Technical Report

# IT as a Service

## Storage Automation Using NetApp OnCommand Workflow Automation and HP Operations Orchestration

Dan Herington, NetApp
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## Abstract

NetApp® OnCommand® Workflow Automation (WFA) helps standardize IT administration tasks related to NetApp shared storage and publishes these tasks as workflows for enterprise orchestration tools. This report describes the HP Operations Orchestration (HP OO) content pack, which can be imported into HP OO. This pack allows users to run WFA workflows through the WFA representational state transfer (REST) API and is available on the HP Live Network.

DISCLAIMER: This is a community-contributed content pack. It is provided as is, and is not supported by NetApp. Submit comments and questions to the HPLN Community page.

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# 1 Executive Summary

## 1.1 Introduction

NetApp OnCommand Workflow Automation (WFA) is a powerful framework for automating storage management tasks that enables agility, flexibility, efficiency, and repeatability of best practices in a NetApp shared-storage infrastructure. WFA comes with predefined, supported base building blocks, including the capability to customize and extend the system to suit specific needs. It also features a Web Service API that allows WFA workflows to be triggered from virtually any enterprise orchestration application.

Hewlett-Packard Operations Orchestration (HP OO) software integrates enterprise-management systems and automates standard operations as well as critical Information Technology Infrastructure Library processes. HP OO provides out-of-the-box workflows for data centers and can also be extended and customized to suit particular deployment requirements.

This document describes a content pack for HP OO that provides OO subflows to execute the WFA REST API that is used to execute and manage WFA storage automation workflows. This document contains:

- An overview of the integration of HP OO and OnCommand WFA
- An overview of the WFA REST API and the HP OO operations available in the integration content pack
- A description of how to download and import the NetApp WFA content pack into HP OO
- A description of how to modify the example HP OO flows in the content pack to execute any other WFA workflow that you developed

## 1.2 IT as a Service

Many IT organizations are exploring and/or implementing cloud computing technologies. Originally, the primary benefit of cloud computing was thought to be cost savings. However, the most compelling advantage has been a significant reduction in the time required to deploy new applications and solutions. One of the primary reasons for this reduction is that much of the lifecycle of virtualized infrastructure is automated, resulting in:

- Reduced implementation time
- Fewer errors compared to those from implementing custom solutions for individual applications
- Lower maintenance costs because automated processes implement standard configurations that are easier to troubleshoot

## 1.3 The IT Automation Challenge

To realize the benefits of automation, you must design, implement, and test the automation itself. This is not cost effective unless the process being automated is run many times. Therefore, you must build a flexible infrastructure derived from standardized building blocks. In addition, automation typically requires a deep understanding of the underlying technological components and the APIs for those components.

Although many enterprise automation and orchestration tools are available in the market, it can be challenging to integrate and maintain a single enterprise management tool that directly manages all aspects of an IT infrastructure. It is therefore desirable to modularize the automation of individual infrastructure domains (such as servers, storage, and so on) and to have the enterprise orchestration tool provide overall coordination leveraging well-defined interfaces. This means that, for any change in an enterprise orchestration tool or other aspect of the IT infrastructure, there is no need to recreate administrative workflows that minimize the effect on the previously developed and tested automation of any specific element.


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Some examples of use cases for this modular approach to leveraging WFA for storage automation and OO for higher-level orchestration include:

- Creating a new storage volume or LUN and attaching it to a server, virtual machine (VM) host, or VM in a single workflow
- Updating a configuration management database in conjunction with the creation or modification of a storage volume or LUN
- Automation of the failover of an application in conjunction with the breaking of a storage replication mirror on the remote side
- Automation of a nondisruptive move of a storage volume to a higher-performance storage tier in response to the detection of a performance issue within an application

# 2 Software Components and Integration

This section describes the interaction of the individual software components used to implement IT service automation using HP OO while leveraging WFA for storage automation. The four main software components are:

- **Self-service portal.** The interface that service consumers use to request access to IT resources
- **HP OO.** The orchestration platform that develops end-to-end automation flows for IT service provisioning
- **OnCommand WFA.** The automation framework for NetApp storage services
- **NetApp OnCommand Unified Manager (OCUM).** The monitoring solution for NetApp storage solutions

Figure 1 shows the basic interactions between these components and the user roles that interact with them.


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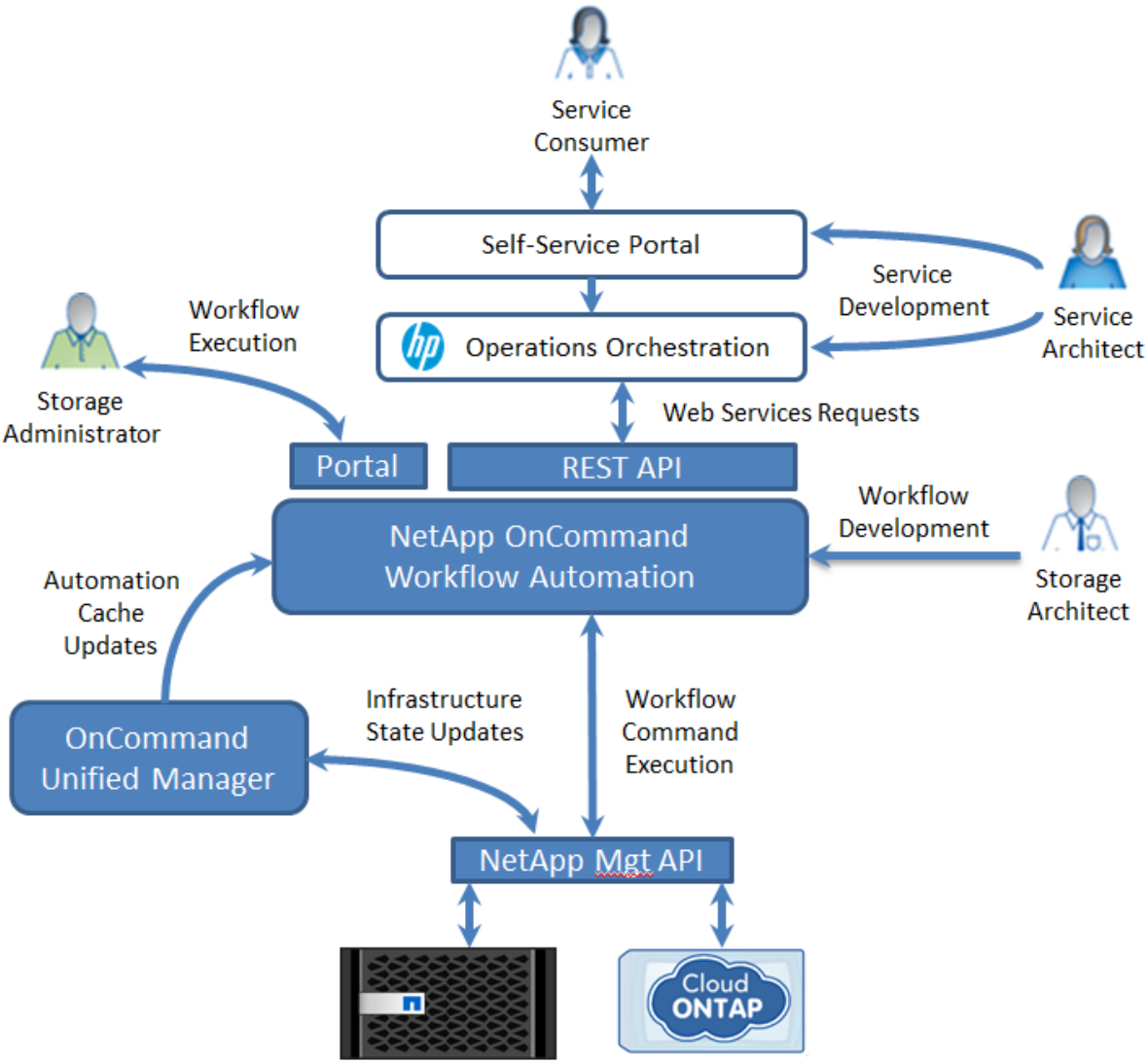
Figure 1) Software component and role interaction.




