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Split-NVE Control Plane Requirements
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Abstract

In a Split-NVE architecture, the functions of the NVE are split across a server and an external network equipment which is called an external NVE. The server-resident control plane functionality resides in control software, which may be part of a hypervisor or container management software; for simplicity, this draft refers to the hypervisor as the location of this software.

A control plane protocol(s) between a hypervisor and its associated external NVE(s) is used for the hypervisor to distribute its virtual machine networking state to the external NVE(s) for further handling. This document illustrates the functionality required by this type of control plane signaling protocol and outlines the high level requirements. Virtual machine states as well as state transitioning are summarized to help clarifying the needed protocol requirements.

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1. Introduction

In the Split-NVE architecture shown in Figure 1, the functionality of the NVE is split across an end device supporting virtualization and an external network device which is called an external NVE. The portion of the NVE functionality located on the end device is called the tNVE and the portion located on the external NVE is called the nNVE in this document. Overlay encapsulation/decapsulation functions are normally off-loaded to the nNVE on the external NVE.

The tNVE is normally implemented as a part of hypervisor or container and/or virtual switch in an virtualized end device. This document uses the term "hypervisor" throughout when describing the Split-NVE scenario where part of the NVE functionality is off-loaded to a separate device from the "hypervisor" that contains a VM connected to a VN. In this context, the term "hypervisor" is meant to cover any device type where part of the NVE functionality is off-loaded in this fashion, e.g.,a Network Service Appliance, Linux Container.

The problem statement [RFC7364], discusses the needs for a control plane protocol (or protocols) to populate each NVE with the state needed to perform the required functions. In one scenario, an NVE provides overlay encapsulation/decapsulation packet forwarding services to Tenant Systems (TSs) that are co-resident within the NVE on the same End Device (e.g. when the NVE is embedded within a hypervisor or a Network Service Appliance). In such cases, there is no need for a standardized protocol between the hypervisor and NVE, as the interaction is implemented via software on a single device. While in the Split-NVE architecture scenarios, as shown in figure 2 to figure 4, a control plane protocol(s) between a hypervisor and its associated external NVE(s) is required for the hypervisor to distribute the virtual machines networking states to the NVE(s) for further handling. The protocol indeed is an NVE-internal protocol and runs between tNVE and nNVE logical entities. This protocol is mentioned in NVO3 problem statement [RFC7364] and appears as the third work item.

Virtual machine states and state transitioning are summarized in this document to show events where the NVE needs to take specific actions. Such events might correspond to actions the control plane signaling protocols between the hypervisor and external NVE will need to take. Then the high level requirements to be fulfilled are outlined.

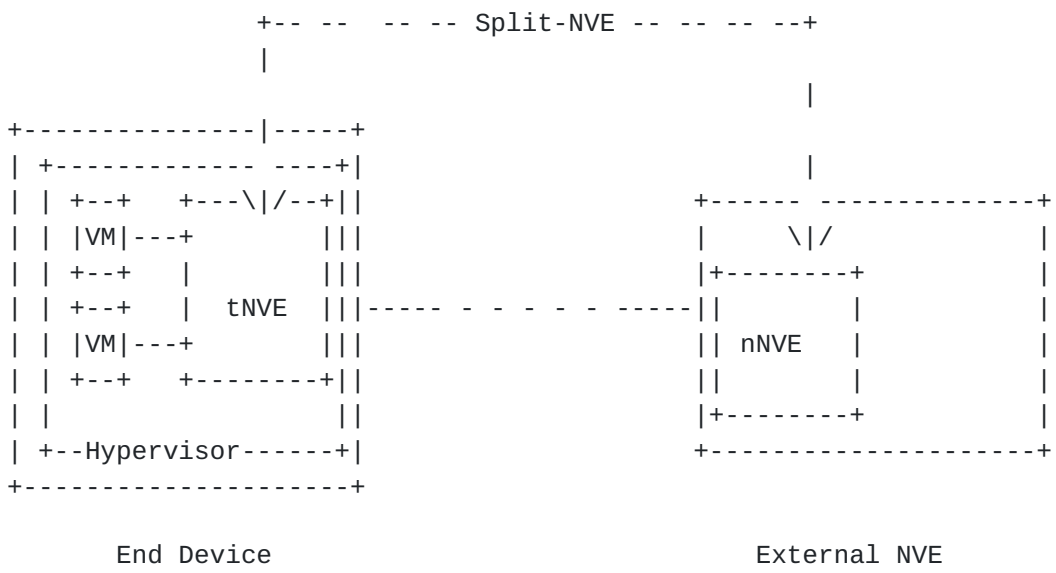

Figure 1 Split-NVE structure

This document uses VMs as an example of Tenant Systems (TSs) in order to describe the requirements, even though a VM is just one type of Tenant System that may connect to a VN. For example, a service instance within a Network Service Appliance is another type of TS, as are systems running on an OS-level virtualization technologies like containers. The fact that VMs have lifecycles(e.g., can be created and destroyed), can be moved, and can be started or stopped results in a general set of protocol requirements, most of which are applicable to other forms of TSs. It should also be noted that not all of the requirements are applicable to all forms of TSs.

