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

Testing specifications – Testing specifications for Cloud computing

Test suite for interoperability testing of a virtual switch

Recommendation ITU-T Q.4044

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Recommendation ITU-T Q.4044

Test suite for interoperability testing of a virtual switch

Summary

Recommendation ITU-T Q.4044 provides a test suite for interoperability testing of a virtual switch, a collection of test cases specifying the test objective, test procedures and expected results.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T Q.4044	2021-08-29	11	11.1002/1000/14764

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Interoperability, specification, test suite, testing, virtual switch.

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Recommendation ITU-T Q.4044

Test suite for interoperability testing of a virtual switch

1 Scope

The scope of this Recommendation consists of:

1) Overview of the test suite for interoperability testing (IOPT) of a virtual switch;
2) Test cases for IOPT of a virtual switch between a virtual switch and a virtual machine (VM);
3) Test cases for IOPT of a virtual switch between a virtual switch and other network equipment;
4) Test cases for IOPT of a virtual switch between a virtual switch and a management entity;
5) Test cases for IOPT of a virtual switch between a virtual switch and computing virtualization.

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 Q.4043] Recommendation ITU-T Q.4043 (2019), *Interoperability testing requirements of a virtual switch.*

[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 terms defined elsewhere:

3.1.1 interoperability [b-ITU-T Y.101]: The ability of two or more systems or applications to exchange information and to mutually use the information that has been exchanged.

3.1.2 virtual switch [b-ITU-T Y.101]: Resource abstraction and control function abstracting physical network resources to offer virtual network capabilities.

3.2 Terms defined in this Recommendation

None.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

ACL Access Control List

ARP Address Resolution Protocol

BGP-4 Border Gateway Protocol Version 4

CIDR Classless Inter-Domain Routeing

DDOS	Distributed Denial of Service
DOS	Denial of Service
DPDK	Data Plane Development Kit
EGP	Exterior Gateway Protocol
FTP	File Transfer Protocol
GRE	Generic Routeing Encapsulation
ICMP	Internet Control Message Protocol
ID	Identifier
IGMP	Internet Group Management Protocol
IGP	Interior Gateway Protocol
IOPT	Interoperability Testing
IP	Internet Protocol
IS-IS	Intermediate System-to-Intermediate System
L2	Layer 2
L3	Layer 3
MAC	Media Access Control
MTU	Maximum Transmission Unit
NAT	Network Address Translation
NFV	Network Function Virtualization
NIC	Network Interface Card
NVGRE	Network Virtualization using Generic Routeing Encapsulation
QinQ	802.1Q-in-802.1Q
OSPF	Open Shortest Path First
OVSDB	Open vSwitch Database
QoS	Quality of Service
RIP	Routeing Information Protocol
SDN	Software Defined Network
SFC	Service Function Chaining
SNMP	Simple Network Management Protocol
SR-IOV	Single Root I/O Virtualization
STP	Spanning Tree Protocol
STT	Stateless Transport Tunnelling
SYN	Synchronize Sequence Numbers
TCP	Transport Control Protocol
TFTP	Trivial File Transfer Protocol
UDP	User Datagram Protocol
VLAN	Virtual Local Area Network

VM Virtual Machine

VIM Virtualized Infrastructure Manager

VNF Virtual Network Function

VSIT Virtual Switch Interoperability tester

VXLAN Virtual Extensible LAN

5 Conventions

This Recommendation uses the following convention:

QinQ refers to IEEE 802.1ad [b-IEEE 802.1ad].

6 Overview of the test suite for the IOPT of a virtual switch

Virtual switches, running on the mainstream virtualization platform, are basic components in the high level architecture of either the software defined network (SDN) or the network visualization function (NFV). In SDNs [ITU-T Y.3300], virtual switches belong to the resource layer, decoupling the virtual network from the physical network with a tunnelling function, offering layer 2 (L2) network switching and layer 3 (L3) IP routeing for both VMs on the same or different hosts and offering capabilities related to network isolation, quality of service (QoS), network operation and maintenance. In the NFV, virtual switches belong to the infrastructure network domain [b-ETSI NFV-INF 003], offering basic network forwarding functions and advanced network functions such as service function chaining (SFC) support.

The interoperability of a virtual switch is the ability to interact with other entities. Virtual switch IOPT is carried out to verify whether the interactions are as expected and as those described in [ITU-T Q.4043].

This test suite for virtual switch IOPT is a combination of virtual switch interoperability test cases. It is recommended to consider the following four testing areas in the suite:

- Testing area 1: "**virtual switch** – **VM**", which provides test cases for testing the interactions between a virtual switch and a VM.
- Testing area 2: "**virtual switch** – **network equipment**", which provides test cases for testing the interactions between a virtual switch and other network equipment.
- Testing area 3: "**virtual switch – management entity**", which provides test cases for testing the interactions between a virtual switch and a management entity.
- Testing area 4: "**virtual switch – computing virtualization**", which provides test cases for testing the interactions between a virtual switch and computing virtualization.

For each testing area, specific relevant test cases need to be devised to verify different capabilities in different aspects. It is recommended that these capabilities be classified into seven aspects: **network connectivity**, **network security**, **network QoS**, **tunnelling**, **control plane coordination**, **reference points** and **computing virtualization compatibility** [ITU-T Q.4043]. The test cases that should be provided in a suite for virtual switch IOPT are shown in Table 6-1.

