ABSTRACT
This whitepaper describes the configuration of vCAC, vCO and Wavemaker for building a CMDB by leveraging the extensibility package that comes as part of vCO plug-in for vCAC.

August 2014
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Part Number H13337
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXECUTIVE SUMMARY</td>
<td>4</td>
</tr>
<tr>
<td>SYSTEM REQUIREMENTS</td>
<td>5</td>
</tr>
<tr>
<td>TENANT CONFIGURATION</td>
<td>7</td>
</tr>
<tr>
<td>CONFIGURING VCENTER AND VCO ENDPOINTS</td>
<td>10</td>
</tr>
<tr>
<td>CREATING FABRIC GROUPS</td>
<td>10</td>
</tr>
<tr>
<td>CREATING BUSINESS GROUPS</td>
<td>11</td>
</tr>
<tr>
<td>CREATING MACHINE PREFIXES AND RESERVATION POLICY</td>
<td>12</td>
</tr>
<tr>
<td>CREATING NETWORK PROFILE</td>
<td>12</td>
</tr>
<tr>
<td>CREATING RESERVATIONS</td>
<td>13</td>
</tr>
<tr>
<td>CREATING BLUEPRINTS</td>
<td>13</td>
</tr>
<tr>
<td>VCO CONFIGURATIONS</td>
<td>15</td>
</tr>
<tr>
<td>VCENTER CONFIGURATIONS</td>
<td>18</td>
</tr>
<tr>
<td>WORKFLOWS FOR CMDB</td>
<td>19</td>
</tr>
<tr>
<td>CONFIGURING STUBS TO BLUEPRINTS USING VCO WORKFLOWS</td>
<td>21</td>
</tr>
<tr>
<td>CREATING POLICY IN VCO</td>
<td>23</td>
</tr>
<tr>
<td>CREATING SERVICES AND MANAGING CATALOG ITEMS IN VCAC</td>
<td>24</td>
</tr>
<tr>
<td>CREATING ENTITLEMENTS</td>
<td>24</td>
</tr>
<tr>
<td>VM CREATION</td>
<td>25</td>
</tr>
<tr>
<td>DAY 2 OPERATIONS: VM MODIFY AND DELETE</td>
<td>28</td>
</tr>
<tr>
<td>BUILDING A FRONT END FOR CMDB WITH WAVEMAKER</td>
<td>33</td>
</tr>
<tr>
<td>CONCLUSION</td>
<td>35</td>
</tr>
</tbody>
</table>
EXECUTIVE SUMMARY

Everywhere Clouds are built differently than traditional IT. Nevertheless cloud is not a standalone entity. For private or hybrid clouds to be successful, they need to integrate and work with existing IT infrastructure, management tools and best practices.

To facilitate integration with existing IT infrastructure and management ecosystems, a cloud management platform must deliver broad multivendor support as well as an extensible architecture.

According to Wikipedia, “In systems architecture, extensibility means the system is designed to include hooks and mechanisms for expanding and enhancing the current capabilities without having to make major changes to the system infrastructure.”

vCloud® Automation Center from VMware is one of the most comprehensive and flexible cloud management platform, with broad multi-vendor, multi-cloud support and extensible design.

This extensibility design enables integration with many 3rd party management systems like – CMDB, Service Desk, DNS, Load Balancers, IPAM, Monitoring, Web Services etc.

There are three options for using extensibility feature in vCloud automation center.

1. Leveraging user-centric, business aware policies
2. Leveraging vCloud automation center Design Center (visual workflow editor for out-of-the-box automation)
3. Leveraging vCloud automation center Development kit (Separately licensed developer tools needed to extend a cloud infrastructure solution in new and unique ways)

This paper demonstrates option 2 i.e. the extensibility capabilities of vCloud® Automation Center (vCAC) Design center integrated with vCenter Orchestrator (vCO) via building a configuration management database (CMDB) for vCAC.

Now why is CMDB important? When a user creates and subsequently deletes a VM, the same is lost in vCAC database inventory. CMDB retains this VM information. Also CMDB can be configured to capture all other related information like user, costing of the VM etc.

