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SERIES Q: SWITCHING AND SIGNALLING, AND ASSOCIATED MEASUREMENTS AND TESTS

Signalling requirements and protocols for SDN – Resource control protocols

Signalling requirements of the Sew interface for virtual data centres

Recommendation ITU-T Q.3718

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Recommendation ITU-T Q.3718

Signalling requirements of the Sew interface for virtual data centres

Summary

Recommendation ITU-T Q.3718 focuses on the inter-domain Sew interface which is standardized to allow for multiple control entities within a virtual data centre (VDC). In VDCs, the SDN control entities exchange the control plane related information with each other through the Sew interface.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
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Keywords

Sew, signalling requirement, software-defined networking; virtual data centre, VxLAN

* To access the Recommendation, type the URL http://handle.itu.int/ in the address field of your web browser, followed by the Recommendation's unique ID. For example, http://handle.itu.int/11.1002/1000/11830-en.

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Signalling requirements of the Sew interface for virtual data centres

1 Scope

This Recommendation defines signalling requirements between multiple control entities within a virtual data centre. This Recommendation only focuses on the inter-domain Sew interface for multi-vendor interoperability. The signalling exchanged via the Sew interface is mainly related to the VxLAN protocol.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[ITU-T Y.3300] Recommendation ITU-T Y.3300 (2014), *Framework of software-defined networking*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following term defined elsewhere:

3.1.1 software-defined networking [ITU-T Y.3300]: A set of techniques that enables to directly program, orchestrate, control and manage network resources, which facilitates the design, delivery and operation of network services in a dynamic and scalable manner.

3.2 Terms defined in this Recommendation

This Recommendation defines the following term:

3.2.1 virtual data centre (VDC): A data centre in which the physical resources are abstracted and integrated by using virtualization technology.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

CE	Control Entity
CO-FA	Control Entity Failure notification
CO-FAR	Control Entity Failure notification Response
CO-ST	Control Entity Status querying
CO-STR	Control Entity Status querying Response
ID	Identification
DC	Data Centre
IP	Internet Protocol

KE-AL	Keep Alive
KE-ALR	Keep Alive Response
MAC	Media Access Control
NE	Network Entity
NE-FA	NE Failure notification
NE-FAR	NE Failure notification Response
NE-IQ	NE Information Query
NE-IQR	NE Information Query Response
NE-EX	NE Information Exchange
NE-EXR	NE Information Exchange Response
OP-HA	Open Handshaking
OP-HAR	Open Handshaking Response
SDN	Software-Defined Networking
TCP	Transmission Control Protocol
TLS	Transport Layer Security
UDP	User Datagram Protocol
VDC	Virtual Data Centre
VM	Virtual Machine
VN-FA	VNI Failure notification
VN-FAR	VNI Failure notification Response
VNI	VXLAN Network Identifier
VN-IQ	VNI Information Query
VN-IQR	VNI Information Query Response
VN-EX	VNI Information Exchange
VN-EXR	VNI Information Exchange Response
VTEP	VXLAN Tunnel End Point
VT-FA	VTEP Failure notification
VT-FAR	VTEP Failure notification Response
VT-IQ	VTEP Information Query
VT-IQR	VTEP Information Query Response
VT-EX	VTEP information Exchange
VT-EXR	VTEP information Exchange Response
VXLAN	Virtual extensible Local Area Network
XML	Extensible Markup Language

5 Conventions

The keywords "is required to" indicate a requirement which must be strictly followed and from which no deviation is permitted if conformance to this document is to be claimed.

In the body of this document and its annexes, the words shall, shall not, should and may sometimes appear, in which case they are to be interpreted, respectively, as is required to, is prohibited from, is recommended and can optionally. The appearance of such phrases or keywords in an appendix or in material explicitly marked as informative are to be interpreted as having no normative intent.

{A} indicates that the parameter A is mandatory.

* indicates that the parameter may be multiple items.

