Fabric Connectivity

Registering Devices

To manage service nodes through the Application Policy Infrastructure Controller (APIC), the administrator must explicitly register the service devices. During the registration step, you must provide the following information:

- Topology information: How device interfaces are connected to the fabric leaf nodes.
- Label interfaces: Based on the device requirements. The labels are used by the APIC to bind an interface with a connector for specific functions that are provided by the service device.
- IP address and port information: Information that is needed to connect to the device.
- Username and password: Credentials used for configuring the device.

The sample firewall device specification below defines three labels for interfaces:

- `Inside`: Identifies network interfaces that are more trusted (secure).
- `Outside`: Identifies network interfaces that are less trusted.
- `Management`: Identifies the interface used for management connectivity.

The labels are defined in the device specification using the `vnsMIfLbl` tag. All interfaces on the firewall device are categorized into one of the types defined by the device specification.

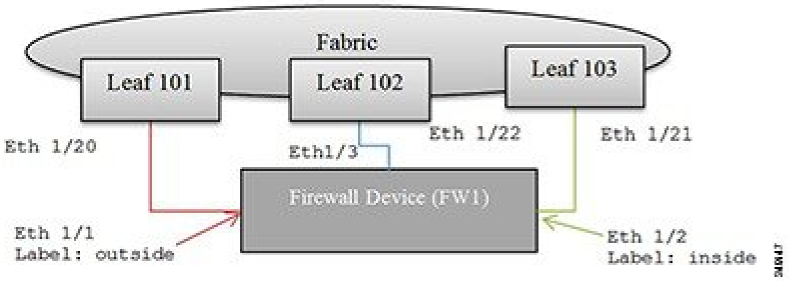
Note The APIC does not check if the interface actually exists on the device.

The following example shows a Northbound XML post for registering a device with the APIC. You can either post the request as shown or use the APIC GUI to register the device:

```
<polUni>
    <fvTenant
        dn="uni/tn-Tenant1"
        name="Tenant1">
        <vnsLDevVip name="Firewall-1">

            <vnsLIf name="external">
                <vnsRsMetaIf tDn="uni/infra/mDev-CISCO-ASA-1.0.1.16/mIfLbl-external"/>
                <vnsRsCIfAtt tDn="uni/tn-Tenant1/lDevVip-Firewall/cDev-ASA/cIf-Eth1_1"/>
            </vnsLIf>
            <vnsLIf name="internal">
                <vnsRsMetaIf tDn="uni/infra/mDev-CISCO-ASA-1.0.1.16/mIfLbl-internal"/>
                <vnsRsCIfAtt tDn="uni/tn-Tenant1/lDevVip-Firewall/cDev-ASA/cIf-Eth1_2"/>
            </vnsLIf>
            <vnsCDev name="FW1">

                <vnsCIf name="Eth1_1">
                       <vnsRsCIfPathAtt tDn="topology/pod-1/paths-101/pathep-[eth1/20]"/>
                </vnsCIf>
                <vnsCIf name="Eth1_2">
                       <vnsRsCIfPathAtt tDn="topology/pod-1/paths-102/pathep-[eth1/21]"/>
                </vnsCIf>
                <vnsCIf name="Eth1_3">
                       <vnsRsCIfPathAtt tDn="topology/pod-1/paths-103/pathep-[eth1/22]"/>
                </vnsCIf>

                <vnsCMgmt name="devMgmt"
                          host="192.168.78.62"
                          port="80"
                          />

               <vnsCCred name="username"
                          value="admin"
                          />
               <vnsCCredSecret name="password"
                          value="insieme"
                          />
            </vnsCDev>
        </vnsLDevVip>
    </fvTenant>
</polUni>
```

The following figure shows the topology of registering a device.

Figure 1: Topology of Registering a Device



The three steps the to register the device are as follows:

1 Register the interfaces:

- Eth 1/1: Labeled as `outside`. Connected to Leaf node 101, Eth 1/20.

- Eth 1/2: Labeled as `inside`. Connected to Leaf node 102, Eth 1/21.
- Ethernet 1/3: Labeled as `management`. Connected to Leaf node 103, Eth 1/22.

