Configuration Parameters

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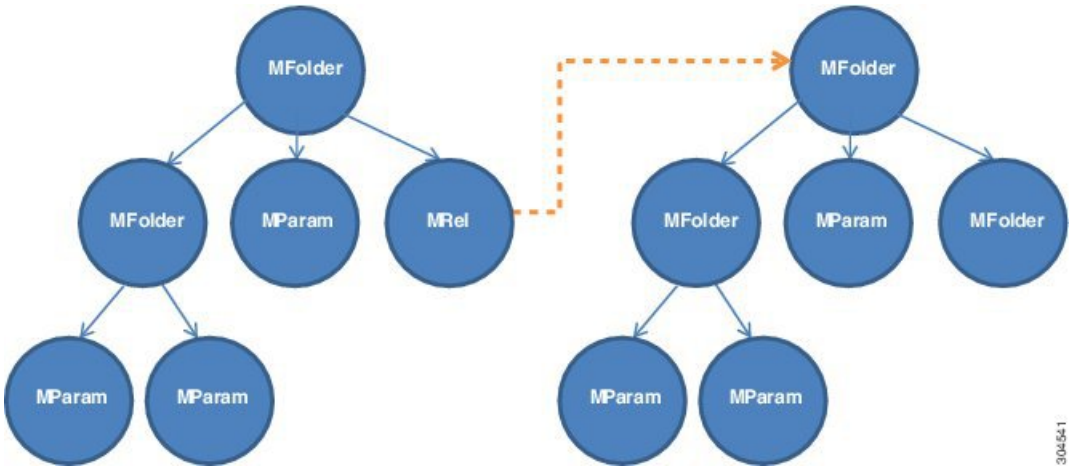
Configuration Parameters Inside the Device Package Specification

A device package contains an XML file that describes the specification for the service device. This specification includes device information as well as various functions provided by the service device.

As part of the device specification, this file must contain the declaration for the configuration needed by the service device. This configuration is needed to configure various functions that are provided by the service device during graph instantiation.

The following figure shows the configuration parameters hierarchy inside the device package.

Figure 1: Configuration Parameters Hierarchy Inside the Device Package



MFolder

MFolder is a group of configuration items that can contain MParams and other nested MFolders. An MFolder has following attributes:

Attribute	Description
Key	Defines the type of the configuration item. The key is defined in the device package and can never be overwritten. The key is used as a matching criterion as well as for validation.
Description	Describes the configuration item.
Cardinality	Specifies the cardinality of the configuration item. The default value of cardinality is `1`. If cardinality is `N`, The Application Policy Infrastructure Controller (APIC) allows N instances of the configuration parameter to be configured.
ScopedBy	Specifies the scope for the parameter resolution. ScopedBy determines where to look for parameter values when APIC resolves the parameter from configuration MOs. Default value is `Epg`. Supported values are `Tenant`, `Ap`, `Bd`, and `Epg`.
RsConnector	A relation that associates a configuration item to an MConn.
DevCtx	Allows a configuration item to be associated with a specific physical device (CDev) in a device (LDev).
Locked	Allows a configuration item value to be locked. Once locked, the value cannot be changed.

MParam

MParam is the basic unit of configuration parameters that declares a single configuration parameter. MParam has following attributes:

Attribute	Description
Key	Defines the type of the configuration item. The key is defined in the device package and can never be overwritten. The key is used as a matching criterion as well as for validation.
Description	Describes the configuration item.

Attribute	Description
Cardinality	Specifies the cardinality of the configuration item. The default value of cardinality is `1`. If cardinality is `N`, The APIC allows N instances of the configuration parameter to be configured.
RsConnector	A relation that associates a configuration item to an MConn.
Mandatory	Allows a configuration item to be marked as mandatory.
Locked	Allows a configuration item value to be locked. Once locked, the value cannot be changed.
Validation	Specifies the validation method for the value.

MRel

MRel allows one MFolder to refer to another MFolder. Using MRel inside an MFolder, an administrator can associate the containing MFolder to the MFolder that is pointed by the MRel using the RsTarget relation contained inside MRel. MRel has following attributes:

Attribute	Description
Key	Defines the type of the configuration item. The key is defined in the device package and can never be overwritten. The key is used as a matching criterion as well as for validation.
Description	Describes the configuration item.
Cardinality	Specifies the cardinality of the configuration item. The default value of cardinality is `1`.
RsTarget	A relation that associates a configuration folder to another MFolder. The value of TDn for this relation is the DN of the target folder.
RsConnector	A relation that associates a configuration item to an MConn.
Mandatory	Allows a configuration item to be marked as mandatory.

Configuration Scope of a Device Package Specification

In a device specification file, configuration items are arranged in different sections.

MDevCfg

The MDevCfg section describes the device level configuration, which is shared by all service graphs using the device. The Application Policy Infrastructure Controller (APIC) does a reference counting of the configuration objects created by using the configuration items described in this section. Objects are only deleted from a service device after all the graph instances that use the device are deleted.

MFuncCfg

The MFuncCfg describes the configuration that is local to a service function and is specific to a service function. The APIC does a reference counting of the configuration objects created by the configuration items described in this section. Objects are created and deleted whenever a service function is instantiated and deleted.

MGrpCfg

The MGrpCfg describes the configuration that is shared by all functions of a service graph using the device. The APIC does a reference counting of the configuration objects created by using the configuration items described in this section. Objects are only deleted from a service device after all functions from the service graph are deleted.

