Virtual Machine Manager Domains

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Cisco ACI VM Networking Support for Virtual Machine Managers

Benefits of ACI VM Networking

Cisco Application Centric Infrastructure (ACI) virtual machine (VM) networking supports hypervisors from multiple vendors. It provides the hypervisors programmable and automated access to high-performance scalable virtualized data center infrastructure.

Programmability and automation are critical features of scalable data center virtualization infrastructure. The Cisco ACI open REST API enables virtual machine integration with and orchestration of the policy model-based Cisco ACI fabric. Cisco ACI VM networking enables consistent enforcement of policies across both virtual and physical workloads that are managed by hypervisors from multiple vendors.

Attachable entity profiles easily enable VM mobility and placement of workloads anywhere in the Cisco ACI fabric. The Cisco Application Policy Infrastructure Controller (APIC) provides centralized troubleshooting, application health score, and virtualization monitoring. Cisco ACI multi-hypervisor VM automation reduces or eliminates manual configuration and manual errors. This enables virtualized data centers to support large numbers of VMs reliably and cost effectively.

Supported Products and Vendors

Cisco ACI supports virtual machine managers (VMMs) from the following products and vendors:

- **Cisco Unified Computing System Manager (UCSM)**

  Integration of Cisco UCSM is supported beginning in Cisco Cisco APIC Release 4.1(1). For information, see the chapter "Cisco ACI with Cisco UCSM Integration in the *Cisco ACI Virtualization Guide, Release 4.1(1)*.

- **Cisco Application Centric Infrastructure (ACI) Virtual Pod (vPod)**

  Cisco ACI vPod is in general availability beginning in Cisco APIC Release 4.0(2). For information, see the Cisco ACI vPod documentation on Cisco.com.

- **Cisco ACI Virtual Edge**

  For information, see the Cisco ACI Virtual Edge documentation on Cisco.com.

- **Cloud Foundry**

  Cloud Foundry integration with Cisco ACI is supported beginning with Cisco APIC Release 3.1(2). For information, see the knowledge base article, Cisco ACI and Cloud Found Integration on Cisco.com.

- **Kubernetes**

  For information, see the knowledge base article, Cisco ACI and Kubernetes Integration on Cisco.com.

- **Microsoft System Center Virtual Machine Manager (SCVMM)**

  For information, see the chapters "Cisco ACI with Microsoft SCVMM" and "Cisco ACI with Microsoft Windows Azure Pack" in the *Cisco ACI Virtualization Guide* on Cisco.com

- **OpenShift**

  For information, see the OpenShift documentation on Cisco.com.

- **OpenStack**

  For information, see the OpenStack documentation on Cisco.com.

- **Red Hat Virtualization (RHV)**

  For information, see the knowledge base article, Cisco ACI and Red Hat Integration on Cisco.com.

- **VMware Virtual Distributed Switch (VDS)**

  For information, see the chapter "Cisco "ACI with VMware VDS Integration" in the Cisco ACI Virtualization Guide.

See the Cisco ACI Virtualization Compatibility Matrix for the most current list of verified interoperable products.

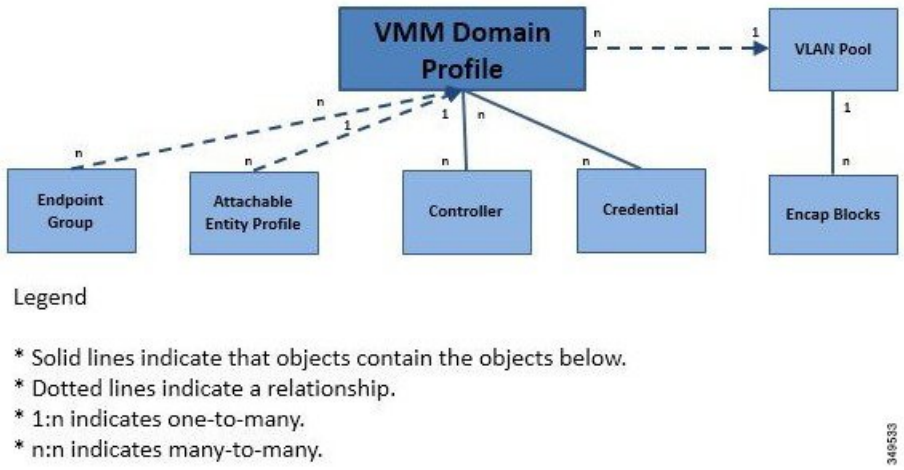
Note Beginning with Cisco APIC Release 5.0(1), Cisco Application Virtual Switch (AVS) is no longer supported. If you use Cisco AVS and upgrade to Cisco APIC Release 5.0(1), in case of issues, the fabric will not be supported. Also, a fault will be raised for the Cisco AVS domain.