2 Provide the management IP address (192.168.78.62) and port (80) to reach to the device.

3 Provide the username and password credentials to use for communicating with the device.

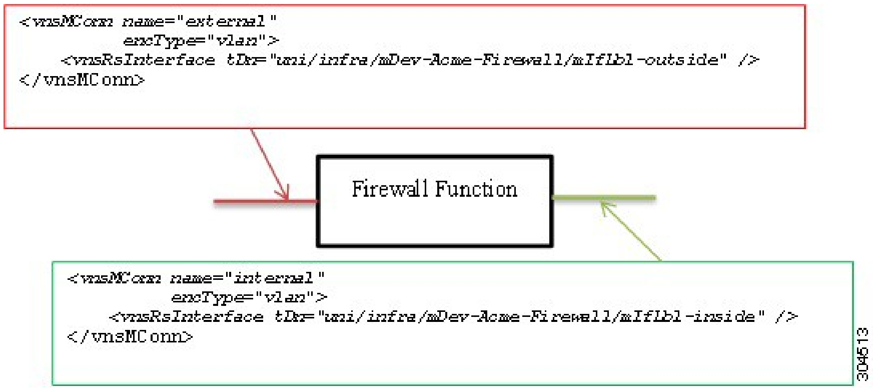
Connectors

The connectors for a `vnsMFunc` define connectivity between two or more function nodes or between a function node and the fabric within a graph. A connector has the following attributes:

- `name`: Identifies a specific connector.
- `encType`: Defines whether the packets are tagged with a VLAN header or are VXLAN encapsulated.
- `vnsRsInterface`: If the connector provides connectivity to the fabric, this interface associates the connector to an interface type on the device.

In the following figure, two connectors are associated to a firewall function. The first connector represents connectivity to an external or outside network, and the second connector represents connectivity to an internal or inside network on the firewall device. Both are tagged with a VLAN header.

Figure 2: Connectors Associated to a Firewall Function



```
<vnsMConn name="external"
          encType="vlan">
    <vnsRsInterface tDn="uni/infra/mDev-Acme-Firewall/mIfLbl-outside" />
</vnsMConn>
```

```
<vnsMConn name="internal"
          encType="vlan">
    <vnsRsInterface tDn="uni/infra/mDev-Acme-Firewall/mIfLbl-inside" />
</vnsMConn>
```

Service Graphs

A service graph is an ordered set of functions between a set of terminals. You can manually create a service graph using the GUI or CLI, or create one programmatically using the Application Policy Infrastructure Controller (APIC) Northbound Service Integration API. A function within the graph might require one or more parameters and have one or more connectors.

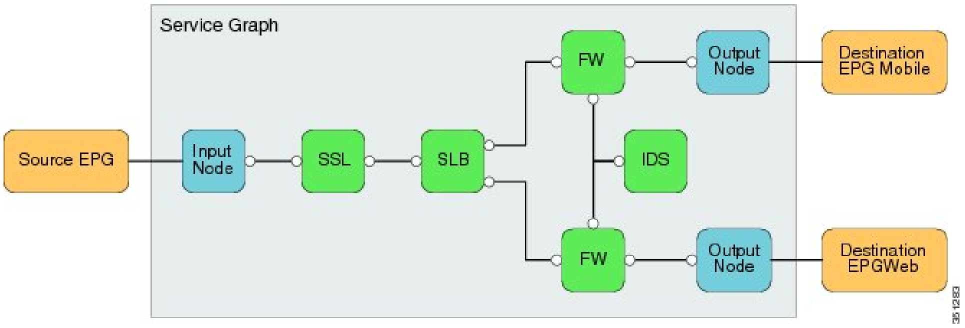
A service graph represents the network using the following elements:

- Function Nodes (green)—A function applied to traffic such as a transform (SSL termination, VPN gateway), filter (firewalls), or terminal (intrusion detection systems)

- Terminal Nodes (blue)—Input and outputs from the service graph
- Connector (white)—Input and output from a node
- Connections—How traffic is forwarded through the network

The following figure shows a service graph.

Figure 3: Service Graph



Note Although this generic service graph shows two output nodes, the fabric supports only a single input node and a single output node from a service graph at this time.

The `serviceModify` function is used to instantiate the network and function configurations.