Table 6-1 – Test cases that should be provided for virtual switch IOPT

Testing area	Aspects that should be verified	Specific relevant test cases
Virtual switch – VM	Network connectivity	Data frame forwarding
		VLAN
		MTU
		Port aggregation
		Jumbo frame
		IP protocol
		Transport protocol
		ARP proxy
		Forwarding acceleration
		Ethernet interface
		Ethernet autonegotiation
		STP
		QinQ
		ICMP
		IGMP
		IGP
		EGP
		Static route
		Routeing policy
		NAT
	Network security	Traffic filtering
		Anti MAC spoofing
		Security group
		Network security
		ACL
		Anti DOS/DDOS
	Network QoS	Traffic classification
		Rate limitation
Virtual switch – network equipment	Tunnelling	Tunnelling protocol
		Bridging tunnelling-based network and VLAN network
Virtual switch – management entity	Reference points	Reference points for network functions
		Reference points for network operations
		Reference point format
		Changing configuration remotely
Virtual switch – computing virtualization	Computing virtualization	Deploying on server virtualization platform
		Accessing VM's virtual port
		VM status awareness
		Monitoring resource allocation

7 Test cases for IOPT between a virtual switch and a VM

IOPT between a virtual switch and a VM evaluates the interaction between a virtual switch and a VM for network connectivity, network security and network QoS functions. For a description of related functional requirements, refer to [ITU-T Q.4043].

7.1 Interoperability test cases for testing between a virtual switch and a VM in the aspect of network connectivity

Verification of network connectivity includes the verification of the following abilities: data frame forwarding, VLAN, MTU, port aggregation, jumbo frames, forwarding acceleration, Ethernet interface, Ethernet autonegotiation, STP, QinQ, ICMP, IGMP, IGP, EGP, static route, NAT, routeing policy, ARP proxy and IP protocol.

7.1.1 Test case: Data frame forwarding

Table 7.1-1 shows the test case for data frame forwarding.

Table 7.1-1 – Test case: Data frame forwarding

Data frame forwarding test description				
Test purpose		To verify that the virtual switch provides the data frame forwarding function, which forwards data frames from virtual ports based on address information in the data frames.		
Reference		[ITU-T Q.4043] clause 8.1.1		
Test procedures	Step	Type	Description	
	1	Stimulus	Virtual switch interoperability tester (VSIT) login to the configuration interface of the virtual switch.	
	2	Stimulus	Create VLAN1 on the virtual switch, then add virtual port1 and virtual port2 in VLAN1.	
	3	Stimulus	Create two virtual machines, VM1 and VM2, to connect to port1 and port2, respectively. Configure VM1 with IP1 and VM2 with IP2.	
	4	Stimulus	From VM1 ping IP2 and from VM2 ping IP1, which should produce expected result1.	
Expected results	Step	Type	Description	Result
	1	Check	VM1 and VM2 can ping each other.	
Notes				
Test verdict		If all checks described in the test case are successful, it is deemed successfully terminated. If at least one check is successful but at least one check is failed, the test is deemed partially passed. If no checks are successful, the test is deemed failed."		

7.1.2 Test case: VLAN

Table 7.1-2 shows the test case for VLAN.

Table 7.1-2 – Test case: VLAN

VLAN test description				
Test purpose		To verify that the virtual switch provides VLAN function in order to create a partitioned and isolated broadcast domain in a computer network at the data link layer.		
Reference		[ITU-T Q.4043] clause 8.1.1		
Test procedures	Step	Type	Description	
	1	Stimulus	VSIT login to the configuration interface of the virtual switch.	
	2	Stimulus	Create VLAN1 and VLAN2 on the virtual switch, add virtual port1 and virtual port2 in VLAN1, add virtual port3 in VLAN2.	
	3	Stimulus	Create three virtual machines, VM1, VM2 and VM3, to connect to port1, port2 and port3, respectively.	
	4	Stimulus	From VM1, using virtual instrumentation send continuous broadcast packet, which should produce expected result1.	
Expected results	Step	Type	Description	Result
	1	Check	VM2 receives packet from VM1 and VM3 does not receive any packet.	
Notes				
Test verdict		If all checks described in the test case are successful, it is deemed successfully terminated. If at least one check is successful but at least one check is failed, the test is deemed partially passed. If no checks are successful, the test is deemed failed.		

7.1.3 Test case: Maximum transmission unit

Table 7.1-3 shows the test case for a maximum transmission unit (MTU).

Table 7.1-3 – Test case: MTU

MTU test description			
Test purpose		To verify that the virtual switch limits the maximum frame size allowed through the ports.	
Reference		[ITU-T Q.4043] clause 8.1.1	
Test procedures	Step	Type	Description
	1	Stimulus	VSIT login to the configuration interface of the virtual switch.
	2	Stimulus	Create VLAN1 on virtual switch1, add virtual port1 and virtual port2 in VLAN1.
	3	Stimulus	Create two virtual machines, VM1 and VM2, to connect to port1 and port2, respectively. Configure VM1 with IP1, and VM2 with IP2.
	4	Stimulus	Create VLAN1 on virtual switch2 of another host, add virtual port3 within it.
	5	Stimulus	Create VM3 and connect it to virtual switch2 through virtual port3. Configure VM3 with IP3.
	6	Stimulus	Configure the uplink port MTU of virtual switch1 to 1000 bits.
	7	Stimulus	From VM1 ping IP3 with 1500 bits, capture packet in uplink of virtual switch1, which should produce expected result1.