The CMDB captures the following details for each of the virtual machines deployed in vCAC.

1. VM Name
2. Owner
3. Operating System
4. IP address
5. vCPU
6. Memory
7. Amount of Storage size
8. Raw device mapping LUN size if provisioned
9. Total Storage
10. Service Profile – Whether Bronze, Silver or Gold
11. Status – Whether the VM is created, modified or deleted
12. The cost center – The business group that the VM belongs to
13. Time stamp
SYSTEM REQUIREMENTS

INFRASTRUCTURE:
Separate Compute and Storage with sufficient resources and network in place for Production and Management.
Active Directory or LDAP authentication in place.

SOFTWARE:
Before installing get all the required software downloaded.
- VMware Identity Appliance – 2.0.1.0
- VMware vCAC Appliance – 6.0.1.0
- VMware vCenter – 5.1 or later
- Microsoft MSSQL-2008 or later
- VMware vSphere – 5.1 or later
- VMware vCenter Orchestrator – 5.1 or later
- VMware Wavemaker – 6.6.0

NETWORK SETTINGS:
- DNS resolution (Forward/Reverse lookup) for all IP’s.
- All the ports must be opened as required for vSphere, vCenter, vCloud automation center and vCenter orchestrator installation and configuration.

LICENSING:
- vCloud Suite Enterprise license.
- You must use a vSphere Enterprise license or above in order to use VMware High Availability (HA) and VMware Distributed Resources Scheduler (DRS).

vSPHERE AND vCENTER:
Install and configure the following before setting up vCAC
- Install vSphere on all the servers
- Add the vSphere servers to vCenter servers. One vCenter would be for required for production and another for management.
- Enable vSphere HA and vSphere DRS. Enable Host Monitoring.
- Enable Admission Control and set desired policy. The default policy is to tolerate one host failure.
- Set the virtual machine restart priority to High
- Set the virtual machine monitoring to virtual machine and Application Monitoring.
- Set the Monitoring sensitivity to High.
- Enable vMotion and Fault Tolerance Logging.
- All hosts in the cluster have Hardware VT enabled in the BIOS.
- Enable the vSphere Network Time Protocol on the ESXi hosts. The Network Time Protocol (NTP) daemon ensures that time-dependent processes occur in sync across hosts.
- vSphere Distributed Switch configured which acts as a single switch across all attached hosts.
- Resource pools must be created on vCenter. Each resource pool must correspond to a tenant so the same needs to be named appropriately.

**vCLOUD AUTOMATION CENTER:**
- Deploy VMware Identity Appliance
- Deploy VMware vCAC Appliance either with its own inbuilt Postgresql or an external database
- Install Microsoft SQL on a windows 2008 or later server.
- Deploy and configure the vCAC IaaS Server
- Install vCenter orchestrator and add the following plugins.
  - vCloud Automation Center
  - Active Directory
  - SQL Plugin
- Install Wavemaker.
- Install the vCenter agent on the IaaS Server. Note the same name must be used later when configuring this vCenter in vCAC.
TELENT CONFIGURATION

- After the configuration of Identity Appliance, vCAC Virtual Appliance and registering the IaaS component, log on to the [https://<vCAC-Appliance-IPaddress>/shell-ui-app/](https://<vCAC-Appliance-IPaddress>/shell-ui-app/) in your browser to configure the tenant with the username administrator@vsphere.local and with the password you have configured for the appliance. vCAC can have single or multiple tenants.

![Login screen of the default tenant](image)

Fig 1: Login screen of the default tenant

- Once you login, you can find the default tenant "vsphere.local". Click on it and click on **Next**.

![Adding Tenant](image)

Fig 2: Adding Tenant

- Create the Identity Store for "vsphere.local" tenant by clicking on green "+". The Identity Store can be OpenLDAP or Active Directory.
Fill in the Identity Store details. Type the name of the service account in the Name space.
Click on Test Connection and verify that all the details entered are valid. If the entered details are correct you’ll find a green tick mark indicating that “Connection is available”.