6 The Sew interface in VDC

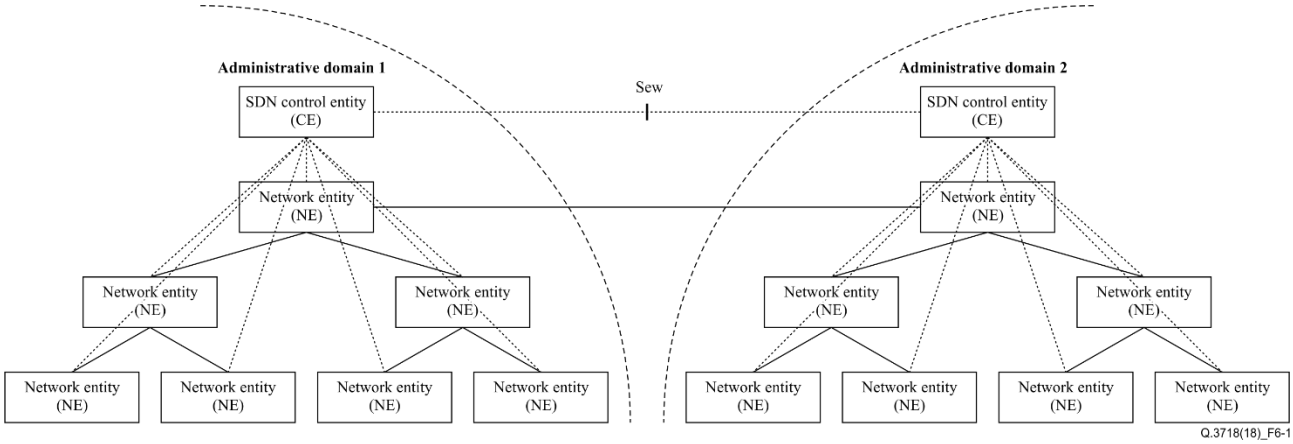

Figure 6-1 – The position of the Sew interface

The Sew interface permits the SDN control entities to interact, either within the same administrative domain (intra-domain), or between administrative domains (inter-domain):

– The intra-domain Sew interface is typically a single-vendor interface contained within a single-carrier network. Since it is a single-vendor, this interface may contain proprietary elements specifically to that vendor. Therefore, the intra-domain Sew interface is out of the scope of this Recommendation.

– The inter-domain Sew interface is between multiple control entities that cross domain boundaries. The domain boundaries are defined by the carriers and can include administrative boundaries within a carrier's network, boundaries between different vendors within a carrier's network or boundaries between carriers.

A VDC connects multiple physical DCs together to form a logical DC. However, different physical DCs could be controlled by different SDN control entities. From one DC network element to another DC network element, it is usually necessary to build a large layer 2 network, and VxLAN protocol [b-IETF RFC 7348] is a common solution.

Therefore, the SDN control entities exchange control plane related information over the Sew interface in a VDC, such as the VXLAN network identifier (VNI) information of VxLAN and the MAC address of network entities (NEs). Also, the NE can be a router, a switch, a server or a virtual machine (VM).

Through the Sew interface, the SDN control entities firstly establish connections with each other by handshake signalling, then the SDN control entities exchange information including the VXLAN tunnel end point (VTEP), VNI and MAC address of the NE. If there is lack of the information on VTEP, VNI or an NE's MAC address, the SDN control entities can trigger the inquiry process with

information query signalling. When there is a failure, the SDN control entity will send failure notification signalling to the other SDN control entities in order to refresh the status information.

7 The signalling requirements of the Sew interface

7.1 Overview of signalling requirements

Among different peer control entities, a handshake shall be made first before exchanging information. After confirming the identification of each other, the control entity should send its own information to each other.

When any network entity fails, its SDN control entity should notify the peer control entities, for helping the peer control entities to refresh its information accordingly.

Category 1: handshaking

1-1 Open handshaking message and response message

1-2 Keep alive message and response message

Category 2: information exchange

2-1 VTEP information exchange message and response message

2-2 VNI information exchange message and response message

2-3 NE information exchange message and response message

Category 3: status query

3-1 VTEP status query message and response message

3-2 VNI query message and response message

3-3 NE status query message and response message

Category 4: failure notification

4-1 Control entity failure notification message and response message

4-2 VTEP failure notification message and response message

4-3 VNI failure notification message and response message

4-4 NE failure notification message and response message

NOTE – No transport protocol for the signalling messages is specified here. No message content format is specified here either.

The signalling messages may be XML-based messages over (or carried by) TCP, UDP, SCTP, TLS, etc. All of the messages consist of the message header and the message body.

The message format is described in Figure 7-1 as follows:

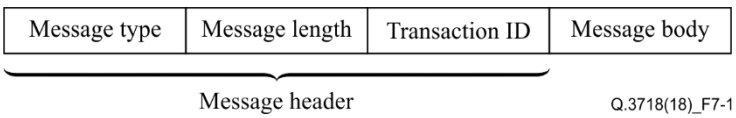

Figure 7-1 – Message composition

The message header field contains the following information:

1) Message type: uniquely specifies the type of the message;
2) Message length: specifies the length of the message body;

3) Message transaction ID: generated by the sender of the message. If there is a response message for the request message, the transaction IDs of the request and response messages are the same.

