Dynamically Allocated Virtual Clustering Management System User’s Guide

by Kelvin M Marcus

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Computational and Information Sciences Directorate, ARL

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The Dynamically Allocated Virtual Clustering Management System (DAVC) is an experimentation infrastructure that provides the means to dynamically create, deploy, and manage virtual clusters of heterogeneous nodes within a cloud computing environment. The system allows researchers to create virtual clusters of nodes that can be used for experimentation, software development, and integration with existing hardware and software. This report provides usage instructions for the DAVC version 2.0 web application.
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INTENTIONALLY LEFT BLANK.
1. Introduction

The Dynamically Allocated Virtual Clustering Management System (DAVC) is an experimentation infrastructure that provides the means to dynamically create, deploy, and manage virtual clusters of heterogeneous nodes within a cloud computing environment. The system allows researchers to create virtual clusters of nodes that can be used for experimentation, software development, and integration with existing hardware and software. This report provides usage instructions for the DAVC version 2.0 web application.

This report is separated into the following sections, which detail, via examples and step-by-step instructions, actions the user will perform when using DAVC version 2.0:

1) Accessing and logging into DAVC
2) DAVC cluster configuration
3) DAVC cluster instantiation
4) DAVC cluster and node details
5) DAVC virtual hard disk management
6) DAVC block disk/persistent storage management
7) Creating a new virtual hard disk from a cluster node

Each section contains slides from a PowerPoint presentation on using DAVC version 2.0. The slides are presented without change from the original version or additional comment.
2. Accessing and Logging into DAVC

Welcome To DAVC: Dynamically Allocated Virtual Clustering

DAVC is an experimentation support application that allows users to create, deploy and manage virtual network clusters of heterogeneous nodes within a cloud computing environment based upon resource utilization.

Key Capabilities:
- Auto-configuration of Multiple Woody Clusters
- Dynamic provisioning of virtual resources
- Configured network services (SDN, DNS, DHCP, IPS)
- Hybrid Virtual Storage Support
- Dynamic allocation of virtual systems and application stacks
- Fine tuning of node physical hardware attributes (e.g., Hard Disk, RAM, CPU)
- Deploy Multiple Private VLANs
- Balance online traffic between applications
- Multiple experiments conducted simultaneously
- Dynamic Node To Host Barrier Assignment

Register DAVC User:
- Username
- Password
- Request password
- First name
- Last name

2. Register or Login with your Username/Password

1. From a web browser access the DAVC web application via the URL http://<ip address>/davc
3. DAVC Cluster Configuration

There are 3 ways to begin the Cluster configuration process...choose one to begin configuration.

- Create A Cluster
- My Clusters
- Virtual Hard Disk Mgmt
- Block Disk Mgmt
- Usage Statistics
- Logout

DEMO Cluster Administration

Cluster Usage
- 20 of 20 CPU Cores Remaining
- 25600 of 25600 MB Remaining

Messages

DEMO Cluster Configurations

You Don't Have Any Cluster Configurations

Create One
1. Replace the random hash with a suitable Cluster Name

2. Input a short description of the Cluster

3. Indicate if the Cluster will be Private (unclonable by other users)

4. Proceed to creating the Cluster networks

---

The Networks tab lists all of the networks currently added to the cluster.

1. Click ‘Add Cluster Networks’ to add a new network

2. Input network in CIDR format

3. Click ‘Add Network’ to add it to the Cluster
More Networks can be added or deleted from this tab.

Click 'Delete' to remove a network

Click 'Add More Networks' to add additional networks

Click 'Add Nodes' to begin adding nodes to the Cluster

The Nodes tab lists all of the nodes currently associated with the cluster.

Click 'Add More Nodes' to begin adding Nodes
The Add Cluster Nodes dialog is used to set the attributes of the nodes that will be added to the cluster.

1. Click the Ostype/Virtual Machine template dropdown box

2. Select a Virtual Machine

---

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1. The default values for the CPU Cores, Non-Persistent Block Storage Size, RAM, and Virtual Network Driver are automatically populated. Update if necessary.