Table 7.1-3 – Test case: MTU

MTU test description				
	8	Stimulus	Modify the uplink port MTU of virtual switch1 to 9000 bits.	
	9	Stimulus	Capture the packet in uplink of virtual switch1, which should produce expected result2.	
	10	Stimulus	Configure the downstream port MTU between virtual switch1 and VM1 to 1 000 bits.	
	11	Stimulus	From VM2 ping IP1 with 1 500 bits, capture packet in VM1, which should produce expected result3.	
	12	Stimulus	Modify downstream port MTU between virtual switch1 and VM1 to 9 000 bits.	
	13	Stimulus	Capture packet in VM1, which should produce expected result4.	
Expected results	Step	Type	Description	Result
	1	Check	There is no packet captured from VM1 to VM3.	
	2	Check	Captured packet with 1 500 bits from VM1 to VM3.	
	3	Check	There is no packet captured from VM2 to VM1.	
	4	Check	Captured packet with 1 500 bits from VM2 to VM1.	
Notes				
Test verdict		If all checks described in the test case are successful, it is deemed successfully terminated. If at least one check is successful but at least one check is failed, the test is deemed partially passed. If no checks are successful, the test is deemed failed.		

7.1.4 Test case: Port aggregation

Table 7.1-4 shows the test case for port aggregation.

Table 7.1-4 – Test case: Port aggregation

Port aggregation test description			
Test purpose		To verify that the virtual switch logically uses multiple independent links as a single link to achieve flexible high bandwidth and link redundancy.	
Reference		[ITU-T Q.4043] clause 8.1.1	
Test procedures	Step	Type	Description
	1	Stimulus	VSIT configure port aggregation for two uplinks of virtual switch1 through the configuration interface.
	2	Stimulus	Create VLAN1 on virtual switch1, add virtual port1 in VLAN1.
	3	Stimulus	Create VM1 and connect it to virtual switch1 through virtual port1. Configure VM1 with IP1.
	4	Stimulus	Create VLAN1 on virtual switch2 of another host, add virtual port2 within it.
	5	Stimulus	Create VM2 and connect it to virtual switch2 through virtual port2. Configure VM2 with IP2.
	6	Stimulus	From VM1 continuously ping IP2, which should produce expected result1.

Table 7.1-4 – Test case: Port aggregation

Port aggregation test description				
	7	Stimulus	Disconnect one uplink of virtual switch1, which should produce expected result2.	
Expected results	Step	Type	Description	Result
	1	Check	VM2 receives packet from VM1.	
	2	Check	VM2 still receives packet from VM1 without packet loss.	
Notes				
Test verdict		If all checks described in the test case are successful, it is deemed successfully terminated. If at least one check is successful but at least one check is failed, the test is deemed partially passed. If no checks are successful, the test is deemed failed.		

7.1.5 Test case: Jumbo frames

Table 7.1-5 shows the test case for jumbo frames.

Table 7.1-5 – Test case: Jumbo frames

Jumbo frame test description				
Test purpose		To verify that the virtual switch recognizes and forwards jumbo frames to reduce the number of packets and the overhead of frame header processing.		
Reference		[ITU-T Q.4043] clause 8.1.1		
Test procedures	Step	Type	Description	
	1	Stimulus	VSIT login to the configuration interface of the virtual switch and enable jumbo frame function.	
	2	Stimulus	Create VLAN1 on virtual switch1, add virtual port1 in VLAN1.	
	3	Stimulus	Create VM1 and connect it to virtual switch1 through virtual port1. Configure VM1 with IP1.	
	4	Stimulus	Create VLAN1 on virtual switch2 of another host, add virtual port2 within it.	
	5	Stimulus	Create VM2 and connect it to virtual switch2 through virtual port2. Configure VM2 with IP2.	
	6	Stimulus	From VM1 send jumbo frame to VM2. Capture packet in uplink of virtual switch1, which should produce expected result1. Capture packet in VM2, which should produce expected result2.	
Expected results	Step	Type	Description	Result
	1	Check	The captured packet in uplink of virtual switch1 is jumbo frame.	
	2	Check	VM2 receives jumbo frame.	
Notes				
Test verdict		If all checks described in the test case are successful, it is deemed successfully terminated. If at least one check is successful but at least one check is failed, the test is deemed partially passed. If no checks are successful, the test is deemed failed.		

7.1.6 Test case: Forwarding acceleration

Table 7.1-6 shows the test case for forwarding acceleration.

Table 7.1-6 – Test case: Forwarding acceleration

Forwarding acceleration test description				
Test purpose		To verify that the virtual switch supports forwarding acceleration in order to meet the high forwarding performance of VNF.		
Reference		[ITU-T Q.4043] clause 8.1.1		
Test procedures	Step	Type	Description	
	1	Stimulus	VSIT login to the configuration interface of the virtual switch and disable DPDK function. NOTE – Forwarding acceleration can be realized by DPDK, SR-IOV and smart NIC. SR-IOV and smart NIC, which are implemented by NICs, are beyond the scope of this Recommendation.	
	2	Stimulus	Create VLAN1 on virtual switch1, add virtual port1 in VLAN1.	
	3	Stimulus	Create VM1 and connect it to virtual switch1 through virtual port1. Configure VM1 with IP1.	
	4	Stimulus	Create VLAN1 on virtual switch2 of another host, add virtual port2 within it.	
	5	Stimulus	Create VM2 and connect it to virtual switch2 through virtual port2. Configure VM2 with IP2.	
	6	Stimulus	VSIT disable DPDK function. From VM1 continuously ping IP2. Use virtual instrumentation to measure bandwidth in the uplink of virtual switch1. Record the average bandwith1.	
	7	Stimulus	VSIT enable DPDK function. From VM1 continuous ping IP2. Use virtual instrumentation to measure bandwidth in the uplink of virtual switch1. Record the average bandwith2. Compare with average bandwith1, which should produce expected result1.	
Expected results	Step	Type	Description	Result
	1	Check	Average bandwidth2 is significantly higher than average bandwith1.	
Notes				
Test verdict		If all checks described in the test case are successful, it is deemed successfully terminated. If at least one check is successful but at least one check is failed, the test is deemed partially passed. If no checks are successful, the test is deemed failed.		