Example XML of Configuration Parameters Inside the Device Package

The following XML example shows configuration parameters inside of the device package:

```
<vnsMFolder key="VServer" scopedBy="epg">
    <vnsRsConnector tDn="uni/infra/mDev-Acme-ADC-1.0/mFunc-SLB/mConn-external"/>
    <vnsMParam key="vservername" description="Name of VServer" mandatory="true"/>
    <vnsMParam key="vip" description="Virtual IP"/>
    <vnsMParam key="subnet" description="Subnet IP"/>
    <vnsMParam key="port" description="Port for Virtual server"/>
    <vnsMParam key="persistencetype" description="persistencetype"/>
    <vnsMParam key="servicename" description="Service bound to this vServer"/>
    <vnsMParam key="servicetype" description="Service bound to this vServer"/>
    <vnsMParam key="clttimeout" description="Client timeout"/>
    <vnsMFolder key="VServerGlobalConfig"
      description="This references the global configuration">
        <vnsMRel key="ServiceConfig">
            <vnsRsTarget tDn="uni/infra/mDev-Acme-ADC-1.0/mDevCfg/mFolder-Service"/>
        </vnsMRel>
        <vnsMRel key="ServerConfig">
            <vnsRsTarget tDn="uni/infra/mDev-Acme-ADC-1.0/mDevCfg/mFolder-Server"/>
        </vnsMRel>
        <vnsMRel key="VipConfig">
            <vnsRsTarget
              tDn="uni/infra/mDev-Acme-ADC-1.0/mDevCfg/mFolder-Network/mFolder-vip"/>
            <vnsRsConnector tDn="uni/infra/mDev-Acme-ADC-1.0/mFunc-SLB/mConn-external"/>
        </vnsMRel>
    </vnsMFolder>
</vnsMFolder>
```

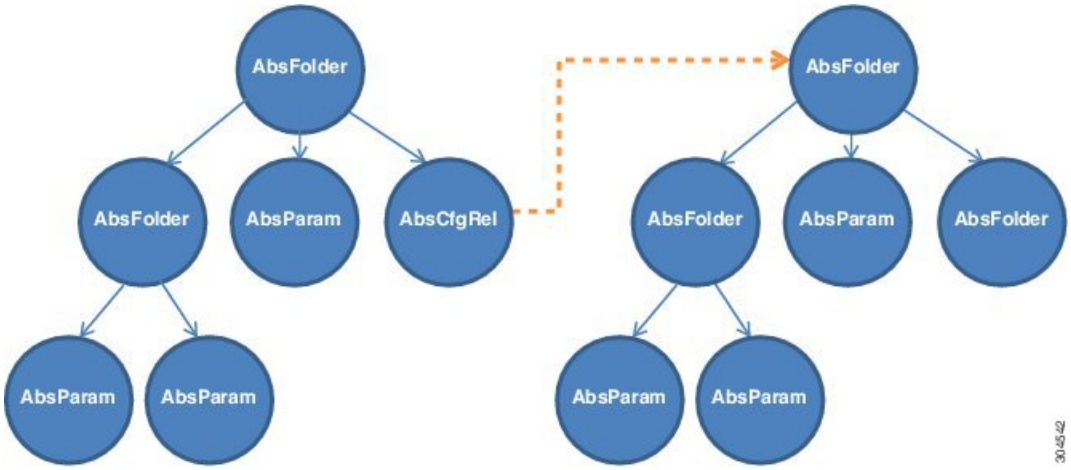
Configuration Parameters Inside An Abstract Function Profile

An abstract profile allows an administrator to configure the default values for the configuration parameters. An abstract function profile contains configuration parameters with values. These values are used as default values during graph instantiation.

An abstract function profile is attached to a function node in a service graph. The default values specified in an abstract function profile is then used when rendering the function onto the service device at the graph instantiation time.

The following figure shows the configuration parameters hierarchy within an abstract function profile.

Figure 2: Configuration Parameters Hierarchy Within an Abstract Function Profile



AbsFolder

AbsFolder is a group of configuration items that can contain AbsParams and other nested AbsFolders. For each AbsFolder, there must be an MFolder inside the device package. The Application Policy Infrastructure Controller (APIC) validates each AbsFolder to ensure that the AbsFolder has a corresponding MFolder in the package. An AbsFolder has the following attributes:

Attribute	Description
Key	Defines the type of the configuration item. The key is defined in the device package and can never be overwritten. The key is used as a matching criterion as well as for validation.
Description	Describes the configuration item.
Cardinality	Specifies the cardinality of the configuration item. The default value is `1`.
ScopedBy	Specifies the scope for the parameter resolution. ScopedBy determines where to look for parameter values when the APIC resolves the parameter from configuration MOs. Default value is `Epg`. Supported values are `Tenant`, `Ap`, `Bd`, and `Epg`.
DevCtx	Allows a configuration item to be associated with a specific physical device (CDev) in a device cluster (LDev).
Locked	Allows a configuration item value to be locked. Once locked, the value cannot be changed.

AbsParam

AbsParam is the basic unit of configuration parameters. AbsParam defines a single configuration parameter. As with an AbsFolder, each AbsParam must have an equivalent MFolder in the device specification. The APIC validates the specification to ensure that AbsParam has a corresponding MFolder in the package. The value of an AbsParam is validated using the validation method specified in MParam. An AbsParam has following attributes:

Attribute	Description
Key	Defines the type of the configuration item. The key is defined in the device package and can never be overwritten. The key is used as a matching criterion as well as for validation.
Value	Holds the value for a given configuration item. Values are not supported for MParam.
Description	Describes the configuration item.
Cardinality	Specifies the cardinality of the configuration item. The default value is `1`.
Mandatory	Allows a configuration item to be marked as mandatory.
Locked	Allows a configuration item value to be locked. Once locked, the value cannot be changed.
Validation	Specifies the validation mechanism to be used to validate the configuration parameter.