Section 2 describes VM states and state transitioning in its lifecycle. Section 3 introduces Hypervisor-to-NVE control plane protocol functionality derived from VM operations and network events. Section 4 outlines the requirements of the control plane protocol to achieve the required functionality.

1.1 Terminology

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in RFC 2119 [RFC2119].

This document uses the same terminology as found in [RFC7365] and [I-D.ietf-nvo3-nve-nva-cp-req]. This section defines additional terminology used by this document.

Split-NVE: a type of NVE that the functionalities of it are split across an end device supporting virtualization and an external network device.

tNVE: the portion of Split-NVE functionalities located on the end device supporting virtualization. It interacts with tenant system by internal interface in end device.

nNVE: the portion of Split-NVE functionalities located on the network device which is directly or indirectly connects to the end device holding the corresponding tNVE. nNVE normally performs encapsulation and decapsulation to the overlay network.

External NVE: the physical network device holding nNVE

Hypervisor/Container: the logical collection of software, firmware and/or hardware that allows the creation and running of server or service appliance virtualization. tNVE is located on Hypervisor/Container. It is loosely used in this document to refer to the end device supporting the virtualization. For simplicity, we also use Hypervisor in this document to represent both hypervisor and container.

VN Profile: Meta data associated with a VN that is applied to any attachment point to the VN. That is, VAP properties that are appliaed to all VAPs associated with a given VN and used by an NVE when ingressing/egressing packets to/from a specific VN. Meta data could include such information as ACLs, QoS settings, etc. The VN Profile contains parameters that apply to the VN as a whole. Control protocols between the NVE and NVA could use the VN ID or VN Name to obtain the VN Profile.

VSI: Virtual Station Interface. [IEEE 802.1Qbg]

VDP: VSI Discovery and Configuration Protocol [IEEE 802.1Qbg]

1.2 Target Scenarios

In the Split-NVE architecture, an external NVE can provide an offload of the encapsulation / decapsulation function, network policy enforcement, as well as the VN Overlay protocol overhead. This offloading may provide performance improvements and/or resource savings to the End Device (e.g. hypervisor) making use of the external NVE.

The following figures give example scenarios of a Split-NVE architecture.