7.1.7 Test case: Ethernet interface

Table 7.1-7 shows the test case for Ethernet interface.

Table 7.1-7 – Test case: Ethernet interface

Ethernet interface test description				
Test purpose		To verify that the virtual switch supports Ethernet interface, including 10 Mbit/s Ethernet interface, 100 Mbit/s Fast Ethernet interface, gigabit Ethernet interface, 10 G Ethernet interface, 40 G Ethernet interface and 100 G Ethernet interface.		
Reference		[ITU-T Q.4043] clause 8.1.1		
Test procedures	Step	Type	Description	
	1	Stimulus	VSIT login to the configuration interface of the virtual switch.	
	2	Stimulus	Create VLAN on the virtual switch, add virtual port in VLAN.	
	3	Stimulus	Create VM, configure VM with 10 Mbit/s network adapter and connect it to the virtual switch through a virtual port.	
	4	Stimulus	Use ethtool to display the current network port parameters, which should produce expected result1. NOTE – ethtool is a tool to query or control network driver and hardware settings.	
	5	Stimulus	Reconfigure VM with 100 Mbit/s network adapter. Use ethtool to display the current network port parameters, which should produce expected result2.	
	6	Stimulus	Reconfigure VM with gigabit network adapter. Use ethtool to display the current network port parameters, which should produce expected result3.	
	7	Stimulus	Reconfigure VM with 10 G network adapter. Use ethtool to display the current network port parameters, which should produce expected result4.	
	8	Stimulus	Reconfigure VM with 40 G network adapter. Use ethtool to display the current network port parameters, which should produce expected result5.	
	9	Stimulus	Reconfigure VM with 100 G network adapter. Use ethtool to display the current network port parameters, which should produce expected result6.	
Expected results	Step	Type	Description	Result
	1	Check	The speed parameter is 10 Mbit/s.	
	2	Check	The speed parameter is 100 Mbit/s.	
	3	Check	The speed parameter is 1 000 Mbit/s.	
	4	Check	The speed parameter is 10 000 Mbit/s.	
	5	Check	The speed parameter is 40 000 Mbit/s.	
	6	Check	The speed parameter is 100 000 Mbit/s.	
Notes				
Test verdict		If all checks described in the test case are successful, it is deemed successfully terminated. If at least one check is successful but at least one check is failed, the test is deemed partially passed. If no checks are successful, the test is deemed failed.		

7.1.8 Test case: Ethernet autonegotiation

Table 7.1-8 shows the test case for Ethernet autonegotiation.

Table 7.1-8 – Test case: Ethernet autonegotiation

Ethernet autonegotiation test description				
Test purpose		To verify that the virtual switch supports a port to communicate with the device on the other end of the link to determine the optimal duplex mode and speed for the connection.		
Reference		[ITU-T Q.4043] clause 8.1.1		
Test procedures	Step	Type	Description	
	1	Stimulus	VSIT login to the configuration interface of the virtual switch.	
	2	Stimulus	Create virtual port1 on the virtual switch and connect the virtual port1 with the physical NIC1 of the host. Set the autonegotiation parameter of the virtual port1 to ON option.	
	3	Stimulus	Set the speed of physical NIC1 at 100 Mbit/s, the duplex mode to FULL and the autonegotiation to ON.	
	4	Stimulus	Create VLAN1 on the virtual switch, add virtual port2 in VLAN1.	
	5	Stimulus	Create VM1 and connect it to virtual switch1 through virtual port2.	
	6	Stimulus	From VM1 send packet out. At the same time, use virtual instrumentation to send packet to VM1 through physical NIC1 and measure bandwidth in the uplink of virtual switch1, which should produce expected result1.	
	7	Stimulus	Reset the speed of physical NIC1 at 1 000 Mbit/s, and keep the autonegotiation set to ON.	
	8	Stimulus	Use virtual instrumentation to send packet to VM1 through physical NIC1 and measure bandwidth in the uplink of virtual switch1, which should produce expected result2.	
Expected results	Step	Type	Description	Result
	1	Check	VM1 receives packet from virtual instrumentation without packet loss. The bandwidth of the virtual switch uplink is 100 Mbit/s.	
	2	Check	The bandwidth of the virtual switch uplink is 1 000 Mbit/s.	
Notes				
Test verdict		If all checks described in the test case are successful, it is deemed successfully terminated. If at least one check is successful but at least one check is failed, the test is deemed partially passed. If no checks are successful, the test is deemed failed.		

7.1.9 Test case: Spanning tree protocol (STP)

Table 7.1-9 shows the test case for spanning tree protocol (STP).