Click on Add.
Click on Next and assign the required users the roles of Tenant Administrator and Infrastructure administrator and click on Add. The infrastructure administrator can be the overall cloud administrator.
Fig 5: Assigning Roles to users

- Click **Update** to finish it. Repeat the above steps if you want to create a new Tenant.
- Logging into vCAC is by navigating to [https://<vCAC-Appliance-IPaddress>/shell-ui-app/org/tenantname](https://<vCAC-Appliance-IPaddress>/shell-ui-app/org/tenantname) and using your username in the format `userid@domain.com` and your domain Password.
- Access to vCAC is completely role based and it’s good to review at all the roles available and choose the users for the roles appropriately beforehand.

![Fig 6: Role privileges in vCAC](image)

**Add Tenant**

<table>
<thead>
<tr>
<th>General</th>
<th>identity stores</th>
<th>Administrators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Select Users and Groups from your identity stores to grant the Tenant administrator role</td>
<td>[Details]</td>
<td>[Details]</td>
</tr>
</tbody>
</table>

![Add Tenant Interface](image)
CONFIGURING vCO AND vCENTER ENDPOINT

- Log into the tenant as Infrastructure administrator and navigate to Infrastructure -> Endpoint -> Credentials. Update the administrator credentials for vCenter and vCO.
- To create a vCenter Endpoint click on Endpoints. Navigate to New Endpoint -> Virtual -> vSphere. Enter the Endpoint, Address and Credential details and click OK.
- To create a vCenter Orchestrator Endpoint click on Endpoints. Navigate to New Endpoint -> Orchestration -> vCenter Orchestrator. Enter the Endpoint, Address and Credential details and click OK.
- The endpoint name for vCenter should be exactly same as provided while installing the vCenter Agent in the IaaS Server.

Fig 7: Creating vCenter and vCO Endpoints

CREATING FABRIC GROUPS

- Once the vCenter Endpoint is created, Compute Resources will be visible during the creation of Fabric Groups. Select the required Compute Resources.
- Enter the users who need to be given Fabric administrator role and click OK. In most cases the Infrastructure administrators and Fabric administrators will be the same users. Once the group is created log out.
CREATING GROUPS

Log into the tenant as Tenant administrator and navigate to Administration -> Groups. Here user groups can be configured and roles can be assigned to them. Groups help us to centrally manage users.

CREATING BUSINESS GROUPS

- While still logged in as Tenant administrator navigate to Infrastructure -> Groups -> Business Groups and click on New Business Groups.
- Enter the required details. Here Groups as configured in the previous exercise can be used directly instead of giving specific user names.
CREATING MACHINE PREFIXES

- Login to vCAC as Fabric administrator.
- Navigate to Blueprints -> Machine Prefix and click on New Machine Prefix.
- Machine Prefix represents the name (vmname and hostname) that will be assigned to the VM when it is deployed through vCAC.
- Number of Digits represents the maximum limit of the VM’s that are deployed with that Machine Prefix name.
- Next Number represents the number that will be taken during the deployment.
- After entering the details, click on the green tick button.

![Image of creating machine prefixes](image)

Fig 10: Creating Machine Prefixes

CREATING RESERVATION POLICY

- Navigate to the Infrastructure -> Reservations -> Reservation Policies and click on New Reservation Policy.
- A reservation policy is a tag that can be set to a reservation (resource pool in vCenter) and a blueprint so as to restrict the provisioning of that blueprint to that reservation only. Fill in the details and click on the green tick mark.
- We can similarly create storage policy if required.

CREATING NETWORK PROFILES

- Navigate to the Infrastructure -> Reservations -> Network Profiles and click on New Network Profile and select External.
- Fill in the details of Subnet Masks, DNS etc., and Click on the IP Ranges and select New IP Range.
- Define the range of IP by mentioning the start and end IP Range and click OK. This will display all the IP’s in the mentioned range in the IP addresses tab. Click OK.
CREATING RESERVATIONS

- Navigate to the Infrastructure -> Reservations -> Reservation and click on New Reservation.
- Click on Virtual and then vSphere.
- Enter the details you want to tag the Reservation to by mentioning the Compute Resources, Name, Tenant, Business Groups, Reservation Policies and Priority.
- Once you have filled the details in Reservation Information tab click on the Resources tab. Here the Memory, Storage and Resource Pool (created in vCenter) can be configured for this reservation.
- Click on the Networks tab and assign the Network Profile created earlier and click OK.