## 2.1 Roles and Functionality

There are four main user roles in this environment:

- **Service consumer.** The ultimate consumer of services offered by the self-service portal.
- **Service architect.** Designs the services offered in the self-service portal (for example, HP Cloud Service Automation). Defines the HP OO service flows, combining resources such as those offered by OnCommand WFA and others provided by compute systems, applications, and so on. The service architect develops HP OO flows to interact with defined WFA storage automation workflows.
- **Storage architect.** Implements storage-management policies by creating the storage workflows in WFA, which are in turn offered as resources for the creation of services in the self-service portal and HP OO.
- **Storage administrator.** Manages the storage infrastructure and can directly access the WFA workflows to perform storage administration tasks according to defined policies. These workflows may or may not be accessible to HP OO as storage resource operations.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## 2.2 HP Operations Orchestration

The focus of HP OO is to automate IT processes and reduce manual activity. HP OO orchestrates across the functions of multiple technology-management frameworks to accommodate the execution of end-to-end workflows. Adapters provide an interface between HP OO workflows, IT components, and management frameworks. An HP OO workflow might leverage the workflows of multiple different underlying automation frameworks that are specific to the technologies they were designed to automate.

HP OO is accessed, possibly indirectly, by a service consumer when the consumer requests, for example, a predefined service. Service templates can be created by a service architect based on a packaged combination of available resources from storage, compute, and application elements for easy consumption by service consumers.

## 2.3 NetApp OnCommand Workflow Automation

OnCommand WFA is a software solution that offers one-click automation for key storage processes. You can automate storage management tasks such as storage provisioning, migration, backup, restore, disaster recovery failover and failback, decommissioning, and cloning. You can use WFA to build workflows that do exactly what your processes require. WFA provides a robust workflow design interface and a rich set of predefined content to simplify the workflow development process. There is also an ever-increasing amount of content available from the NetApp Storage Automation Store, which can be imported into your instance of WFA and customized to meet your requirements.

Workflows are available through a RESTful web services interface for use by HP OO. The content pack described in this document provides HP OO subflows for all of the WFA REST API calls that are relevant to the execution of WFA workflows. It also includes some examples of how to use the subflows to execute example WFA workflows.

WFA relies on OnCommand Unified Manager (OCUM) to maintain status information concerning the storage infrastructure (available storage controllers and the presence and state of aggregates, volumes, and so on) and the allocation of storage into resource pools. WFA collects this data from OCUM and stores it in a local cache on a regular basis. WFA can also collect and make use of data from other data sources, including OnCommand Performance Advisor and VMware vCenter (not shown in Figure 1).

## 2.4 NetApp OnCommand Unified Manager

NetApp OCUM is the primary monitoring and reporting tool for NetApp storage systems. It provides both a human interface and an API for integration with other management software. The API uses well-defined XML objects for communication, providing transparency and interoperability.

Data collected by OCUM is queried by WFA to provide a subset of relevant information for use with automation workflows. Multiple OCUM systems can feed into a single WFA installation. The storage administrator can directly access OCUM to create storage management reports and perform monitoring activities.

## 2.5 Architectural Considerations

A common question when considering an automation solution is whether it would be simpler to call the storage system APIs directly from the orchestration system rather than inserting another automation layer, such as NetApp WFA. We have chosen to implement this content pack between HP OO and NetApp WFA because:

- OnCommand WFA was implemented to provide a deep understanding of the underlying architecture of NetApp storage systems and the best practices for deploying storage on those systems. Because it also provides a standards-based REST interface, WFA allows the higher-level orchestration products to leverage that inherent knowledge with a minimum of added complexity.


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- WFA comes with extensive automation content out of the box. This content can also be modified to support unique use cases, much like OO content. Although it would be possible to implement this functionality in OO, it would be very time consuming and expensive.
- The WFA framework and certified packages are supported and maintained by NetApp. If you were to implement OO flows directly in the storage systems, you would have to support and maintain this code yourself.
- The content pack implements 11 REST calls to WFA. There are many hundreds of API calls to each of the various NetApp storage systems. The PowerShell Toolkit for the NetApp Data ONTAP® operating system alone contains over 600 functions.
- WFA supports every currently supported OS version of NetApp storage systems. When a new version is released, WFA is typically updated concurrently to support the new version.
- NetApp is making extensive investments to improve the WFA product and is also implementing additional supported automation content. Version 3.0 of WFA introduces the new Storage Automation Store, where new content can be released independently of WFA releases. This enables more rapid delivery of content and includes content supporting additional NetApp storage systems as they become available.

# 3 The HP OO Content Pack for NetApp OnCommand WFA

This section shows how to download and install the HP OO content pack for OnCommand WFA. This content pack is available for download from the HP Live Network site and can be imported into HP OO to allow OO flow developers to leverage WFA workflows in their automation flows.

The HP OO content pack for OnCommand WFA contains subflows that execute each of the REST API calls available for WFA, in addition to some utility and sample OO flows. This section describes how to download and import the content pack into HP OO. It also describes the components of the content pack.

## 3.1 Import and Configure the Content Pack in HP OO

To import and configure the content pack, complete the following steps:

1. Download the HP OO content pack for OnCommand WFA from the NetApp page on the HP Live Network. Access to the HP Live Network site requires an HP Passport account.


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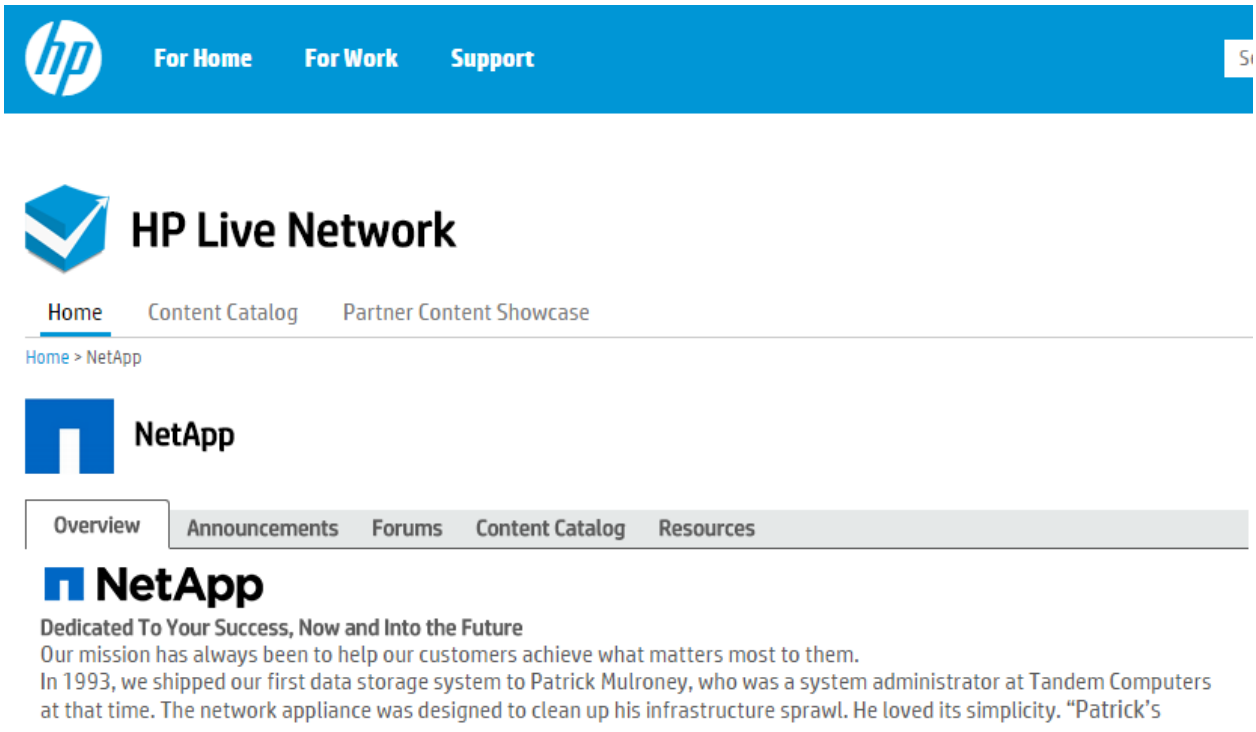
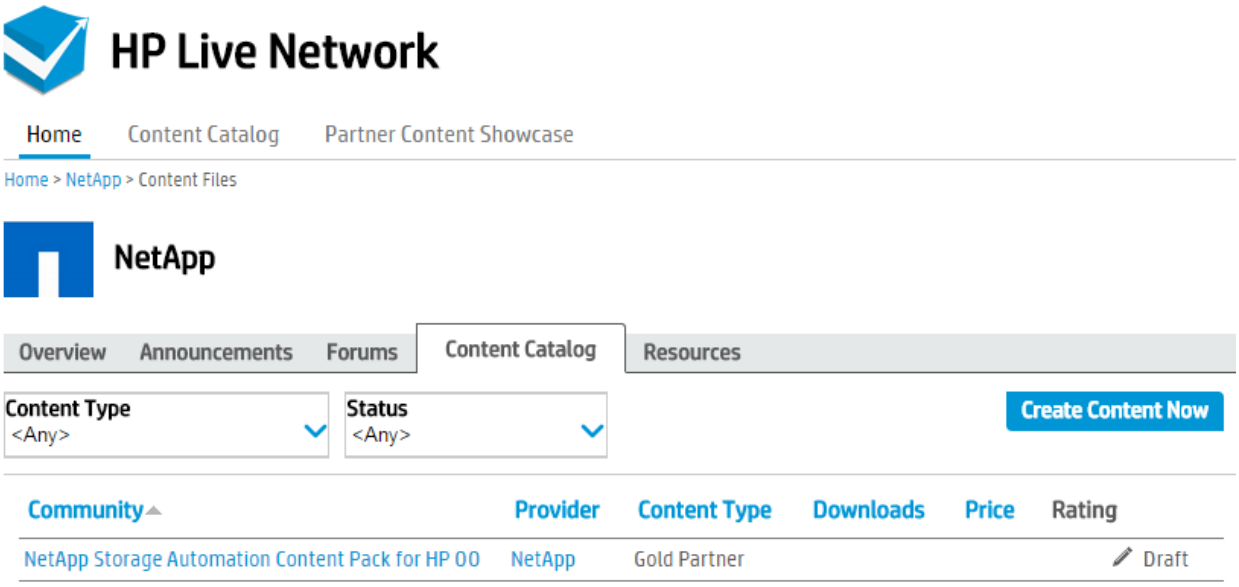
Figure 2) NetApp page on HP Live Network.