Graph Rendering

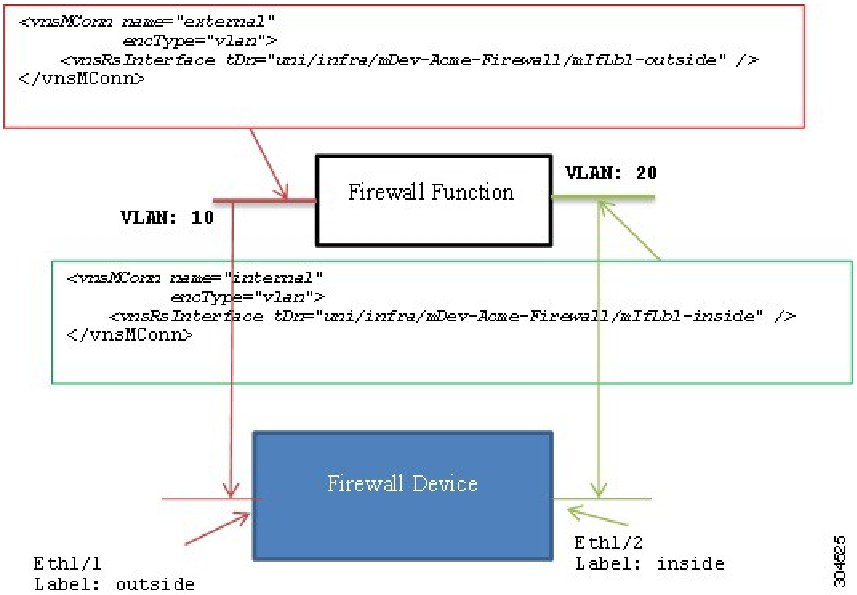
When instantiating a function on the device, the Application Policy Infrastructure Controller (APIC) does the following:

- Assigns a VLAN/VXLAN ID for the connector. The APIC checks whether the previous node has been allocated a VLAN/VXLAN ID. It either uses the previous node value or allocates a new tag for the connector. The `encType` indicates whether the VLAN/VXLAN ID is allocated.
- Uses interface relation and device interface label information to associate an interface to a connector. In the previous figure, rendering a firewall function on the firewall device will result in these bindings:
    - Connector labeled as `external`: Device Interface Eth1/1
    - Connector labeled as `internal`: Device Interface Eth1/2

You should enable or bind the VLAN or VXLAN tags that are assigned to the connector to the associated interfaces.

In the following figure, the APIC assigns VLAN 10 to the outside connector and VLAN 20 to the inside connector. The device script must configure VLAN 10 on interface Eth1/1 and bind it to the firewall function. Similarly, the device script must configure VLAN 20 on interface Eth1/2 and bind it to the firewall function.

Figure 4: A Firewall With Bound VLANs



```
<vnsMConn name="external"
          encType="vlan">
    <vnsRsInterface tDn="uni/infra/mDev-Acme-Firewall/mIfLbl-outside" />
</vnsMConn>
```

```
<vnsMConn name="internal"
          encType="vlan">
    <vnsRsInterface tDn="uni/infra/mDev-Acme-Firewall/mIfLbl-inside" />
</vnsMConn>
```

Device Script Interface

The VXLAN/VLAN encapsulation, interface, and association between the interface and VLAN/VXLAN are passed as device configuration parameters to the device script. In the previous figure, the Application Policy Infrastructure Controller (APIC) provides the following information in the device configuration:

- Encapsulation: VLAN 10, VLAN 20
- Interface: Eth1/1, Eth1/2
- Association of encapsulation to a logical interface:
    - 'Firewall-1_outside_1553': (VLAN -10, Eth1/1)
    - 'Firewall-1_inside_7697': (VLAN-20, Eth1/2)