CREATING BLUEPRINTS

- Navigate to Infrastructure -> Blueprints -> Blueprints and click on New Blueprint and select Virtual-vSphere.
• Name the blueprint and select the reservation policy and machine prefix you wish to tag to the blueprint and set the archive days according to your requirement.

Fig 13: Blueprint Information page

• Click on the Build Information tab and select the option Clone in the Action space.
• Click on the button next to Clone from option. This enables you to select the template you created in the vCenter. Choose the required template and click OK.
• Fill the Customization Spec space with the customization specification you created in the vCenter. It can be either Windows or Linux based on the template you select.
• Once you choose the template, the CPU, Memory and Storage options will be automatically filled based on the configuration of the template you select.

Fig 14: Assigning Customization spec and machine resources for blueprints

• Click on the Properties tab and under the Custom Property click on New Property.
• Add a property with name "VMware.VCenterOrchestrator.EndpointName" and enter the name you gave for vCO Endpoint in the value space and click the green tick button. This helps your blueprint to communicate with the vCO during the deployment process.

![Fig 15: Adding Custom properties for blueprints](image)

• Click on the **Actions** tab and ensure all the Machine Operations are ticked. Click **OK** and your blueprint will be created.
• You can view the blueprint you have created under the Blueprints tab. It should be published to make it available for creating a Service, Catalog etc.,
• Place the cursor on the newly created blueprint and select the Publish option and click **OK**. Now you can see that the Publish option next to your blueprint would have turned to “Yes”.

![Fig 16: Publish blueprint](image)

**vCO CONFIGURATIONS**

**ADDING A vCAC HOST:**

• As a cloud administrator log into vCO with its credentials and navigate to **Workflows -> Library -> vCloud Automation Center -> Configuration**.
• Right click on the **Add a vCAC Host** workflow and select **Start Workflow**.
• Type a name for the vCAC host and mention the IP or the FQDN in Host space option and click **Next**.
• Choose “Yes” option for Automatic install SSL Certificates option.
• Enter the vCAC service account credentials for the Shared Session Mode and click **Next**.
• Enter the Domain for NTLM Authentication and click **Submit**.
• Once the workflow is successful, navigate to **Inventory -> vCAC** in vCO and check whether all the Blueprints, Virtual Machines etc. that are in vCAC are reflected in vCO.
INSTALL vCO CUSTOMIZATION:

- Navigate to Workflows -> Library -> vCloud Automation Center -> Extensibility -> Installations and right click on Install vCO Customization Workflow and select Start Workflow.
- Enter the vCAC host name and click Next. Check the required state change workflow stubs and click on Next.
- Enter the number of Menu operations required in the given space and click Submit. Once the workflow executes successfully you can view the Menu operations in vCAC under the Actions tab of any blueprint. It is these stubs that enable us to capture the virtual machine details while being provisioned or while being deleted.
Fig 19: Menu operations obtained after vCO Customization

CONFIGURING DATABASE:

- In vCO navigate to Workflows -> Library -> SQL-> Configurations and right click on the Add a database workflow and select Start Workflow.
- Fill the name of the Database and select the database type and type the URL.
- Type the user Credentials for the shared session and click on Submit.
- After this workflow runs successfully right click on the Add tables to database workflow and select Start Workflow.
- Select the database to which the tables should be added and click Next. Select the tables you want to add to the database and click Submit.
- Every time a new row or column or tables are added to the database, run the Update a database workflow under the SQL -> Configurations folder.

As seen in figure-19 there is no workflow stub for machine modification. For this reason we are using SNMP traps based workflows to capture any modifications that a virtual machine undergoes.