AbsRel

AbsRel allows one AbsFolder to refer to another AbsFolder. An AbsRel has following attributes:

Attribute	Description
Key	Defines the type of the configuration item. The key is defined in the device package and can never be overwritten. The key is used as a matching criterion as well as for validation.
Value	Holds the value for a given configuration item. Values are not supported for MParam.
Description	Describes the configuration item.
Cardinality	Specifies the cardinality of the configuration item. The default value is `1`.
Mandatory	Allows a configuration item to be marked as mandatory.

Configuration Scope of an Abstract Function Profile

Within an abstract function profile, the configuration parameters are structured in a similar manner as to how they are structured inside a device package. There are three different scopes.

AbsDevCfg

This section provides the default value for the configuration items that are declared to be the device level configuration inside of a device package. The configuration items are specified under MDevCfg.

For each configuration item, there must be an equivalent configuration item under the device package.

The configuration that is described in this section is shared by all service graphs that use the device. The Application Policy Infrastructure Controller (APIC) does a reference counting of the configuration objects that are created by using the configuration items that are described in this section. Objects are only deleted from a service device after all graph instances that are using the device are deleted.

AbsGrpCfg

This section provides the default value for the configuration items that are declared to be the device level configuration inside of a device package. The configuration items are specified under MGrpCfg.

For each configuration item, there must be an equivalent configuration item under the device package.

The configuration described in this section is shared by all functions of a service graph that use the device. The APIC does a reference counting of the configuration objects that are created by using the configuration items that are described in this section. Objects are only deleted from a service device after all graph instances that are using the device are deleted.

AbsFuncCfg

This section provides the default value for the configuration items that are declared to be the function level configuration inside of a device package. The configuration items are specified under MFuncCfg.

For each configuration item, there must be an equivalent configuration item under the device package.

This section is used to describe the configuration that is local to a service function. The configuration described in this section is specific to a service function. The APIC does a reference counting of the configuration objects that are created by the configuration items that are described in this section. Objects are created and deleted whenever a service function is instantiated and deleted.

Example XML POST for an Abstract Function Profile With Configuration Parameters

The following XML POST example shows an abstract function profile with configuration parameters:

```
<vnsAbsFuncProfContr name = "NP">
    <vnsAbsFuncProfGrp name = "Grp1">
        <vnsAbsFuncProf name = "P1">
            <vnsRsProfToMFunc tDn="uni/infra/mDev-Acme-ADC-1.0/mFunc-SLB"/>
            <vnsAbsDevCfg name="D1">
                <vnsAbsFolder key="Service" name="Service-Default" cardinality="n">
                    <vnsAbsParam name="servicetype" key="servicetype" value="TCP"/>
                    <vnsAbsParam name="serviceport" key="serviceport" value="80"/>
                    <vnsAbsParam name="maxclient" key="maxclient" value="1000"/>
                    <vnsAbsParam name="maxreq" key="maxreq" value="100"/>
                    <vnsAbsParam name="cip" key="cip" value="enable"/>
                    <vnsAbsParam name="usip" key="usip" value="enable"/>
                    <vnsAbsParam name="sp" key="sp" value=""/>
                    <vnsAbsParam name="svrtimeout" key="svrtimeout" value="60"/>
                    <vnsAbsParam name="clttimeout" key="clttimeout" value="60"/>
                    <vnsAbsParam name="cka" key="cka" value="NO"/>
                    <vnsAbsParam name="tcpb" key="tcpb" value="NO"/>
                    <vnsAbsParam name="cmp" key="cmp" value="NO"/>
                </vnsAbsFolder>
            </vnsAbsDevCfg>
            <vnsAbsFuncCfg name="SLB">
                <vnsAbsFolder key="VServer" name="VServer-Default">
                    <vnsAbsParam name="port" key="port" value="80"/>
                    <vnsAbsParam name="persistencetype" key="persistencetype"
                      value="cookie"/>
                    <vnsAbsParam name="clttimeout" key="clttimeout" value="100"/>
                    <vnsAbsParam name="servicetype" key="servicetype" value="TCP"/>
                    <vnsAbsParam name="servicename" key="servicename"/>
                </vnsAbsFolder>
            </vnsAbsFuncCfg>
        </vnsAbsFuncProf>
    </vnsAbsFuncProfGrp>
</vnsAbsFuncProfContr>
```

