

Creating and deploying a provider-specific IPAM integration package for VMware Cloud Assembly

This document applies to vendor-specific IPAM integration in VMware vRealize Automation Cloud and VMware vRealize Automation 8.x.

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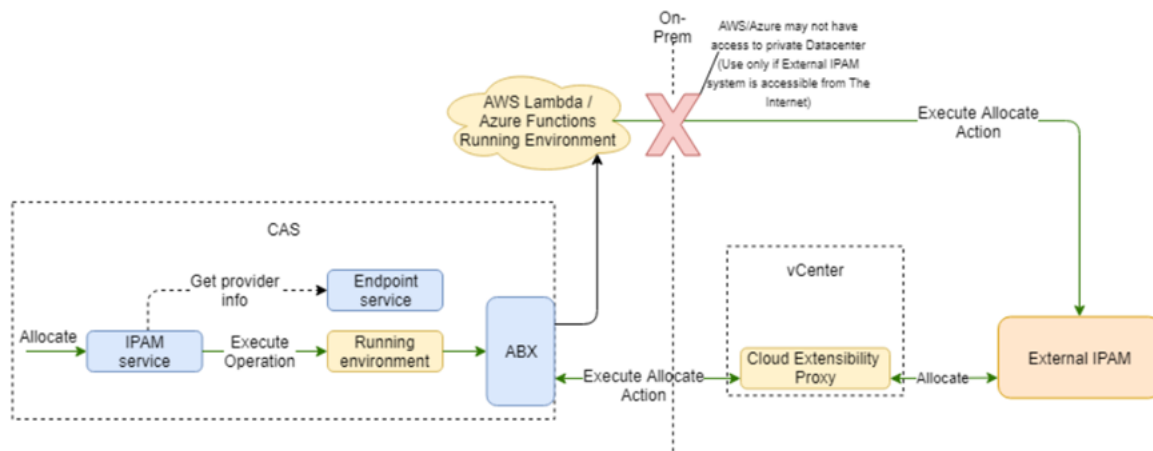
Revision History

DATE	VERSION	DESCRIPTION
October 17, 2019	1.0	Initial version.

Summary

The goal of this document is to provide the information needed by external IPAM providers to integrate their external IPAM system with the Cloud Assembly service in either *vRealize Automation Cloud* (SaaS) or *vRealize Automation 8x* (on-premises).

Reference this document when building a custom external IPAM integration for *vRealize Automation Cloud* and/or *vRealize Automation 8x*.



After you create the external IPAM integration package using the instruction provided in this document, you can use the following workflow scenarios in the Cloud Assembly product documentation to create and use the IPAM integration point.

- *vRealize Automation Cloud* (SaaS) – [The provider-specific external IPAM integration use case](#)
- *vRealize Automation 8x* (on-premises) – [The provider-specific external IPAM integration use case](#)

Running environment

The running environment is the communication engine between Cloud Assembly and the external IPAM system. Integrators of external IPAM systems work with the tools provided by the running environment to build a set of scripts and workflows that can execute IPAM operations.



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Creating and deploying a provider-specific IPAM integration package for VMware Cloud Assembly

You implement one script or workflow for each operation that the IPAM service supports. The IPAM service sends requests in a properly defined format to the running environment and asks it to perform a certain IPAM operation, such as **Allocate IP for VM** or **Obtain a list of IP ranges**.

To complete the IPAM operation, the running environment executes the respective script or workflow that performs that specific task.

Currently, the only supported running environment is actions-based extensibility or ABX. You create ABX workflows in Cloud Assembly in either *vRealize Automation Cloud* (SaaS) or *vRealize Automation 8x* (on-premises)

With ABX, you can use the full potential of FaaS services such as AWS Lambda, Azure Functions, and OpenFaaS (action-based extensibility on-prem). Author the source code scripts in Python, NodeJS, or any other language that ABX supports.

For more information about creating a running environment within the context of a sample external IPAM integration workflow, see the following product documentation:

- *vRealize Automation Cloud* (SaaS) – [Create a running environment for an IPAM integration point in Cloud Assembly](#)
- *vRealize Automation 8x* (on-premises) – [Create a running environment for an IPAM integration point in vRealize Automation Cloud Assembly](#)

IPAM operation definitions

Cloud Assembly supports these IPAM service operations. Operation inputs are received as script function or method arguments.

Operation name	Description	Input	Output	Required
Allocate IP	Allocate next available IP address for each Allocation info.	IpAllocationRequest	IpAllocationResponse	Yes
Deallocate IP	Release allocated IP addresses.	IpDeallocationRequest	IpDeallocationResponse	Yes



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Operation name	Description	Input	Output	Required
Get IP Ranges	Get a page of IP ranges from IPAM endpoint.	GetIpRangesRequest	GetIpRangesResponse	Yes
Update Record	Updates the created host record. Could be used to update MAC address of machine after it has been provisioned.	RecordUpdateRequest	RecordUpdateRequest	No
Validate Endpoint	Validates that the IPAM endpoint credentials are valid and that a connection to the external IPAM system can be established successfully.	EndpointValidationRequest	EndpointValidationResponse	Yes

Baseline contract between Cloud Assembly IPAM service and external IPAM providers

Cloud Assembly supports these IPAM service baseline contracts for the integrated external IPAM provider.

Entity: ProviderRequestBase

Property	Type	Optional	Description
endpoint	Endpoint	false	A parent class for all request types DTOs.



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Property	Type	Optional	Description
			Provides basic information about the IPAM provider endpoint in Cloud Assembly.