2. Upon reaching the NetApp page, select the Content Catalog tab under the NetApp logo and then select NetApp Storage Automation Content Pack for HP OO.

   **Note:** The HP OO content pack for OnCommand WFA was implemented using HP OO 10.21 with the Base Content Pack 1.3.1 and OnCommand WFA 3.0.

Figure 3) NetApp Content Catalog.




3. The content page displays the Download button.


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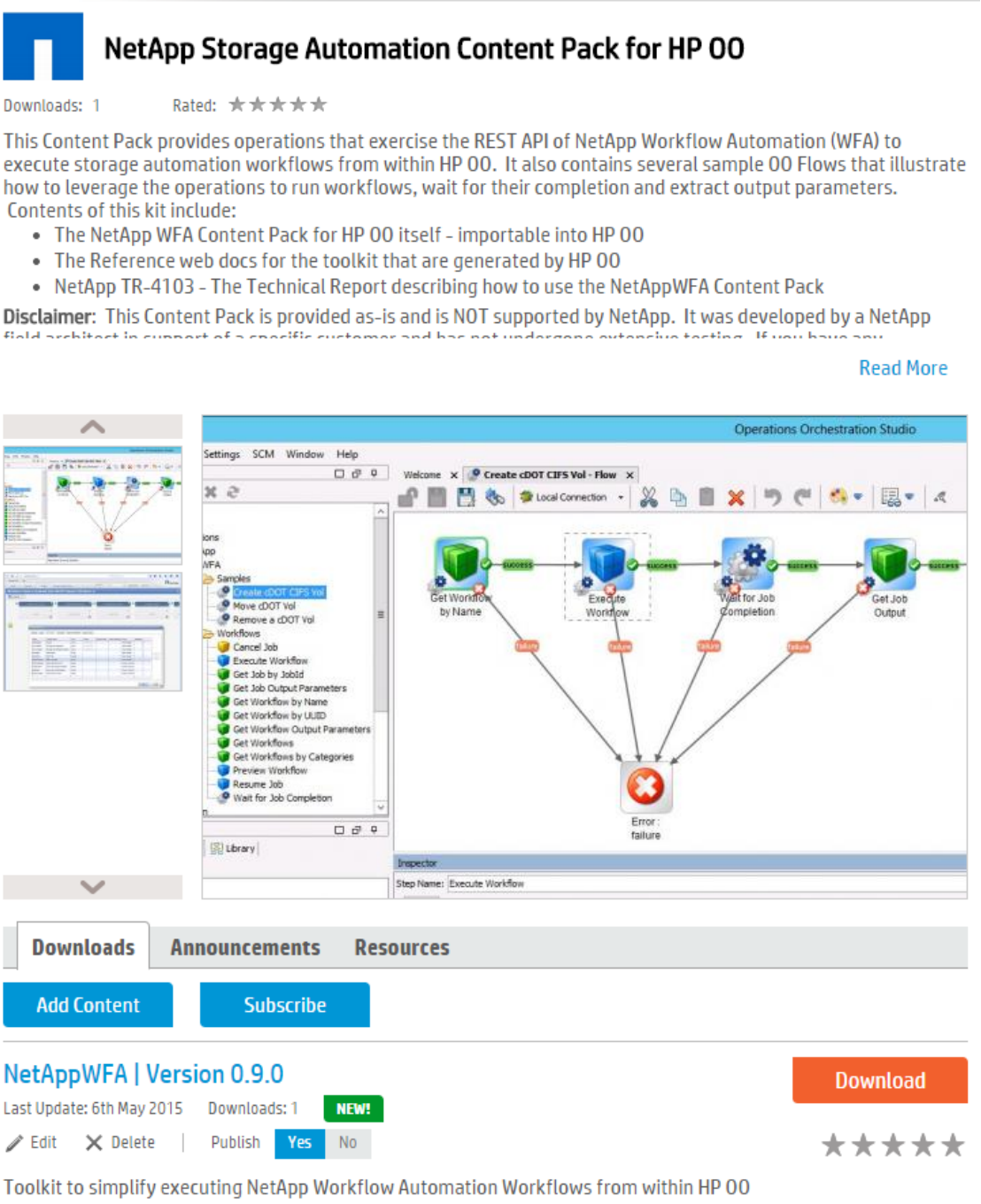
**Figure 4) Content pack description.**




4. Selecting the Download button downloads all the files in the content pack as a zip archive. The files include the `cp jar` file, a reference to the flows in Javadoc format and this document.


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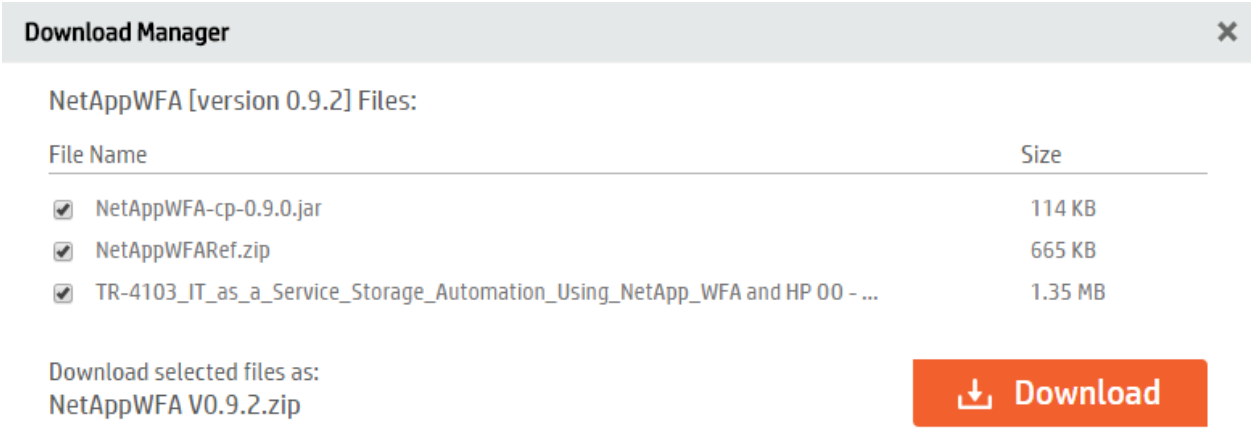
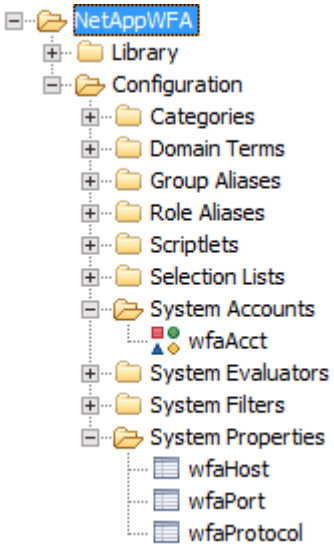
**Figure 5) Contents of the content pack download.**




5. After downloading the content pack to your system, extract the files from the compressed zip file.
6. Open HP OO Studio. Under Content Packs, select Import Content Pack.
7. There are four items in the Configuration folder that you must modify before the flows can work correctly. These configuration items, shown in Figure 6, are used by all of the other subflows in the content pack.