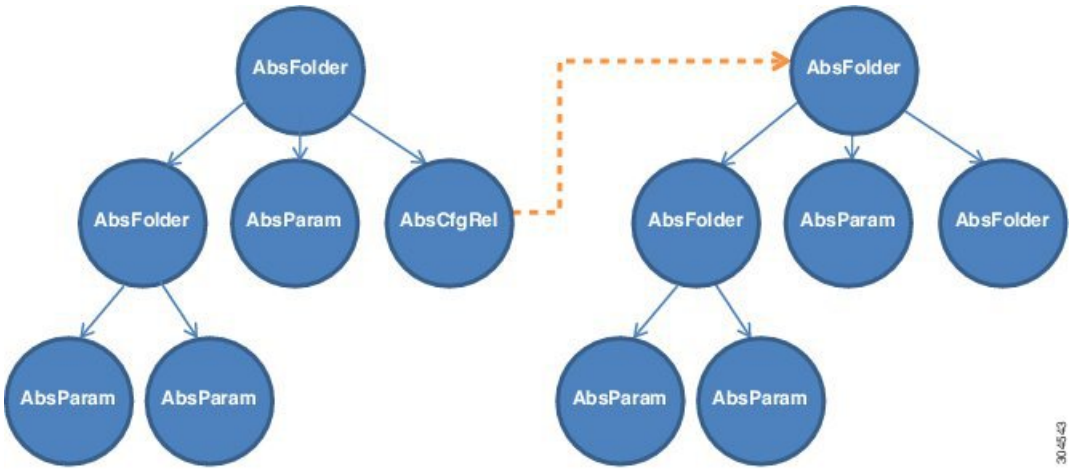
Configuration Parameters Inside an Abstract Function Node in a Service Graph

A function node inside a service graph allows an administrator to configure values for the configuration parameters. These values are used during graph instantiation.

Within an abstract function node, the configuration parameters are structured in a similar manner as to how they are structured inside an abstract function profile.

The following figure shows the configuration parameters hierarchy inside an abstract function node.

Figure 3: Configuration Parameters Hierarchy Inside an Abstract Function Node



AbsDevCfg

This section is used to provide the default value for the configuration items that are declared to be the device level configuration inside of the device package. The configuration items are specified under MDevCfg.

For each of these configuration items, there must be an equivalent configuration item under the device package.

AbsGrpCfg

This section is used to provide the default value for the configuration items that are declared to be the device level configuration inside of the device package. The configuration items are specified under MGrpCfg.

For each of these configuration items, there must be an equivalent configuration item under the device package.

The configuration that is described in this section is shared by all functions of a service graph that use the device. The Application Policy Infrastructure Controller (APIC) does a reference counting of the configuration objects that are created by using the configuration items that are described in this section. Objects are only deleted from a service device after all functions from the service graph are deleted.

AbsFuncCfg

This section is used to provide the default value for the configuration items that are declared to be the function level configuration inside of the device package. The configuration items are specified under MFuncCfg.

For each of these configuration items, there must be an equivalent configuration item under the device package.

This section is used to describe the configuration that is local to a service function. The configuration that is described in this section is specific to a service function. The APIC does a reference counting of the configuration objects that are created by the configuration items that are described in this section. Objects are created and deleted whenever a service function is instantiated and deleted.

AbsFolder

AbsFolder is a group of configuration items that can contain AbsParamss and other nested AbsFolders. For each AbsFolder, there must be an MFolder inside the device package. The APIC validates each AbsFolder to ensure that the AbsFolder has a corresponding MFolder in the package. AbsFolder has the following attributes:

Attribute	Description
Key	Defines the type of the configuration item. The key is defined in the device package and can never be overwritten. The key is used as a matching criterion as well as for validation.
Description	Describes the configuration item.
Cardinality	Specifies the cardinality of the configuration item. The default value is `1`.
ScopedBy	Specifies the scope for the parameter resolution. ScopedBy determines where to look for parameter values when the APIC resolves the parameter from configuration MOs. Default value is `Epg`. Supported values are `Tenant`, `Ap`, `Bd`, and `Epg`.
RsCfgToConn	A relation that associates a configuration item to an AbsConn.
DevCtx	Allows a configuration item to be associated with a specific physical device (CDev) in a device (LDev).
Locked	Allows a configuration item value to be locked. Once locked, the value cannot be changed.

AbsParam

AbsParam is the basic unit of configuration parameters. AbsParam defines a single configuration parameter. As with an AbsFolder, each AbsParam must have an equivalent MFolder in the device specification. The APIC validates the specification to ensure that AbsParam has a corresponding MFolder in the package. The value of an AbsParam is validated using the validation method specified in MParam. AbsParam has following attributes:

Attribute	Description
Key	Defines the type of the configuration item. The key is defined in the device package and can never be overwritten. The key is used as a matching criterion as well as for validation.
Value	Holds the value for a given configuration item. Values are not supported for MParam.
Description	Describes the configuration item.
Cardinality	Specifies the cardinality of the configuration item. The default value is `1`.
RsCfgToConn	A relation that associates a configuration item to an MConn.

Attribute	Description
Mandatory	Allows a configuration item to be marked as mandatory.
Locked	Allows a configuration item value to be locked. Once locked, the value cannot be changed.
Validation	Specifies the validation mechanism to be used to validate the configuration parameter.

AbsRel

AbsRel allows one AbsFolder to refer to another AbsFolder. AbsRel has following attributes:

Attribute	Description
Key	Defines the type of the configuration item. The key is defined in the device package and can never be overwritten. The key is used as a matching criterion as well as for validation.
Value	Holds the value for a given configuration item. Values are not supported for MParam.
Description	Describes the configuration item.
Cardinality	Specifies the cardinality of the configuration item. The default value is `1`.
RsCfgToConn	A relation that associates a configuration item to an MConn.
Mandatory	Allows a configuration item to be marked as mandatory.
Locked	Allows a configuration item value to be locked. Once locked, the value cannot be changed.