The encapsulation tags, interfaces, and association are destroyed only when all functions across all graphs using the tag are deleted from the device. By providing encapsulation information in the device configuration, the APIC ensures the encapsulation tag is not deleted from the device until all functions that refer to the tag are deleted. The following example shows a sample dictionary:

```
Configuration =
{
 (0, '', <LdevInstance>): {
   ...
   (7, '', <encap-instance>): {'state': 1, 'tag': TagValue, 'type': TagType},
   (7, '', <encap-instance>): {'state': 1, 'tag': TagValue, 'type': 0},
   (8, '', <encap-association-Instance>): {
         'state': 1,
         'encap': <encapInstance>,
         'vif': <LogicalInterfaceInstanceID>}
   },
   (8, '', <encap-association-Instance>): {
         'state': 1,
         'encap': <encapInstance>,
         'vif': <LogicalInterfaceInstanceID>},
   },
   (10, '', <LogicalInterfaceInstance>): {
         'state': 0,
         'cifs': {
            'cDevInstance': <Interface Value>
         }
   },
   (10, '', <LogicalInterfaceInstance>): {
         'state': 0,
         'cifs': {
            'cDevInstance': <Interface Value>
         }
   },
 }
}

Legend:
The dictionary format is as follows:

(type, key, name): {
   'state': StateValue,
   'device': CDevName,
   'connector': connectorValue,
   'value': Parameter Value,
}


type:
7 – Encap Instance [Encap Type=0 (VLAN), Encap Type=1 (VXLAN))]
                    Encap Tag = VLAN ID or VNID (VXLAN case)
8 – VEncapAss (Device Interface and Encap (VXLAN/VLAN) association)
10 – VIF (logical interface) – Identifies interface on the device.

CDevName: Identifies a specific device within a cluster node. This attribute is not applicable
 to encap, VIF, or vEncapAss.

connectorValue: Identifies the connector to which this parameter should be bound. This
attribute is not applicable to encap, VIF, or vEncapAss.

value: Value of the parameter.

StateValue:
0 – No change
1 – Create
2 – Modify
3 - Destroy
```

The connectors within the function are related to the encapsulation association parameter specified in the device configuration. The encapsulation association parameter binds the connector to a specific VLAN/VXLAN tag and interface. In the above example, the dictionary for the function would contain the following connector information:

```
Configuration =
{
    (0, '', 'Firewall-1'): {
      'state': 2,
      'value': {
         (7, '', '1553'): {'state': 1, 'tag': 10, 'type': 0},
         (7, '', '7697'): {'state': 1, 'tag': 20, 'type': 0},
         (8, '', 'Firewall-1_outside_1553'): {'state': 1,
                                              'encap': '1553',
                                              'vif': 'Firewall-1_outside'},
         (8, '', 'Firewall-1_inside_7697'): {'state': 1,
                                             'encap': '1553',
                                             'vif': 'Firewall-1_inside'},

         (10, '', 'Firewall-1_outside'): {'state': 1,
                                          'cifs': {'FW2': 'Eth1/1' }
                                         },
         (10, '', 'Firewall-1_inside'):  {'state': 1,
                                          'cifs': {'FW': 'Eth1/2'}}
                                         }
         (1, '', '4552'): {
            'state': 1,
            'value': {
              (3, 'Firewall', 'F1’): {
                  'state': 1,
                  'value': {
                      (2, 'external', 'conn1'): { 'state': 1,
                          'value': {
                             ('9', '', 'outside_1553'): {
                                  'state': 1,
                                  'value': 'Firewall-1-outside_1553'
                             },
                          }
                      },
                      (2, 'internal', 'conn2'): { 'state': 1
                          'value': {
                             ('9', '', 'inside_7697'): {
                                  'state': 1,
                                  'value': 'Firewall-1-inside_7697'
                             },
                          }
                      },
                      (4, 'Firewall-Config', 'FW-Config 1'): {
                           'state': 1,
                           'value' : {
                               (5, 'Param-1', ''): { 'state': 1, 'value': value },
                           . . .
                           }
                      },
                  },
              },
           },
         },
      },
}
```

Based on the above dictionary, you should configure the device script to do the following:

- Enable VLAN 10 on interface Eth1/1:
  - Create subinterface Eth1/1.10 with encap VLAN 10
  - Add Eth1/1 to VLAN 10
- Enable VLAN 20 on interface Eth1/2:
  - Create subinterfaceEth1/2.20 with encap VLAN 20
  - Add Eth1/2 to VLAN 20

Note The connector value is a dictionary that allows each device within the cluster to use different interfaces.