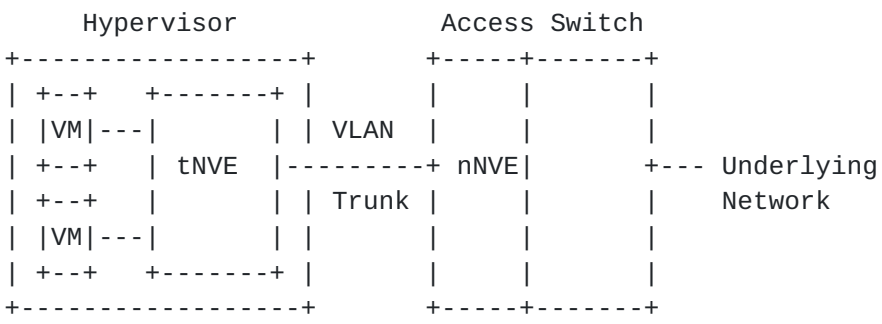

Figure 2 Hypervisor with an External NVE

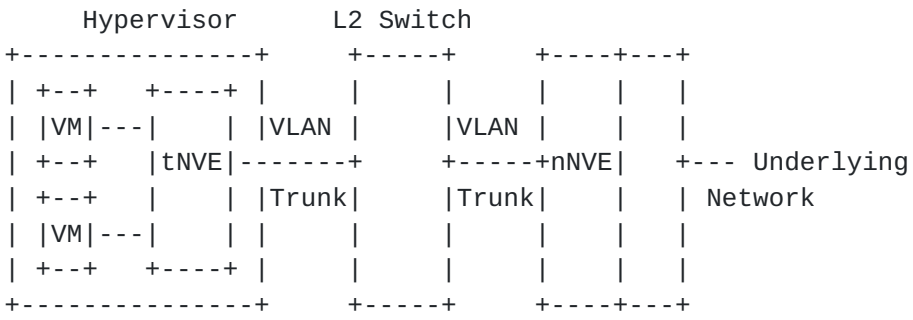

Figure 3 Hypervisor with an External NVE
across an Ethernet Access Switch

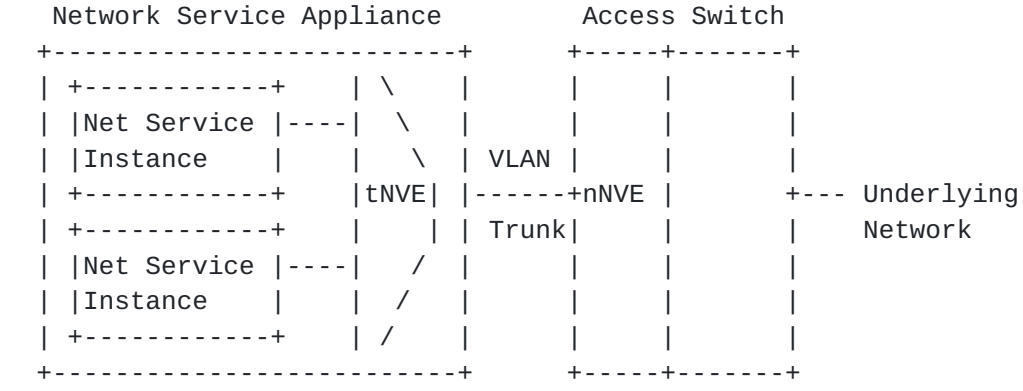

Figure 4 Physical Network Service Appliance with an External NVE

Tenant Systems connect to external NVEs via a Tenant System Interface (TSI). The TSI logically connects to the external NVE via a Virtual Access Point (VAP) [I-D.ietf-nvo3-arch]. The external NVE may provide Layer 2 or Layer 3 forwarding. In the Split-NVE architecture, the external NVE may be able to reach multiple MAC and IP addresses via a TSI. For example, Tenant Systems that are providing network services (such as transparent firewall, load balancer, VPN gateway) are likely

to have complex address hierarchy. This implies that if a given TSI disassociates from one VN, all the MAC and/or IP addresses are also disassociated. There is no need to signal the deletion of every MAC or IP when the TSI is brought down or deleted. In the majority of cases, a VM will be acting as a simple host that will have a single TSI and single MAC and IP visible to the external NVE.

Figures 2-4 show the use of VLANs to separate traffic for multiple VNs between the tNVE and nNVE; VLANs are not strictly necessary if only one VN is involved, but multiple VNs are expected in most cases, and hence this draft assumes their presence.

2. VM Lifecycle

Figure 2 of [I-D.ietf-opsawg-vmm-mib] shows the state transition of a VM. Some of the VM states are of interest to the external NVE. This section illustrates the relevant phases and events in the VM lifecycle. It should be noted that the following subsections do not give an exhaustive traversal of VM lifecycle state. They are intended as the illustrative examples which are relevant to Split-NVE architecture, not as prescriptive text; the goal is to capture sufficient detail to set a context for the signaling protocol functionality and requirements described in the following sections.

2.1 VM Creation Event

VM creation event makes the VM state transiting from Preparing to Shutdown and then to Running [I-D.ietf-opsawg-vmm-mib]. The end device allocates and initializes local virtual resources like storage in the VM Preparing state. In Shutdown state, the VM has everything ready except that CPU execution is not scheduled by the hypervisor and VM's memory is not resident in the hypervisor. From the Shutdown state to Running state, normally it requires the human execution or system triggered event. Running state indicates the VM is in the normal execution state. As part of transitioning the VM to the Running state, the hypervisor must also provision network connectivity for the VM's TSI(s) so that Ethernet frames can be sent and received correctly. No ongoing migration, suspension or shutdown is in process.

In the VM creation phase, the VM's TSI has to be associated with the external NVE. Association here indicates that hypervisor and the external NVE have signaled each other and reached some agreement. Relevant networking parameters or information have been provisioned properly. The External NVE should be informed of the VM's TSI MAC address and/or IP address. In addition to external network

connectivity, the hypervisor may provide local network connectivity between the VM's TSI and other VM's TSI that are co-resident on the same hypervisor. When the intra or inter-hypervisor connectivity is extended to the external NVE, a locally significant tag, e.g. VLAN ID, should be used between the hypervisor and the external NVE to differentiate each VN's traffic. Both the hypervisor and external NVE sides must agree on that tag value for traffic identification, isolation and forwarding.

The external NVE may need to do some preparation work before it signals successful association with TSI. Such preparation work may include locally saving the states and binding information of the tenant system interface and its VN, communicating with the NVA for network provisioning, etc.

Tenant System interface association should be performed before the VM enters running state, preferably in Shutdown state. If association with external NVE fails, the VM should not go into running state.

2.2 VM Live Migration Event

Live migration is sometimes referred to as "hot" migration, in that from an external viewpoint, the VM appears to continue to run while being migrated to another server (e.g., TCP connections generally survive this class of migration). In contrast, "cold" migration consists of shutdown VM execution on one server and restart it on another. For simplicity, the following abstract summary about live migration assumes shared storage, so that the VM's storage is accessible to the source and destination servers. Assume VM live migrates from hypervisor 1 to hypervisor 2. Such migration event involves the state transition on both hypervisors, source hypervisor 1 and destination hypervisor 2. VM state on source hypervisor 1 transits from Running to Migrating and then to Shutdown [I-D.ietf-opsawg-vmm-mib]. VM state on destination hypervisor 2 transits from Shutdown to Migrating and then Running.