The message body field contains the message content.

7.2 Signalling requirements for handshaking

7.2.1 Handshaking message and response message

The handshaking message is defined as the HA-SH message.

The HA-SH message, indicated by the message type in the message header field, is sent by the SDN control entity to start negotiation with each other and set up a connection for information exchange afterwards.

Message format:

```
< HA-SH Message > ::=< Message header >
        {Destination-SDN-Control-Entity-Address}
         {Source-SDN-Control-Entity-Address}
         {Hold-time}
```

Meanings and explanations:

1) `Destination-SDN-Control-Entity-Address` uniquely specifies the destination SDN control entity address.
2) `Source-SDN-Control-Entity-Address` uniquely specifies the source SDN control entity address.
3) `Hold-time` indicates the effective time of the HA-SH message.

The response message to the HA-SH message is defined as the HA-SHR message.

The HA-SHR message, indicated by the message type in the message header field, is sent by the destination SDN control entity to the source SDN control entity in response to the HA-SH message.

Message format:

```
< HA-SHR Message > ::=< Message header >
        {Destination-SDN-Control-Entity-Address}
         {Source-SDN-Control-Entity-Address}
         {Result}
```

Meanings and explanations:

1) `Destination-SDN-Control-Entity-Address` uniquely specifies the destination SDN control entity address.
2) `Source-SDN-Control-Entity-Address` uniquely specifies the source SDN control entity address.
3) `Result` shows the handshaking result between the SDN control entities.

7.2.2 Keep alive message and response message

The keep alive message is defined as the KE-AL message. This message, indicated by the message type in the message header field, is sent by the SDN control entity after successful handshaking. This message is sent every certain time to keep the connection alive.

Message format:

```
<KE-AL Message > ::=< Message header >
            {Destination-SDN-Control-Entity-Address}
            {Source-SDN-Control-Entity-Address}
            {Hold-time}
```

Meanings and explanations:

1) `Destination-SDN-Control-Entity-Address` uniquely specifies the destination SDN control entity address.
2) `Source-SDN-Control-Entity-Address` uniquely specifies the source SDN control entity address.
3) `Hold-time` indicates for the destination SDN control entity the maximum waiting time for a response message.

The response message to the KE-AL message is defined as the KE-ALR message.

The KE-ALR message, indicated by the message type in the message header field, is sent by the destination SDN control entity to the source SDN control entity in response to the KE-AL message.

Message format:

```
< KE-ALR Message > ::=< Message header >
            {Destination-SDN-Control-Entity-Address}
            {Source-SDN-Control-Entity-Address}
            {Hold-time}
```

Meanings and explanations:

1) `Destination-SDN-Control-Entity-Address` uniquely specifies the destination SDN control entity address.
2) `Source-SDN-Control-Entity-Address` uniquely specifies the source SDN control entity address.
3) `Hold-time` indicates for the source SDN control entity the maximum waiting time for another KE-AL message.

7.3 Signalling requirements for information exchange

7.3.1 VTEP information exchange message and response message

The VTEP information exchange message is defined as the VT-EX message.

The VT-EX message, indicated by the message type in the message header field, is sent by the SDN control entity to exchange the information of the VTEP.

Message format:

```
< VT-EX Message > ::=< Message header >
          {Destination-SDN-Control-Entity-Address}
            {Source-SDN-Control-Entity-Address}
            {Local-VTEP-Address}
            {Local-VTEP-Information}
            {Valid-time}
```

Meanings and explanations:

1) `Destination-SDN-Control-Entity-Address` uniquely specifies the destination SDN control entity address.

2) `Source-SDN-Control-Entity-Address` uniquely specifies the source SDN control entity address.

3) `Local-VTEP-Address` uniquely specifies the VTEP controlled by the source SDN control entity.

4) `Local-VTEP-Information` uniquely specifies the information of the VTEP to be exchanged between SDN control entities, including type, capacity, etc.

5) `Valid-time` indicates the maximum valid time of the information contained in this message.

The response message to the VT-EX message is defined as the VT-EXR message.

The VT-EXR message, indicated by the message type in the message header field, is sent by the destination SDN control entity to the source SDN control entity in response to the VT-EX message.