Entity: ProviderResponseBase

Property	Type	Optional	Description
error	ErrorStatus	true	A parent class for all response types DTOs. Propagates error to Cloud Assembly in the event of a failure.

Entity: ErrorStatus

Property	Type	Optional	Description
errorCode	String	false	<p>If an external IPAM provider action fails, it returns a descriptive error to the Cloud Assembly IPAM service.</p> <p>IPAM service defines a set of error codes for common error conditions.</p> <ul style="list-style-type: none">• 1001 - Error allocating specific IP address [x.x.x.x] because it is already allocated.• 1002 - Error allocating or creating next available range.• 1005 - Error allocating IP address(es) because list of available IP ranges is exhausted.• 1007 - Error allocating IP address [x.x.x.x] because it doesn't belong to IP range [x.x.x.x-x.x.x.x].• 2000-xx - Reserved for on-demand IPAM errors.• 3000 - Connection refused, should return 502 bad gateway.



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Property	Type	Optional	Description
			<ul style="list-style-type: none">3001 - Invalid credentials, should return 401 unauthorized.3002 - Error validating the X509 certificate of the external IPAM provider system.5000 - Unexpected exception has occurred. <p>Note: The only error code that the IPAM service can process is 3002. Use the information in a Validate Endpoint operation to propagate a self-signed certificate from the external IPAM provider to the Cloud Assembly UI and allow the user to accept it.</p>
errorMessage	String	false	Displays a human-readable description of the error.

Entity: EndpointValidationRequest

Property	Type	Optional	Description
authCredentialsLink	String	false	<p>Carries host and credentials data about the external IPAM provider that is needed to validate the connection.</p> <p>Contains the link to the credentials store where the external IPAM provider credentials are kept in VRealize Automation Cloud or vRealize Automation 8x.</p>
endpointProperties	Map<String, String>	false	<p>Carries host and credentials data about the external IPAM provider that is needed to validate the connection.</p> <p>Contains a collection that holds provider-specific endpoint properties, such as</p>



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Property	Type	Optional	Description
			hostname and others that are defined in the endpoint-schema.json file.

Entity: EndpointValidationResponse: ProviderResponseBase

Property	Type	Optional	Description
message	String	true	Response of the EndpointValidationRequest. Indicates successful validation of endpoint credentials and connectivity
certificateInfo	CertificateInfo	true	Response of the EndpointValidationRequest. If the certificate for the external IPAM provider is not automatically trusted, this field can be used along with 'error' to propagate the certificate to the Cloud Assembly and allow the user to confirm certificate trust.

Entity: GetIpRangesRequest : ProviderRequestBase

Property	Type	Optional	Description
pagingAndSorting	pagingAndSorting	true	Carries information about which IP ranges to acquire from the external IPAM provider. Contains paging and sorting information in OData format.

Entity: Endpoint

Property	Type	Optional	Description
id	String	false	An entity representing the registered external IPAM provider, for example Infoblox.



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Property	Type	Optional	Description
			CAS specific endpoint id
authCredentialsLink	String	false	An entity representing the registered external IPAM provider, for example Infoblox. Contains a link to an AuthCredentialsState document in the VRealize Automation Cloud or vRealize Automaton 8x database that stores credentials in a secure way. Can be accessed from an ABX script by using <i>context.request(<link>, GET)</i> syntax.
endpointProperties	String	false	An entity that represents the registered external IPAM provider, for example Infoblox. Contains IPAM provider endpoint properties.

Entity: PagingAndSorting

Property	Type	Optional	Description
maxResults	Integer	true	Specifies the maximum number of returned results per page. If the number of available results is larger than maxResults, the IPAM provider must return a nextPageToken to get the next page of results in subsequent list requests.
pageToken	Integer	true	Specifies a page token to use. to get the next page of results, set the pageToken to the nextPageToken returned by a previous list request. See the following entity for information about nextPageToken.

Entity: GetIpRangesResponse : ProviderResponseBase



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Property	Type	Optional	Description
ipRanges	List<IpRange>	false	Contains the list of IP ranges returned in the result set.
nextPageToken	String	true	Allows you to get the next page of results for list requests. If the number of results is larger than maxResults (see above entity), use the nextPageToken as a value for the query parameter pageToken in the next list request. Subsequent list requests have their own nextPageToken to continue paging through the results.

Entity: IpRange

Property	Type	Optional	Description
id	String	false	Provider specific id. If the provider doesn't have ids, the workflow/action can generate id using a combination of range start address, end address and address space.
name	String	false	User friendly name.
description	String	true	User friendly description.
startIPAddress	String	false	Range start IP address.
endIPAddress	String	false	Range end IP address.
ipVersion	Enum: {IPv4, IPv6}	false	Range IP version – IPv4 or IPv6.
addressSpaceId	String	true	Address space where the range belongs.
gatewayAddress	String	true	The gateway IP address.
subnetPrefixLength	Integer	false	The length of the subnet mask
dnsServerAddresses	List<String>	true	Ordered list of DNS servers.



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Property	Type	Optional	Description
domain	String	true	DNS domain of this range.
dnsSearchDomains	List<String>	true	Ordered list of DNS domain search.
properties	Map	true	Provider specific range properties.
tags	List<Tag>	true	Tags collection, for example the extensible attributes in Infoblox.

Entity: IpAllocationRequest : ProviderRequestBase

Property	Type	Optional	Description
resourceInfo	ResourceInfo	false	Contains information about the resource, for example a machine or load balancer, to which the range is associated.
ipAllocations	List<IpAllocation>	false	Contains the list of allocations to be reserved for this resource. For example, a machine may have multiple NICs and a separate IP allocation should be supplied for each NIC.

