Private Cloud Configuration with MetaConfig

Thomas Damgaard Nielsen
and
Christian Iversen

Cirego A/S
info@cirego.com
Private Clouds

• Some confusion with the term ”cloud”
• Our understanding of ”cloud”:
  • A collection of physical machines
  • Virtualized environment
  • Collection of virtual machines + their configuration
• Private cloud:
  • A private collection of servers running a cloud
  • Not outsourced to a third party
Challenges

- How to efficiently assign virtual machines to physical resources?
- How to maintain machine configuration congruent with specifications?
  - Even in face of unexpected changes?
- How to efficiently represent configuration specifications?
MetaConfig

• MetaConfig enables
  • Convergent as well as congruent configuration management
  • Full bootstrapping of physical and virtual machines
  • Automatic allocation of virtual machines on to physical machines
  • Automated virtual machine operations

• License: GPLv3
Private cloud configuration

- Seamless configuration of virtual and physical machines entails:
  - Configuration management
  - Virtual machine allocation
  - Bootstrapping
Configuration Management

• What is configuration?

• Automated configuration according to specification

Traditional workflow:

Informal specification → Manual changes

Metaconfig workflow:

Formal specification → Configuration system → Automated changes
Specifying configuration

- Specification must be:
  - Compact
  - Modular
  - Non-redundant

- Execution must be:
  - Reproducible
  - Idempotent

- Approaches:
  - Domain-Specific Language (DSL)
  - Declarative: specifies what is desired, not how it is obtained
Applying configuration

Configuration source files

Component 1
Component 2
Component 3

Template source files

Template file 1
Template file 2
Template file 3
Template file 4

Host configuration

Configuration data structure

Apply configuration
Metaconfig architecture

- Three sub-systems:
  - Configuration management
  - Virtual ressource management
  - Bootstrap
Virtual Machine management

• Virtual resources:
  • CPU cores
  • RAM
  • Storage devices
  • Network interfaces
    – IP addresses
    – MAC addresses

• VM operations
  • Create
  • Start
  • Shutdown
  • Destroy
  • Reboot
  • Bootstrap
  • Migrate
Virtual Machine Allocation

Physical machine
Provides 8 GB RAM,
2 CPUs of amd64
architecture

8 GB RAM
amd64
architecture

2 CPUs

Allocator

Virtual machine
requires 2 CPUs,
2 GB RAM,
amd64 architecture

2 GB RAM
amd64
architecture
2 CPUs

Physical machine
that hosts one virtual
machine

3 of 8 GB RAM used
amd64
architecture
2 CPUs
Virtual Machine Allocation

- VM allocation similar to multidimensional bin-packing (NP-hard)
- Heuristic based approach
- Possibility of having pluggable optimisation engines for specific optimisation goals
Bootstrapping

• Problem:
  • Given a blank machine and a specification:
    Bring the machine into the desired configuration

• Goals:
  • Minimal interactivity
  • Efficient storage utilization
  • Flexible

• Several subproblems, including:
  – Boot computer
  – Partition
  – Install operating system
  – Install MetaConfig client
  – Configure network connectivity
  – Obtain configuration specification
  – Apply configuration
Bootstrap dependencies

- 2-phase approach
## Comparison to other projects

<table>
<thead>
<tr>
<th></th>
<th>MetaConfig</th>
<th>Puppet</th>
<th>Cfengine</th>
<th>OpenStack</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specification language</td>
<td>Custom DSL</td>
<td>Custom DSL</td>
<td>Custom DSL</td>
<td>N/A</td>
</tr>
<tr>
<td>Template language</td>
<td>Custom DSL</td>
<td>ERB</td>
<td>None</td>
<td>N/A</td>
</tr>
<tr>
<td>Convergence</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>N/A</td>
</tr>
<tr>
<td>Congruence</td>
<td>Yes</td>
<td>Unknown</td>
<td>No</td>
<td>N/A</td>
</tr>
<tr>
<td>Bootstrap</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Dry-run</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>N/A</td>
</tr>
<tr>
<td>Idempotence</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>N/A</td>
</tr>
<tr>
<td>VM allocation</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>VM operations</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Note: "Yes" indicates the feature is supported, "No" indicates it is not, and "Unknown" indicates the feature's status is unknown.
Conclusion

- Fully automated private cloud configuration:
  - Domain-specific language for efficient configuration specification
  - Automatic deployment and maintenance of configuration on multiple machines
  - Bootstrapping: Automatic installation/reinstallation of machines
  - Automated virtual machine operations
  - Automatic virtual machine allocation
Thank you. Questions?

Check out our poster near the escalators

See also: www-metaconfig.com