Message format:

```
<VT-EXR Message > ::=< Message header >
          {Destination-SDN-Control-Entity-Address}
            {Source-SDN-Control-Entity-Address}
            {Result}
```

Meanings and explanations:

1) `Destination-SDN-Control-Entity-Address` uniquely specifies the destination SDN control entity address.

2) `Source-SDN-Control-Entity-Address` uniquely specifies the source SDN control entity address.

3) `Result` shows whether the information is successfully received by the destination SDN control entity.

7.3.2 VNI information exchange message and response message

The VNI information exchange message is defined as the VN-EX message.

The VN-EX message, indicated by the message type in the message header field, is sent by the SDN control entity to exchange the information of the VNI.

Message format:

```
< VNI-EX Message > ::=< Message header >
          {Destination-SDN-Control-Entity-Address}
            {Source-SDN-Control-Entity-Address}
            {Local-VTEP-Address}
            *{Local-VNI-Information}
            {Valid-time}
```

Meanings and explanations:

1) `Destination-SDN-Control-Entity-Address` uniquely specifies the destination SDN control entity address.

2) Source-SDN-Control-Entity-Address uniquely specifies the source SDN control entity address.

3) Local-VTEP-Address uniquely specifies the VTEP whose VNI information is to be exchanged.

4) Local-VNI-Information uniquely specifies the information of the local VNI in the local VTEP to be exchanged between SDN control entities, including the VNI and its extensions. There may be one or multiple VNIs in the same message.

5) Valid-time indicates the maximum valid time of the information contained in this message.

The response message to the VN-EX message is defined as the VN-EXR message.

The VN-EXR message, indicated by the message type in the message header field, is sent by the destination SDN control entity to the source SDN control entity in response to the VN-EX message.

Message format:

```
<VN-EXR Message > ::=< Message header >
          {Destination-SDN-Control-Entity-Address}
            {Source-SDN-Control-Entity-Address}
            {Received-VTEP-Address}
            {Result}
```

Meanings and explanations:

1) Destination-SDN-Control-Entity-Address uniquely specifies the destination SDN control entity address.

2) Source-SDN-Control-Entity-Address uniquely specifies the source SDN control entity address.

3) Received-VTEP-Address uniquely specifies the VTEP controlled by the source SDN control entity.

4) Result shows whether the information is successfully received by the destination SDN control entity.

7.3.3 NE information exchange message and response message

The NE information exchange message is defined as the NE-EX message. This message indicated by the message type in the message header field, is sent by the source SDN control entity to exchange the information of the local NEs.

Message format:

```
<NE-EX Message > ::=< Message header >
            {Destination-SDN-Control-Entity-Address}
            {Source-SDN-Control-Entity-Address}
            {Local-VNI}
            *{Local-NE-Information}
            {Valid-time}
```

Meanings and explanations:

1) Destination-SDN-Control-Entity-Address uniquely specifies the destination SDN control entity address.

2) Source-SDN-Control-Entity-Address uniquely specifies the source SDN control entity address.

3) Local-VNI uniquely specifies the local VNI.

4) Local-NE-Information uniquely specifies the information of the NE associated with the local VNI, including MAC address, type of the NE, etc. There may be one or multiple values for an NE in the same message.

5) Valid-time indicates the maximum valid time of the information contained in this message.

The response message to the NE-EX message is defined as the NE-EXR message.

The NE-EXR message, indicated by the message type in the message header field, is sent by the destination SDN control entity to the source SDN control entity in response to the NE-EX message.

Message format:

```
< NE-EXR Message > ::=< Message header >
            {Destination-SDN-Control-Entity-Address}
            {Source-SDN-Control-Entity-Address}
            {Received-VNI}
            {Result}
```

Meanings and explanations:

1) Destination-SDN-Control-Entity-Address uniquely specifies the destination SDN control entity address.

2) Source-SDN-Control-Entity-Address uniquely specifies the source SDN control entity address.

3) Received-VNI uniquely specifies the received VNI controlled by the source SDN control entity.

4) Result shows the results whether information is successfully received by the destination SDN control entity.

7.4 Signalling requirements for status query

7.4.1 VTEP status query message and response message

The VTEP status query message is defined as the VT-IQ message. This message indicated by the message type in the message header field, is sent by the source SDN control entity to query the VTEP status controlled by the destination SDN control entity.

Message format:

```
<VT-IQ Message > ::=< Message header >
            {Destination-SDN-Control-Entity-Address}
            {Source-SDN-Control-Entity-Address}
            {Query-VTEP-Address}
```

Meanings and explanations:

1) Destination-SDN-Control-Entity-Address uniquely specifies the destination SDN control entity address.

