HP UDC – Standardizing and Automizing Data Center Operations

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Workshop Network and Service Infrastructures, Löbsal. April 20, 2004

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Motivation

- Problems in Data Centers (*Rechenzentren*)
  - Manual operations by system administrators.
  - Limited automation with few standards
  - Overprovisioning

- Demanding tasks:
  - Adding new hardware or software
  - Migrations
  - Reorganizing network topology
HP Utility Data Center (UDC)

• Set of Resources
  – Diskless servers with Fiberchannel controllers
  – Storage array with SAN
  – Network Appliances
    • (switch, router, load balancer, fw, ...)

• Management & Support
  – Management Rack
  – Operations Center Rack (HP OpenView)
  – Backup Rack

UDC at HP Labs, Palo Alto
UDC: Benefits

• Flexible creation of „farms“ in a data center

• Decoupling applications from machines

• Virtualization allows standardization and consolidation

• automation and hiding of internal management operations

• Software and configuration management
UDC: Weak points of Controller Software

- Utility Controller user interface is completely graphical
- Limited support for virtual or transitional devices
- None of the evolving “Grid” standards have been incorporated yet
- Fix set of resource types
- No planning capabilities
Idea: Reservation System

• Information Model describes
  
  – **Request** is a container for:
    • MetaData, Resource Descriptions, Profiles
  
  – **Resource Description** *(What do I need?)*
    • Properties
    • Construction
  
  – **Profiles** *(How many? When?)*
    • Quantity over Time

Request Form

___________
10 Linux servers

___________
__next week__

__Smith__
Information Model: Profile

Sub-intervals T4, T define a recurring period until T5 ends, outer, half-open T4[t3,]

Q

T1 T2 T3 T4 (half-open, recurring) T5 (half-open, not recurring)

T0: <start> (absolute time)

t0

t1 t2 t3 t4 (ends recurring T4,)

∞
Information Model: Resource Description

• Metadata
  – ID, name, version, creator, ...

• Associations, such as super class or construction hierarchy

• Properties
  – Attribute-Value pairs

• Constraints
  – Container for rules in policy language format
Implementation: XML Schemas

- XML schemas
- Include mechanism
- XML documents are linked
„Quartermaster“ prototype architecture
The two Interfaces: Shell and GUI

- Allocation
- Calendar
- CalendarShell
- stdin
- stdout
- Persistent data store

- Browser
- Cocoon
- HTTP
- periodic update
Shell Interface

- Allocation
- Calendar
- CalendarShell
- stdin
- stdout
- Persistent data store

- Browser
- Cocoon
- HTTP
- periodic update
• Provides scripting capabilities for the „site calendar“