**Figure 6) Content pack configuration items.**




8. Modify wfaHost to the IP address or host name of the host where WFA is running. The wfaPort and wfaProtocol entries default to 443 and HTTPS. You do not need to modify these parameters unless you change the defaults within WFA.
9. Double-click the wfaAcct system account and enter the login credentials for the WFA user used by HP OO to execute WFA workflows through the web service interface.

   **Note:** For security and auditing purposes, you might want to create a new WFA user specifically for this purpose.

10. After making these configuration changes, the content pack is now ready for use. As a good smoke test, run the Get Workflows subflow because it has no inputs. If you get a large XML blob back that has information about each of the WFA workflows, the configuration works correctly.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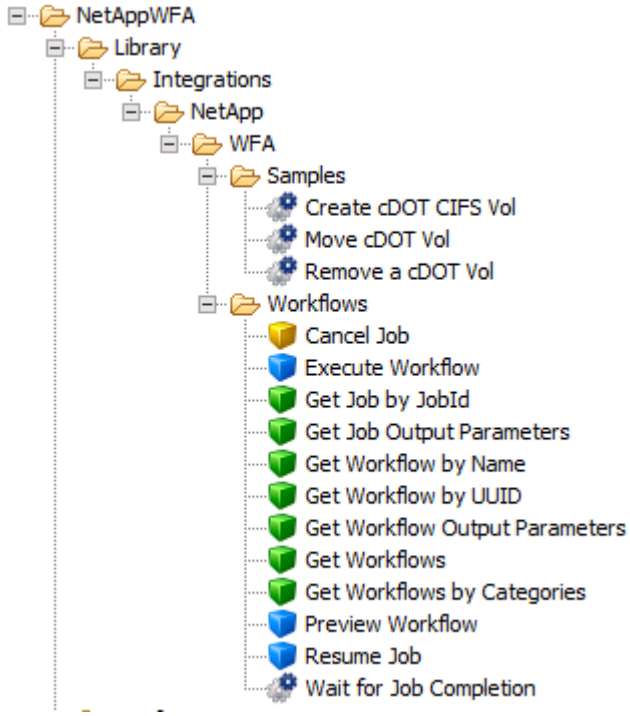
## 3.2 HP OO Subflows for WFA Web Service Calls

This section examines the flows available in the content pack.

There are several web service interfaces for WFA. This content pack contains HP OO subflows that execute workflows and manage workflow jobs.

**Figure 7) Content pack subflows.**




For details about the functionality of each of these REST calls, see the WFA Web Services primer. You can also access the reference on your WFA host at `https://<wfaHost>/rest/docs/`.

## 3.3 Utility Subflow

To simplify the development of HP OO flows based on the underlying WFA web service calls, the utility subflow `Wait For Job Completion` was developed as part of the content pack.

By default, WFA workflows are run asynchronously. This is because they can be scheduled for future execution, and it is also possible to insert approval points. The subflow `Wait For Job Completion` allows you to create an end-to-end OO flow that runs the WFA workflow and then waits for it to complete without requiring looping constructs in the OO flow.

## 3.4 Sample End-to-End OO Flows

The content pack also contains sample OO flows that run three of the workflows provided with WFA out of the box. The next section describes how to select one of these samples and then modify it to call any other WFA workflow.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# 4 Create an OO Flow to Run Your WFA Workflow

This section first describes the steps required to run a WFA workflow from the REST API. It then describes how to copy and customize the sample OO flows provided in the content pack to run your own customized WFA workflows.

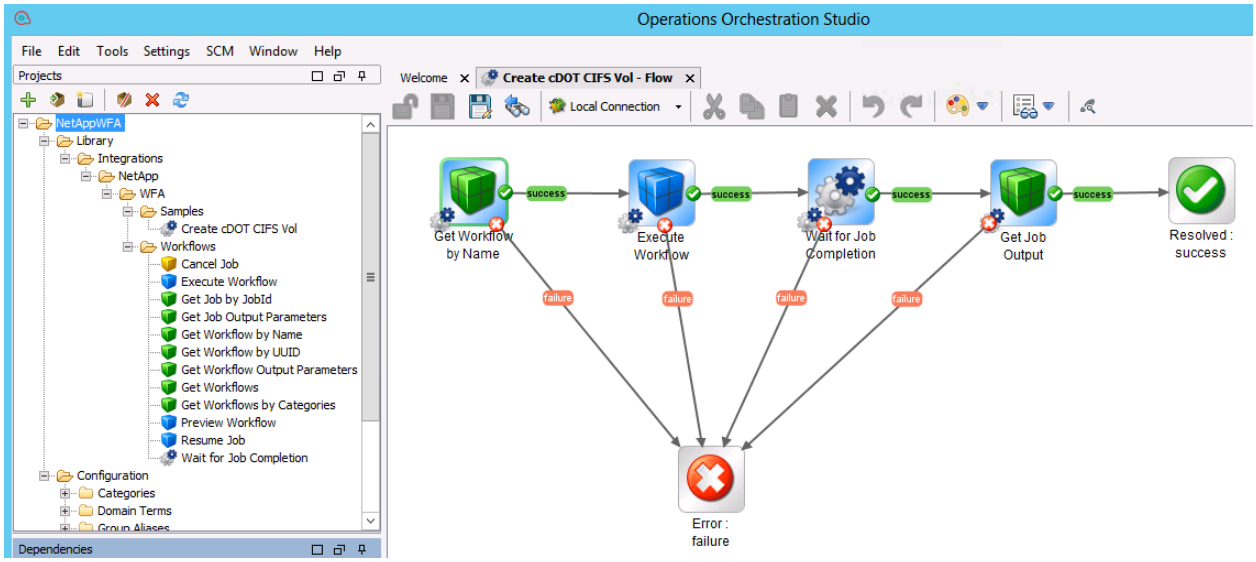
## 4.1 Anatomy of an OO Flow for WFA

The process required to run WFA workflows by using the REST API involves four primary steps:

1. **Obtain the ID of the desired workflow.** In this step, we query WFA using the `Get Workflow by Name` subflow and request that it return information about a specific named workflow. This returns information about the workflow, including the universally unique identifier (UUID) and the list of input parameters the workflow expects. We extract the ID so that we can execute the workflow in the next step.
2. **Execute.** A selected WFA workflow is parameterized and executed by using the `Execute Workflow` WFA REST call. Execution can also be scheduled for a later time. In either case, a job ID is returned that can be used as a reference to retrieve further execution information.
3. **Track status.** The execution status of a WFA workflow can be retrieved by using the `"Wait for Job Completion"` utility subflow. This subflow runs in a loop waiting until the job completes before moving to the next phase.
4. **Extract return parameters.** If the WFA workflow has return parameters, those parameters are extracted and assigned to the OO flow results so that they can be used by other HP OO operations.

Figure 8 illustrates an example HP OO flow called `Create cDOT CIFS Vol`.

**Figure 8) Create cDOT CIFS Volume OO flow.**




## 4.2 Customize Examples for Your WFA Workflow

To customize the example flows to run any arbitrary WFA workflow, complete the following steps:

1. Select a sample OO flow to start with.
2. Copy the chosen flow, open it, and rename it.
3. Update the input parameters to the OO flow to match the WFA workflow.
4. Update the workflow name in the call `Get Workflow by Name`.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5. Update the input parameters for `Execute Workflow` to match the WFA workflow inputs.
6. If there are return parameters, update them in the call `Get Job Output`.