Table 7.1-9 – Test case: STP

STP test description				
Test purpose		To verify that the virtual switch implements STP protocols [b-IEEE 802.1q].		
Reference		[ITU-T Q.4043] clause 8.1.1		
Test procedures	Step	Type	Description	
	1	Stimulus	VSIT login to the configuration interface of two virtual switches on different hosts. Enable STP of both virtual switches.	
	2	Stimulus	Use duplicate cables to connect two hosts to build a physical loop.	
	3	Stimulus	Create VLAN1 on virtual switch1, add virtual port1 in VLAN1. Create VM1 and connect it to virtual switch1 through virtual port1. Configure VM1 with IP1.	
	4	Stimulus	Create VLAN1 on virtual switch2 of another host, add virtual port2 within it.	
	5	Stimulus	Create VM2 and connect it to virtual switch2 through virtual port2. Configure VM2 with IP2.	
	6	Stimulus	From VM1 ping IP2, which should produce expected result1.	
Expected results	Step	Type	Description	Result
	1	Check	VM2 receives packet from VM1.	
Notes				
Test verdict		If all checks described in the test case are successful, it is deemed successfully terminated. If at least one check is successful but at least one check is failed, the test is deemed partially passed. If no checks are successful, the test is deemed failed.		

7.1.10 Test case: QinQ

Table 7.1-10 shows the test case for QinQ.

Table 7.1-10 – Test case: QinQ

QinQ test description			
Test purpose		To verify that the virtual switch supports to encapsulate the private network VLAN tag in the public network VLAN so that the packet can be forwarded with two VLAN tags [b- IEEE 802.1q].	
Reference		[ITU-T Q.4043] clause 8.1.1	
Test procedures	Step	Type	Description
	1	Stimulus	VSIT login to the configuration interface of the virtual switch.
	2	Stimulus	Create VLAN1 on virtual switch1, add virtual port1 in VLAN1.
	3	Stimulus	Create VM1 and connect it to virtual switch1 through virtual port1. Configure VM1 with IP1. Configure virtual port1 to support QinQ.

Table 7.1-10 – Test case: QinQ

QinQ test description				
	4	Stimulus	Create VLAN1 on virtual switch2 of another host, add virtual port2 within it.	
	5	Stimulus	Create VM2 and connect it to virtual switch2 through virtual port2. Configure VM2 with IP2.	
	6	Stimulus	From VM1, using virtual instrumentation, send packet encapsulated with VLAN2 header to VM2. Capture packet in uplink of virtual switch1, which should produce expected result1.	
Expected results	Step	Type	Description	Result
	1	Check	The captured packet has 2 VLAN tags. The inner tag VLAN2 is encapsulated in the outer tag VLAN1.	
Notes				
Test verdict		If all checks described in the test case are successful, it is deemed successfully terminated. If at least one check is successful but at least one check is failed, the test is deemed partially passed. If no checks are successful, the test is deemed failed.		

7.1.11 Test case: Internet control message protocol (ICMP)

Table 7.1-11 shows the test case for Internet control message protocol (ICMP).

Table 7.1-11 – Test case: ICMP

ICMP test description				
Test purpose		To verify that the virtual switch supports sending ICMP destination unreachable messages and can choose a code that is closest to the reason for being unreachable [b-IETF RFC 792] [b-IETF RFC 1122].		
Reference		[ITU-T Q.4043] clause 8.1.1		
Test procedures	Step	Type	Description	
	1	Stimulus	VSIT login to the configuration interface of the virtual switch.	
	2	Stimulus	Create VLAN1 on virtual switch1, add virtual port1 in VLAN1.	
	3	Stimulus	Create VM1 and connect it to virtual switch1 through virtual port1. Configure VM1 with IP1.	
	6	Stimulus	Use VM1 to ping IP2, which should produce expected result1. NOTE – There is no existing entity with IP2.	
Expected results	Step	Type	Description	Result
	1	Check	VM1 receives IP2 unreachable message.	
Notes				
Test verdict		If all checks described in the test case are successful, it is deemed successfully terminated. If at least one check is successful but at least one check is failed, the test is deemed partially passed. If no checks are successful, the test is deemed failed.		

7.1.12 Test case: Internet group management protocol (IGMP)

Table 7.1-12 shows the test case for Internet group management protocol (IGMP).

Table 7.1-12 – Test case: IGMP

IGMP test description				
Test purpose		To verify that the virtual switch supports the IGMP v2 [b-IETF RFC 3376].		
Reference		[ITU-T Q.4043] clause 8.1.1		
Test procedures	Step	Type	Description	
	1	Stimulus	VSIT login to the configuration interface of the virtual switch.	
	2	Stimulus	Create VLAN1 on virtual switch1, add virtual port1 and virtual port2 in VLAN1.	
	3	Stimulus	Create two virtual machines, VM1 and VM2, to connect to port1 and port2, respectively. Configure VM1 with IP1 and VM2 with IP2.	
	4	Stimulus	Create VLAN1 on virtual switch2 of another host, add virtual port3 within it.	
	5	Stimulus	Create VM3 and connect it to virtual switch2 through virtual port3. Configure VM3 with IP3.	
	6	Stimulus	Configure VM1, VM2 and VM3 into a multicast group with group ID IP4.	
	7	Stimulus	From VM1, use virtual instrumentation to send packet with destination IP4, which should produce expected result1.	
Expected results	Step	Type	Description	Result
	1	Check	VM2 and VM3 receive packet from VM1.	
Notes				
Test verdict		If all checks described in the test case are successful, it is deemed successfully terminated. If at least one check is successful but at least one check is failed, the test is deemed partially passed. If no checks are successful, the test is deemed failed.		