Entity: ResourceInfo

Property	Type	Optional	Description
id	String	false	The resource ID, for example PhM documentSelfLink.
name	String	false	The resource name.
hostName	String	true	The resource hostname.
description	String	true	The resource description.



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Property	Type	Optional	Description
type	Enum {VM, LOADBALANCER, NAT, OTHER}	false	The resource type.
owner	String	false	The resource owner, for example fritza@vmware.com).
orgId	String	false	The tenant ID or organization ID in which the resource resides.
properties	Map	true	The resource-specific custom properties.

Entity: IpAllocation

Property	Type	Optional	Description
id	String	false	ID of the IpAllocation. This ID is set by the IPAM service to match the IpAllocation value with the corresponding AllocationResult value.
description	String	true	Description for allocation requesting human-readable format, for example in CIDR format.
ipRangeIds	List<String>	false	Provider-specific range IDs to use to allocate IP addresses. To avoid DNS and gateway information mismatch, only one range is used to allocate all IP addresses.
nicIndex	Integer	false	Nic index of the resource.
isPrimary	Boolean	false	Set to true when allocating a primary IP for the Nic Index of the resource.
start	String	true	Start IP address. Used to allocate specific IP address.
size	Integer	false	Number of IP addresses to allocate. Used to allocate more than one IP address. If <i>start</i> is



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Property	Type	Optional	Description
			also specified, continues IP addresses to be allocated.
properties	Map	false	The provider-specific properties.

Entity: IpAllocationResponse : ProviderResponseBase

Property	Type	Optional	Description
ipAllocations	List<AllocationResult>	false	List of IP allocations to match with allocations in the request.

Entity: AllocationResult

Property	Type	Optional	Description
ipAllocationId	String	false	ID of the specified IpAllocation. This is set by the IPAM service to match the IpAllocation value with the corresponding AllocationResult value.
ipAddresses	List<String>	false	Allocated IP addresses. If a start address was specified, this is a continues block of IP addresses. If no start address was specified, any IP addresses within a single range are allocated.
ipRangeId	String	false	Provide- specific range ID used to allocate IP addresses.
ipVersion	Enum {IPv4, IPv6}	false	IP version range.

Entity: IpDeallocationRequest : ProviderRequestBase



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Property	Type	Optional	Description
resourceInfo	ResourceInfo	false	Contains information about the resource, for example a machine or load balancer, that the range is associated with.
ipDeallocations	List<IpDeallocation>	false	List of deallocations containing info about which IPs to release for the resource.

Entity: IpDeallocation

Property	Type	Optional	Description
id	String	false	ID of IpDeallocation. The ID is set by the IPAM service to match the IpDeallocation value with the corresponding DeallocationResult value.
ipAddress	String	false	The IP address to deallocate.
ipRangeId	String	false	Provider-specific range ID of the IP range used for allocating this IP address.

Entity: IpDeallocationResponse : ProviderResponseBase

Property	Type	Optional	Description
ipDeallocations	List<DeallocationResult>	false	List of deallocations to match with deallocation IPs from the request.

Entity: DeallocationResult

Property	Type	Optional	Description
ipDeallocationId	String	false	ID of IpDeallocation. The ID is set by the IPAM service to match the IpDeallocation value with the corresponding DeallocationResult value.



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Property	Type	Optional	Description
message	String	true	Optional message to include in the deallocation response.

Entity: RecordUpdateRequest : ProviderRequestBase

Property	Type	Optional	Description
resourceInfo	ResourceInfo	false	Information about the resource, for example the machine or load balancer, to which this IP range is associated.
hostName	String	false	The resource hostname.
addressInfos	List<AddressInfo>	false	List of address information to be used for updating the MAC address of the record.

Entity: AddressInfo

Property	Type	Optional	Description
address	String	false	IP address of the record.
macAddress	String	false	MAC address of the record.
nicIndex	Integer	false	0-based index of the NIC.



Packaging format

IPAM operations (in the form of ABX scripts) are packaged with configurations and metadata into an **IPAM.zip** file. The **IPAM.zip** file is uploaded to [VMware Marketplace](https://marketplace.vmware.com/vsx/). (<https://marketplace.vmware.com/vsx/>) or to the integrator's own web site customer for customer download and deployment to *vRealize Automation Cloud* (SaaS) or *vRealize Automation 8x* (on-premises). After deployment, the external IPAM integration is visible by using the Cloud Assembly menu sequence **Infrastructure → Connections → Integrations → Add Integration → IPAM → Provider**.

New Integration

IPAM Provider

Specify IPAM provider for integration. Add new if no providers are registered in Cloud Assembly

Provider *

Q Search for IPAM providers.

IMPORT PROVIDER PACKAGE

ADD

CANCEL






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Sample IPAM.zip

The **IPAM.zip** package consists of the following files: **bundle.zip**, **endpoint-schema.json**, **logo.png**, and **registration.yaml**.

Name	Type	Compressed size	Password ...	Size	Ratio
 bundle.zip	Compressed (zipped) Fol...	2 KB	No	2 KB	33%
 endpoint-schema.json	JSON File	1 KB	No	1 KB	62%
 registration.yaml	YAML File	1 KB	No	1 KB	45%

- **registration.yaml:**
Format (can be extended in the future):

```
---
name: "Sample IPAM"
description: "Sample IPAM integration for CAS"
version: "0.1"

abxConfig:
  allocateIPActionId: "SampleIPAM_AllocateIP"
  deallocateIPActionId: "SampleIPAM_DeallocateIP"
  validateEndpointActionId: "SampleIPAM_ValidateEndpoint"
  updateResourceActionId: "SampleIPAM_Update"
  getIPRangesActionId: "SampleIPAM_GetIPRanges"
```

Description: Contains meta information about the contents of the **IPAM.zip**. Describes the ABX action IDs to invoke for the different types of IPAM operations. The IPAM provider name and description is also stored here.