ADDING A SNMP DEVICE:

- Log into the vCO and navigate to Workflows -> Library -> SNMP -> Device Management.
- Right click on the Register an SNMP device workflow and select Start Workflow.
- Enter the address of your vCenter in the Device Address name space. Choose “Yes” for Advanced Option and click on Next.
- Enter the port number as 4000 and select V2C under Version tab and enter Public under the community name and click Submit.
Successful execution of the workflow will be indicated by a green tick mark.

- Right click on the **Set the SNMP trap port** under the **Trap Host Management** folder and click on **Start Workflow**.
- Enter the value of the port in Port space that was previously used while executing the Register an SNMP device workflow and click **Submit**.

### vCenter Configurations

**Configuring SNMP in SNMP Receivers:**

- Log into vCenter with administrator credentials and navigate to **Administration tab -> vCenter Server Settings -> SNMP** and enter the IP address of the vCO Client you are using in the Receiver URL under Primary Receivers.
- Enter the port number that was used to configure SNMP device in vCO in the earlier steps next to Receiver URL space and fill the Community String space by “public” and click **OK**.

### Alarm Configurations:

- Log into vCenter with administrator credentials and find the Resource Pool you created earlier.
- Right click on the Resource Pool and navigate to **Alarm -> Add Alarm** and this opens up a new window.
• In the **General** tab, enter the name of the Alarm and select “Virtual Machines” under Monitor and check the “Monitor for specific events occurring in this object” option and “Enable this alarm” option.

• Navigate to **Triggers** tab and click on **Add**. Under the **Events** tab select “VM Reconfigured” option, set the status to “Unset”.

• Navigate to **Actions** tab and click on **Add**. Under the **Action** tab select “Send a notification trap” and select the option “Once” for the “From warning to alert” option and click **OK**. This configures the alarm to the Resource Pool.

Fig 22: Configuring SNMP traps in vCenter Server using Alarm

**WORKFLOWS FOR CMDB**

We have built custom workflows for updating the DB.

**CREATE OPERATION: vCenter - Create**

This workflow is for new VM deployments in vCAC.

Fig 23: vCenter - Create workflow
The “Collect Records” task collects the information such as the CPU count, memory, storage, IP Address, user who requested for the VM, business group etc.,

The "Assign values to attribute" task collects the records obtained and assigns them to the attributes which is later used to update the CMDB.

The "Calculating Cost" task calculates the cost of CPU, Memory and Storage per day based on the Reservation Policy that we set in the blueprint. The cost for per unit vCPU, memory and storage are hardcoded based on the reservation policy. Also based on the reservation policy, CPU and memory allocations and reservations are set in this task.

Based on provisioning of RDM to the VM a decision is made by the decision element. If the RDM is not required, the workflow moves towards updating the database. A small amount of delay is introduced for certain internal operations to execute during the process.

The "Update Database" task updates the all the acquired information such as vmname, owner, operating system, CPU counts, memory, storage, IP addresses etc., to the database. The status in the DB reads as “Created” since it is a new VM that is being deployed.

Once the database is updated, the Send Email task sends out a mail to the user who requested for the VM. The mail contains the information of the VM and login credentials of that VM etc.

**MODIFY OPERATION: vCenter - Modify**

This workflow is run when the configuration/properties of existing VM’s is modified/edited.

- The "Get VM name Modified" task acquires the name of the VM from the vCenter once the trap is sent to vCO during the edit operation initiated from vCAC.
- The "Query for DB" name task queries the records in the database by using the VM name. Since VM names are unique, the complete information which is in the DB associated with that VM is obtained.
- The "Proceed if VM name exists" task makes a decision to execute the workflow based on whether the vm name acquired is valid or not.
- The "Status of the VM" decision element does exactly that. It decides based on the status of the VM.
- The "Collect Modify Info" task collects the modified information of the VM like change in the CPU or Memory or Storage and assigns these modified details to attributes.
- For the new values of CPU or Memory or Storage, cost is calculated based on the reservation policy under "Calculate Cost".
- Finally under "Update DB" the database is updated with new values. In the database, the status reads as "Modified" if the values are modified.
DELETE OPERATION: vCenter - Delete

This workflow is run when the VM is deleted.