The external NVE connected to destination hypervisor 2 has to associate the migrating VM's TSI with it by discovering the TSI's MAC and/or IP addresses, its VN, locally significant VID if any, and provisioning other network related parameters of the TSI. The external NVE may be informed about the VM's peer VMs, storage devices and other network appliances with which the VM needs to communicate or is communicating. The migrated VM on destination hypervisor 2 SHOULD not go to Running state before all the network provisioning and binding has been done.

The migrating VM SHOULD not be in Running state at the same time on

the source hypervisor and destination hypervisor during migration. The VM on the source hypervisor does not transition into Shutdown state until the VM successfully enters the Running state on the destination hypervisor. It is possible that VM on the source hypervisor stays in Migrating state for a while after VM on the destination hypervisor is in Running state.

2.3 VM Termination Event

VM termination event is also referred to as "powering off" a VM. VM termination event leads to its state going to Shutdown. There are two possible causes to terminate a VM [I-D.ietf-opsawg-vmm-mib], one is the normal "power off" of a running VM; the other is that VM has been migrated to another hypervisor and the VM image on the source hypervisor has to stop executing and to be shutdown.

In VM termination, the external NVE connecting to that VM needs to deprovision the VM, i.e. delete the network parameters associated with that VM. In other words, the external NVE has to de-associate the VM's TSI.

2.4 VM Pause, Suspension and Resumption Events

The VM pause event leads to the VM transiting from Running state to Paused state. The Paused state indicates that the VM is resident in memory but no longer scheduled to execute by the hypervisor [I-D.ietf-opsawg-vmm-mib]. The VM can be easily re-activated from Paused state to Running state.

The VM suspension event leads to the VM transiting from Running state to Suspended state. The VM resumption event leads to the VM transiting state from Suspended state to Running state. Suspended state means the memory and CPU execution state of the virtual machine are saved to persistent store. During this state, the virtual machine is not scheduled to execute by the hypervisor [I-D.ietf-opsawg-vmm-mib].

In the Split-NVE architecture, the external NVE should keep any paused or suspended VM in association as the VM can return to Running state at any time.

3. Hypervisor-to-NVE Control Plane Protocol Functionality

The following subsections show the illustrative examples of the state transitions on external NVE which are relevant to Hypervisor-to-NVE Signaling protocol functionality. It should be noted they are not prescriptive text for full state machines.

3.1 VN connect and Disconnect

In Split-NVE scenario, a protocol is needed between the End Device(e.g. Hypervisor) making use of the external NVE and the external NVE in order to make the external NVE aware of the changing VN membership requirements of the Tenant Systems within the End Device.

A key driver for using a protocol rather than using static configuration of the external NVE is because the VN connectivity requirements can change frequently as VMs are brought up, moved and brought down on various hypervisors throughout the data center or external cloud.

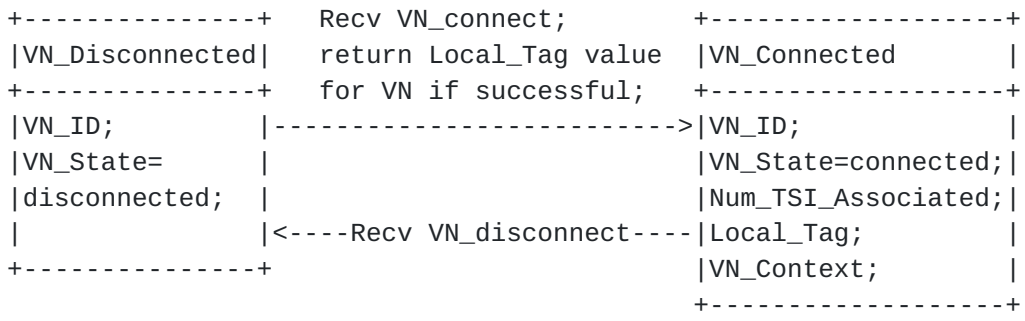

Figure 5 State Transition Example of a VAP Instance on an External NVE

Figure 5 shows the state transition for a VAP on the external NVE. An NVE that supports the hypervisor to NVE control plane protocol should support one instance of the state machine for each active VN. The state transition on the external NVE is normally triggered by the hypervisor-facing side events and behaviors. Some of the interleaved interaction between NVE and NVA will be illustrated for better understanding of the whole procedure; while others of them may not be shown. More detailed information regarding that is available in [I-D.ietf-nvo3-nve-nva-cp-req].

The external NVE must be notified when an End Device requires connection to a particular VN and when it no longer requires connection. In addition, the external NVE must provide a local tag value for each connected VN to the End Device to use for exchange of packets between the End Device and the external NVE (e.g. a locally significant 802.1Q tag value). How "local" the significance is depends on whether the Hypervisor has a direct physical connection to

the external NVE (in which case the significance is local to the physical link), or whether there is an Ethernet switch (e.g. a blade switch) connecting the Hypervisor to the NVE (in which case the significance is local to the intervening switch and all the links connected to it).