2) Source-SDN-Control-Entity-Address uniquely specifies the source SDN control entity address.

3) Query-VTEP-Address uniquely specifies the VTEP address which the source SDN control entity wants to query.

The response message to the VT-IQ message is defined as the VT-IQR message.

The VT-IQR message, indicated by the message type in the message header field, is sent by the destination SDN control entity to the source SDN control entity in response to the VT-IQ message.

Message format:

```
<VT-IQR Message > ::=< Message header >
          {Destination-SDN-Control-Entity-Address}
            {Source-SDN-Control-Entity-Address}
            {Queried-VTEP-Address}
            {Status}
```

Meanings and explanations:

1) Destination-SDN-Control-Entity-Address uniquely specifies the destination SDN control entity address.

2) Source-SDN-Control-Entity-Address uniquely specifies the source SDN control entity address.

3) Queried-VTEP-Address uniquely specifies the VTEP which the source SDN control entity wants to query.

4) Status specifies the status of the VTEP.

7.4.2 VNI query message and response message

The VNI query message is defined as the VN-IQ message. This message indicated by the message type in the message header field, is sent by the source SDN control entity to query the VNI which belongs to the destination SDN control entity.

Message format:

```
<VN-IQ Message > ::=< Message header >
            {Destination-SDN-Control-Entity-Address}
            {Source-SDN-Control-Entity-Address}
            {Query-VNI}
```

Meanings and explanations:

1) Destination-SDN-Control-Entity-Address uniquely specifies the destination SDN control entity address.

2) Source-SDN-Control-Entity-Address uniquely specifies the source SDN control entity address.

3) Query-VNI uniquely specifies the VNI which the source SDN control entity wants to query.

The response message to the VN-IQ message is defined as the VN-IQR message.

The VN-IQR message, indicated by the message type in the message header field, is sent by the destination SDN control entity to the source SDN control entity in response to the VN-IQ message.

Message format:

```
<VN-IQR Message > ::=< Message header >
            {Destination-SDN-Control-Entity-Address}
            {Source-SDN-Control-Entity-Address}
            {Query-VNI}
            {VNI-Information}
```

Meanings and explanations:

1) `Destination-SDN-Control-Entity-Address` uniquely specifies the destination SDN control entity address.
2) `Source-SDN-Control-Entity-Address` uniquely specifies the source SDN control entity address.
3) `Query-VNI` uniquely specifies the VNI which the source SDN control entity wants to query.
4) `VNI-Information` defines the information of the VNI, including the VNI and its extensions.

7.4.3 NE status query message and response message

The NE status query message is defined as the NE-IQT message. This message indicated by the message type in the message header field, is sent by the source SDN control entity to query the NE status controlled by the destination SDN control entity.

Message format:

```
<NE-IQ Message > ::=< Message header >
            {Destination-SDN-Control-Entity-Address}
            {Source-SDN-Control-Entity-Address}
            {Query-VNI}
            {Query-NE-Address}
```

Meanings and explanations:

1) `Destination-SDN-Control-Entity-Address` uniquely specifies the destination SDN control entity address.
2) `Source-SDN-Control-Entity-Address` uniquely specifies the source SDN control entity address.
3) `Query-VNI` uniquely specifies the VNI associated with the NE which the source SDN control entity wants to query.
4) `Query-NE-Address` uniquely specifies the NE associated with the queried VNI.

The response message to the NE-IQ message is defined as the NE-IQR message.

The NE-IQR message, indicated by the message type in the message header field, is sent by the destination SDN control entity to the source SDN control entity in response to the NE-IQ message.

Message format:

```
<NE-IQR Message > ::=< Message header >
            {Destination-SDN-Control-Entity-Address}
            {Source-SDN-Control-Entity-Address}
```

```
{Queried-VNI}
{Queried-NE-Address}
{Status}
```

Meanings and explanations:

1) `Destination-SDN-Control-Entity-Address` uniquely specifies the destination SDN control entity address.
2) `Source-SDN-Control-Entity-Address` uniquely specifies the source SDN control entity address.
3) `Queried-VNI` uniquely specifies the VNI with which the NE is associated is queried.
4) `Queried-NE-Address` uniquely specifies the NE which the source SDN control entity wants to query.
5) `Status` defines the status of the NE.

7.5 Signalling requirements for failure notification

7.5.1 Control entity failure notification message and response message

The control entity failure notification message is defined as the CO-FA message.

The CO-FA message, indicated by the message type in the message header field, is sent by the source SDN control entity to notify the failure to the destination SDN control entity.