If you use Cisco AVS, we recommend that you migrate to Cisco Application Centric Infrastructure (ACI) Virtual Edge Virtual Edge. See the *Cisco ACI Virtual Edge Installation Guide, Release 3.0(x)* on Cisco.com.

VMM Domain Policy Model

VMM domain profiles (`vmmDomP`) specify connectivity policies that enable virtual machine controllers to connect to the ACI fabric. The figure below provides an overview of the `vmmDomP` policy.

Figure 1: VMM Domain Policy Model Overview



Virtual Machine Manager Domain Main Components

ACI fabric virtual machine manager (VMM) domains enable an administrator to configure connectivity policies for virtual machine controllers. The essential components of an ACI VMM domain policy include the following:

- **Virtual Machine Manager Domain Profile**—Groups VM controllers with similar networking policy requirements. For example, VM controllers can share VLAN pools and application endpoint groups (EPGs). The APIC communicates with the controller to publish network configurations such as port groups that are then applied to the virtual workloads. The VMM domain profile includes the following essential components:
  - **Credential**—Associates a valid VM controller user credential with an APIC VMM domain.
  - **Controller**—Specifes how to connect to a VM controller that is part of a policy enforcement domain. For example, the controller specifies the connection to a VMware vCenter that is part a VMM domain.

Note A single VMM domain can contain multiple instances of VM controllers, but they must be from the same vendor (for example, from VMware or from Microsoft.

- **EPG Association**—Endpoint groups regulate connectivity and visibility among the endpoints within the scope of the VMM domain policy. VMM domain EPGs behave as follows:
  - The APIC pushes these EPGs as port groups into the VM controller.

    - An EPG can span multiple VMM domains, and a VMM domain can contain multiple EPGs.

- **Attachable Entity Profile Association**—Associates a VMM domain with the physical network infrastructure. An attachable entity profile (AEP) is a network interface template that enables deploying VM controller policies on a large set of leaf switch ports. An AEP specifies which switches and ports are available, and how they are configured.
- **VLAN Pool Association**—A VLAN pool specifies the VLAN IDs or ranges used for VLAN encapsulation that the VMM domain consumes.

Virtual Machine Manager Domains

An APIC VMM domain profile is a policy that defines a VMM domain. The VMM domain policy is created in APIC and pushed into the leaf switches.

VMM domains provide the following:

- A common layer in the ACI fabric that enables scalable fault-tolerant support for multiple VM controller platforms.
- VMM support for multiple tenants within the ACI fabric.

VMM domains contain VM controllers such as VMware vCenter or Microsoft SCVMM Manager and the credential(s) required for the ACI API to interact with the VM controller. A VMM domain enables VM mobility within the domain but not across domains. A single VMM domain can contain multiple instances of VM controllers but they must be the same kind. For example, a VMM domain can contain many VMware vCenters managing multiple controllers each running multiple VMs but it may not also contain SCVMM Managers. A VMM domain inventories controller elements (such as pNICs, vNICs, VM names, and so forth) and pushes policies into the controller(s), creating port groups, and other necessary elements. The ACI VMM domain listens for controller events such as VM mobility and responds accordingly.

VMM Domain VLAN Pool Association

VLAN pools represent blocks of traffic VLAN identifiers. A VLAN pool is a shared resource and can be consumed by multiple domains such as VMM domains and Layer 4 to Layer 7 services.

Each pool has an allocation type (static or dynamic), defined at the time of its creation. The allocation type determines whether the identifiers contained in it will be used for automatic assignment by the Cisco APIC (dynamic) or set explicitly by the administrator (static). By default, all blocks contained within a VLAN pool have the same allocation type as the pool but users can change the allocation type for encapsulation blocks contained in dynamic pools to static. Doing so excludes them from dynamic allocation.

A VMM domain can associate with only one dynamic VLAN pool. By default, the assignment of VLAN identifiers to EPGs that are associated with VMM domains is done dynamically by the Cisco APIC. While dynamic allocation is the default and preferred configuration, an administrator can statically assign a VLAN identifier to an endpoint group (EPG) instead. In that case, the identifiers used must be selected from encapsulation blocks in the VLAN pool associated with the VMM domain, and their allocation type must be changed to static.

The Cisco APIC provisions VMM domain VLAN on leaf ports based on EPG events, either statically binding on leaf ports or based on VM events from controllers such as VMware vCenter or Microsoft SCVMM.