Example XML POST for an Abstract Function Node With Configuration Parameters

The following XML POST example shows an abstract function node with configuration parameters:

```
<vnsAbsNode name = "SLB" funcType="GoTo" >
   <vnsRsDefaultScopeToTerm tDn="uni/tn-tenant1/AbsGraph-G3/AbsTermNode-Output1/outtmnl"/>

    <vnsAbsFuncConn name = "C4" direction = "input">
        <vnsRsMConnAtt tDn="uni/infra/mDev-Acme-ADC-1.0/mFunc-SLB/mConn-external" />
    </vnsAbsFuncConn>
    <vnsAbsFuncConn name = "C5" direction = "output">
        <vnsRsMConnAtt tDn="uni/infra/mDev-Acme-ADC-1.0/mFunc-SLB/mConn-internal" />
    </vnsAbsFuncConn>

    <vnsAbsDevCfg>
        <vnsAbsFolder key="Network" name="Network" scopedBy="epg">
            <!-- Following scopes this folder to input terminal or Src Epg -->
          <vnsRsScopeToTerm tDn="uni/tn-tenant1/AbsGraph-G3/AbsTermNode-Output1/outtmnl"/>


            <!-- VIP address -->
            <vnsAbsFolder key="vip" name="vip" scopedBy="epg">
                <vnsAbsParam name="vipaddress" key="vipaddress" value=""/>
            </vnsAbsFolder>

            <!-- SNIP address -->
            <vnsAbsFolder key="snip" name="snip" scopedBy="epg">
                <vnsAbsParam name="snipaddress" key="snipaddress" value=""/>
            </vnsAbsFolder>
```

```
        </vnsAbsFolder>

        <vnsAbsFolder key="Service" name="Service" scopedBy="epg" cardinality="n">
          <vnsRsScopeToTerm tDn="uni/tn-tenant1/AbsGraph-G3/AbsTermNode-Output1/outtmnl"/>

            <vnsAbsParam name="servicename" key="servicename" value=""/>
            <vnsAbsParam name="servername" key="servername" value=""/>
            <vnsAbsParam name="serveripaddress" key="serveripaddress" value=""/>
        </vnsAbsFolder>
    </vnsAbsDevCfg>

    <vnsAbsFuncCfg>
        <vnsAbsFolder key="VServer" name="VServer" scopedBy="epg">
          <vnsRsScopeToTerm tDn="uni/tn-tenant1/AbsGraph-G3/AbsTermNode-Output1/outtmnl"/>

            <!-- Virtual Server Configuration -->
            <vnsAbsParam name="vip" key="vip" value=""/>
            <vnsAbsParam name="vservername" key="vservername" value=""/>
            <vnsAbsParam name="servicename" key="servicename"/>
            <vnsRsCfgToConn tDn="uni/tn-tenant1/AbsGraph-G3/AbsNode-Node2/AbsFConn-C4" />
        </vnsAbsFolder>
    </vnsAbsFuncCfg>
    <vnsRsNodeToMFunc tDn="uni/infra/mDev-Acme-ADC-1.0/mFunc-SLB"/>
</vnsAbsNode>
```

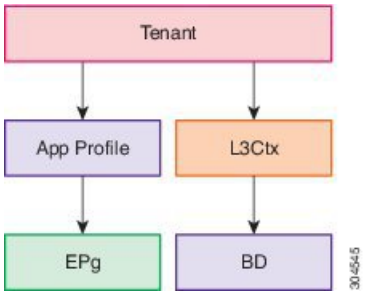
Configuration Parameters Inside Various Configuration MOs

An administrator can specify configuration parameters for a service function as part of various Application Policy Infrastructure Controller (APIC) MOs, such as EPG, tenant, BD, or AP. When a graph is instantiated, the APIC resolves the needed configuration for a graph by looking up the parameters from various places. At instantiation, parameter values are resolved and passed to the device script.

The flexibility of being able to keep configuration parameters inside various MOs allows an administrator to configure a single service graph and then use the graph for different tenants or end point groups (EPGs) with a different configuration for different tenants or EPGs.

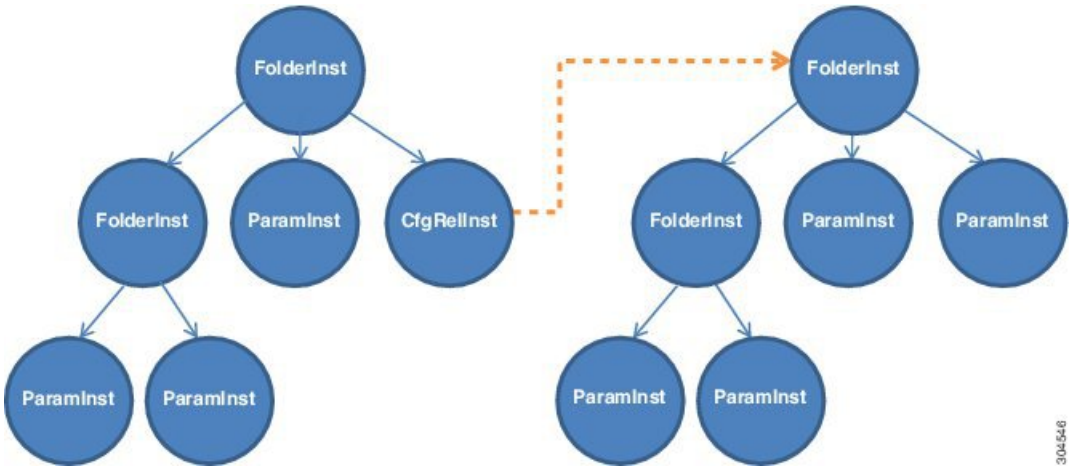
The following figure shows the hierarchy of an APIC MO.