- **endpoint-schema.json**
Format: The form definition format is documented in **Appendix A**.
Description: Contains the custom form definition that renders the IPAM provider's specific fields during IPAM endpoint registration.

Important: The **endpoint-schema.json** file must contains entries for **privateKey** and **privateKeyId** fields. See examples in the **SampleIPAM.zip** file.
These fields indicate sensitive data within the custom form that must be stored in a secure way.



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- **bundle.zip**
Format: Uses the same format as ABX for exporting sets of actions.
Description: Contains the set of ABX actions in the established ABX format.
- **logo.png**
Description: Contains the logo icon for the specific IPAM provider.

Sample IPAM integration package

If available, you can download and open a **SampleIPAM.zip** sample package as reference for implementing a custom external IPAM provider for *vRealize Automation Cloud* (SaaS) or *vRealize Automation 8x* (on-premises). It is written in python and uses an ABX running environment. The zip contents include custom implementations of the currently supported IPAM operations - **Allocate IP**, **Deallocate IP**, **Get IP Ranges**, **Update Record**, and **Validate Endpoint**.

You can also use the supplied Infoblox package **IPAM.zip** that is available for download at <https://marketplace.vmware.com/vsx/solutions/cas-infoblox-plugin-for-abx-0-0-1> as *CAS Infoblox plugin* as reference.

Implementing sample IPAM external provider integration

The following sections describe the process that was used during building of the above **SampleIPAM.zip**.

Download and open the **SampleIPAM.zip** file and familiarize yourself with its contents before continuing. Focus especially on the bundle.zip file.

Action-based extensibility (ABX) running environment

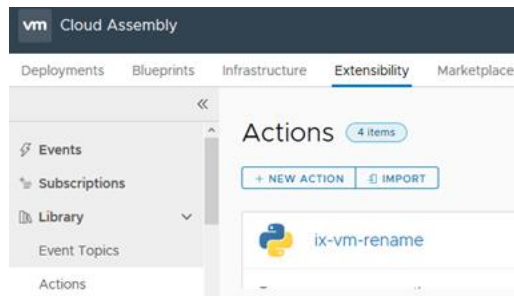
You must implement the ABX actions **Allocate IP**, **Deallocate IP**, **Get IP Ranges**, **Validate Endpoint** (**Update Record** is optional) by using the Cloud Assembly menu sequence **Extensibility → Library → Actions → New Action** in either *vRealize Automation Cloud* (SaaS) or *vRealize Automation 8x* (on-premises).

The process for creating ABX actions in Cloud Assembly is described in the following product documentation topics:

- *vRealize Automation Cloud* (SaaS) – [Learn more about extensibility actions](#)
- *vRealize Automation 8x* (on-premises) – [Learn more about extensibility actions](#)



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1. Create placeholder actions.

Defining placeholder actions for the four mandatory actions (**Allocate IP**, **Deallocate IP**, **Get IP Ranges**, and **Validate Endpoint**).

Select **Extensibility** → **Actions** → **New Action**. Enter a name for the **Validate Endpoint** action, for example **SampleIPAM_ValidateEndpoint**, and select an arbitrary project.

Click **Next** and then specify a **Custom script** for the template value. Select **python 3** as the runtime value.

Set the FaaS provider to **Auto**.

Enter **requests==2.21.0, ndg-httpsclient, pyopenssl, pyasn1 & idna** as the dependencies value.

You use the python *requests* library in the script for issuing REST requests to the SampleIPAM REST API. The other dependencies are used for fetching and parsing the X509 certificate from the SampleIPAM system and propagating it to the Cloud Assembly user.

Note: If you have client SDK in python/nodejs format for your IPAM solution, you can define it as a dependency here and use it in the script.

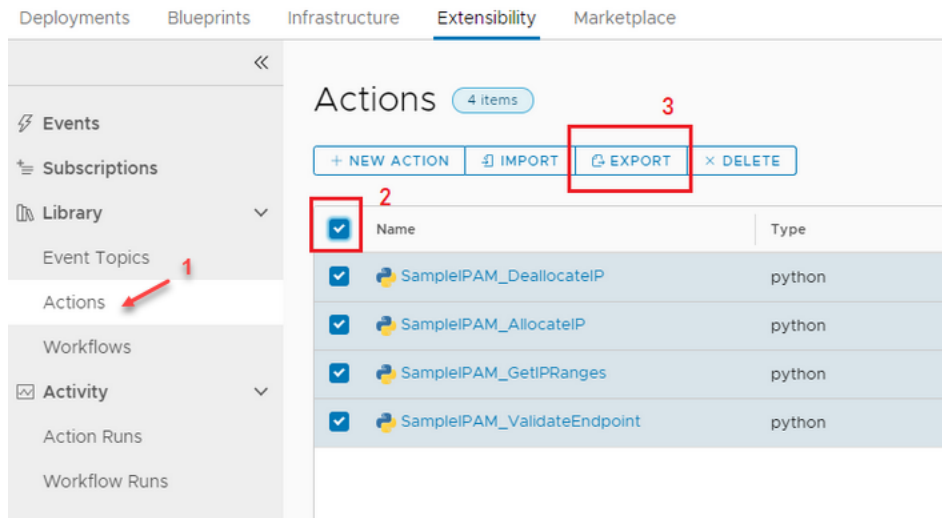
Select **Set custom timeout and limits** and specify a memory limit value and timeout value for your script. Recommended values are at least 600 MB for the memory limit value and 6000 seconds for the timeout value.