7.1.13 Test case: Open shortest path first (OSFP)

Table 7.1-13 shows the test case for open shortest path first (OSFP).

Table 7.1-13 – Test case: OSFP

OSFP test description			
Test purpose		To verify that the virtual switch supports OSFP [b-IETF RFC 2328].	
Reference		[ITU-T Q.4043] clause 8.1.1	
Test procedures	Step	Type	Description
	1	Stimulus	VSIT login to the configuration interface of the virtual switch.
	2	Stimulus	Create VLAN1 on the virtual switch, add virtual port1 in VLAN1.
	3	Stimulus	Create VM1 and connect it to the virtual switch through virtual port1. Configure VM1 with IP1.
	4	Stimulus	Configure external network equipment (simulated by physical test instrumentation) with OSPF.

Table 7.1-13 – Test case: OSFP

OSFP test description				
	5	Stimulus	Configure the virtual switch with OSPF and let it send out route to VM1, which should produce expected result1	
	6	Stimulus	Configure external network equipment to send out route to external IP2, which should produce expected result2.	
	7	Stimulus	From VM1, ping IP2, which should produce expected result3.	
Expected results	Step	Type	Description	Result
	1	Check	External network equipment learned route to VM1 by OSPF.	
	2	Check	Virtual switch learned route to external IP2.	
	3	Check	VM1 receives reply packet from IP2.	
Notes				
Test verdict		If all checks described in the test case are successful, it is deemed successfully terminated. If at least one check is successful but at least one check is failed, the test is deemed partially passed. If no checks are successful, the test is deemed failed.		

7.1.14 Test case: Intermediate system to intermediate system (IS-IS)

Table 7.1-14 shows the test case for intermediate system to intermediate system (IS-IS).

Table 7.1-14 – Test case: IS-IS

IS-IS test description				
Test purpose		To verify that the virtual switch supports IS-IS [b-IETF RFC 1142].		
Reference		[ITU-T Q.4043] clause 8.1.1		
Test procedures	Step	Type	Description	
	1	Stimulus	VSIT login to the configuration interface of the virtual switch.	
	2	Stimulus	Create VLAN1 on the virtual switch, add virtual port1 in VLAN1.	
	3	Stimulus	Create VM1 and connect it to the virtual switch through virtual port1. Configure VM1 with IP1.	
	4	Stimulus	Configure external network equipment (simulated by physical test instrumentation) with IS-IS.	
	5	Stimulus	Configure the virtual switch with IS-IS and let it send out route to VM1, which should produce expected result1.	
	6	Stimulus	Configure external network equipment to send out route to external IP2, which should produce expected result2.	
	7	Stimulus	From VM1 ping IP2, which should produce expected result3.	
Expected results	Step	Type	Description	Result
	1	Check	External network equipment learned route to VM1 by IS-IS.	
	2	Check	Virtual switch learned route to external IP2.	
	3	Check	VM1 receives reply packet from IP2.	

Table 7.1-14 – Test case: IS-IS

IS-IS test description	
Notes	
Test verdict	If all checks described in the test case are successful, it is deemed successfully terminated. If at least one check is successful but at least one check is failed, the test is deemed partially passed. If no checks are successful, the test is deemed failed.

7.1.15 Test case: Routeing information protocol (RIP)

Table 7.1-15 shows the test case for routeing information protocol (RIP).

Table 7.1-15 – Test case: RIP

RIP test description				
Test purpose		To verify that the virtual switch supports RIP [b-IETF RFC 2453]		
Reference		[ITU-T Q.4043] clause 8.1.1		
Test procedures	Step	Type	Description	
	1	Stimulus	VSIT login to the configuration interface of the virtual switch.	
	2	Stimulus	Create VLAN1 on the virtual switch, add virtual port1 in VLAN1.	
	3	Stimulus	Create VM1 and connect it to the virtual switch through virtual port1. Configure VM1 with IP1.	
	4	Stimulus	Configure external network equipment (simulated by physical test instrumentation) with RIP.	
	5	Stimulus	Configure the virtual switch with RIP and let it send out route to VM1, which should produce expected result1.	
	6	Stimulus	Configure external network equipment to send out route to external IP2, which should produce expected result2.	
	7	Stimulus	From VM1 ping IP2, which should produce expected result3.	
Expected results	Step	Type	Description	Result
	1	Check	External network equipment learned route to VM1 by RIP.	
	2	Check	Virtual switch learned route to external IP2.	
	3	Check	VM1 receives reply packet from IP2.	
Notes				
Test verdict		If all checks described in the test case are successful, it is deemed successfully terminated. If at least one check is successful but at least one check is failed, the test is deemed partially passed. If no checks are successful, the test is deemed failed.		

7.1.16 Test case: Exterior gateway protocol (EGP)

Table 7.1-16 shows the test case for exterior gateway protocol (EGP).

