L05 Configuration Management

Markus Raab

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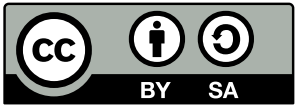

CM Tools

Learning Outcomes

Students will be able to

- describe systematic approaches for configuration management and exemplary configuration management tools.

Definition

Configuration Management

system administrator:

- ensures computers are assembled from desired parts (inventory list)
- ensures correct applications are installed
- maintains files/databases (backup, etc.)
- monitors infrastructure
- ***manipulates configuration settings***

Definition

Configuration Management Tools:

- help system administrators in configuration management
- describe the desired configuration of the whole managed system
- converge the actual configuration to the desired one [1]

Cloning

It all started with:

- clone all files with rdist, NFS, rsync or unison (“golden image”)
- then do necessary modifications with scripts or profiles

+ works good for many identical stateless machines
– fails if differences between machines are too big

Profiles

Profiles are groups of configuration settings between which the user can easily switch.

- by hostname, EEPROM, ...
- can be activated via the `profile` plugin:

```
1 [application/profile]
2 type := string
3 opt := p
4 opt/long := profile
5 default := current
```

with a config like:

```
1 application/current/key = "current"
2 application/myprofile/key = "myprofile"
3 application/%/key = "default"
```

Scripts

Next improvement: have a script to create the “golden image”. Possible benefits:

- Documentation
- Customization (using configuration settings)
- **Reproducability**: Reproduce creation using different operating system versions

Possible problems:

- imperative style
- configuration drift

Possible Benefits of CM tools

- All advantages scripts have:
  Documentation, Customization, Reproducability
- Declarative description of the system
  (Infrastructure as Code [3])
- Error handling
- Reusability
- Abstractions

List of CM tools

- CFengine (1993)
- Puppet (2005)
- Chef (2009)
- cdist (2010)
- Salt (2011)
- Ansible (2012)
- Itamae (2014)
- Bolt (2018)
- Transilience (2020, no release yet)

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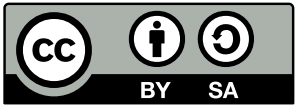

Key-value Access

Layers of Abstractions

Recursively define useful abstractions (meta-levels):

- Bits in (configuration) files and memory
- *Key/value view of configuration settings*

- CM code to instantiate settings in the whole network
- Global optimization: allocation of nodes and decision regarding topology

Precise Editing

- Precise editing is natural for humans.
- Preserves (security-relevant!) defaults.

In CM following methods are used:

- replace full content of configuration files (with templates)
- line based manipulation (e.g., file_line): match line and replace it
- Augeas/XML: match a key with XPath and replace it
- Elektra: key/value access

Key/value access in puppet-libelektra [4]:

```
1 kdbkey {'system:/slapd/threads/listener':
2     ensure => 'present',
3     value => '4'
4 }
```

Key/value access in puppet-libelektra:

```
kdbmount {'system:/sw/samba':
    ensure => 'present',
    file => '/etc/samba/smb.conf',
    plugins => 'ini'
}
kdbkey {'system:/sw/samba/global/workgroup':
    ensure => 'present',
    value => 'MY_WORKGROUP'
}
kdbkey {'system:/sw/samba/global/log level':
    ensure => 'absent'
}
```

Uniqueness of keys is essential. Ideally, applications already mount their configuration at installation.

Key/value specifications in puppet-libelektra:

```
kdbkey {'system:/sw/samba/global/log level':
    ensure => 'present',
    value => 'MY_WORKGROUP', # not an int
    check => {
        'type' => 'short',
        'range' => '0-10',
        'default' => '1',
        'description' => 'Sets the amount of log/
            debug messages that are sent to the
            log file. 0 is none, 3 is consider-
            able.'
}
```

Key/value specifications in puppet-libelektra:

```
kdbkey {'spec:/xfce/pointers/Mouse/RightHanded':
    ensure => 'present',
    check => {
        'visibility' => 'important',
        'default' => 'false',
        'check/type' => 'boolean'
}
```

Ideally, applications already specify their settings.