Click **Save** and repeat for the other 3 actions - **Allocate IP**, **Deallocate IP**, and **Get IP Ranges**.

2. Export the four actions into **bundle.zip** by selecting the newly created actions and clicking **Export**. Save the file as **bundle.zip**.



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The exported **bundle.zip** file contains a .py file and a .abx file for each of the four actions. The .py file contains the script itself, while the .abx file contains metadata about the script such as the timeout, dependencies, and action name that you configured in step 1.

3. Create **registration.yaml**, **endpoint-schema.json**, and **logo.png**.

You need a **registration.yaml** file to inform the IPAM service which operation ID to call during endpoint validation, when fetching IP ranges, and so on.

name: "Sample IPAM"

description: "Sample IPAM integration for Cloud Assembly"

version: "0.1"

abxConfig:

allocateIPActionId: "" → **Open the .abx file for the Allocate IP action from the exported bundle.zip. Copy the exportId value and populate it here**

deallocateIPActionId: "" → **Open the .abx file for the Deallocate IP action from the exported bundle.zip. Copy the exportId value and populate it here**

validateEndpointActionId: "" → **Open the .abx file for the Validate Endpoint action from the exported bundle.zip. Copy the exportId value and populate it here**

getIPRangesActionId: "" → **Open the .abx file for the Get IP Ranges action from the exported bundle.zip. Copy the exportId value and populate it here**

Note: In the **bundle.zip** file in the provided **SampleIPAM.zip**, instead of using the auto-



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generated UUIDs for exportId, this example uses optional custom values such as *SampleIPAM_AllocateIP*.

Specify a *name*, *description*, and *version* for the IPAM integration.

For **logo.png**, use your company logo.

For **endpoint-schema.json**, use the custom forms format. One caveat here is that the file must contain entries for **privateKey** and **privateKeyId** fields, see the example in the provided **SampleIPAM.zip** file. You can use the file from **SampleIPAM.zip** as-is or modify it to meet your needs. See **Appendix A** for the file format.

4. Zip the four files - **bundle.zip**, **registration.yaml**, **endpoint-schema.json**, and **logo.png** into an **IPAM.zip** file. You'll use this **IPAM.zip** file for deployment into *vRealize Automation Cloud* (SaaS) or *vRealize Automation 8x* (on-premises) as part of the process of creating an external IPAM integration point in Cloud Assembly.
5. Log in to Cloud Assembly. Deploy the **IPAM.zip** by selecting *Infrastructure* → *Connections* → *Integrations* → *Add Integration* → *IPAM* → *Import Provider Package*. If everything is configured correctly, you should see **Sample IPAM** (the name you specified in step 3 above) in the Providers drop-down menu. Select **Sample IPAM**. The custom form that you defined in the **endpoint-schema.json** file is rendered in the page.

This part of the procedure is documented in the following workflow topics:

- *vRealize Automation Cloud* (SaaS) – [Add an external IPAM integration point](#)
 - *vRealize Automation 8x* (on-premises) – [Add an external IPAM integration point](#)
6. Enter all mandatory fields. Select a **Running Environment** and click **Validate**. This triggers a new ABX action run. In a new tab, go to **Extensibility** → **Activity** → **Action Runs** to see the action for the **Validate Endpoint** operation.
 7. Implement the source code of the actions itself. Reference the sample implementation in the supplied **SampleIPAM.zip**.



Sample IPAM scripts source code – considerations and tips

- The `context.request()` can be used to execute REST requests against Cloud Assembly. This is used for obtaining the auth credentials.
- Special Error Code 3002 in the **Validate Endpoint** user interface call can be used to propagate a self-signed certificate from the external IPAM to Cloud Assembly for the user to accept the certificate manually.
- Sharing code between separate scripts is not supported out-of-the-box. One option to share code is to put common code in a python/nodejs library, publish it in pip, and use it as a dependency in each of the scripts.
- The **Deallocate IP** operation contract dictates that it must finish with success when asked to deallocate a non-existing IP address. This prevents failure in case an attempt is made from Cloud Assembly to deallocate the same IP twice.
- The **Allocate IP** operation can handle multiple IP allocations in a single request. Failure in one of the consecutive allocations results in failure for the whole operation. Because the IPAM service is not transactional, the script is responsible for rolling back already allocated IPs.



Appendix A – format for endpoint-schema.json

This appendix describes the form definition format for the endpoint-schema.json file contents.

The form definition is a declarative means expressing the user interface controls used to render form fields, the validations to perform, form field values dependencies, where predefined list of values are retrieved from, and so on. The form renderer generates HTML and JavaScript. Scripts can also include calls to vRA backend services for retrieving dynamic data.

Custom Form Definition (Updated)

```
{
  "layout": {
    "pages": [{
      "id": "page_1",
      "title": "First page title",
      "sections": [{
        "id": "section_1",
        "fields": [{
          "id": "field_1"
          "display": ...
          ...
        }, {
          "id": "field_2"
        }]
      }, {
        "id": "section_2",
        "fields": []
      }]
    }, {
      "id": "page_2",
      "title": "Second page title",
      "sections": []
    }]
  },
  "schema": {
    "field_1": {},
    "field_2": {}
  },
  "options": {
    "externalValidations": [
      ...
    ]
  }
}
```



Layout (Updated)

The layout part of the form definition can have pages and/or sections. Each section can be hidden based on a constant or on a field value. Sections usually have one or more input fields, which can initially be hidden or read-only until something on the form is changed.