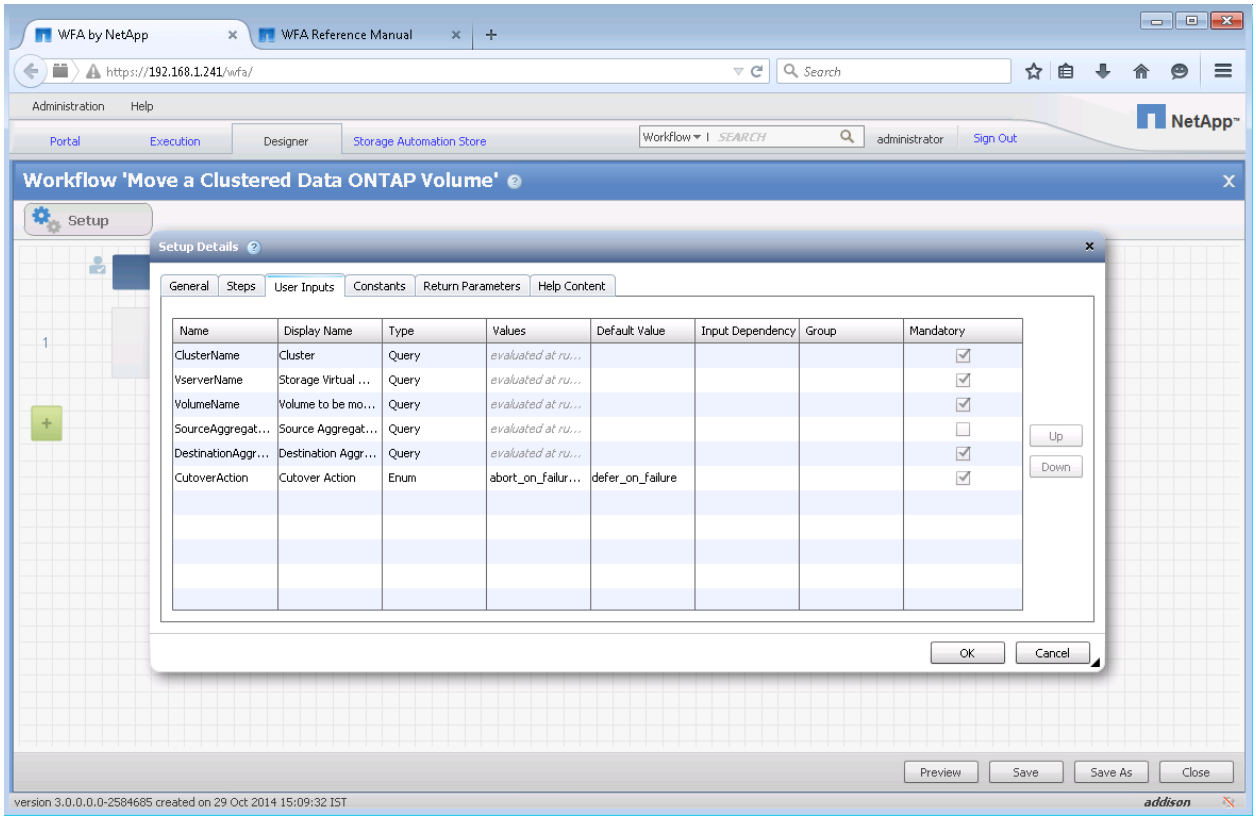
The rest of this section shows how to follow this process to create an OO flow to run another example WFA workflow.

## Select a Sample Flow

The first step is to determine which example flow to start with, based on which sample is the most similar to the WFA workflow you want to run (in other words, one that has a similar number or similar types of inputs and outputs).

1. Select the WFA workflow you want to run in the WFA GUI and click the Setup button. Then click the User Inputs tab and the Return Parameters tab (see Figure 9).

**Figure 9) WFA workflow input parameters dialog box.**




This workflow has similar inputs and outputs to those in the `Create cDOT CIFS Vol` sample OO flow, so we use this one to start.

2. In OO Studio, right-click the `Create cDOT CIFS Vol` flow and select Edit > Duplicate.
3. Open the copy that was created and click the Properties tab.
4. Change the name to something appropriate; in this case, `Move cDOT Vol`.

## Update OO Flow Input Parameters

While the Properties tab is open, you also need to modify the input parameters of this flow to match the input parameters of the WFA workflow that you are going to call. To do so, complete the following steps: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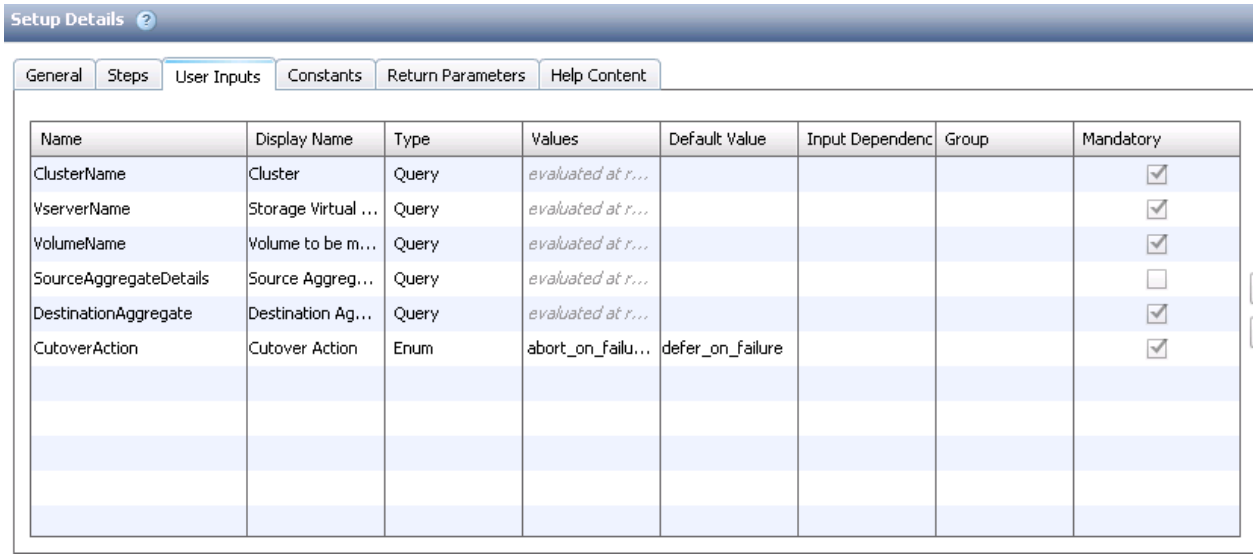
1. Back in the WFA, click the User Inputs tab in the Workflow Preferences dialog box, as shown in Figure 10.

