to reuse software

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If you're a baker, making bread, you're a baker. If you make the best bread in the world, you're not an artist, but if you bake the bread in the gallery, you're an artist. So the context makes the difference.

— Marina Abramovic

As adapted from Chalmers [1]:

> *Context* is the circumstances relevant to the configuration settings of the application.

We extend the definition with:

> *Context-aware configurations* are configuration settings that are consistent with its context. *Context-aware configuration access* is configuration access providing context-aware configuration.

Types of Configuration
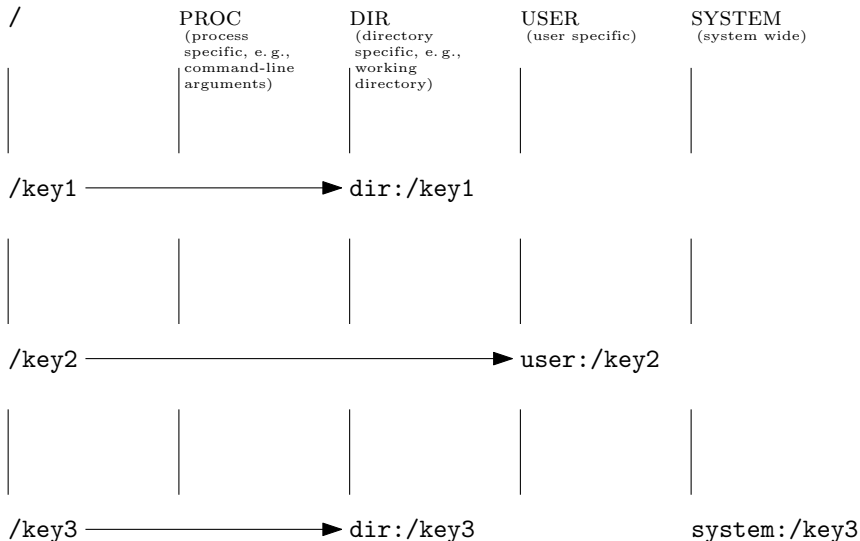
Valid configuration does not contradict the present validation
specifications. With a valid configuration,
applications can start but they may not do what the
user wanted or may be inconsistent with context.

Suitable configuration is valid with respect to additional
specifications from the user that describe the system
the user requires [10].

Optimal configuration is optimal with respect to given optimization
criteria. Optimization criteria are important if
managing configuration of many computers but are
rarely needed for configuration access discussed in
this book.

Context-aware configuration is in accordance with its context.
Unlike configuration settings, the context changes in
ways outside of our control.

valid configurations

all configurations

optimal configurations

suitable configurations

context-aware configurations
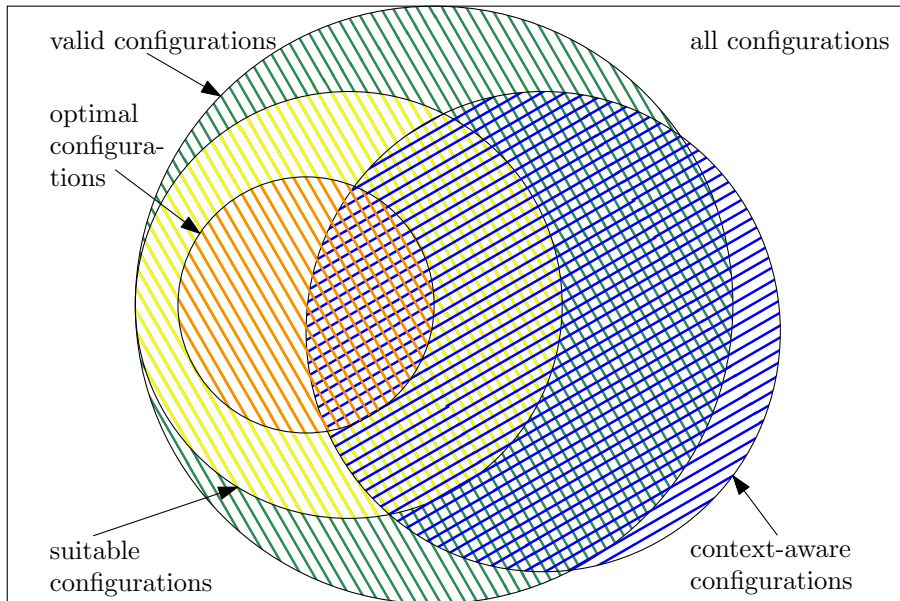
Viewpoints

Sensors: derive context from information sources of the system. Adding new context sensors increases the context available in a system.

Users: Context awareness can be subjective with respect to the needs of a user. For different users, we may need different context specifications. Configuration that is context aware for one user, can be context unaware regarding the wishes of another user. According to Khalil and Connelly [8, 9] personalization is essential.

Time: Because context varies in time, on changes, we need to renew the context awareness of configuration settings. In such situations we speak of **context changes** [2, 7].

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Cascading (Recapitulation)

/	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

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Context-aware Lookup

- Determine threads from CPUs:

```
1  [ env / layer / cpu ]
2    type := long
3  [ slapd / threads / listener ]
4    context := / slapd / threads /%cpu%/ listener
```

- Determine vibration from sensors:

```
1  [ phone / call / vibration ]
2    type := boolean
3    context := / phone / call /%inpocket%/ vibration
```

- Determine proxy settings from network:

```
1  [ env / override / http_proxy ]
2    context := / http_proxy /%interface%/%network%
```

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