- *pages*
 - *id*
 - *title*
 - *sections*
 - *id*
 - *state*
 - *visible*
 - *fields*
 - *id*
 - *display* (default = "text")
 - *styles*
 - *size*
 - *state*
 - *read-only*
 - - - - *visible*

```
"layout": {
  "pages": [{
    "id": "general",
    "title": "General",
    "sections": [{
      "id": "section_1",
      "fields": [{
        "id": "description",
        "display": "textField"
      }, {
        "id": "reason",
        "display": "textField"
      }]
    }, {
      "id": "section_2",
      "fields": [{
```



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```
        "id": "deployments",
        "display": "integerField"
      }, {
        "id": "leaseDate",
        "display": "textField"
      }
    ]
  }
},
{
  "id": "serviceInformation",
  "title": "Service Information",
  "sections": []
}]
}
```

UI Controls (Updated)

The display property specifies which UI control is rendered. If not set, the default value is “text.”

Drop-Down	"dropDown"
Checkbox	"checkbox"
Radio Group	"radio"
Data Grid	"datagrid"
MultiSelect	"multiSelect"
Datetime Picker	"dateTime"
Value Picker	"valuePicker"
ComboBox	"combobox"
Multi-value Picker	"multiValuePicker"
Dual List	"dualList"
Link	"link"
Slider	Not Defined

Submit (Updated)

```
"layout": {
  "pages": [{
    "id": "page_1",
    "title": "First page title",
    "sections": [{
      "id": "seccion_1",
      "fields": [{
        "id": "form_label"
        "display": "text"
      }
    ]
  }
}]
}
```



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```
        "submit": false
      }
    }
  }
}
```

Decimal step (updated)

The "step" property in the schema specifies the legal number intervals for the decimal field.

```
"schema": {
  "storage": {
    "type": {
      "dataType": "decimal"
    },
    "label": "Storage (GB)",
    "step": 0.1
  }
}
```

Integer step (updated)

The "step" property in the schema specifies the legal number intervals for the integer field.

```
"schema": {
  "memory": {
    "type": {
      "dataType": "integer"
    },
    "label": "Memory (MB)",
    "step": 1024
  }
}
```

Image description (updated)

The "description" property in the schema specifies alternate text for an image.

```
"schema": {
  "clarity": {
    "type": {
      "dataType": "string"
    },
  },
}
```



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```
"default": "https://cto.vmware.com/wp-
content/uploads/2016/11/Picture1.png",
"placeholder": "Clarity logo"
}
}
```

Drop down option label (updated)

The "placeholder" property in the schema specifies a placeholder for the dropdown field.

```
"schema": {
  "vm-size": {
    "type": {
      "dataType": "string"
    },
    "label": "Deployment size:",
    "valueList": [{
      "label": "Small",
      "value": "small"
    }, {
      "label": "Medium",
      "value": "medium"
    }, {
      "label": "Large",
      "value": "large"
    }, {
      "label": "Custom",
      "value": "custom"
    }
  ],
  "placeholder": "Select deployment size..."
}
}
```

Data grid (updated)

The "size" property in the layout specifies the number of items displayed per page. The default is 10.

The "placeholder" property in the schema specifies placeholder text when there is no data displayed.

```
"layout":
...
{
  "id": "properties",
  "display": "datagrid",
```



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```
        "size": 20
      }
    "schema": {
      "properties": {
        "type": {
          "dataType": "complex",
          "fields": [{
            "label": "Name",
            "id": "column_1",
            "type": {
              "dataType": "string"
            }
          }, {
            "label": "Value",
            "id": "column_2",
            "type": {
              "dataType": "string"
            }
          }
        ]
      },
      "placeholder": "No items exist.",
      "default": [{
        "column_1": "first_prop",
        "column_2": "first"
      }, {
        "column_1": "second_prop",
        "column_2": "second"
      }
    ]
  }
}
```

Multi-value data picker (updated)

The "size" layout property specifies the number of items displayed per page. The default is 10.
The "placeholder" schema property specifies placeholder text when there is no data displayed.
The "shortValueName" schema property specifies which fields display in the multi-value picker list.
"layout":

```
    ...
    {
      "id": "networks",
      "display": "multiValuePicker",
      "size": 20
    }

    "schema": {
      "networks": {
```



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```
"type": {
  "dataType": "complex",
  "fields": [{
    "label": "Name",
    "id": "name",
    "type": {
      "dataType": "string"
    }
  }, {
    "label": "Zone",
    "id": "zone",
    "type": {
      "dataType": "string"
    }
  },
  {
    "label": "Network Domain",
    "id": "network-domain",
    "type": {
      "dataType": "string"
    }
  }, {
    "label": "Support Public IP",
    "id": "support-public-ip",
    "type": {
      "dataType": "boolean"
    }
  }
  ]
},
"shortValueName": ["name", "zone"],
"placeholder": "No items exist.",
"default": [{
  "name": "appnet-isolated-dev",
  "zone": "us-east-1a",
  "network-domain": "rainpole-dev",
  "support-public-ip": false
},
{
  "name": "public-subnet-us-east-1b",
  "zone": "us-east-1b",
  "network-domain": "Public VPC",
  "support-public-ip": true
}
]
}
```

Constant Visible State (Updated)



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```
{
  "id": "cpu",
  "display": "integerField",
  "state": {
    "visible": false
  }
}
```