These VLAN tags are used to differentiate between different VNs as packets cross the shared access network to the external NVE. When the external NVE receives packets, it uses the VLAN tag to identify the VN of packets coming from a given TSI, strips the tag, and adds the appropriate overlay encapsulation for that VN and sends it towards the corresponding remote NVE across the underlying IP network.

The Identification of the VN in this protocol could either be through a VN Name or a VN ID. A globally unique VN Name facilitates portability of a Tenant's Virtual Data Center. Once an external NVE receives a VN connect indication, the NVE needs a way to get a VN Context allocated (or receive the already allocated VN Context) for a given VN Name or ID (as well as any other information needed to transmit encapsulated packets). How this is done is the subject of the NVE-to-NVA protocol which are part of work items 1 and 2 in [RFC7364].

VN_connect message can be explicit or implicit. Explicit means the hypervisor sending a message explicitly to request for the connection to a VN. Implicit means the external NVE receives other messages, e.g. very first TSI associate message (see the next subsection) for a given VN, to implicitly indicate its interest to connect to a VN.

A VN_disconnect message will indicate that the NVE can release all the resources for that disconnected VN and transit to VN_disconnected state. The local tag assigned for that VN can possibly be reclaimed by other VN.

3.2 TSI Associate and Activate

Typically, a TSI is assigned a single MAC address and all frames transmitted and received on that TSI use that single MAC address. As mentioned earlier, it is also possible for a Tenant System to exchange frames using multiple MAC addresses or packets with multiple IP addresses.

Particularly in the case of a TS that is forwarding frames or packets from other TSs, the external NVE will need to communicate the mapping between the NVE's IP address (on the underlying network) and ALL the addresses the TS is forwarding on behalf of for the corresponding VN to the NVA.

The NVE has two ways in which it can discover the tenant addresses for which frames must be forwarded to a given End Device (and ultimately to the TS within that End Device).

1. It can glean the addresses by inspecting the source addresses in packets it receives from the End Device.

2. The hypervisor can explicitly signal the address associations of a TSI to the external NVE. The address association includes all the MAC and/or IP addresses possibly used as source addresses in a packet sent from the hypervisor to external NVE. The external NVE may further use this information to filter the future traffic from the hypervisor.

To perform the second approach above, the "hypervisor-to-NVE" protocol requires a means to allow End Devices to communicate new tenant addresses associations for a given TSI within a given VN.

Figure 6 shows the example of a state transition for a TSI connecting to a VAP on the external NVE. An NVE that supports the hypervisor to NVE control plane protocol may support one instance of the state machine for each TSI connecting to a given VN.

Figure 6 State Transition Example of a TSI Instance on an External NVE

Associated state of a TSI instance on an external NVE indicates all the addresses for that TSI have already associated with the VAP of the external NVE on port p for a given VN but no real traffic to and from the TSI is expected and allowed to pass through. An NVE has reserved all the necessary resources for that TSI. An external NVE may report the mappings of its' underlay IP address and the associated TSI addresses to NVA and relevant network nodes may save such information to its mapping table but not forwarding table. A NVE may create ACL or filter rules based on the associated TSI addresses on the attached port p but not enable them yet. Local tag for the VN corresponding to the TSI instance should be provisioned on port p to receive packets.

VM migration event(discussed section 2) may cause the hypervisor to send an associate message to the NVE connected to the destination hypervisor the VM migrates to. VM creation event may also lead to the

same practice.

The Activated state of a TSI instance on an external NVE indicates that all the addresses for that TSI functioning correctly on port p and traffic can be received from and sent to that TSI via the NVE. The mappings of the NVE's underlay IP address and the associated TSI addresses should be put into the forwarding table rather than the mapping table on relevant network nodes. ACL or filter rules based on the associated TSI addresses on the attached port p in NVE are enabled. Local tag for the VN corresponding to the TSI instance MUST be provisioned on port p to receive packets.

The Activate message makes the state transit from Init or Associated to Activated. VM creation, VM migration and VM resumption events discussed in section 4 may trigger the Activate message to be sent from the hypervisor to the external NVE.

TSI information may get updated either in Associated or Activated state. The following are considered updates to the TSI information: add or remove the associated addresses, update current associated addresses (for example updating IP for a given MAC), update NVE port information based on where the NVE receives messages. Such updates do not change the state of TSI. When any address associated to a given TSI changes, the NVE should inform the NVA to update the mapping information on NVE's underlying address and the associated TSI addresses. The NVE should also change its local ACL or filter settings accordingly for the relevant addresses. Port information update will cause the local tag for the VN corresponding to the TSI instance to be provisioned on new port p and removed from the old port.