- During the Unprovision state of the VM, this workflow executes. The “Collect Records” task obtains the VM information when the VM is getting destroyed.

![Fig 25: vCenter – Delete workflow](image)

- The values are assigned to attributes under “Assign Values to At” and the database is updated under “Update DB” with the available information. The status reads as “Deleted”.

CONFIGURING STUBS TO BLUEPRINTS IN vCO

VM Create and Delete Operations:

- Log into the vCO again using its credentials through the vCO Client and navigate to Workflows.
- Under this find Assign a state change workflow to a blueprint and its virtual machine workflow by navigating to Library -> vCloud Automation Center -> Extensibility.
- First, right click on this workflow and select Start Workflow. A new window pops up. Select MachineProvisioned stub under the vCAC workflow stub to enable this stub. Select you vCAC host and click Next.
- Tags the blueprints created in vCAC, by clicking on it and then click Next.

![Fig 26: Assigning State change workflows to the blueprint](image)

- Assign a vCenter - Create workflow in the vCO to that blueprint. When the blueprint is deployed from vCAC and is in Machine Provisioned state, this workflow runs. As shown above this workflow captures the details of the VM and updates the database.
- Select the option “Yes” or ”No” based on your requirement and click Submit.
• The workflow starts to execute and once it is successfully done you can see a green tick mark on its left.
• Similarly Assign a **vCenter - Delete** customized workflow in the vCO to that blueprint so that the workflow executes when the VM is in unprovision state i.e. when the VM is deleted.
• Select the option "Yes" or "No" based on your requirement and click **Submit**.

To ensure the process was successful, log in back to vCAC and navigate to **Infrastructure -> Blueprints -> Blueprints** and click on the **Edit** option of your blueprint and navigate to **Properties** tab. You will see newly added properties. This is added by the workflows ran in the vCO. Click **OK**.
Repeat the above procedure if you want to capture the VM properties during other stages of VM provision/unprovision based on your requirements.

**CREATING POLICY IN vCO: VM MODIFICATION OPERATIONS**

- In vCO, navigate to Policies and click on Create New Policy and enter a name for policy and click OK.

- Newly created policy can be viewed in the left pane. Right click on the policy and click on Edit option. Right click on the policy and select Add Policy Element and select SNMP: SnmpDevice option and click OK.
- Choose the SNMP device you configured using the workflows as in the earlier steps and click Select.

- Right click on the SNMP device and select Add trigger event option and select OnTrap option in the Trigger tab and click on Select Trigger. This opens up a scripting window where a customized code is written to initiate a vCenter – Modify workflow during reconfiguration processes like changing/editing of VM configuration/properties etc. Click on Save and Close.
• Under the Policies tab you can view the newly created policy, right click on it and click on **Start Policy** option. Now the policy is running.

![Policy in running state](image)

**CREATING SERVICES AND MANAGING CATALOG ITEMS IN vCAC**

Services help us to segregate the catalog into different buckets. Catalog items can then be added to these services.

• Log into vCAC as Tenant administrator and Navigate to **Administration -> Catalog Management -> Service** and click on green “+” to create service.

• Type the name of the service you wish to create and change the status to “Active” and click **Add**. Once the service is created you can view it under Services tab.

• Click on the service and select Manage Catalog Items.

• The created service here is ”Infrastructure-Virtual”, we should add the blueprint that is created to the newly created Service.

• Click on the green “+” next to Catalog item to add blueprint.

![Adding Catalog item](image)

• Check the blueprint you have created and click on **Add**.

![Choosing the blueprint to make it as a catalog item](image)

**CREATING ENTITLEMENTS**

Entitlements help us to provide access to Business groups and users to the various services, catalog items as created earlier along with their Day 2 operation actions.

• Navigate to **Administration -> Catalog Management -> Entitlements** and click on green “+”. 

![We are here: Home > Administration > Catalog Management > Entitlements](image)
• Enter the details required and change the status Active and select the required Business Group and add the Users and click Next. Click on the Items and Approvals tab.
• Click on the green “+” next to Entitled Services and Entitled Catalog Items and add the Service and Catalog Item respectively that was created earlier and click OK.
• Click on the green “+” next to Entitled Actions and add all the VM related actions and click OK and then Update.