Figure 4: Hierarchy of an APIC MO



The following figure shows configuration parameters inside various configuration MOs.

Figure 5: Configuration Parameters Inside Various Configuration MOs



FolderInst

FolderInst is a group of configuration items that can contain ParamInsts and other nested FolderInsts. A FolderInst has the following attributes:

Attribute	Description
Key	Defines the type of the configuration item. The key is defined in the device package and can never be overwritten. The key is used as a matching criterion as well as for validation.
ctrctNameOrLbl	Finds a matching FolderInst during parameter resolution. For a FolderInst to be used for parameter resolution, this property must match with the name of the contract that is associated with the service graph. Otherwise, this FolderInst is skipped and values are not used from this FolderInst. The value of this field can be "any" to allow this FolderInst to be used for all contracts.
graphNameOrLbl	Finds a matching FolderInst during parameter resolution. For a FolderInst to be used for parameter resolution, this property must match with the service graph name. Otherwise, this FolderInst is skipped and values are not used from this FolderInst. The value of this field can be “any” to allow this FolderInst to be used for all service graphs.
nodeNameOrLbl	Finds a matching FolderInst during parameter resolution. For a FolderInst to be used for parameter resolution, this property must match with the node name. Otherwise, this FolderInst is skipped and values are not used from this FolderInst. The value of this field can be “any” to allow this FolderInst to be used for all nodes in a service graph.

ParamInst

ParamInst is the basic unit of configuration parameters. ParamInst defines a single configuration parameter. As with a FolderInst, each ParamInst must have an equivalent MParam in the device specification. The APIC validates the specification to ensure that ParamInst has a corresponding MParam in the package. The value

of an ParamInst is validated using the validation method specified in the corresponding MParam. ParamInst has following attributes:

Attribute	Description
Key	Defines the type of the configuration item. The key is defined in the device package and can never be overwritten. The key is used as a matching criterion as well as for validation.
Value	Holds the value for a given configuration item. Values are not supported for MParam.

CfgRelInst

CfgRelInst has following attributes:

Attribute	Description
Key	Defines the type of the configuration item. The key is defined in the device package and can never be overwritten. The key is used as a matching criterion as well as for validation.
Value	Holds the path for the target FolderInst.

Example XML POST for an Application EPG With Configuration Parameters

The following XML example shows configuration parameters inside of the device package:

```
<fvAEPg dn="uni/tn-acme/ap-myApp/epg-app"  name="app">

    <vnsFolderInst ctrctNameOrLbl="any" graphNameOrLbl="any" nodeNameOrLbl="any" key="Monitor"

       name="monitor1">
        <vnsRsFolderInstToMFolder tDn="uni/infra/mDev-Acme-ADC-1.0/mDevCfg/mFolder-Monitor"/>

          <vnsParamInst name="weight" key="weight" value="10"/>
     </vnsFolderInst>

    <vnsFolderInst ctrctNameOrLbl="any" graphNameOrLbl="any" nodeNameOrLbl="any" key="Service"

       name="Service1">
         <vnsParamInst name="servicename" key="servicename" value="crpvgrtst02-8010"/>
         <vnsParamInst name="servicetype" key="servicetype" value="TCP"/>
         <vnsParamInst name="servername" key="servername" value="s192.168.100.100"/>
        <vnsParamInst name="serveripaddress" key="serveripaddress" value="192.168.100.100"/>

         <vnsParamInst name="serviceport" key="serviceport" value="8080"/>
         <vnsParamInst name="svrtimeout" key="svrtimeout" value="9000" />
         <vnsParamInst name="clttimeout" key="clttimeout" value="9000" />
         <vnsParamInst name="usip" key="usip" value="NO" />
         <vnsParamInst name="useproxyport" key="useproxyport" value="" />
         <vnsParamInst name="cip" key="cip" value="ENABLED" />
         <vnsParamInst name="cka" key="cka" value="NO" />
         <vnsParamInst name="sp" key="sp" value="OFF" />
         <vnsParamInst name="cmp" key="cmp" value="NO" />
         <vnsParamInst name="maxclient" key="maxclient" value="0" />
         <vnsParamInst name="maxreq" key="maxreq" value="0" />
         <vnsParamInst name="tcpb" key="tcpb" value="NO" />
         <vnsCfgRelInst name="MonitorConfig" key="MonitorConfig" targetName="monitor1"/>
     </vnsFolderInst>

    <vnsFolderInst ctrctNameOrLbl="any" graphNameOrLbl="G2" nodeNameOrLbl="any" key="Network"
```