Message format:

```
<CO-FA Message > ::=< Message header >
     {Destination-SDN-Control-Entity-Address}
       {Source-SDN-Control-Entity-Address}
       {Failure}
```

Meanings and explanations:

1) `Destination-SDN-Control-Entity-Address` uniquely specifies the destination SDN control entity address.
2) `Source-SDN-Control-Entity-Address` uniquely specifies the source SDN control entity address.
3) `Failure` defines the failure event of the source SDN control entity.

The response message to the CO-FA message is defined as the CO-FAR message.

The CO-FAR message, indicated by the message type in the message header field, is sent by the destination SDN control entity to the source SDN control entity in response to the CO-FA message.

Message format:

```
<CO-FAR Message > ::=< Message header >
         {Destination-SDN-Control-Entity-Address}
           {Source-SDN-Control-Entity-Address}
           {Result}
```

Meanings and explanations:

1) `Destination-SDN-Control-Entity-Address` uniquely specifies the destination SDN control entity address.

2) `Source-SDN-Control-Entity-Address` uniquely specifies the source SDN control entity address.

3) `Result` shows whether the failure notification is correctly received by the destination SDN control entity.

7.5.2 VTEP failure notification message and response message

The VTEP failure notification message is defined as the VT-FA message.

The VT-FA message, indicated by the message type in the message header field, is sent by the source SDN control entity to notify the failure of its VTEP to the destination SDN control entity.

Message format:

```
<VT-FA Message > ::=< Message header >
     {Destination-SDN-Control-Entity-Address}
       {Source-SDN-Control-Entity-Address}
       {Local-VTEP-Address}
       {Failure}
```

Meanings and explanations:

1) `Destination-SDN-Control-Entity-Address` uniquely specifies the destination SDN control entity address.

2) `Source-SDN-Control-Entity-Address` uniquely specifies the source SDN control entity address.

3) `Local-VTEP-Address` uniquely specifies the VTEP in error.

4) `Failure` defines the failure event of the VTEP.

The response message to the VT-FA message is defined as the VT-FAR message.

The VT-FAR message, indicated by the message type in the message header field, is sent by the destination SDN control entity to the source SDN control entity in response to the VT-FA message.

Message format:

```
<VT-FAR Message > ::=< Message header >
          {Destination-SDN-Control-Entity-Address}
            {Source-SDN-Control-Entity-Address}
            {Received-VTEP-Address}
            {Result}
```

Meanings and explanations:

1) `Destination-SDN-Control-Entity-Address` uniquely specifies the destination SDN control entity address.

2) `Source-SDN-Control-Entity-Address` uniquely specifies the source SDN control entity address.

3) `Received-VTEP-Address` uniquely specifies the VTEP received through the ST-FA message.

4) `Result` shows whether the failure notification is correctly received by the destination SDN control entity.

7.5.3 VNI failure notification message and response message

The VNI failure notification message is defined as the VN-FA message.

The VN-FA message, indicated by the message type in the message header field, is sent by the source SDN control entity to notify the failure of its VNI to the destination SDN control entity.

Message format:

```
<VN-FA Message > ::=< Message header >
     {Destination-SDN-Control-Entity-Address}
       {Source-SDN-Control-Entity-Address}
       {Local-VNI}
       {Failure}
```

Meanings and explanations:

1) `Destination-SDN-Control-Entity-Address` uniquely specifies the destination SDN control entity address.
2) `Source-SDN-Control-Entity-Address` uniquely specifies the source SDN control entity address.
3) `Local-VNI` uniquely specifies the VNI in error.
4) `Failure` defines the failure event of the VNI.

The response message to the VN-FA message is defined as the VN-FAR message.

The VN-FAR message, indicated by the message type in the message header field, is sent by the destination SDN control entity to the source SDN control entity in response to the VN-FA message.

Message format:

```
<VN-FAR Message > ::=< Message header >
         {Destination-SDN-Control-Entity-Address}
           {Source-SDN-Control-Entity-Address}
           {Received-VNI}
           {Result}
```

Meanings and explanations:

1) `Destination-SDN-Control-Entity-Address` uniquely specifies the destination SDN control entity address.
2) `Source-SDN-Control-Entity-Address` uniquely specifies the source SDN control entity address.
3) `Received-VNI` uniquely specifies the VNI received through the VN-FA message.
4) `Result` shows whether the failure notification is correctly received by the destination SDN control entity.

7.5.4 NE failure notification message and response message

The NE failure notification message is defined as the NE-FA message.