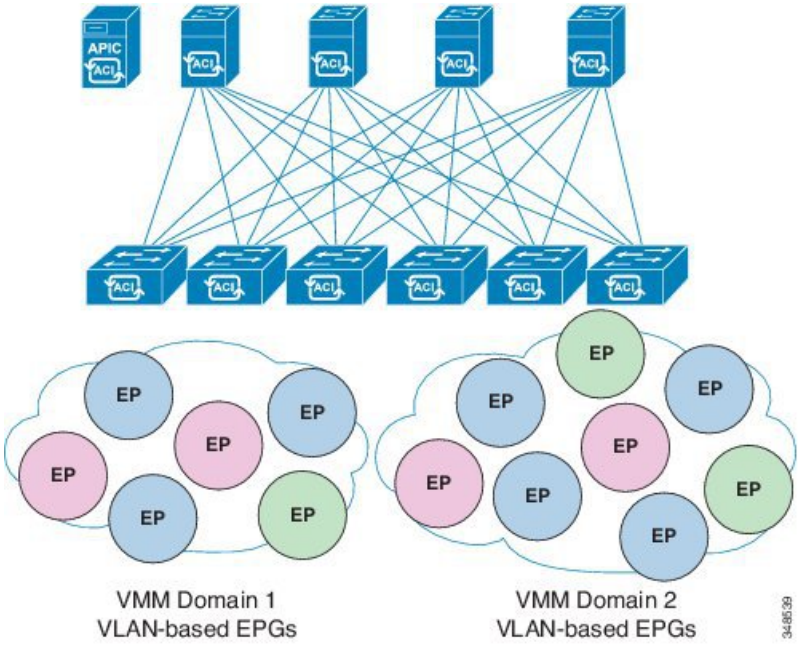
Note In dynamic VLAN pools, if a VLAN is disassociated from an EPG, it is automatically reassociated with the EPG in five minutes.

Note Dynamic VLAN association is not a part of configuration rollback, that is, in case an EPG or tenant was initially removed and then restored from the backup, a new VLAN is automatically allocated from the dynamic VLAN pools.

VMM Domain EPG Association

The Cisco Application Centric Infrastructure (ACI) fabric associates tenant application profile endpoint groups (EPGs) to virtual machine manager (VMM) domains, The Cisco ACI does so either automatically by an orchestration component such as Microsoft Azure, or by a Cisco Application Policy Infrastructure Controller (APIC) administrator creating such configurations. An EPG can span multiple VMM domains, and a VMM domain can contain multiple EPGs.

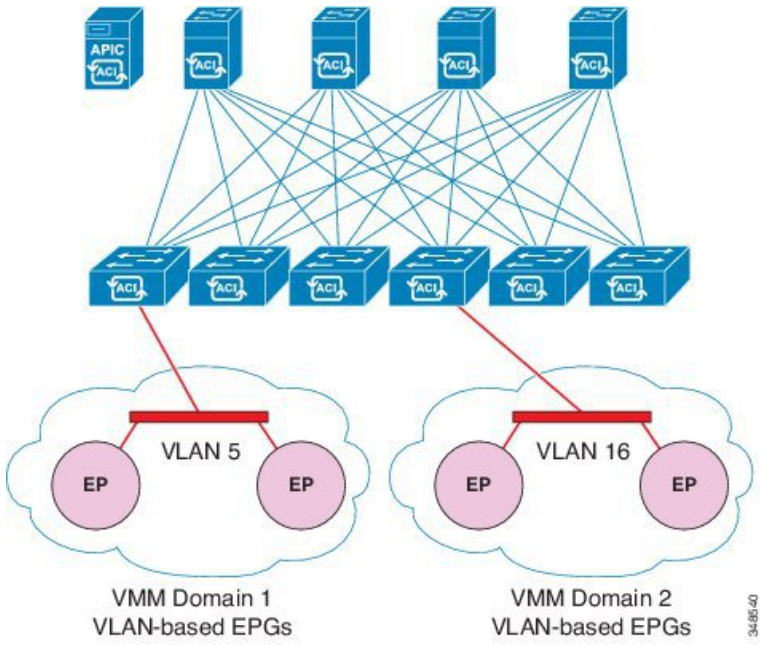
Figure 2: VMM Domain EPG Association



In the preceding illustration, end points (EPs) of the same color are part of the same EPG. For example, all the green EPs are in the same EPG although they are in two different VMM domains.

See the latest *Verified Scalability Guide for Cisco ACI* for virtual network and VMM domain EPG capacity information.