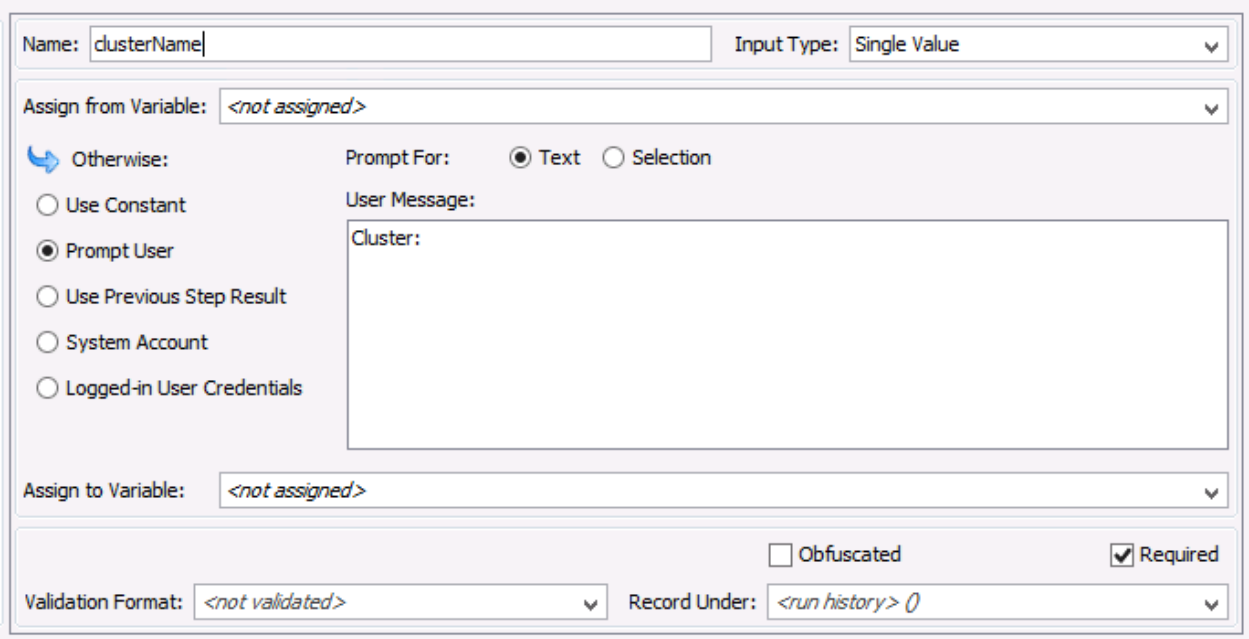
**Figure 10) WFA workflow user inputs dialog box.**




2. Modify the input parameters in OO to match this list.

   Back in OO Studio, we changed all of the input variables to match the names in WFA. Although we plan to call this flow from a self-service portal, we set Otherwise to Prompt User and the User Message to the WFA Display Name to make it easier to test the OO flow in the debugger. Figure 11 shows the settings for one of the input parameters. Repeat this process for the remaining inputs. This is not necessary for inputs that are not required in WFA.

**Figure 11) OO flow input parameters.**




Upon completion, the Inputs screen appears as shown in Figure 12.


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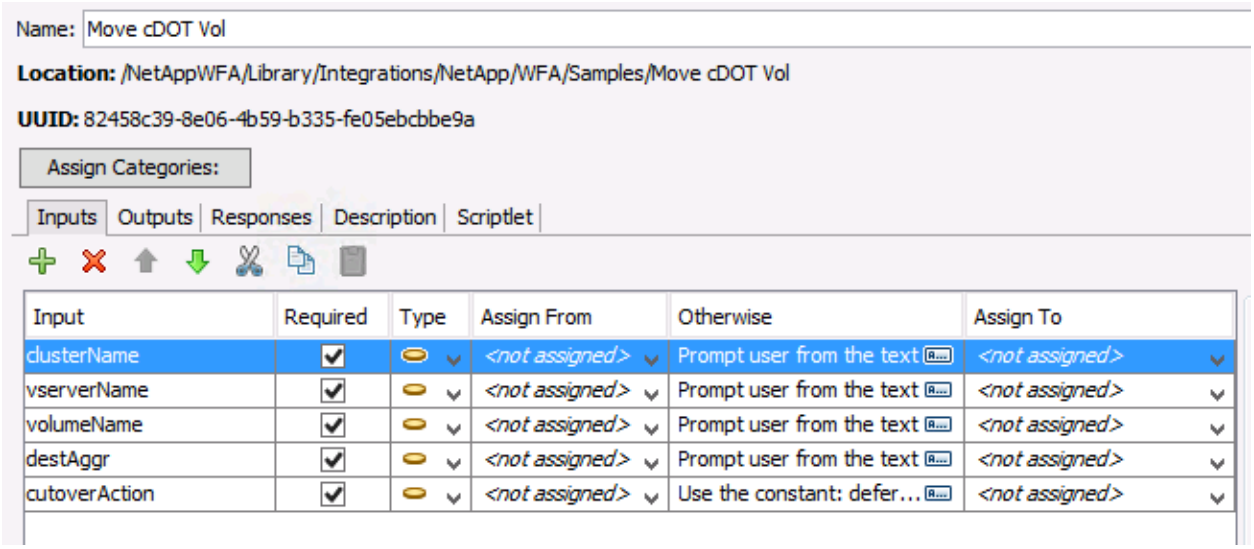
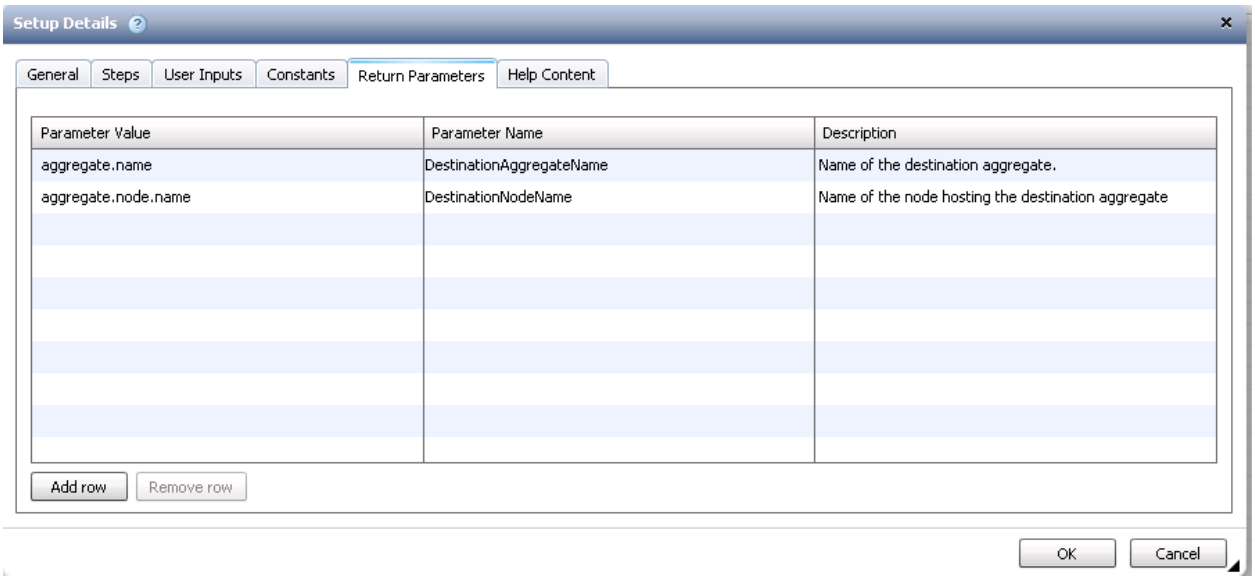
**Figure 12) Move cDOT Vol OO flow inputs.**




## Update OO Flow Outputs

The next step is to update the outputs of the OO flow to match the outputs from the WFA workflow. For this, we use a process that is very similar to what we did for the inputs. In the WFA Setup dialog for the workflow, select the Return Parameters tab.

**Figure 13) Move cDOT volume workflow return parameters.**




In this case, we see that the OO flow we duplicated already contains both of these parameters. Therefore, we need to remove only the other two outputs. We do not set any filters here because we filter the outputs inside the OO flow in a later step.


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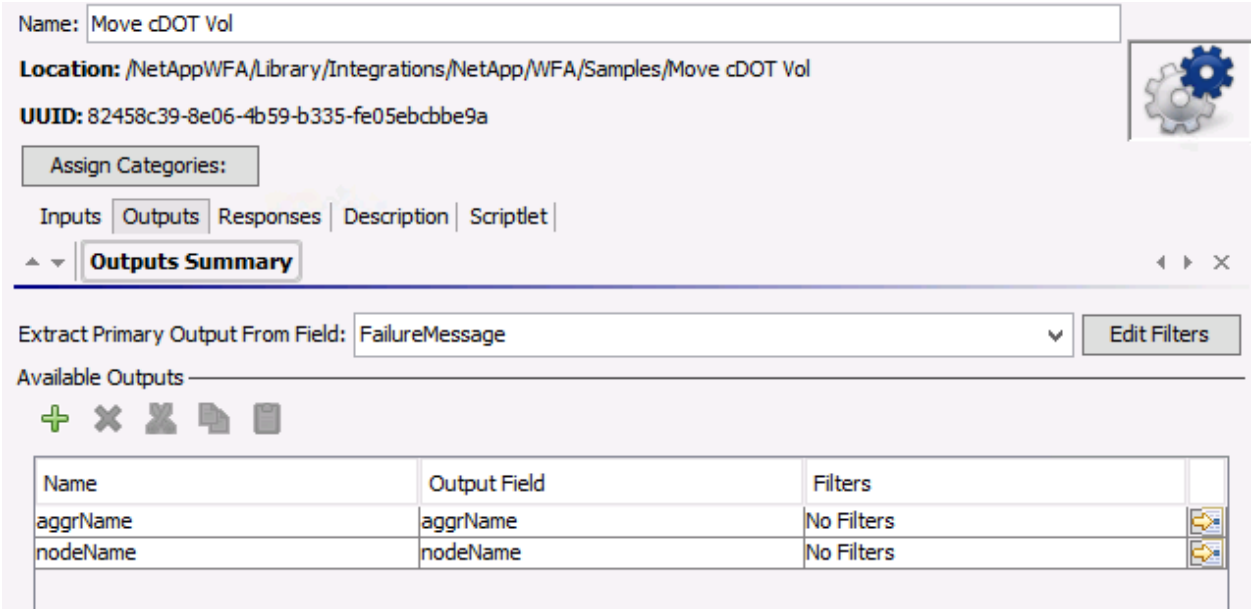
Figure 14) Move cDOT Vol OO flow outputs.