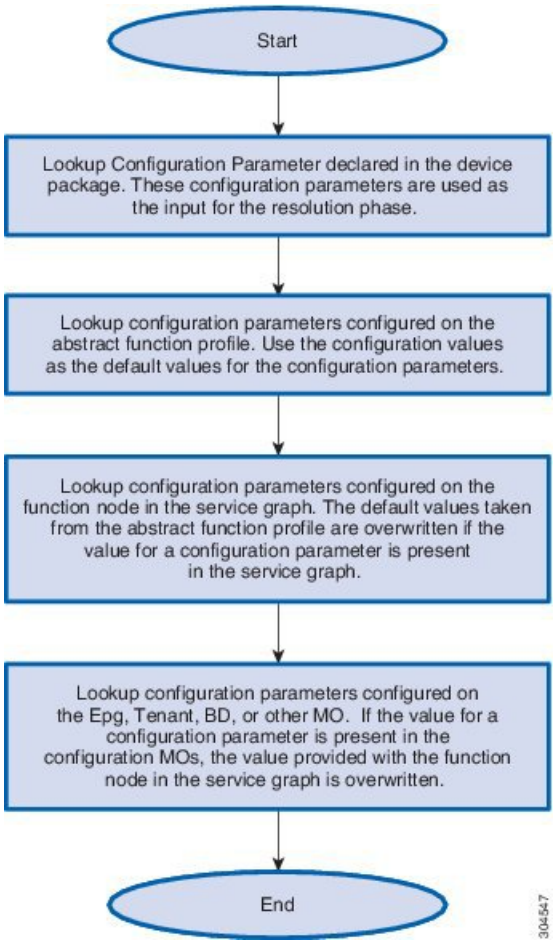
```
      name="Network">
       <vnsFolderInst ctrctNameOrLbl="any" graphNameOrLbl="G2" nodeNameOrLbl="any" key="vip"

          name="vip">
            <vnsParamInst name="vipaddress1" key="vipaddress" value="10.10.10.200"/>
        </vnsFolderInst>
        <vnsFolderInst ctrctNameOrLbl="any" graphNameOrLbl="G2" nodeNameOrLbl="any"
          devCtxLbl="C1" key="snip" name="snip1">
            <vnsParamInst name="snipaddress" key="snipaddress" value="192.168.1.200"/>
        </vnsFolderInst>
        <vnsFolderInst ctrctNameOrLbl="any" graphNameOrLbl="G2" nodeNameOrLbl="any"
          devCtxLbl="C2" key="snip" name="snip2">
    <vnsFolderInst ctrctNameOrLbl="any" graphNameOrLbl="G1" nodeNameOrLbl="any" key="Network"

      name="Network">
       <vnsFolderInst ctrctNameOrLbl="any" graphNameOrLbl="G1" nodeNameOrLbl="any" key="vip"

          name="vip">
            <vnsParamInst name="vipaddress1" key="vipaddress" value="10.10.10.100"/>
        </vnsFolderInst>
        <vnsFolderInst ctrctNameOrLbl="any" graphNameOrLbl="G1" nodeNameOrLbl="any"
          devCtxLbl="C1" key="snip" name="snip1">
            <vnsParamInst name="snipaddress" key="snipaddress" value="192.168.1.100"/>
        </vnsFolderInst>
        <vnsFolderInst ctrctNameOrLbl="any" graphNameOrLbl="G1" nodeNameOrLbl="any"
          devCtxLbl="C2" key="snip" name="snip2">
            <vnsParamInst name="snipaddress" key="snipaddress" value="192.168.1.101"/>
        </vnsFolderInst>
        <vnsFolderInst ctrctNameOrLbl="any" graphNameOrLbl="G1" nodeNameOrLbl="any"
          devCtxLbl="C3" key="snip" name="snip3">
            <vnsParamInst name="snipaddress" key="snipaddress" value="192.168.1.102"/>
        </vnsFolderInst>
     </vnsFolderInst>

     <!-- SLB Configuration -->
    <vnsFolderInst ctrctNameOrLbl="any" graphNameOrLbl="any" nodeNameOrLbl="any" key="VServer"

      name="VServer">
        <!-- Virtual Server Configuration -->
        <vnsParamInst name="port" key="port" value="8010"/>
        <vnsParamInst name="vip" key="vip" value="10.10.10.100"/>
        <vnsParamInst name="vservername" key="vservername" value="crpvgrtst02-vip-8010"/>
        <vnsParamInst name="servicename" key="servicename" value="crpvgrtst02-8010"/>
        <vnsFolderInst ctrctNameOrLbl="any" graphNameOrLbl="any" nodeNameOrLbl="any"
          key="VServerGlobalConfig" name="VServerGlobalConfig">
           <vnsCfgRelInst name="ServiceConfig" key="ServiceConfig" targetName="Service1"/>

            <vnsCfgRelInst name="VipConfig" key="VipConfig" targetName="Network/vip"/>
        </vnsFolderInst>
    </vnsFolderInst>
</fvAEPg>
```

Parameter Resolution

During graph instantiation, the Application Policy Infrastructure Controller (APIC) resolves the configuration parameters for each function in the service graph. After resolution completes, the parameter values are passed to the device script. The device script uses these parameter values to configure the service on the service appliance.

The following flow chart describes the parameter resolution steps.

Figure 6: Parameter Resolution



Looking Up an MO During Parameter Resolution

The Application Policy Infrastructure Controller (APIC) uses two main constructs while finding the suitable configuration MO to take the configuration parameters from.

RsScopeToTerm

The RsScopeToTerm relation for a function node or for an AbsFolder indicates the terminal node of the service graph that is connected with the configuration MOs that has parameters for the graph. The APIC uses the configuration MOs that are connected to the specified terminal node in RsScopeToTerm to find the graph configuration parameters.

If there is no RsScopeToTerm configuration specified, APIC uses the terminal connected to the provider EPG by default.

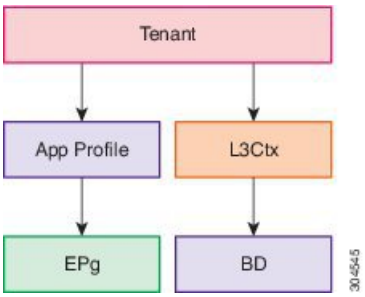
ScopedBy Attribute

The ScopedBy attribute is used to find the starting MO from which to resolve the parameter. For example, if scopedBy has a value of "Epg", the APIC starts the parameter resolution from the endpoint group. The APIC

then walks up in the hierarchy to resolve the parameters, walking to the application profile and then to the tenant to resolve the configuration parameters.