Table 7.1-16 – Test case: EGP

EGP test description				
Test purpose		To verify that the virtual switch supports EGP to distribute routeing information between ASs, such as border gateway protocol (BGP) version 4 (BGP-4) [b-IETF RFC 4271].		
Reference		[ITU-T Q.4043] clause 8.1.1		
Test procedures	Step	Type	Description	
	1	Stimulus	VSIT login to the configuration interface of the virtual switch.	
	2	Stimulus	Create VLAN1 on virtual switch, add virtual port1 in VLAN1.	
	3	Stimulus	Create VM1 and connect it to the virtual switch through virtual port1. Configure VM1 with IP1.	
	4	Stimulus	Configure external network equipment (simulated by physical test instrumentation) with BGP.	
	5	Stimulus	Configure the virtual switch with BGP and let it send out the route to VM1, which should produce expected result1.	
	6	Stimulus	Configure external network equipment to send out the route to external IP2, which should produce expected result2.	
	7	Stimulus	From VM1 ping IP2, which should produce expected result3.	
Expected results	Step	Type	Description	Result
	1	Check	External network equipment learned route to VM1 by BGP.	
	2	Check	Virtual switch learned route to external IP2.	
	3	Check	VM1 receives reply packet from IP2.	
Notes				
Test verdict		If all checks described in the test case are successful, it is deemed successfully terminated. If at least one check is successful but at least one check is failed, the test is deemed partially passed. If no checks are successful, the test is deemed failed.		

7.1.17 Test case: Static routes

Table 7.1-17 shows the test case for static routes.

Table 7.1-17 – Test case: Static routes

Static route test description			
Test purpose		To verify that the virtual switch supports the definition of static routes to specific destinations defined by network prefix.	
Reference		[ITU-T Q.4043] clause 8.1.1	
Test procedures	Step	Type	Description
	1	Stimulus	VSIT login to the configuration interface of the virtual switch.
	2	Stimulus	Create VLAN1 on the virtual switch, add virtual port1 in VLAN1.
	3	Stimulus	Create VM1 and connect it to the virtual switch through virtual port1. Configure VM1 with IP1.

Table 7.1-17 – Test case: Static routes

Static route test description				
	4	Stimulus	Configure external network equipment (simulated by physical test instrumentation) with IP2. Add static route to IP1 in external network equipment.	
	5	Stimulus	Configure the virtual switch with a static route to IP2.	
	6	Stimulus	From VM1 ping IP2, which should produce expected result1.	
Expected results	Step	Type	Description	Result
	3	Check	External network equipment receives packet from IP1.	
Notes				
Test verdict		If all checks described in the test case are successful, it is deemed successfully terminated. If at least one check is successful but at least one check is failed, the test is deemed partially passed. If no checks are successful, the test is deemed failed.		

7.1.18 Test case: Network address translation (NAT)

Table 7.1-18 shows the test case for network address translation (NAT).

Table 7.1-18 – Test case: NAT

NAT test description				
Test purpose		To verify that the virtual switch supports NAT by converting the internal network address (possibly a private address) to an external network address in order to complete the communication between the internal network and the external network, and ensure the independence and privacy of the internal network.		
Reference		[ITU-T Q.4043] clause 8.1.1		
Test procedures	Step	Type	Description	
	1	Stimulus	VSIT login to the configuration interface of the virtual switch.	
	2	Stimulus	Create VLAN1 on virtual switch1, add virtual port1 in VLAN1.	
	3	Stimulus	Create VM1 and connect it to virtual switch1 through virtual port1. Configure VM1 with IP1.	
	4	Stimulus	Add NAT rule in virtual switch, bind IP1 with external IP2.	
	5	Stimulus	From virtual instrumentation send packet to IP2, which should produce expected result1.	
Expected results	Step	Type	Description	Result
	1	Check	VM1 receives packet.	
Notes				
Test verdict		If all checks described in the test case are successful, it is deemed successfully terminated. If at least one check is successful but at least one check is failed, the test is deemed partially passed. If no checks are successful, the test is deemed failed.		

7.1.19 Test case: Routeing policy

Table 7.1-19 shows the test case for routeing policy.

Table 7.1-19 – Test case: Routeing Policy

Routeing policy test description				
Test purpose		To verify that the virtual switch supports routeing policy with route filtering and attributes setting to control traffic forwarding.		
Reference		[ITU-T Q.4043] clause 8.1.1		
Test procedures	Step	Type	Description	
	1	Stimulus	VSIT login to the configuration interface of the virtual switch.	
	2	Stimulus	Create VLAN1 on virtual switch1, add virtual port1 and virtual port2 in VLAN1.	
	3	Stimulus	Create two virtual machines, VM1 and VM2, to connect to port1 and port2, respectively. Configure VM1 with IP1 and VM2 with IP2.	
	4	Stimulus	Create routeing policy1 and add routeing rule1 within it. Configure routeing rule1 to allow connection between IP1 and IP2.	
	5	Stimulus	From VM1 ping VM2, which should produce expected result1.	
	6	Stimulus	Reconfigure routeing rule1 to deny connection between IP1 and IP2.	
	7	Stimulus	From VM1 ping VM2, which should produce expected result2.	
Expected results	Step	Type	Description	Result
	1	Check	VM2 receives packets from VM1.	
	2	Check	VM2 cannot receive packets from VM1.	
Notes				
Test verdict		If all checks described in the test case are successful, it is deemed successfully terminated. If at least one check is successful but at least one check is failed, the test is deemed partially passed. If no checks are successful, the test is deemed failed.		

7.1.20 Test case: Address resolution protocol (ARP) proxy

Table 7.1-20 shows the test case for address resolution protocol (ARP) proxy.