2. Select the networks the node will be apart of.

3. Select how many instances of this Virtual Machine should be added to the Cluster.

4. Click ‘Add Nodes’ to add the nodes to the Cluster.

Each node is automatically added to the system’s control (blue) network in addition to the networks the user selected.

1. Delete or edit nodes as necessary.

2. Click ‘Add More Nodes’ to add more nodes.

3. Click ‘Create Cluster’ when done.
4. DAVC Cluster Instantiation

The Cluster details page list is separated into the following areas (continued on the next page):

- Launch Cluster Button
- Cluster Name
- System Messages
- Edit Cluster Info Button
- Cluster Networks
- Core Allocation Policy

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A Cluster can be launched from the user dashboard’s Cluster Configuration List or from the Cluster Details page. The Cluster Configuration List option is shown below:

1. Click the ‘Launch’ button in the ‘Cluster Options’ dropdown menu.

During cluster instantiation the Cluster status updates to ‘INITIALIZING’ then to ‘ACTIVE’.

And the users CPU Cores and Ram is decreased according to the amount allocated to the Cluster nodes.
A Cluster can also be launched from the Cluster Details page as shown below:

1. Click the ‘Launch’ button

During cluster instantiation each node’s status updates to ‘INITIALIZING’, to ‘CHECKING IN’, then ‘ACTIVE’
The Cluster is active once all of the nodes are in the ‘ACTIVE’ state.

Cluster Details: DEMO

<table>
<thead>
<tr>
<th>Networks</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>Net</td>
</tr>
<tr>
<td>Exp1</td>
<td>192.168.1.0/24</td>
</tr>
</tbody>
</table>

Cluster Nodes (3)

<table>
<thead>
<tr>
<th>Node</th>
<th>Status</th>
<th>Host Server</th>
<th>OS/Image</th>
<th>Non-Persistent Block Space (GB)</th>
<th>RAM (MB)</th>
<th>Cores</th>
<th>VNC</th>
<th>IP Addresses</th>
</tr>
</thead>
<tbody>
<tr>
<td>demo-1</td>
<td>ACTIVE</td>
<td>d10</td>
<td>Ubuntu14.04_6G</td>
<td>1</td>
<td>256</td>
<td>1</td>
<td>virto</td>
<td>eth0: 192.168.1.0/24</td>
</tr>
<tr>
<td>demo-2</td>
<td>ACTIVE</td>
<td>d11</td>
<td>Ubuntu14.04_6G</td>
<td>1</td>
<td>256</td>
<td>1</td>
<td>virto</td>
<td>eth0: 192.168.1.0/24</td>
</tr>
<tr>
<td>demo-3</td>
<td>ACTIVE</td>
<td>d9</td>
<td>Ubuntu14.04_6G</td>
<td>1</td>
<td>256</td>
<td>1</td>
<td>virto</td>
<td>eth0: 192.168.1.0/24</td>
</tr>
</tbody>
</table>
5. **DAVC Cluster and Node Details**

This section highlights the details of an active cluster and its nodes.

**Cluster Details: DEMO**

**Cluster Controls**

<table>
<thead>
<tr>
<th>Networks</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>Net</td>
</tr>
<tr>
<td>Exp1</td>
<td>192.108.1.0/24</td>
</tr>
</tbody>
</table>

**Messages**

Core Allocation Policy: No Core Sharing

**Cluster Nodes (3)**

<table>
<thead>
<tr>
<th>Node Name</th>
<th>Status</th>
<th>Host Server</th>
<th>OS/Image</th>
<th>Non-Persistent Block Space (GB)</th>
<th>RAM (GB)</th>
<th>Cores</th>
<th>VNC</th>
<th>IP Addresses</th>
</tr>
</thead>
<tbody>
<tr>
<td>demo-1</td>
<td>ACTIVE</td>
<td>d19</td>
<td>Ubuntu 14.04_6G</td>
<td>1</td>
<td>2GB</td>
<td>1</td>
<td>virt0</td>
<td></td>
</tr>
</tbody>
</table>
| eth0: 160.25.915  
eth1:192.108.1.0/24 |
| demo-2 | ACTIVE | d11 | Ubuntu 14.04_6G | 1 | 2GB | 1 | virt0 |  
| eth0: 160.25.915  
eth1:192.108.1.0/24 |
| demo-3 | ACTIVE | d9 | Ubuntu 14.04_6G | 1 | 2GB | 1 | virt0 |  
| eth0: 160.25.915  
eth1:192.108.1.0/24 |
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Below is the list of a node’s network interfaces and IP addresses. User can also set the data rate of all the non-control network interfaces of active nodes.