Expression Visible State (Updated)

```
[{
  "id": "environment",
  "display": "dropDown"
},
{
  "id": "backup-options",
  "display": "dropDown",
  "state": {
    "visible": [{
      "equals": {
        "environment": "production"
      },
      "value": true
    }]
  }
}]
```

Constant Read Only State (Updated)

```
{
  "id": "vsphere-tag",
  "display": "textField",
  "state": {
    "read-only": true
  }
}
```

Schema

The "schema" part of the form definition describes the input data that is expected to be entered in the form. The schema consists of a list of fields with the following properties:

- label - label for the input field
- description - short text that will be displayed as a tooltip
- signpost - additional information that will be displayed in a separate popup box
- type - data type of the field



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- default - default value
- valueList - a list of predefined values
- constraints - field constraints
 - required
 - *min-value*
 - *max-value*
 - *pattern*
 - *match*

Schema (Updated)

```
"schema":{
  "description": {
    "label": "Description",
    "type": {
      "dataType": "string"
    }
  },
  "reason": {
    "label": "Reason for request",
    "signpost": "Specify a reason for this request.",
    "type": {
      "dataType": "string"
    },
    "constraints":{
      "required": true
    }
  },
  "deployments": {
    "label": "Deployments",
    "type": {
      "dataType": "integer"
    },
    "default": 1,
    "constraints":{
      "required": true,
      "min-value": 1,
      "max-value": 100
    }
  },
  "leaseDate": {
    "label": "Lease Date",
    "type": {
      "dataType": "string"
    }
  }
}
```



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Signpost

The “signpost” property is the help content that appears in a popup box. Signpost can be plain text or HTML that contains text, links, and images.

```
"signpost": "<a href='https://vmware.github.io/clarity/'>Clarity</a>"
```

```
"signpost": "Plain text"
```

Field data type

The field data “type” property value can be string, integer, decimal, boolean, secure string, complex, or reference. If not set, the default value is string. Use the “type” property when calculating expression field state or constraints.

Field data type	Field value
String	"type": { "dataType": "string"}
Integer	"type": { "dataType": "integer"}
Decimal	"type": { "dataType": "decimal"}
Boolean	"type": { "dataType": "boolean"}
Secure string	"type": { "dataType": "secureString"}
Date Time	"type": { "dataType": "dateTime"}
Multiple	"type": { "dataType": "string", "isMultiple": true}
Complex	"type": { "dataType": "complex", "fields": []}
Reference	"type": { "dataType": "reference", "referenceType": "AD:User"}

Operators



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Each field state type supports different operator types.

Field type	Operator type
String, Secure string, Reference	"equals", "notEqual", "contains", "endsWith", "startsWith", "within"
Integer, Decimal, Date Time	"equals", "notEqual", ">", ">=", "<", "<="
Boolean, Complex	"equals", "notEqual"
Multiple	"contains"

Field Constraints

Each field can have multiple constraints that are evaluated in the rendered form:

- required
- min-value
- max-value
- pattern
- match

Deployments field constraints

```
"fields": {
  "numberOfDeployments": {
    "type": {
      "dataType": "integer"
    },
    "constraints": {
      "required": "true",
      "min-value": "1",
      "max-value": {
        "type": "scriptAction",
        "id": "com.vmware.vra.endpoint.azure/getReservationLimit"
      }
    }
  },
  "email": {
    "type": {
      "dataType": "string"
    },
    "constraints": {
      "required": "true",
      "pattern": {
        "value": "^[A-Za-z0-9._%+-]+@[A-Za-z0-9.-]+\\.[A-Za-z]{2,}$",
        "message": "Must be valid e-mail address."
      }
    }
  }
}
```



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```
    }
  },
  "confirm-email": {
    "label": "Confirm Email:",
    "constraints": {
      "match": "email"
    }
  }
}
```

Constant Required Constraint

```
"deployments": {
  "label": "Deployments",
  "type": {
    "dataType": "integer"
  },
  "constraints": {
    "required": true
  }
}
```

Expression Required Constraint (Updated)

```
"reason": {
  "label": "Reason for request",
  "constraints": {
    "required": [{
      ">": {
        "deployments": 10
      },
      "value": true
    }]
  }
}
```

Constant min-value Constraint

A min-value constraint can be set with constant or expression value. If field type is string min-value will specify minimum value of characters length.

```
"password": {
  "label": "Password",
  "type": {
    "dataType": "secureString"
  },
  "constraints": {
    "min": 8
  }
}
```



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```
    "constraints": {  
      "min-value": 8  
    }  
  }  
}
```

Expression min-value Constraint (Updated)

A min-value constraint can be set with constant or expression value. If field type is string min-value will specify minimum value of characters length.

```
"deployments": {  
  "label": "Deployments:",  
  "type": {  
    "dataType": "integer"  
  },  
  "constraints": {  
    "min-value": [{  
      "equals": {  
        "environment": "production"  
      },  
      "value": 4  
    }]  
  }  
}
```

Constant max-value Constraint

A max-value constraint can be set with constant or expression value. If field type is string max-value will specify maximum value of characters length.

```
"description": {  
  "label": "Description",  
  "type": {  
    "dataType": "string"  
  },  
  "constraints": {  
    "max-value": 50  
  }  
}
```

Expression max-value Constraint

A max-value constraint can be set with constant or expression value. If field type is string max-value will specify maximum value of characters length.