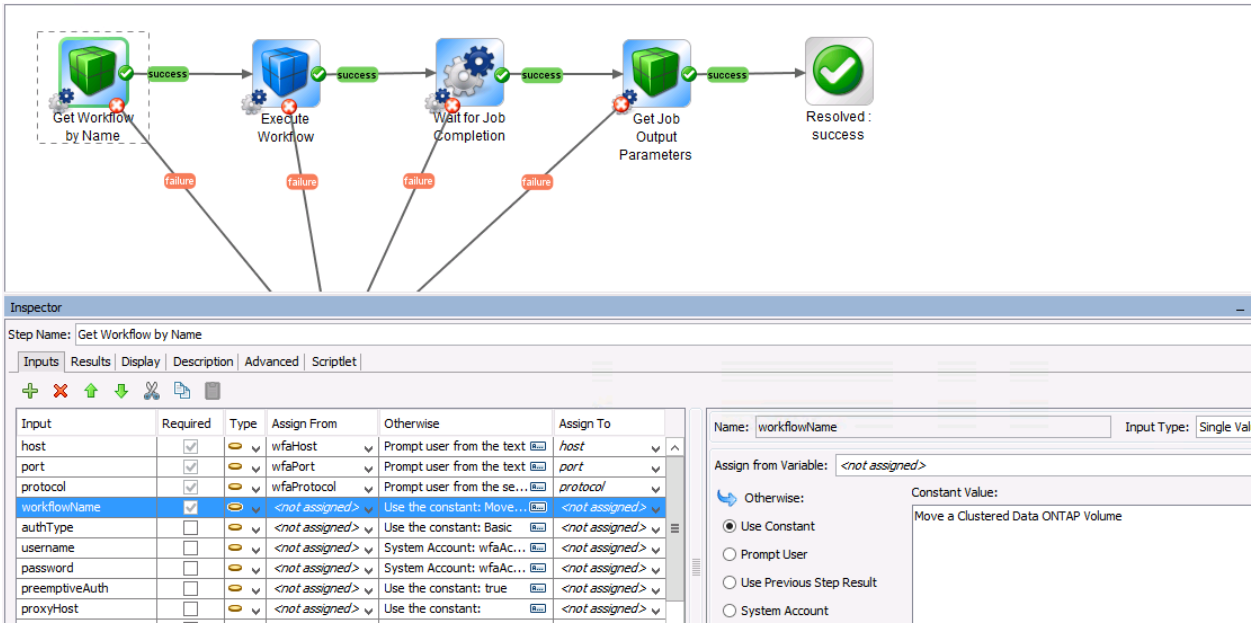



## Update OO Flow Steps

The final task is to update the steps in the OO flow. To do so, complete the following steps:

1. Click the Design tab at the bottom of OO Studio to view the flow steps.
2. Double-click the `Get Workflow by Name` step. Select the workflowName input and change the constant to the name of the WFA workflow. This must be the exact name of the workflow in WFA, so cut and paste this name from the WFA workflow Setup dialog in the General tab.

Figure 15) Update workflow name.





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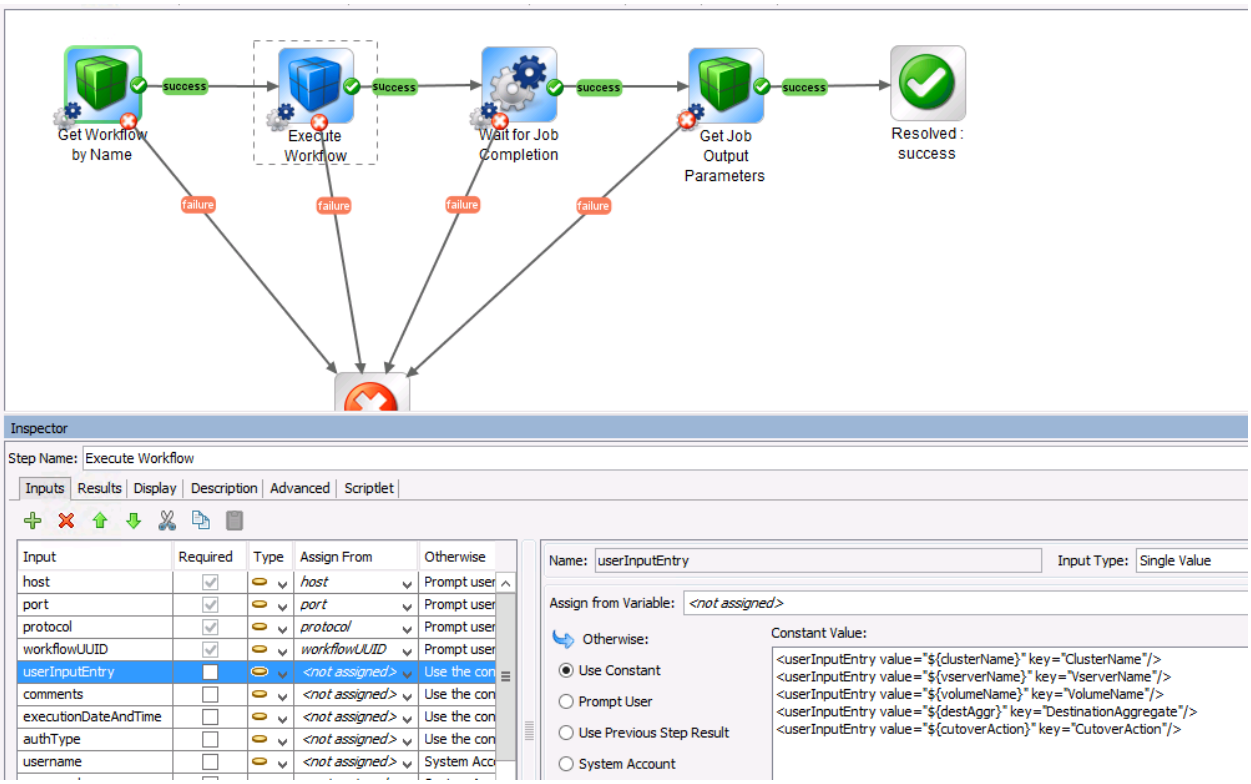
3. Select the Execute Workflow step and update the userInputEntry input to match the inputs that we set for this flow (see Figure 12). Be careful to ensure that the key value in the input exactly matches the parameter name in the Name field in WFA (see Figure 10) and that the value matches the flow input.

**Figure 16) Updated userInputEntry in Execute Workflow step.**




4. Select the Get Job Output Parameters step and go to the Results tab. You must match these step results with the OO flow outputs set in Figure 14.