![Fig 35: Editing Entitlements](image)

Everything is now setup and can be tested. We can start with VM deployment

**VM CREATION**

• Login as end user and navigate to the Catalog tab and find the Catalog Item (Blueprint) you had created and tied to the respective Services.
• To deploy the blueprint, click on Request. Edit the configurations as per the requirement and click Submit and then click OK.

![Fig 36: Catalog item under the Services](image)

• Click on the Request tab and note that the deployment status is “In Progress”.
• Log in to the vCO, and navigate to Workflows -> Library -> vCloud Automation Center -> Extensibility -> WorkflowStubs -> WFStubMachineProvisioned and note that the WFStubMachineProvisioned stub will start to execute when the VM is in Machine Provisioned stage.
The WFStubMachineProvisioned workflow in turn calls a workflow named Workflow Runner which helps in initializing the vCenter – Create workflow.

The Workflow Runner workflow helps in acquiring properties such as CPU, Memory, Storage, User etc., from the VM which is getting deployed.

This workflow will in-turn run the workflow we tagged to the blueprint i.e., vCenter – Create in our use case and passes all the VM properties to the same.
• As mentioned earlier the **vCenter – Create** workflow, collects all the required information and based on the Reservation Policy tagged to the blueprint it calculates the per day cost of the VM and updates the DB.
• Once the workflow execution is successfully done, we can see a green tick mark to the left of the workflow.

![Fig 40: vCenter – Create workflow](image)

• On refreshing the vCAC Request tab, the status of the deployment will be shown as “Successful”.

![Fig 42: Status of the VM in vCAC once it is created](image)

• Click on the **Items** tab and notice that the machine is present under this tab now. Placing the cursor on the machine will show the Day 2 operation action elements that were added while creating the Entitlements.
• The information obtained will be updated to the database as shown below.
DAY 2 OPERATIONS: VM MODIFY AND DELETE

EDIT VM:

- Under the Items tab in vCAC, click on the VM you have created. That will open up a window as shown below.

- This tab gives us the status and configuration details of the deployed VM. Navigate between Storage, Network tabs etc., to get the VM information.

- The Action tab in the right side of the picture shows the different operations that can be performed on the VM. The Day 2 operations involves editing the configuration of the VM, powering off the VM, restarting, shutting Down of VM etc.,

- In our use case we will edit the configuration of the VM. Click on the **Edit** option.
• Change the CPU and Memory of the VM by clicking on their respective boxes.
• There is a provision to change the owner of the VM too. If this is required then type the new owner name followed by your domain name and click **Save**.
• To add additional Storage, click on the **Storage** tab and click on **New Volume**.

![Fig 45: Editing of VM details such as CPU, Memory and User](image1.png)

- Enter the required value of storage under the Capacity space and click on the green tick mark and click **Save**. Note that the total storage should not exceed the maximum storage that is been assigned while creating a blueprint.
- In the same way new network adapters or new properties can be added to the VM. After making the required changes click on **Submit** and click **OK**.
Navigate to the **Requests** tab and note that the status of the operation you requested will be as "In Progress".

During this process, in vCenter, the VM undergoes a set of processes. First, Initial Guest OS Shutdown process takes place which is followed by reconfiguration and powering on of the VM.

The reconfiguration process triggers a SNMP trap in vCenter. SNMP traps are configured by setting Alarms to the Resource Pool in which the VM gets deployed as was shown earlier.

These SNMP taps are sent to the vCO. This triggers a **vCenter – Modify** workflow which helps us to capture the new configuration details of the VM.

As explained earlier these details are updated to database after the successful execution of the workflow which is indicated by a green tick mark on the left of the workflow.
• Navigate to the **Requests** tab in vCAC and note that status now reads as “Successful”.

![Fig 51: Status of the operation in vCAC once it is completed successfully](image)

• Navigate to the Items tab and click on the VM. This will display the new configuration details of the VM.