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```
"deployments": {
  "label": "Deployments:",
  "type": {
    "dataType": "integer"
  },
  "constraints": {
    "max-value": [{
      "equals": {
        "environment": "test"
      },
      "value": 2
    }]
  }
}
```

Pattern constraint

A pattern constraint is an object with two properties - value and message. Value property is constant regular expression value. Message property is custom error message which will be displayed in the tooltip in case of error.

```
"email": {
  "label": "Email",
  "constraints": {
    "pattern": {
      "value": "^[A-Za-z0-9._%+-]+@[A-Za-z0-9.-]+\.[A-Za-z]{2,}$",
      "message": "Must be valid e-mail address."
    }
  }
}
```

Match constraint

A match constraint can be set with a constant value. This value must be other field id.

```
"password": {
  "label": "Password"
},
"confirm-password": {
  "label": "Confirm password:",
  "constraints": {
    "match": "password"
  }
}
```

Constant default value



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The field "default" value can be constant value, option from valueList property, bind to other field value or string concatenation. Default values can also be the result of add, subtract or multiply operations.

```
"cpu": {
  "label": "CPU"
  "type": {
    "dataType": "integer"
  },
  "default": "2"
}
```

Default value from valueList (Updated)

```
"environment": {
  "label": "Environment:",
  "valueList": [{
    "label": "Development",
    "value": "development"
  }, {
    "label": "Test",
    "value": "test"
  }, {
    "label": "Production",
    "value": "production"
  }],
  "default": "production" // Set default value from predefined value list
}
```

Bind default value (Updated)

```
"storage": {
  "label": "Storage",
  "type": {
    "dataType": "integer"
  },
  "default": {
    "bind": "cpu" //Bind storage value to cpu field
  }
}
```

String concatenation

Note: When the value is surrounded with back quotes (for example, "``_machine``") the value is constant.

```
"vsphere-tag": {
```



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```
    "label": "Tag:",
    "default": {
      "bind": {
        "values": ["environment", "`_machine`"] // Bind field value with
string concatenation
      }
    }
  }
}
```

Add operation (Updated)

```
"sum-field": {
  "label": "Sum:",
  "default": {
    "bind": {
      "values": [ "field_1", "field_2", "`100`"],
      "operator": "add"
    }
  }
}
```

Subtract operation (Updated)

```
"subtract-field": {
  "label": "Difference:",
  "default": {
    "bind": {
      "values": [ "field_1", "field_2"],
      "operator": "subtract"
    }
  }
}
```

Multiply operation (Updated)

```
"storage": {
  "type": {
    "dataType": "decimal"
  },
  "label": "Storage (GB)",
  "default": {
    "bind": {
      "values": [ "storage_mb", "`0.001`"],
      "operator": "multiply"
    }
  }
}
```



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vRO Action (Updated)

```
"memory": {
  "type": {
    "dataType": "integer"
  },
  "default": {
    "type": "scriptAction",
    "id": "com.vmware.vra.endpoint.azure/getDefaultMemorySize"
  }
}
```

Value lists (updated)

Lists of values can be assigned to a form field as either static (value is specified in the field schema) or dynamic (value is retrieved from an external data source like a vRealize Automation database, vRealize Orchestrator action or a REST API service). To populate the `valueList` property with a vRealize Orchestrator action, the return type must be **array of string**, **properties** or **array of properties**.

Deployment size values – static (Updated)

```
"fields": [
  "deploymentSize": {
    "type": {
      "dataType": "string"
    },
    "valueList": [{
      "label": "Small",
      "value": "small"
    }, {
      "label": "Medium",
      "value": "medium"
    }, {
      "label": "Large",
      "value": "large"
    }, {
      "label": "Custom",
      "value": "custom"
    }
  ]
}
```

Deployment size values – dynamic (Updated)

```
"fields": {
  "deploymentSize": {
```



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```
"type": {
  "dataType": "string"
},
"valueList": {
  "type": "scriptAction",
  "id": "com.vmware.vra.endpoint.azure/getVmSizes",
  "parameters": [
    {
      "param_1": "field1",
      "$type": {
        "dataType": "boolean"
      }
    },
    {
      "param_2": "`2`",
      "$type": {
        "dataType": "integer"
      }
    },
    {
      "param_3": "field2",
      "$type": {
        "dataType": "string"
      }
    }
  ]
}
}
```

Options

The "options" part of the form additional form functionalities and it is not required unless these functionalities are used. The options consists of the following properties:

- externalValidations - list of external validations applied on form
 - label
 - source
 - type - type of the external source
 - id- unique identifier of the external source
 - parameters - parameters for the external source
 - target - array of fields in which the returned error message is applied (optional)

```
"options": {
  "externalValidations": [
    {
```



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```
    "label": "Amazon form validation",
    "source": {
      "type": "scriptAction",
      "id": "com.zzz.vra.endpoint.aws/myFormExternalValidation1",
      "parameters": []
    },
    "target": []
  },
  {
    "label": "Amazon field validation with params",
    "source": {
      "type": "scriptAction",
      "id":
"com.zzz.vra.endpoint.aws/myInputExternalValidationWithParams",
      "parameters": [
        {
          "param_1": "field1",
          "$type": {
            "dataType": "boolean"
          }
        },
        {
          "param_2": "`2`",
          "$type": {
            "dataType": "integer"
          }
        },
        {
          "param_3": "field2",
          "$type": {
            "dataType": "string"
          }
        }
      ]
    },
    "target": [
      "field_1",
      "field_1"
    ]
  }
]
```



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