Key/value access in Chef:

```
1 kdbset 'system:/sw/samba/global/workgroup' do
2     value 'MY_WORKGROUP'
3     action :create
4 end
```

Key/value access in Chef:

```
1 kdbset 'system:/slapd/threads/listener' do
2     value '4'
3     action :create
4 end
```

Finding

We have CM code representing the settings.

Key/value access in Ansible:

```
1  - name: setup LDAP
2    connection: local
3    hosts: localhost
4    tasks:
5    - name: set listening threads
6      elektra:
7        mountpoint: system:/slapd
8        keys:
9          threads:
10           listener: 4
```

Key/Values

Decide about **changeability** per key:

- Who is responsible (end user, packages, system administrator manual or CM)?
- Who can see it (visibility)?
- Who can edit it (system administrator, end user, both)?
- Which configuration values are allowed (validation)?

Changeability

Ownership of every key must be very clear and documented.

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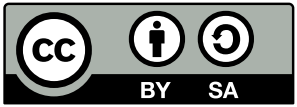

CM Design

Idempotence

idem + potence (same + power)

Yield same result with any number of applications ($n \geq 1$):

$$f(f(x)) = f(x)$$

Siméon and Wadler [5] describe two further properties:

Self-describing means that from the configuration file alone we are able to derive the correct data structure [5].

Round-tripping means that if a data structure is serialized and then parsed again, we end up with an identical data structure [5].

Design Rules [2]

- Maintain clear separation of ownership (for every key).
- Factor processes into containers to avoid overlaps in settings.
- Specify replicated settings in a single source (use links and derivations).
- Document all remaining overlaps (in the specification).
- The manageability of settings is reduced by the number of possible configuration values.

Conclusion

- unique identifiers
  $\rightarrow$ allows to get/set configurations and specifications
- solving CM is solving constraints
  $\rightarrow$ be aware of the specifications
- do not design around tools but design tools around you
- change only settings you need
- use all help you can get: e.g. build tools, preseeding, installer automation, virtualization, package managers, distributions

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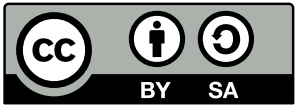

Meeting

Learning Outcomes

Students will be able to

- describe systematic approaches for configuration management and exemplary configuration management tools.

Question

How can we reuse the same configuration setting for different applications?

Answer

- Use CM code to copy the settings to all places as needed.
- Implement support directly in application to fetch setting from central location.
- Override/fallback links in specification.
- Calculate/transform values in specification.

Definition

Configuration Management

system administrator:

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Question

Which tasks did you already do as system administrator?

Definition

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- describe the desired configuration of the whole managed system
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Task

Break.

Possible Benefits of CM tools

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Ansible Presentation

Discussion: CM Languages

- NIX, GNU Guix
- Dockerfiles
- Ansible
- Chef
- Puppet
-
-

Task

Break.

T1 corrections

H2 Implement Specifications

Enough Tasks?

Which CM language do you want to use for H3?

Feedback

- Videos?
- Response time and helpfulness?
- More or less materials?
- Any other suggestions for improvements?

Outlook

- validation techniques
- writing plugins

[1] Mark Burgess. A site configuration engine. In *USENIX Computing systems*, volume 8, pages 309–337, 1995.

[2] Mark Burgess and Alva L Couch. Modeling next generation configuration management tools. In *LISA*, pages 131–147, 2006.

[3] Waldemar Hummer, Florian Rosenberg, Fábio Oliveira, and Tamar Eilam. Testing idempotence for infrastructure as code. In David Eyers and Karsten Schwan, editors, *Middleware 2013*, pages 368–388, Berlin, Heidelberg, 2013. Springer Berlin Heidelberg. ISBN 978-3-642-45065-5.

[4] Markus Raab, Bernhard Denner, Stefan Hahnenberg, and Jürgen Cito. Unified configuration setting access in configuration management systems. In *ICPC '20: 28th International Conference on Program Comprehension, Seoul, Republic of Korea, July 13-15, 2020*, pages 331–341. ACM, 2020. doi: 10.1145/3387904.3389257. URL `https://doi.org/10.1145/3387904.3389257`.

[5] Jérôme Siméon and Philip Wadler. The essence of xml. pages 1–13, 2003. doi: 10.1145/604131.604132. URL `http://dx.doi.org/10.1145/604131.604132`.