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NVO3 Gap Analysis - Requirements Versus Available Technology Choices
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Abstract

This document evaluates candidate protocols against the NVO3 requirements. Gaps are identified and further work recommended.

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1. Introduction

The initial charter of the NVO3 Working Group requires it to identify any gaps between the requirements identified and available technoloogy solutions as a prerequisite to rechartering or concluding the Working Group (if no gaps exist). This document is intended to provide the required gap analysis.

This document provides a tabulation of candidate solutions and their ability to satisfy each requirement identified by the Working Group.

Areas of work are identified where further work is required to ensure that the requirements are met.

The major areas covered in this document include:

o Operational Requirements
  [I-D.ashwood-nvo3-operational-requirement]

o Management Requirements (TBD)

- o Control (Plane) Requirements [I-D.kreeger-nvo3-overlay-cp]

- o Dataplane Requirements [I-D.ietf-nvo3-dataplane-requirements]

Since the Working Group has yet to complete (and in some cases adopt) documents describing requirements for some of these areas, not all areas are complete in the present version of this document.

The initial candidate technologies are:

- o NVGRE [I-D.sridharan-virtualization-nvgre],

- o VxLAN [I-D.mahalingam-dutt-dcops-vxlan],

- o L2VPN: VPLS [RFC4761][RFC4762] and EVPN [I-D.ietf-l2vpn-evpn], and

- o L3VPN [RFC4365].

2. Terminology and Conventions

2.1. Requirements Language

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].

2.2. Conventions

In sections providing analysis of requirements defined in referenced documents, section numbers from each referenced document are used as they were listed in that document.

In order to avoid confusing those section numbers with the section numbering in this document, the included numbering is parenthesized.

L2VPN is represented (in tables and analysis, as a technology) by the two differing approaches: VPLS and EVPN.

2.3. Terms and Abbreviations

This document uses terms and acronyms defined in [RFC3168], [I-D.ietf-nvo3-framework], [I-D.ietf-nvo3-dataplane-requirements], [I-D.kreeger-nvo3-hypervisor-nve-cp] and [I-D.kreeger-nvo3-overlay-cp]. Acronyms are included here for convenience but are meant to remain aligned with definitions in the references included.

ECN: Explicit Congestion Notification [RFC3168]

NVA: Network Virtualization Authority [I-D.kreeger-nvo3-overlay-cp]

NVE: Network Virtualization Edge [I-D.ietf-nvo3-framework]

VAP: Virtual Access Point [I-D.ietf-nvo3-dataplane-requirements]

VNI: Virtual Network Instance [I-D.ietf-nvo3-framework]

VNIC: Virtual Network Interface Card (NIC) [I-D.kreeger-nvo3-hypervisor-nve-cp]

VNID: Virtual Network Identifier [I-D.kreeger-nvo3-overlay-cp]

This document uses the following additional general terms and abbreviations:

DSCP: Differentiated Services Code-Point

ECMP: Equal Cost Multi-Path

L2VPN: Layer 2 Virtual Private Network

L3VPN: Layer 3 Virtual Private Network

NVO3: Network Virtualization Overlay over L3

VM: Virtual Machine

VN: Virtual Network

3. Operational Requirements

TBD

4. Management Requirements

TBD

5. Control Plane Requirements

The NVO3 Problem Statement [I-D.ietf-nvo3-overlay-problem-statement], describes 3 categories of control functions:

1. Control functions associated with implementing the Network Virtualization Authority (e.g. - signaling and control required for interactions between multiple NVA devices).

2. Control functions associated with interactions between an NVA and a Network Virtualization Edge (NVE).

3. Control functions associated with attaching and detaching a Virtual Machine (VM) from a particular Virtual Network Instance (VNI).

As sometimes happens, there is not a 1:1 mapping of the work areas defined in [I-D.ietf-nvo3-overlay-problem-statement] and requirements documents intended to address the problems that have been identified there.

Current control-plane requirement documents include the following:

- Overall control-plane requirements [I-D.kreeger-nvo3-overlay-cp]

- Control-plane requirements specific to VM-to-NVE interactions [I-D.kreeger-nvo3-hypervisor-nve-cp]

5.1. Overall Control-Plane Requirements

In this section, numbering of requirement headings corresponds to section numbering in [I-D.kreeger-nvo3-overlay-cp].

(3.1) Inner to Outer Address Mapping

The requirements document [I-D.kreeger-nvo3-overlay-cp] states that avoiding the need to "flood" traffic to support learning of mapping information from the data-plane is a goal of NVO3 candidate technological approaches.

For each candidate technology, (how) is the mapping of header information present in tenant traffic mapped to corresponding header information to be used in overlay encapsulation (this includes addresses, context identification, etc.) determined?

Supported Approach	NVGRE	VxLAN	VPLS	EVPN	L3VPN
Control Protocol Acquisition?					
- - -	- - -	- - -	- - -	- - -	- - -
Data-Plane Learning?					