The following figure shows the hierarchy of an APIC MO.

Figure 7: Hierarchy of an APIC MO



About Role-Based Access Control Rule Enhancements

Layer 4 to Layer 7 policy configurations in a multi-tenant environment required administrator intervention to create certain objects that cannot be created by tenant administrators using the classic role-based access control (RBAC) domains and roles model definition. An Application Policy Infrastructure Controller (APIC) provides more granular RBAC privileges in the management information tree (MIT) such that you can grant tenant administrators the privileges that are required to create the objects. Tenant administrators can also create RBAC rules through self-service without administrator intervention to grant permissions for resources under their tenant subtree to other tenants and users in the system.

Role-Based Access Control Rule Architecture

The role-based access control (RBAC) rule has a boolean field `allowWrites` that enhances the role-based access control (RBAC) model to allow writeability rules. Without the `allowWrites` field, you can only define read RBAC rules.

The `RbacRule` class is defined as follows:

```
Class aaa:RbacRule (CONCRETE)
Encrypted: false
Exportable: true
Persistent: true
Configurable: true
Write Access: [aaa, admin]
Read Access: [aaa, admin]
```

An RBAC rule allows users from a security domain to read the subtree starting at a specific object.

```
DN FORMAT:   [1] uni/rbacdb/rule-{[objectDn]}-dom-{domain}
```

Table 1: aaa:RbacRule Properties Summary

Property	Type	Class	Description
aaa:Boolean	scalar:Enum8	allowWrites (aaa:RbacRule:allowWrites)	Read-write or read rule.

Property	Type	Class	Description
naming:Name	string:Basic	domain (aaa:RbacRule:domain)	The domain of the counts object. Overrides `aaa:ARbacRule:domain`.
reference:BinRef		objectDn (aaa:RbacRule:objectDn)	Overrides `aaa:ARbacRule:objectDn`.

The `PartialRbacRule` class is defined under the `fvTenant` class to allow tenants to create RBAC Rules (self-service). The `PartialRbacRule` class is defined as follows:

```
Class aaa:PartialRbacRule (CONCRETE)
Encrypted: false
Exportable: true
Persistent: true
Configurable: true
Write Access: [aaa, admin]
Read Access: [aaa, admin]
```

Table 2: aaa:PartialRbacRule Properties Summary

Property	Type	Class	Description
aaa:Boolean	scalar:Enum8	allowWrites (aaa:PartialRbacRule:allowWrites)	Read-write or read rule.
naming:Name	string:Basic	domain (aaa:PartialRbacRule:domain)	The domain of the counts object.
reference:BinRef		monPolDn (aaa:PartialRbacRule:monPolDn)	The monitoring policy attached to this observable object.
reference:BinRef		partialObjectDn (aaa:PartialRbacRule:partialObjectDn)	

The creation of the `PartialRbacRule` class by the tenant must be checked for a legal `partialObjectDn`. If the `partialObjectDn` lies under the tenant subtree, it is legal. Any distinguished names outside of the parent tenant subtree are not permitted.

The administrator can create `RbacRule`s that point to any distinguished name in the system. The tenant administrator can only create `PartialRbacRule`s that point to distinguished names that lie in that tenant administrator's tenant subtree.

Role-Based Access Control Rule System Flow

Either before, during, or after configuring the Layer 4 to Layer 7 policy, the tenant administrator can choose to create `PartialRbacRule`s that grant access to specific firewall and load balancer devices to their own tenant users. The access is implemented by creating `aaaDomain`s that represent each resource group that must be individually assigned. The following information provides an example setup:

Tenant	Acme

Users	acme-admin acme-firewall-1-admin acme-firewall-2-admin acme-loadbalancer-1-admin acme-loadbalancer-2-admin
Firewall Devices	Firewall1 Firewall2
Load Balancer Devices	LB1 LB2

The tenant administrator user acme-admin wishes to create the devices Firewall1, Firewall2, LB1, and LB2. Full write permissions for each device need to be assigned on an individual user basis. For example, user acme-firewall-1-admin must only have write privileges to device Firewall1 policies, while user acme-loadbalancer-1-admin must only have write privileges to device LB1 policies. To accomplish this, the acme-admin user creates 4 `PartialRbacRule`s that grant the following access:

- Firewall1 distinguished name—writeable by domain acme-firewall1
- Firewall2 distinguished name—writeable by domain acme-firewall2
- LB1 distinguished name—writeable by domain acme-lb1
- LB2 distinguished name—writeable by domain acme-lb2

Users are then assigned the following privileges:

- User—acme-firewall-1-admin
  - Domain acme—read-all permissions
  - Domain acme-firewall1—tenant-admin/write
- User—acme-firewall-2-admin
  - Domain acme—read-all permissions
  - Domain acme-firewall2—tenant-admin/write
- User—acme-lb-1-admin
  - Domain acme—read-all permissions
  - Domain acme-lb1—tenant-admin/write
- User—acme-lb-2-admin
  - Domain acme—read-all permissions
  - Domain acme-lb2—tenant-admin/write

For any of the above 4 users, the domain acme's permissions allow them to read the acme tenant subtree, but not write any nodes. The domain acme-lb2's permissions of tenant-admin/write allow the user to write to the LB2 policy subtree only.