Figure 3: VMM Domain EPG VLAN Consumption



Note When multiple VMM domains with an overlapping VLAN ID range are connected to the same leaf switch, those domains should use the same VLAN pool. With the same VLAN pool, Cisco APIC can make sure to pick a different VLAN ID for each domain-to-EPG association. Otherwise, Cisco APIC might pick a VLAN ID that is already used on the switch for another domain-to-EPG association, which causes the VLAN deployment fail.

When multiple VMM domains with an overlapping VLAN ID range are connected to the same leaf switch and those domains use the same VLAN pool, you can have multiple VMM domains associated with the same EPG. However, each domain-to-EPG association deploys a different VLAN ID, respectively, even though the VLANs are for the same EPG and potentially are on the same port. If using VLAN IDs in this manner is suboptimal to your requirements, you can use the same VMM domain with multiple VMM controllers instead of having multiple VMM domains.

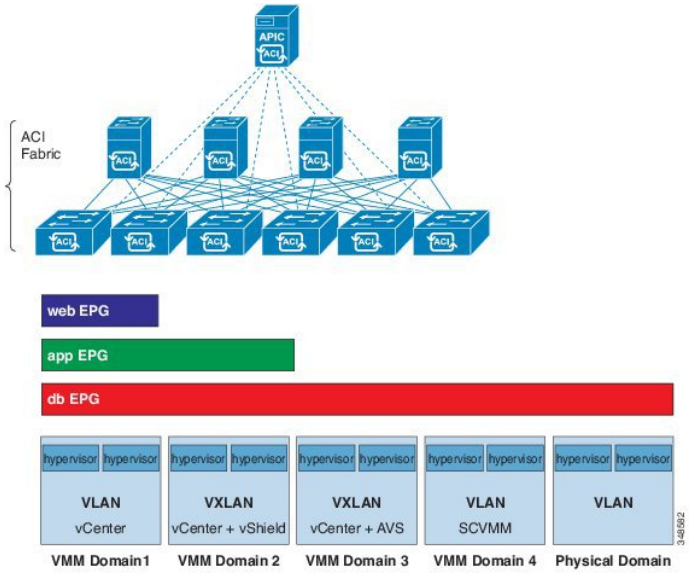
EPGs can use multiple VMM domains in the following ways:

- An EPG within a VMM domain is identified by using an encapsulation identifier. Cisco APIC can manage the identifier automatically, or the administrator can statically select it. An example is a VLAN, a Virtual Network ID (VNID).
- An EPG can be mapped to multiple physical (for baremetal servers) or virtual domains. It can use different VLAN or VNID encapsulations in each domain.

Note By default, the Cisco APIC dynamically manages the allocatiion of a VLAN for an EPG. VMware DVS administrators have the option to configure a specific VLAN for an EPG. In that case, the VLAN is chosen from a static allocation block within the pool that is associated with the VMM domain.

Applications can be deployed across VMM domains.

Figure 4: Multiple VMM Domains and Scaling of EPGs in the Fabric



While live migration of VMs within a VMM domain is supported, live migration of VMs across VMM domains is not supported.

Note When you change the VRF on a bridge domain that is linked to an EPG with an associated VMM domain, the port-group is deleted and then added back on vCenter. This results in the EPG being undeployed from the VMM domain. This is expected behavior.

Trunk Port Group

You use a trunk port group to aggregate the traffic of endpoint groups (EPGs) for VMware virtual machine manager (VMM) domains. Unlike regular port groups, which are configured under the Tenants tab in the Cisco Application Policy Infrastructure Controller (APIC) GUI, trunk port groups are configured under the VM Networking tab. Regular port groups follow the *T*|*A*|*E* format of EPG names.

The aggregation of EPGs under the same domain is based on a VLAN range, which is specified as encapsulation blocks contained in the trunk port group. Whenever the encapsulation of an EPG is changed or the encapsulation block of a trunk port group is changed, the aggregation is re-evaluated to determine if the EGP should be aggregated.

A trunk port group controls the leaf deployment of network resources, such as VLANs, that allocated to the EPGs being aggregated. The EPGs include both base EPG and microsegmented (uSeg) EPGs. In the case of a uSeg EPG, the VLAN ranges of the trunk port group are needed to include both the primary and secondary VLANs.

EPG Policy Resolution and Deployment Immediacy

Whenever an endpoint group (EPG) associates to a virtual machine manager (VMM) domain, the administrator can choose the resolution and deployment preferences to specify when a policy should be pushed into leaf switches.

Resolution Immediacy

- Pre-provision: Specifies that a policy (for example, VLAN, VXLAN binding, contracts, or filters) is downloaded to a leaf switch even before a VM controller is attached to the virtual switch (for example, VMware vSphere Distributed Switch (VDS). This pre-provisions the configuration on the switch.