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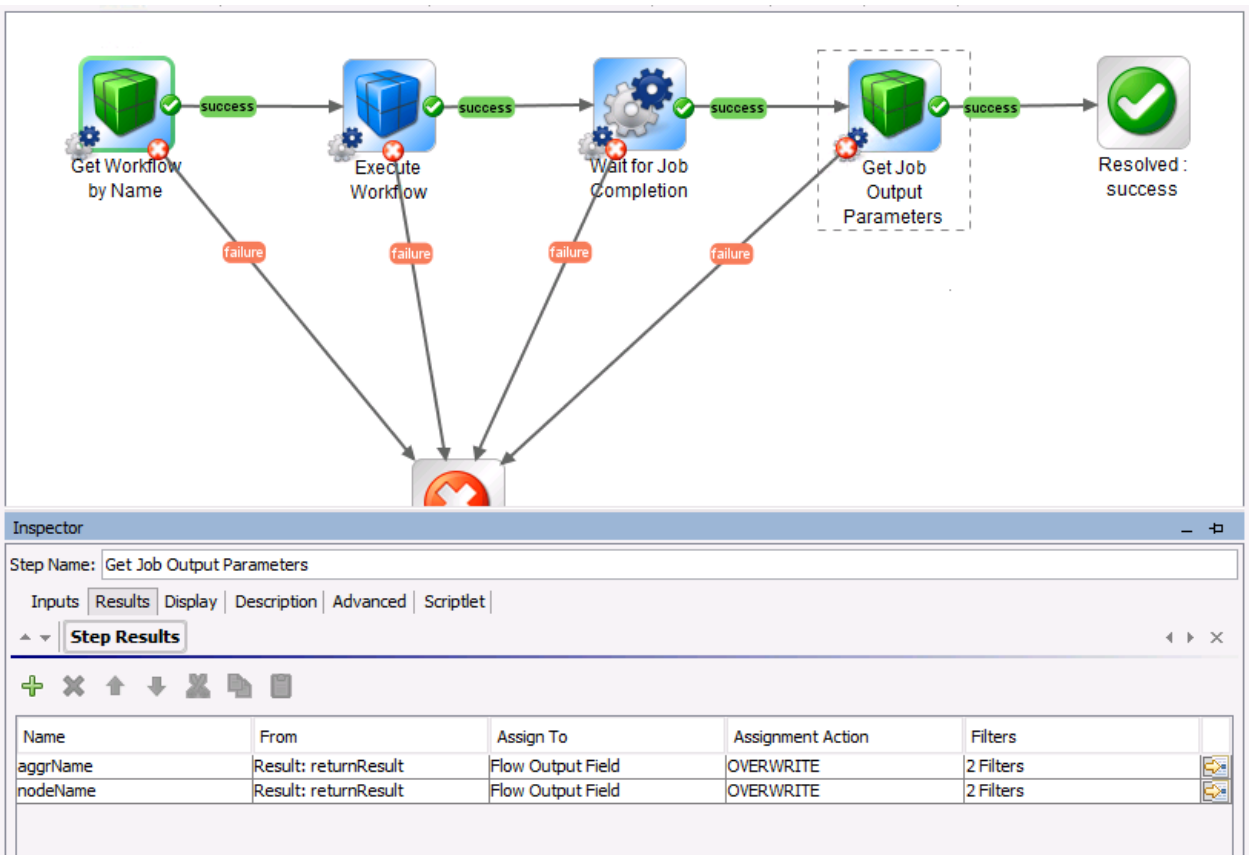
**Figure 17) Setting outputs in Get Job Output Parameters step.**




In most cases, you also need to set the filters to match the actual parameter name from the XML response to the REST call. The simplest way to do this is using Strip filters to remove all the text in the result up to and after the parameter. In this case, although the parameter name is the same in OO, the parameter name in WFA is different (see Figure 13). The result of this step is shown in Figure 18. Do this for all of the return parameters to make sure that they match the outputs from the WFA workflow. You do not need to change the Strip All Characters After filter, because it is simply the quote at the end of the parameter value.


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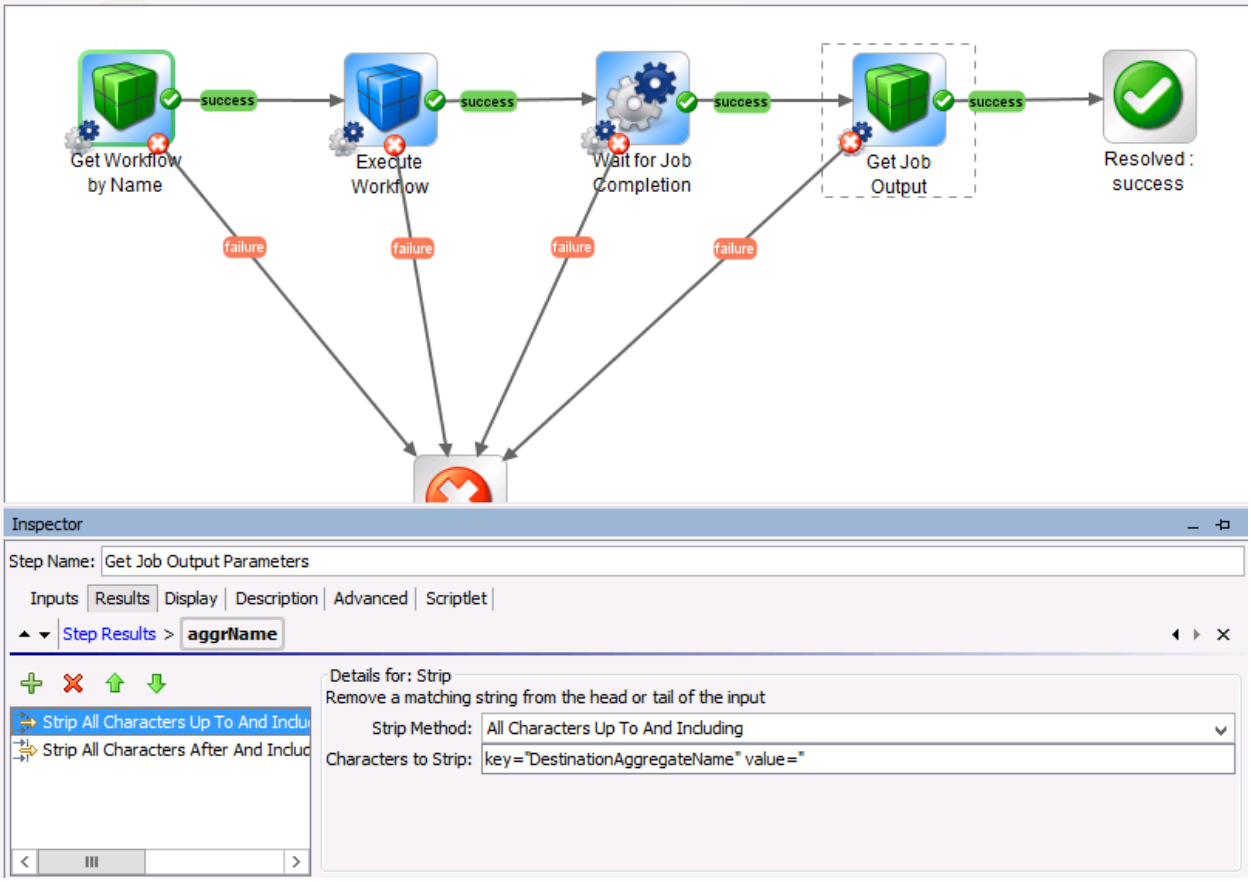
Figure 18) Modify filters for results of Get Job Output parameters.




5. The final step is to update the description of the workflow. Modify any step descriptions if you made any significant changes to how they operate.

# 5 Conclusion

This document:

- Describes how to use the OnCommand WFA content pack for HP OO to execute OnCommand WFA workflows from HP OO
- Provides a foundation for end-to-end automation scenarios for IT-as-a-service providers and enterprises that leverage the best of these two automation frameworks
- Describes a walkthrough of the individual steps and best practices needed to set up the integration and run a selected WFA workflow triggered by HP OO
- Shows how to modify the sample OO flows that come in the content pack to run any other WFA workflow

For an experienced HP OO consultant with basic knowledge of OnCommand WFA, performing the steps described in this document should take only a few minutes, assuming that both HP OO and OnCommand WFA are installed with existing WFA storage workflows.

# References

The following references were used in this technical report: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- OnCommand WFA Web Services Primer: https://communities.netapp.com/docs/DOC-21510
- OnCommand WFA online REST reference: https://<wfaHost>/rest/docs
- OnCommand WFA Communities: https://communities.netapp.com/community/products_and_solutions/storage_management_software/workflow-automation

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