3.3 TSI Disassociate and Deactivate

Disassociate and deactivate conceptually are the reverse behaviors of associate and activate. From Activated state to Associated state, the external NVE needs to make sure the resources are still reserved but the addresses associated to the TSI are not functioning and no traffic to and from the TSI is expected and allowed to pass through. For example, the NVE needs to inform the NVA to remove the relevant addresses mapping information from forwarding or routing table. ACL or filtering rules regarding the relevant addresses should be disabled. From Associated or Activated state to the Init state, the NVE will release all the resources relevant to TSI instances. The NVE should also inform the NVA to remove the relevant entries from mapping table. ACL or filtering rules regarding the relevant addresses should be removed. Local tag provisioning on the connecting port on NVE should be cleared.

A VM suspension event(discussed in section 2) may cause the relevant TSI instance(s) on the NVE to transit from Activated to Associated state. A VM pause event normally does not affect the state of the relevant TSI instance(s) on the NVE as the VM is expected to run again soon. The VM shutdown event will normally cause the relevant TSI instance(s) on NVE transit to Init state from Activated state. All resources should be released.

A VM migration will lead the TSI instance on the source NVE to leave Activated state. When a VM migrates to another hypervisor connecting to the same NVE, i.e. source and destination NVE are the same, NVE should use TSI_ID and incoming port to differentiate two TSI instance.

Although the triggering messages for state transition shown in Figure 6 does not indicate the difference between VM creation/shutdown event and VM migration arrival/departure event, the external NVE can make optimizations if it is notified of such information. For example, if the NVE knows the incoming activate message is caused by migration rather than VM creation, some mechanisms may be employed or triggered to make sure the dynamic configurations or provisionings on the destination NVE are the same as those on the source NVE for the migrated VM. For example IGMP query [RFC2236] can be triggered by the destination external NVE to the migrated VM on destination hypervisor so that the VM is forced to answer an IGMP report to the multicast router. Then multicast router can correctly send the multicast traffic to the new external NVE for those multicast groups the VM had joined before the migration.

4. Hypervisor-to-NVE Control Plane Protocol Requirements

Req-1: The protocol MUST support a bridged network connecting End Devices to External NVE.

Req-2: The protocol MUST support multiple End Devices sharing the same External NVE via the same physical port across a bridged network.

Req-3: The protocol MAY support an End Device using multiple external NVEs simultaneously, but only one external NVE for each VN.

Req-4: The protocol MAY support an End Device using multiple external NVEs simultaneously for the same VN.

Req-5: The protocol MUST allow the End Device initiating a request to its associated External NVE to be connected/disconnected to a given VN.

Req-6: The protocol MUST allow an External NVE initiating a request to its connected End Devices to be disconnected to a given VN.

Req-7: When a TS attaches to a VN, the protocol MUST allow for an End Device and its external NVE to negotiate one or more locally-significant tag(s) for carrying traffic associated with a specific VN (e.g., 802.1Q tags).

Req-8: The protocol MUST allow an End Device initiating a request to associate/disassociate and/or activate/deactive address(es) of a TSI instance to a VN on an NVE port.

Req-9: The protocol MUST allow the External NVE initiating a request to disassociate and/or deactivate address(es) of a TSI instance to a VN on an NVE port.

Req-10: The protocol MUST allow an End Device initiating a request to add, remove or update address(es) associated with a TSI instance on the external NVE. Addresses can be expressed in different formats, for example, MAC, IP or pair of IP and MAC.

Req-11: The protocol MUST allow the External NVE to authenticate the End Device connected.

Req-12: The protocol MUST be able to run over L2 links between the End Device and its External NVE.

Req-13: The protocol SHOULD support the End Device indicating if an associate or activate request from it results from a VM hot migration event.

5. VDP Applicability and Enhancement Needs

Virtual Station Interface (VSI) Discovery and Configuration Protocol (VDP) [IEEE 802.1Qbg] can be the control plane protocol running between the hypervisor and the external NVE. Appendix A illustrates VDP for reader's information.

VDP facilitates the automatic discovery and configuration for Edge Virtual Bridging (EVB) station and Edge Virtual Bridging (EVB) bridge. EVB station is normally an end station running multiple VMs. It is conceptually equivalent to hypervisor in this document. And EVB bridge is conceptually equivalent to the external NVE.

VDP is able to pre-associate/associate/de-associate a VSI on EVB station to a port on the EVB bridge. VSI is approximately the concept

of a virtual port a VM connects to the hypervisor in this document context. The EVB station and the EVB bridge can reach the agreement on VLAN ID(s) assigned to a VSI via VDP message exchange. Other configuration parameters can be exchanged via VDP as well. VDP is carried over Edge Control Protocol(ECP) [IEEE8021Qbg] which provides a reliable transportation over a layer 2 network.

VDP protocol needs some extensions to fulfill the requirements listed in this document. Table 1 shows the needed extensions and/or clarifications in NVO3 context.