![Fig 52: Details of VM](image)

• The database entries pertaining to the creation and modification of the VM are as shown below.

![Fig 53: Database updated with new values](image)

**DELETE THE VM:**

• One of the Day 2 operations is destroying the VM. This removes the VM from the inventory in vCenter.

• Click on the VM under the **Items** tab and click **Destroy** under the Actions tab.
• Click **Submit** and then click **OK**. Navigate to the **Requests** tab to note that the status of the destroy process reads as "In Progress".

• In the vCenter, the VM powers off and then gets destroyed. This process initiates a **WFStubUnprovisionMachine** workflow in vCO.

• Log in to the vCO, and navigate to Workflows -> Library -> vCloud Automation Center -> Extensibility -> WorkflowStubs -> WFStubUnprovisionMachine and note that the **WFStubUnprovisionMachine** stub will start to execute when the VM is in Unprovision stage.

![Fig 54: Execution of WFStubUnprovisionMachine Stub](image)

• The **WFStubUnprovisionMachine** workflow in turn calls a workflow named **Workflow Runner** which helps in initializing the **vCenter – Delete** workflow.

![Fig 55: Execution of WFStubUnprovisionMachine workflow](image)

• The Workflow Runner workflow helps in acquiring the VM properties such as CPU, Memory, Storage, User etc., from the VM which is getting destroyed.

• This workflow will in-turn run the workflow we tagged to the blueprint i.e., **vCenter – Delete** in our use case and passes all of the VM properties.

![Fig 56: vCenter – Delete workflow execution](image)

• Once the workflow execution is successfully done we can see a green tick mark to the left of the workflow.
• Refreshing the vCAC Request tab, the status of the deployment will be shows as “Successful”.

![Fig 57: Successful completion of the workflow](image)

- Click on the Items tab and notice that the machine will not be present under the tab.
- Once the VM is destroyed, the information collected will be updated on the database as shown below.

![Fig 58: Status of delete operation in vCAC](image)

### BUILDING A FRONT END WITH CMDB WITH WAVEemaker

- VMware’s Wavemaker is a powerful platform that helps in creating web based applications. Wavemaker can be designed, developed and integrated with the CMDB as obtained above to provide a rich graphical user interface to view the records in CMDB.
- Launch the Wavemaker application and create the new Project. The front end of the portal can be developed as per the user requirement.
- Navigate to Services tab in Wavemaker and click on Import Database. Select the type of database and enter the credentials of the database and name of the database you want to import.

![Fig 59: Database updated after deleting the VM](image)
• Click **Test Connection**. Once the connection is tested successfully click on the **Import**. The database columns will be imported to the Wavemaker.

• Note that the database columns and the columns that are created in the Wavemaker have the same name.

• Wavemaker provides an option to customize our front end portal appearances. Any column that has to be modified or removed can be done so by right clicking on the layout you have created under the Palette and Canvas tab. Click on Edit Column option and a window pops up. Numerous options are available in this window where you can add or remove the columns, rename the column, change the order of the columns, selecting a format to the respective columns etc.,

• Once the editing is done click **OK**. The changes can be viewed in your layout.

• Select the project that is created and click on it by navigating it to the **Services** tab. The database should be re-imported if any minor changes are done in the original database.

• Click on the **Database** tab and click on the **Database Connection** icon. This pops up a window and verifies that all the details provided are valid. Next click on **Test Connection**. Once the connection is successful click on the **Re-Import** option. Any changes in the database will be replicated in the Wavemaker.
Once the vCO workflows execute and databases are updated, launch the Wavemaker application and open the project you have created. Click on the **Run** tab. The portal gets launched in a new tab and you can find all the entries that are recorded in the database.

This project can then be exported as a war file and deployed in any of the web servers. In our case we imported it into Pivotal Cloud Foundry.

**CONCLUSION**

This is one of the use case for the extensibility feature of vCAC using its Design Center integrated with VCO. One can build similar sorts of numerous use cases for new implementations and integration with existing environments. This thus enables us to provide - Anything-as-a-Service (XaaS) from vCAC.