• Command set:
  – General commands
    • help, exit, #
  – Operations on the site calendar
    • load, save, ls
  – Operations on resource calendars
    • put, ls, schedule, save, rm
  – Operations on demand profiles
    • put, rm
Shell Commands by Example

```
walk@hplaa:~/uram/src/proto-03
$ ./qmsht.bat

Quartermaster Allocation Calendar Shell V0.1
'exit' leaves program.
'help' lists commands.

[QM] $ ls
[diskimage, diskless_compute_node, firewall, subnet, loadbalancer, storage]
    completed: 16. msecs

[QM] $ schedule diskimage
2003-06-01T01:00:00-07:00 : [cap 15, request002 2, request003 1]
2003-06-02T01:00:00-07:00 : [cap 15, request002 2, request003 2]
2003-06-03T01:00:00-07:00 : [cap 15, request002 3, request003 3]
2003-06-04T01:00:00-07:00 : [cap 15, request002 3, request003 4]
2003-06-06T01:00:00-07:00 : [cap 15, request002 2, request003 6]
2003-06-07T01:00:00-07:00 : [cap 15, request002 2, request003 1]
2003-06-09T01:00:00-07:00 : [cap 15, request002 4, request003 1]
2003-06-12T01:00:00-07:00 : [cap 9, request002 2, request003 0]
    completed: 31. msecs

[QM] $ ls subnet
Content of ../frugui/data/alloccoal/prof/capacity/subnet.xml
<?xml version="1.0" encoding="ISO-8859-1"?>
    <Interval recurring="false">
        <Interval id="1" start="2003-08-14T01:49:04-07:00">
```
Shell Commands by Example

```
[QM] $ ls
[diskimage, diskless_compute_node, firewall, subnet, loadbalancer, storage]
completed: 16. msecs

[QM] $ schedule diskimage
2003-06-01T01:00:00-07:00 : [cap 15, request002 2, request003 1]
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2003-06-03T01:00:00-07:00 : [cap 15, request002 3, request003 3]
2003-06-04T01:00:00-07:00 : [cap 15, request002 3, request003 4]
2003-06-05T01:00:00-07:00 : [cap 15, request002 2, request003 5]
2003-06-06T01:00:00-07:00 : [cap 15, request002 2, request003 6]
2003-06-07T01:00:00-07:00 : [cap 15, request002 2, request003 1]
2003-06-08T01:00:00-07:00 : [cap 15, request002 4, request003 1]
2003-06-12T01:00:00-07:00 : [cap 9, request002 2, request003 0]
completed: 31. msecs

[QM] $ ls subnet
Content of ..../frugui/data/alloccal/prof/capacity/subnet.xml
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>  
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Shell Commands by Example

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2003-06-05T01:00:00-07:00 : [cap 15, request002 2, request003 5]
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<?xml version="1.0" encoding="ISO-8859-1"?>
> <Interval recurring="false">
  <Interval id="1" start="2003-08-14T01:49:04-07:00"/>
</Interval>
```
Shell Commands by Example

```
root@hplaa ~/uram/src/proto-03
$ ./qmsh.bat

Quartermaster Allocation Calendar Shell V0.1
'exit' leaves program.
'help' lists commands.

[QM] $ ls
[diskimage, diskless_compute_node, firewall, subnet, loadbalancer, storage]
completed: 16. msecs

[QM] $ schedule diskimage
2003-06-01T01:00:00-07:00 : [cap 15, request002 2, request003 1]
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2003-06-08T01:00:00-07:00 : [cap 9, request002 2, request003 0]
completed: 31. msecs

[QM] $ ls subnet

Content of ../frugui/data/allocaal/prof/capacity/subnet.xml
<?xml version="1.0" encoding="ISO-8859-1"?>
  xsi:schemaLocation="http://hpl.hp.com/rp2">
  <Interval recurring="false">
    <Interval id="1" start="2003-08-14T01:49:04-07:00">
```

```
Cocoon: A web development framework

- **Generator:**
  - Files (XML)
  - Query result from XML or SQL database
  - eXtensible Server Pages (XSP)
  - LDAP

- **Transformer**
  - XSL stylesheets

- **Serializer**
  - HTML, SVG, SVGtoBitmap
Cocoon: Request processing

Matchers on the HTTP Request:
  - URL and its parts (host, domain, path, parameters)
  - Session ID
  - Cookies
  - Browser type
  - Referer
  - Sender IP address

Combinations of the above
+ wildcards + regular expressions!

Sitemap.xmap

```xml
<map:match pattern="view">
  <map:match type="request-parameter-wildcard" pattern="/**/**">
    <map:parameter name="parameter-name" value="data" />
    <map:match type="request-parameter-wildcard" pattern="**"/>
    <map:generate src="data{../0}.xml" />
  </map:match>
</map:match>
<map:transform src="stylesheets/{1}.xsl">
  <map:parameter name="base-url" value="/cocoon/frugui" />
  <map:parameter name="context" value="{../1}" />
</map:transform>
<map:serialize />
</map:match>
```
GUI Screenshot

Quartermaster Browser
(C) 2003, Hewlett-Packard Labs, Palo Alto, CA

Request Inventory
- Sample request 1 (Form View)

Sample request 1
- Requestor: John J. Customer, Customer Corporation Inc.
- Requested resource specification 1: ecommerce
ecommerce.attribute
- Requested resource specification 2: server
- Goals: (satisfy ecommerce.attribute1.number >= 10 &&
  ecommerce.attribute2.number <= 5 &&
  ecommerce.cost < 50);
Decisions and Results

- Separation of Concerns

- Data Organization: Files vs. Database

- Lack of well-established query language for XML

- SQL and XML – mapping data back and forth

- Cocoon runtime performance

- Cocoon documentation
Other people at HP Labs working on:

- policy integration
- agreement protocols in grid environments
- resource type specifications related to Common Information Model (CIM)
- server consolidation, probabilistic capacity planning, Quality of Service management
- workload simulation and placement optimization
- relations to other major HP products: HP Utility Data Center and HP OpenView
Thanks for your attention!