  This helps the situation where management traffic for hypervisors/VM controllers is also using the virtual switch associated to the Cisco Application Policy Infrastructure Controller (APIC) VMM domain (VMM switch).

  Deploying a VMM policy such as VLAN on a Cisco Application Centric Infrastructure (ACI) leaf switch requires Cisco APICto collect CDP/LLDP information from both hypervisors through the VM controller and Cisco ACI leaf switch. However, if the VM controller is supposed to use the same VMM policy (VMM switch) to communicate with its hypervisors or even Cisco APIC, the CDP/LLDP information for hypervisors can never be collected because the policy that is required for VM controller/hypervisor management traffic is not deployed yet.

  When using pre-provision immediacy, policy is downloaded to Cisco ACI leaf switch regardless of CDP/LLDP neighborship. Even without a hypervisor host that is connected to the VMM switch.

- Immediate: Specifies that EPG policies (including contracts and filters) are downloaded to the associated leaf switch software upon ESXi host attachment to a DVS. LLDP or OpFlex permissions are used to resolve the VM controller to leaf node attachments.

  The policy will be downloaded to leaf when you add host to the VMM switch. CDP/LLDP neighborship from host to leaf is required.

- On Demand: Specifies that a policy (for example, VLAN, VXLAN bindings, contracts, or filters) is pushed to the leaf node only when an ESXi host is attached to a DVS and a VM is placed in the port group (EPG).

  The policy will be downloaded to the leaf when host is added to the VMM switch. The VM needs to be placed into a port group (EPG). CDP/LLDP neighborship from host to leaf is required.

  With both immediate and on demand, if host and leaf lose LLDP/CDP neighborship the policies are removed.

Note In OpFlex-based VMM domains, an OpFlex agent on the hypervisor reports a VM/EP virtual network interface card (vNIC) attachment to an EPG to the leaf OpFlex process. When using On Demand Resolution Immediacy, the EPG VLAN/VXLAN is programmed on **all** leaf port channel ports, virtual port channel ports, or both when the following are true:

- Hypervisors are connected to leafs on port channel or virtual port channel attached directly or through blade switches.
- A VM or instance vNIC is attached to an EPG.
- Hypervisors are attached as part of the EPG or VMM domain.

Opflex-based VMM domains are Microsoft Security Center Virtual Machine Manager (SCVMM) and HyperV, Cisco ACI Virtual Edge, and Cisco Application Virtual Switch (AVS).

Deployment Immediacy

Once the policies are downloaded to the leaf software, deployment immediacy can specify when the policy is pushed into the hardware policy content-addressable memory (CAM).

- Immediate: Specifies that the policy is programmed in the hardware policy CAM as soon as the policy is downloaded in the leaf software.
- On demand: Specifies that the policy is programmed in the hardware policy CAM only when the first packet is received through the data path. This process helps to optimize the hardware space.

Note When you use on demand deployment immediacy with MAC-pinned VPCs, the EPG contracts are not pushed to the leaf ternary content-addressble memory (TCAM) until the first endpoint is learned in the EPG on each leaf. This can cause uneven TCAM utilization across VPC peers. (Normally, the contract would be pushed to both peers.)

Guidelines for Deleting VMM Domains

Follow the sequence below to assure that the Cisco Application Policy Infrastructure Controller (APIC) request to delete a VMM domain automatically triggers the associated VM controller (for example VMware vCenter or Microsoft SCVMM) to complete the process normally, and that no orphan EPGs are stranded in the Cisco Application Centric Infrastructure (ACI) fabric.

1. The VM administrator must detach all the VMs from the port groups (in the case of VMware vCenter) or VM networks (in the case of SCVMM), created by the Cisco APIC.
2. The Cisco ACI administrator deletes the VMM domain in the Cisco APIC. The Cisco APIC triggers deletion of VMware VDS or SCVMM logical switch and associated objects.

Note The VM administrator should not delete the virtual switch or associated objects (such as port groups or VM networks); allow the Cisco APIC to trigger the virtual switch deletion upon completion of step 2 above. EPGs could be orphaned in the Cisco APIC if the VM administrator deletes the virtual switch from the VM controller before the VMM domain is deleted in the Cisco APIC.

If this sequence is not followed, the VM controller does delete the virtual switch associated with the Cisco APIC VMM domain. In this scenario, the VM administrator must manually remove the VM and vtep associations from the VM controller, then delete the virtual switch(es) previously associated with the Cisco APIC VMM domain.