The NE-FA message, indicated by the message type in the message header field, is sent by the source SDN control entity to notify the failure of the NE to the destination SDN control entity.

Message format:

```
<NE-FA Message > ::=< Message header >
     {Destination-SDN-Control-Entity-Address}
       {Source-SDN-Control-Entity-Address}
       {Local-VNI}
       {Local-NE-Address}
       {Failure}
```

Meanings and explanations:

1) `Destination-SDN-Control-Entity-Address` uniquely specifies the destination SDN control entity address.
2) `Source-SDN-Control-Entity-Address` uniquely specifies the source SDN control entity address.
3) `Local-VNI` uniquely specifies the VNI with which the NE is associated.
4) `Local-NE-Address` uniquely specifies the NE in error.
5) `Failure` defines the failure event of the NE.

The response message to the NE-FA message is defined as the NE-FAR message.

The NE-FAR message, indicated by the message type in the message header field, is sent by the destination SDN control entity to the source SDN control entity in response to the NE-FA message.

Message format:

```
<NE-FAR Message > ::=< Message header >
          {Destination-SDN-Control-Entity-Address}
            {Source-SDN-Control-Entity-Address}
            {Received-VNI}
            {Received-NE}
            {Result}
```

Meanings and explanations:

1) `Destination-SDN-Control-Entity-Address` uniquely specifies the destination SDN control entity address.
2) `Source-SDN-Control-Entity-Address` uniquely specifies the source SDN control entity address.
3) `Received-VNI` uniquely specifies the VNI received through the NE-FA message.
4) `Received-NE` uniquely specifies the NE received through the NE-FA message.
5) `Result` shows whether the failure notification is correctly received by the destination SDN control entity.

8 Security considerations

The SDN control entities within the same administrative domain (intra-domain), or between administrative domains (inter-domain) exchange information via the Sew interface in VDCs. When the SDN control entities are in different administrative domains, it is necessary to confirm the peer's validation in a safe way, which is similar to other SDN scenarios defined in [ITU-T Y.3300]. This Recommendation does not introduce any new security issues.

Appendix I

Illustration of the Sew interface in VDC

(This appendix does not form an integral part of this Recommendation.**)**

To construct a VDC, VxLAN is a common solution. VxLAN is a network virtualization technology that attempts to improve the scalability problems associated with large cloud computing deployments. It uses a VLAN-like encapsulation technique to encapsulate MAC-based OSI layer 2 Ethernet frames within layer 4 UDP packets, using 4789 as the default IANA-assigned destination UDP port number.

In VxLAN, the VNI is a 24-bit segment ID for identifying the different VxLAN segment. Only NEs within the same VxLAN segment can communicate with each other. Due to the VxLAN encapsulation, VxLAN uses stateless tunnels to build overlay layer 2 networks on top of layer 3 networks. The end point of the tunnel is a VTEP.

VxLAN does not keep a long connection between the NEs, so the VxLAN needs a control plane to record whether the NEs are reachable. The control plane has a mapping table including a VTEP IP, VNI, NE MAC, etc. Like VLAN, VTEPs do not exchange their mapping tables periodically, so for the unknown MAC address, VxLAN must use a multicast or SDN control entity to get the path information.

Therefore, in a VDC scenario, the SDN control entity should configure and maintain the mapping tables of all VTEPs for VxLAN.