Experiment Network IP Address and Current Data Rate

Sets the Experiment Network’s Data Rate

The options under the Node Options drop down allows user to restart the node (all data will be lost) or interact with the node via its VNC terminal.

Open Node VNC Client in Web Browser

Restart/Redeploy Node

Refreshes Node VNC Process if The ‘Open VNC’ Fails
6. DAVC Virtual Hard Disk Management

Users can upload their own VHD as templates for DAVC clusters on the ‘Virtual Hard Disk Mngt’ page shown below. This section summarizes this process.
A VHD template must be preinstalled with the DAVC Node Provisioning Client Python script. Thus Python is a perquisite for the operating system on the VHD.

The DAVC Node Provisioning Client is located in the following location in the DAVC distribution along with a wrapper start script:

- `/davc2.0/davc/scripts/provisioning/rmprovisionclientvhd_v2.py`
- `/davc2.0/davc/scripts/provisioning/provision_startup.sh`

1. Copy the client and startup script to the VHD’s `/opt` directory and add an entry to the `/etc/rc.local`, as shown, so the script will launch at boot time.

```
#!/bin/sh -e
rc.local

This script is executed at the end of each multiuser runlevel.
Make sure that the script will "exit 0" on success or any other value on error.

To enable a script add it to /etc/rc.local.
In order to enable or disable this script just change the execution bits.
By default this script does nothing.

#opt/provision_startup.sh
exit 0
```

The DAVC Node Provisioning Client expects the interfaces ‘lo’ and ‘eth0’ to be active and configured for DHCP on bootup. This can be achieved with the edits shown below.

2. Edit the network interfaces configuration file (Debian-based), as shown to the right.

```
# This file describes the network interfaces available on your system
# and how to activate them. For more information, see interfaces(5).
#
# The loopback network interface
auto lo
iface lo inet loopback
#
# Control network interface
auto eth0
iface eth0 inet dhcp
```

3. Ensure the persistent network labeling rules file is empty so that interfaces provisioned by DAVC will be labeled starting with eth0. The file is located at:

- `/etc/udev/rules.d/70-persistent-net.rules`
DAVC provides each node with a hostname and provides DHCP services as well as a Block Disk storage service for nodes. Perform the steps below in your VHD to ensure these services will function correctly.

4. Clear the hostname file on the VHD by editing the file:
   • /etc/hostname

5. Remove the DHCP leases file on the VHD by running the command
   • rm /var/lib/dhcp/dhclient.eth0*

6. Execute the following commands to add ‘Hotplug Support’ to the VHD. This is required so that DAVC Block Disks can be attached and detached to and from a running instance of the virtual machine:
   • echo ‘acpi phoenix’ >> /etc/modules
   • echo ‘pci_hotsplug’ >> /etc/modules

The VHD is now ready to be uploaded to DAVC. This process is shown next.

A VHD template must be in the qcow2 format with backwards capability before uploading to DAVC.

The qemu-img convert command can be used to convert a VHD to qcow2 format. The syntax of the command is shown below:

- qemu-img convert -o compat=0.10 -f <current format> <image file> -O qcow2 <new image file>.qcow2
- -o compat=0.10 - Ensures the new virtual machine image will be backwards compatible
- <current format> - The current format of your virtual machine (raw, vdi, qcow, cow, vmdk)
- <image file> - The name of your virtual machine image file
- -O qcow2 – Specifies qcow2 as the output format
- <new image file> - The name of the new converted virtual machine image file.
  • Do not use spaces in the file name

Example:
- qemu-img convert -o compat=0.10 -f vmdk ubuntu14.04.vmdk -O qcow2 ubuntu14.04.qcow2

Refer to https://linux.die.net/man/1/qemu-img for more information on the qemu-img command
1. Click ‘Add Virtual Hard Disk Button’

2. Input a descriptive name

3. Input the VHD OS

4. Input the minimum Core and RAM requirements

5. Indicate if the VHD can be shared with other users

6. Browse for the VHD file (qcow2 format)

7. Click ‘Upload VHD’ when complete

A system message will indicate the success or failure of the VHD upload.