<table>
<tr><th>Req</th><th>VDP supported?</th><th>remarks</th></tr>
<tr><td>Req-1</td><td></td><td></td></tr>
<tr><td>Req-2</td><td></td><td>Needs extension. Must be able to send to a specific unicast MAC and should be able to send to a non-reserved well known multicast address other than the nearest customer bridge address</td></tr>
<tr><td>Req-3</td><td>Partially</td><td></td></tr>
<tr><td>Req-4</td><td></td><td></td></tr>
<tr><td>Req-5</td><td>Yes</td><td>VN is indicated by GroupID</td></tr>
<tr><td>Req-6</td><td>Yes</td><td>Bridge sends De-Associate</td></tr>
<tr><td>Req-7</td><td>Yes</td><td>VID==NULL in request and bridge returns the assigned value in response or specify GroupID in request and get VID assigned in returning response. Multiple VLANs per group is allowed</td></tr>
<tr><td>Req-8</td><td>Partially</td><td><table><tr><th>requirements</th><th>VDP equivalence</th></tr><tr><td>associate/disassociate</td><td>pre-asso/de-associate</td></tr><tr><td>activate/deactivate</td><td>associate/de-associate</td></tr></table>Needs extension to allow associate->pre-assoc</td></tr>
<tr><td>Req-9</td><td>Yes</td><td>VDP bridge initiates de-associate</td></tr>
<tr><td>Req-10</td><td>Partially</td><td>Needs extension for IPv4/IPv6 address. Add a new "filter info format" type</td></tr>
<tr><td>Req-11</td><td>No</td><td>Out-of-band mechanism is preferred, e.g. MACSec or 802.1x.</td></tr>
</table>

Req-12	Yes	L2 protocol naturally
		M bit for migrated VM on destination hypervisor and S bit for that on source hypervisor.
Req-13	Partially	It is indistinguishable when M/S is 0 between no guidance and events not caused by migration where NVE may act differently. Needs new New bits for migration indication in new "filter info format" type

Table 1 Compare VDP with the requirements

Simply adding the ability to carry layer 3 addresses, VDP can serve the Hypervisor-to-NVE control plane functions pretty well. Other extensions are the improvement of the protocol capabilities for better fit in NVO3 network.

6. Security Considerations

NVEs must ensure that only properly authorized Tenant Systems are allowed to join and become a part of any specific Virtual Network. In addition, NVEs will need appropriate mechanisms to ensure that any hypervisor wishing to use the services of an NVE are properly authorized to do so. One design point is whether the hypervisor should supply the NVE with necessary information (e.g., VM addresses, VN information, or other parameters) that the NVE uses directly, or whether the hypervisor should only supply a VN ID and an identifier for the associated VM (e.g., its MAC address), with the NVE using that information to obtain the information needed to validate the hypervisor-provided parameters or obtain related parameters in a secure manner.

7. IANA Considerations

No IANA action is required. RFC Editor: please delete this section before publication.

8. Acknowledgements

This document was initiated and merged from the drafts draft-kreeger-nvo3-hypervisor-nve-cp, draft-gu-nvo3-tes-nve-mechanism and draft-kompella-nvo3-server2nve. Thanks to all the co-authors and contributing members of those drafts.

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8. References

8.1 Normative References

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8.2 Informative References

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Appendix A. IEEE 802.1Qbg VDP Illustration (For information only)

VDP has the format shown in Figure A.1. Virtual Station Interface (VSI) is an interface to a virtual station that is attached to a downlink port

of an internal bridging function in server. VSI's VDP packet will be handled by an external bridge. VDP is the controlling protocol running between the hypervisor and the external bridge.

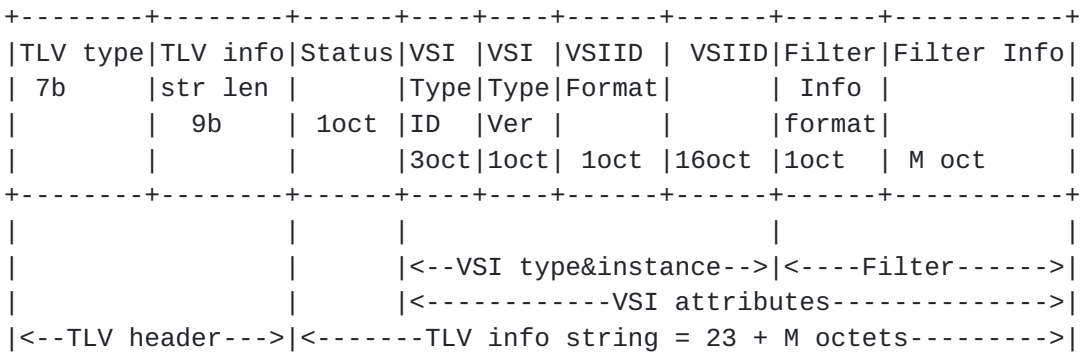

Figure A.1: VDP TLV definitions

There are basically four TLV types.

1. Pre-Associate: Pre-Associate is used to pre-associate a VSI instance with a bridge port. The bridge validates the request and returns a failure Status in case of errors. Successful pre-association does not imply that the indicated VSI Type or provisioning will be applied to any traffic flowing through the VSI. The pre-associate enables faster response to an associate, by allowing the bridge to obtain the VSI Type prior to an association.