Table 1: Inner:Outer Address Mapping

(3.2) Underlying Network Multi-Destination Address(es)

The requirements document [I-D.kreeger-nvo3-overlay-cp] lists 3 approaches that may be used to deliver traffic to multiple destinations in an overlay virtual network:

1. Use the capabilities of the underlay network.

2. Require a sending NVE to replicate traffic.

3. Use a replication service provided within the overlay network.

For each delivery approach, it may be necessary to map specific multipoint (e.g. - broadcast, unknown destination or multicast) traffic to (for instance) addresses used to deliver this traffic via the underlay network.

For each technological approach, which delivery approaches are supported and does the technology provide a method by which an NVE needing to send multi-destination traffic can determine to what address, or addresses to which to send this traffic?

Supported Approach	NVGRE	VxLAN	VPLS	EVPN	L3VPN
Underlay Network Capability					
- - -	- - -	- - -	- - -	- - -	- - -
NVE Sender Replication					
- - -	- - -	- - -	- - -	- - -	- - -
Replication Service					

Table 2: Multi-Destination Delivery

(3.3) VN Connect/Disconnect Notification

The requirements document [I-D.kreeger-nvo3-overlay-cp] states as an assumption that a mechanism exists in the overlay technology by which an NVE is notified of Tenant Systems attaching and detaching from a specific Virtual Network (VN).

For each candidate technology, does the technology currently support these functions?

Requirement	NVGRE	VxLAN	VPLS	EVPN	L3VPN
Connect Notification					

- - -	- - -	- - -	- - -	- - -	- - -
Disconnect Notification					

Table 3: Connect/Disconnect Notification

(3.4) VN Name to VNID Mapping

The requirements document [I-D.kreeger-nvo3-overlay-cp] concludes that having a means to map for a "VN Name to a "VN ID" may be useful.

For each technological approach we are considering, is this function currently available?

Function	NVGRE	VxLAN	VPLS	EVPN	L3VPN
VN-Name:VN-ID Mapping					

Table 4: VN Name to VN ID Mapping

5.2. VM-to-NVE Specific Control-Plane Requirements

In this section, numbering of requirement headings corresponds to section numbering in [I-D.kreeger-nvo3-hypervisor-nve-cp].

(4.1) VN Connect/Disconnect

The requirements document [I-D.kreeger-nvo3-hypervisor-nve-cp] states as a requirement that a mechanism must exist by which an NVE is notified when an end device requires a connection, or no longer requires a connection, to a specific Virtual Network (VN).

The requirements document further states as a requirement that the mechanism(s) used in a candidate technological approach must provide a local indicator (e.g. - 802.1Q tag) that the end device will use in sending traffic to, or receiving traffic from, the NVE (where that traffic is associated with the connected VN).

As an additional related requirement, the requirements document states that the NVE - once notified of a connection to a VN (by VN Name), needs to have a means for getting associated VN context information from the NVA.

For each candidate technology, does the technology currently support these functions?

Requirement	NVGRE	VxLAN	VPLS	EVPN	L3VPN
Connect Notification					
- - -	- - -	- - -	- - -	- - -	- - -
Local VN Indicator					
- - -	- - -	- - -	- - -	- - -	- - -
VN Name to VN Context Mapping					
- - -	- - -	- - -	- - -	- - -	- - -
Disconnect Notification					

Table 5: VN Connect/Disconnect

(4.2) VNIC Address Association

The requirements document [I-D.kreeger-nvo3-hypervisor-nve-cp] lists two approaches for acquiring VNIC address association information:

1. Data Plane Learning (i.e. - by inspecting source addresses in traffic received from an end device).

2. Explicit signaling from the end device when a specific VNIC address is to be associated with a tenant system.

Supported Approaches	NVGRE	VxLAN	VPLS	EVPN	L3VPN
Data Plane Learning					
- - -	- - -	- - -	- - -	- - -	- - -
Explicit Signaling					

Table 6: VNIC Address Association

(4.3) VNIC Address Disassociation

TBD

(4.4) VNIC Shutdown/Startup/Migration

TBD

(4.5) VN Profile

TBD

6. Data Plane Requirements

In this section, numbering of requirement headings corresponds to section numbering in [I-D.ietf-nvo3-dataplane-requirements].

(3.1) Virtual Access Points (VAPs)

Requirement	NVGRE	VxLAN	VPLS	EVPN	L3VPN
MUST support VAP identification					
- - -	- - -	- - -	- - -	- - -	- - -
1) Local interface	YES				
- - -	- - -	- - -	- - -	- - -	- - -
2) Local interface + fields in frame header	YES				

Table 7: VAP Identification Requirements

(3.2) Virtual Network Instance (VNI)

Requirement	NVGRE	VxLAN	VPLS	EVPN	L3VPN
VAP are associated with a specific VNI at service instantiation time.	YES				

Table 8: VAP-VNI Association

(3.2.1) L2 VNI

Requirement	NVGRE	VxLAN	VPLS	EVPN	L3VPN
L2 VNI MUST provide an emulated Ethernet multipoint service as if Tenant Systems are interconnected by a bridge (but instead by using a set of NVO3 tunnels).					
- - -	- - -	- - -	- - -	- - - -	- - -

Loop avoidance capability MUST be provided.					
In the absence of a management or control plane, data plane learning MUST be used to populate forwarding tables.					
When flooding is required, either to deliver unknown unicast, or broadcast or multicast traffic, the NVE MUST either support ingress replication or multicast.					
In this latter case, the NVE MUST be able to build at least a default flooding tree per VNI.					