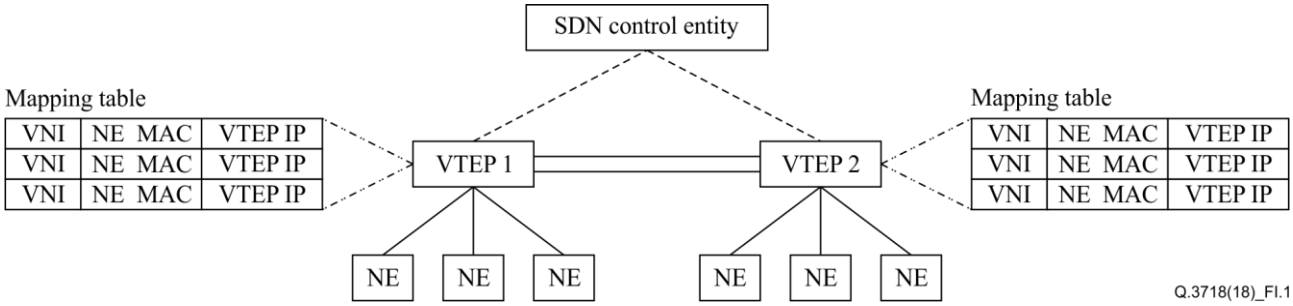

Figure I.1 – One SDN control entity in a VDC

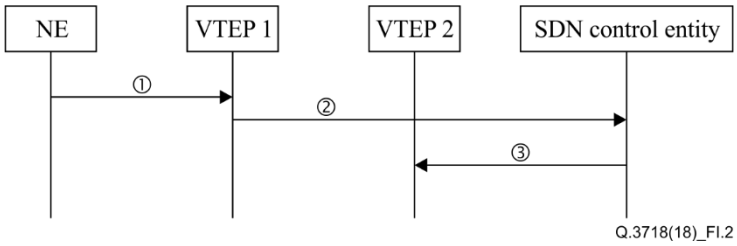

Figure I.2 – The MAC address learning procedures of one SDN control entity in a VDC

The detailed procedures are presented below:

① The NE sends its MAC address to VTEP 1.

② VTEP 1 send the MAC address and the VNI information to the SDN control entity.

③ The SDN control entity sends the final mapping table to VTEP 2.

But in a multiple control entities' scenario, for example, between administrative boundaries within a carrier's network, the different control entities must exchange their VTEPs' status, mapping tables,

etc. The inter-domain Sew interface between the SDN control entities in different sites of a VDC is required.

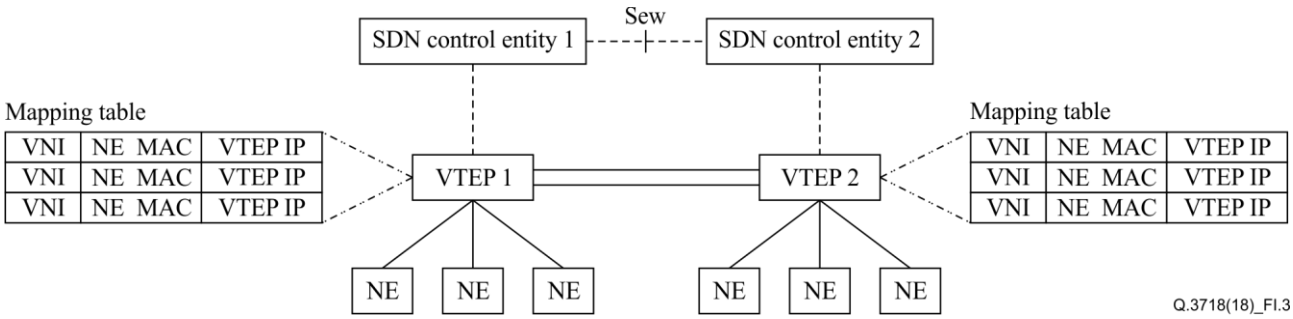

Figure I.3 – Two SDN control entities in a VDC

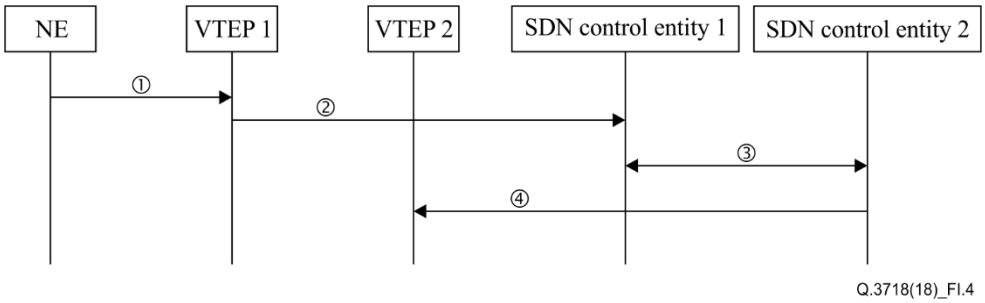

Figure I.4 – The MAC address learning procedures of two SDN control entities in a VDC

The detailed procedures are presented below:

① The VM sends its MAC address to VTEP1.

② VTEP1 sends the MAC address and the VNI information to SDN control entity 1.

③ SDN control entity 1 exchanges a mapping table with SDN control entity 2 through the inter-domain Sew interface.

④ SDN control entity 2 sends the final mapping table of VTEP 1 to VTEP 2.

Bibliography

[b-IETF RFC 7348] IETF RFC 7348 (2014), Virtual eXtensible Local Area Network (VXLAN): *A Framework for Overlaying Virtualized Layer 2 Networks over Layer 3 Networks*.

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