2. Pre-Associate with resource reservation: Pre-Associate with Resource Reservation involves the same steps as Pre-Associate, but on successful pre-association also reserves resources in the Bridge to prepare for a subsequent Associate request.

3. Associate: The Associate creates and activates an association between a VSI instance and a bridge port. The Bridge allocates any required bridge resources for the referenced VSI. The Bridge activates the configuration for the VSI Type ID. This association is then applied to the traffic flow to/from the VSI instance.

4. Deassociate: The de-associate is used to remove an association between a VSI instance and a bridge port. Pre-Associated and Associated VSIs can be de-associated. De-associate releases any resources that were reserved as a result of prior Associate or Pre-Associate operations for that VSI instance.

Deassociate can be initiated by either side and the rest types of messages can only be initiated by the server side.

Some important flag values in VDP Status field:

1. **M-bit (Bit 5): Indicates that the user of the VSI (e.g., the VM) is** migrating (M-bit = 1) or provides no guidance on the migration of the user of the VSI (M-bit = 0). The M-bit is used as an indicator relative to the VSI that the user is migrating to.

2. **S-bit (Bit 6): Indicates that the VSI user (e.g., the VM) is** suspended (S-bit = 1) or provides no guidance as to whether the user of the VSI is suspended (S-bit = 0). A keep-alive Associate request with S-bit = 1 can be sent when the VSI user is suspended. The S-bit is used as an indicator relative to the VSI that the user is migrating from.

The filter information format currently supports 4 types as the following.

1. **VID Filter Info format**

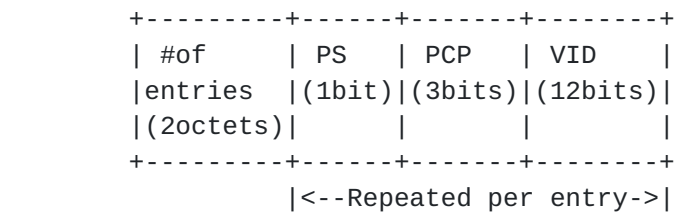

Figure A.2 VID Filter Info format

2. **MAC/VID filter format**

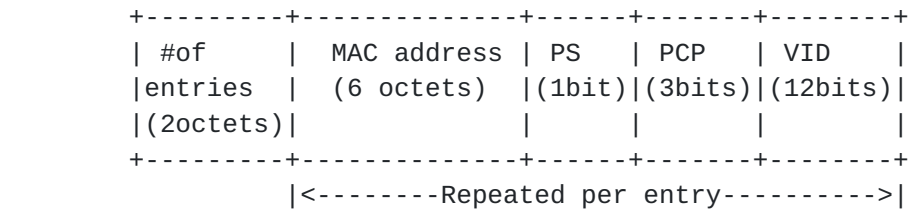

Figure A.3 MAC/VID filter format

3. **GroupID/VID filter format**

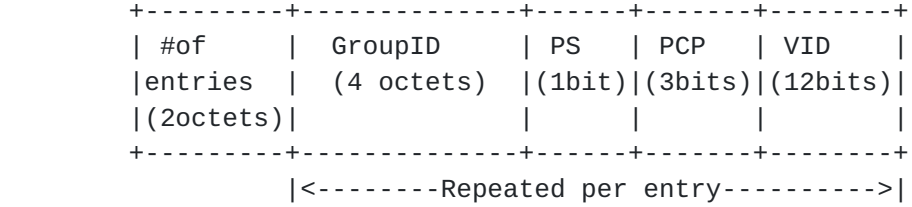

Figure A.4 GroupID/VID filter format

4. GroupID/MAC/VID filter format

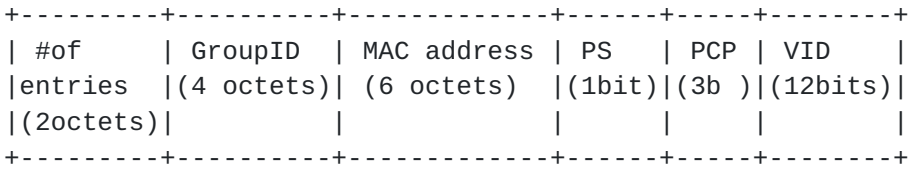

Figure A.5 GroupID/MAC/VID filter format

The null VID can be used in the VDP Request sent from the hypervisor to the external bridge. Use of the null VID indicates that the set of VID values associated with the VSI is expected to be supplied by the Bridge. The Bridge can obtain VID values from the VSI Type whose identity is specified by the VSI Type information in the VDP Request. The set of VID values is returned to the station via the VDP Response. The returned VID value can be a locally significant value. When GroupID is used, it is equivalent to the VN ID in NVO3. GroupID will be provided by the hypervisor to the bridge. The bridge will map GroupID to a locally significant VLAN ID.

The VSIID in VDP request that identify a VM can be one of the following format: IPV4 address, IPV6 address, MAC address, UUID or locally defined.

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