Table 9: L2 VNI Service

(3.2.2) L3 VNI

Requirement	NVGRE	VxLAN	VPLS	EVPN	L3VPN
L3 VNIs MUST provide virtualized IP routing and forwarding.					
L3 VNIs MUST support per-tenant forwarding instance with IP addressing isolation and L3 tunneling for interconnecting instances of the same VNI on NVEs.					

Table 10: L3 VNI Service

(3.3.1) NVO3 overlay header

Requirement	NVGRE	VxLAN	VPLS	EVPN	L3VPN
An NVO3 overlay header MUST be included after the underlay tunnel header when forwarding tenant traffic.	YES	YES	YES	YES	YES

Table 11: Overlay Header

(3.3.1.1) Virtual Network Context Identification

Requirement	NVGRE	VxLAN	VPLS	EVPN	L3VPN
The overlay encapsulation header MUST contain a field which allows the encapsulated frame to be delivered to the appropriate virtual network endpoint by the egress NVE.	YES	YES	YES	YES	YES

Table 12: Virtual Network Context Identification

(3.3.1.2) Service QoS identifier

Requirement	NVGRE	VxLAN	VPLS	EVPN	L3VPN
Traffic flows originating from different applications could rely on differentiated forwarding treatment to meet end-to-end availability and performance objectives.	NO				

Table 13: QoS Service Identification

(3.3.2.1) LAG and ECMP

Requirement	NVGRE	VxLAN	VPLS	EVPN	L3VPN
For performance reasons, multipath over LAG and ECMP paths SHOULD be supported.	YES				

Table 14: Multipath Support

(3.3.2.2) DiffServ and ECN marking

Requirement	NVGRE	VxLAN	VPLS	EVPN	L3VPN
[RFC2983] defines two modes for mapping the DSCP markings from inner to outer headers and vice versa. Both models SHOULD be supported.	NO				
- - -	- - -	- - -	- - -	- - -	- - -
ECN marking MUST be performed according to [RFC6040] which describes the correct ECN behavior for IP tunnels.	NO				

Table 15: DSCP and ECN Marking

(3.3.2.3) Handling of broadcast, unknown unicast, and multicast traffic

Requirement	NVGRE	VxLAN	VPLS	EVPN	L3VPN
NVO3 data plane support for either ingress replication or point-to-multipoint tunnels is required to send traffic destined to multiple locations on a per-VNI basis (e.g. L2/L3 multicast traffic, L2 broadcast and unknown	YES	YES	YES	YES	YES

unicast traffic).					

Table 16: Handling of Broadcast, Unknown Unicast, and Multicast Traffic

(3.4) External NVO3 connectivity

Requirement	NVGRE	VxLAN	VPLS	EVPN	L3VPN
NVO3 services MUST interoperate with current VPN and Internet services. This may happen inside one DC during a migration phase or as NVO3 services are delivered to the outside world via Internet or VPN gateways.	YES				

Table 17: Interoperation

(3.5) Path MTU

Requirement	NVGRE	VxLAN	VPLS	EVPN	L3VPN
Classical ICMP-based MTU Path Discovery ([RFC1191], [RFC1981]) or Extended MTU Path Discovery techniques such as defined in [RFC4821].	NO				
- - -	- - -	- - -	- - -	- - -	- - -
Segmentation and reassembly support from the overlay layer operations without relying on the Tenant Systems to know about the end-to-end MTU.	YES				

Table 18: Path MTU

(3.7) NVE Multi-Homing Requirements

Requirement	NVGRE	VxLAN	VPLS	EVPN	L3VPN
Multi-homing techniques SHOULD be used to increase the reliability of an NVO3 network.	NO				

Table 19: Multihoming

(3.8) OAM

Requirement	NVGRE	VxLAN	VPLS	EVPN	L3VPN
NVE MAY be able to originate/terminate OAM messages for connectivity verification, performance monitoring, statistic gathering and fault isolation. Depending on configuration, NVEs SHOULD be able to process or transparently tunnel OAM messages, as well as supporting alarm propagation capabilities.	NO				

Table 20: OAM Messaging

7. Summary and Conclusions

TBD

8. Acknowledgements

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9. IANA Considerations

This memo includes no request to IANA.

10. Security Considerations

Security considerations of the requirements documents referenced by this analysis document apply.

11. References

11.1. Normative References

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