The VHD will not be available during cluster configuration until it has ‘Synced’ (copied) onto all host servers. This can take a while depending on the size of the VHD.
7. DAVC Block Disk/Persistent Storage Management

Users can allocate blocks of persistent storage and attach them to any of their cluster nodes for logging etc. This is done in the Block Disk Mngt page.

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1. Click the ‘Create A Block Disk Button’

2. Input the Block Size in GB

3. Select a File System format

4. Click Create
1. Ensure Block Disk is not Attached
2. Click the ‘Attach’ Button in the ‘Block Disk Options’ dropdown menu
3. Select the node the Block Disk will be attached to.
4. Click ‘Attach’ to attach
5. Execute `blkid` command to list the block attributes

6. Find the block device (/dev/vda) with the UUID that matches the Block Disk that was just attached
7. Create a mount point/directory for the block

8. Mount the block device to the mount point/directory

9. The Block Disk can now be used to store data.

The process to Detach a Block Disk from a node is shown below:

1. Execute the 'umount' command on the node

2. Click the 'Detach' Button
8. Creating a New Virtual Hard Disk from a Cluster Node

Changes made to a node can be preserved by creating a new VHD from the node’s image. This process is shown below.

 Nodes cannot be saved into new VHDs while active. The following process will render the cluster inactive.

1. Click the ‘Cluster Options’ dropdown

2. Click the ‘Save’ button
3. Click ‘Node Options’ dropdown menu of the node that will be saved to a new VHD.

4. Click ‘Save Image’

5. Update the name of the OS if necessary

6. Click ‘Save Image’

Saving Image....
System message indicates the new VHD has been created.

The new VHD will then be synced (copied) to all host servers. This may take a while to complete.

The new VHD will be listed in the Virtual Hard Disk list

<table>
<thead>
<tr>
<th>ID</th>
<th>Name</th>
<th>Owner</th>
<th>OS</th>
<th>Hypervisor</th>
<th>Size (GB)</th>
<th>Synced</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>New_VHD</td>
<td>demo</td>
<td>Ubuntu 14.04</td>
<td>kvm</td>
<td>6.0</td>
<td>True</td>
</tr>
<tr>
<td>2</td>
<td>Algolink_EF</td>
<td>ef</td>
<td></td>
<td>kvm</td>
<td>20.0</td>
<td>True</td>
</tr>
<tr>
<td>3</td>
<td>Fusion_2016</td>
<td>fusion</td>
<td>ubuntu-14.04-25G.qcow2</td>
<td>kvm</td>
<td>26.0</td>
<td>True</td>
</tr>
<tr>
<td>4</td>
<td>Fusion_2016_v2</td>
<td>fusion</td>
<td>ubuntu-14.04-25G.qcow2</td>
<td>kvm</td>
<td>26.0</td>
<td>True</td>
</tr>
<tr>
<td>5</td>
<td>Android</td>
<td>kmarus</td>
<td></td>
<td>kvm</td>
<td>3.0</td>
<td>True</td>
</tr>
<tr>
<td>6</td>
<td>DDP</td>
<td>kmarus</td>
<td>DDP_Ubuntu_14.04</td>
<td>kvm</td>
<td>3.1028570742659</td>
<td>True</td>
</tr>
<tr>
<td>7</td>
<td>EMANE_S2_16G</td>
<td>kmarus</td>
<td>Ubuntu 14.04</td>
<td>kvm</td>
<td>16.0</td>
<td>True</td>
</tr>
</tbody>
</table>
9. Conclusion

This report displayed the step-by-step instructions to perform common DAVC version 2.0 operations to access DAVC and manage DAVC clusters, nodes, virtual hard disks, and persistent block storage.