Table 7.1-20 – Test case: ARP proxy

ARP proxy test description			
Test purpose		To verify that the virtual switch provides ARP response to VMs in order to reduce ARP broadcast packet in the broadcast domain.	
Reference		[ITU-T Q.4043] clause 8.1.1	
Test procedures	Step	Type	Description
	1	Stimulus	VSIT login to the configuration interface of the virtual switch and enable ARP proxy function.
	2	Stimulus	Create VLAN1 on virtual switch1, add virtual port1 and virtual port2 in VLAN1.
	3	Stimulus	Create two virtual machines, VM1 and VM2, to connect to port1 and port2, respectively. Configure VM1 with IP1 and VM2 with IP2.

Table 7.1-20 – Test case: ARP proxy

ARP proxy test description				
	4	Stimulus	Create VLAN1 on virtual switch2 of another host, add virtual port3 within it.	
	5	Stimulus	Create VM3 and connect it to virtual switch2 through virtual port3. Configure VM3 with IP3	
	6	Stimulus	Clear ARP cache of VM1, VM2 and VM3. NOTE – The CLI commands to check the ARP cache are as follows: Delete all ARP cache: # arp −d List ARP table: #arp −a	
	7	Stimulus	Keep capturing packet from VM2 and VM3. From VM1 ping IP2.	
	8	Stimulus	Check VM2 and VM3, which should produce expected result1.	
	9	Stimulus	Check ARP cache of VM1, which should produce expected result2.	
Expected results	Step	Type	Description	Result
	1	Check	VM2 and VM3 do not receive any ARP REQUEST packet.	
	2	Check	VM1 learned the MAC of VM2.	
Notes				
Test verdict		If all checks described in the test case are successful, it is deemed successfully terminated. If at least one check is successful but at least one check is failed, the test is deemed partially passed. If no checks are successful, the test is deemed failed.		

7.1.21 Test case: IP protocol

Table 7.1-21 shows the test case for IP protocol.

Table 7.1-21 – Test case: IP protocol

IP protocol test description			
Test purpose		To verify that the virtual switch supports IP protocol [b-IETF RFC 791] and functions related to IP protocol, including IP packet forwarding, IP subnet [b-IETF RFC 950], IP broadcast [b-IETF RFC 922] and CIDR [b-IETF RFC 4632].	
Reference		[ITU-T Q.4043] clause 8.1.1	
Test procedures	Step	Type	Description
	1	Stimulus	VSIT login to the configuration interface of the virtual switch.
	2	Stimulus	Create VLAN1 and VLAN2 on virtual switch1, add virtual port1 in VLAN1, and add virtual port2 in VLAN2.
	3	Stimulus	Create two virtual machines, VM1 and VM2, to connect to port1 and port2, respectively. Configure VM1 with IP1 and VM2 with IP2.
	4	Stimulus	Create VLAN2 on virtual switch2 of another host, add virtual port3 within it.
	5	Stimulus	Create VM3 and connect it to virtual switch2 through virtual port3. Configure VM3 with IP3.

Table 7.1-21 – Test case: IP protocol

IP protocol test description				
	6	Stimulus	Configure two virtual switches to provide network connection between VLAN1 and VLAN2.	
	7	Stimulus	From VM1 ping IP2, which should produce expected result1.	
	8	Stimulus	From VM1 ping IP3, which should produce expected result2.	
Expected results	Step	Type	Description	Result
	1	Check	VM2 receives packet from VM1.	
	2	Check	VM3 receives packet from VM1.	
Notes				
Test verdict		If all checks described in the test case are successful, it is deemed successfully terminated. If at least one check is successful but at least one check is failed, the test is deemed partially passed. If no checks are successful, the test is deemed failed.		

7.2 Interoperability test cases for testing between a virtual switch and a VM in the aspect of network security

The verification of network security includes the verification of the following abilities: traffic filtering, security group, anti MAC spoofing, network security, ACL and anti-DOS/DDOS.

7.2.1 Test case: Traffic filtering

Table 7.2-1 shows the test case for traffic filtering.

Table 7.2-1 – Test case: Traffic filtering

Traffic filtering test description			
Test purpose	To verify that the virtual switch filters each port's traffic according to various packet-header-information-based filtering rules, including MAC address, IP address, TCP/UDP port and also the MAC address, IP address and TCP/UDP port of the inner encapsulated original packet for the tunnelling protocol packet. NOTE – The filtering rule is usually stateful and can identify the data packets of a flow.		
Reference	[ITU-T Q.4043] clause 8.1.2		
Test procedures	Step	Type	Description
	1	Stimulus	VSIT login to the configuration interface of the virtual switch.
	2	Stimulus	Create VLAN1 on virtual switch, add virtual port1 and virtual port2 in VLAN1.
	3	Stimulus	Create two virtual machines, VM1 and VM2, to connect to port1 and port2, respectively. Configure VM1 with IP1 and VM2 with IP2.
	4	Stimulus	Create traffic filtering rule1, which enables packet from IP1 to IP2 with port number 22. Create traffic filtering rule2, which disables packet from IP2 to IP1 with port number 22. Apply traffic filtering rule1 and rule2 to VM1.
	5	Stimulus	From VM1, telnet VM2 with port number 22, which should produce expected result1.

Table 7.2-1 – Test case: Traffic filtering

Traffic filtering test description				
	6	Stimulus	From VM2, telnet VM1 with port number 22, which should produce expected result2.	
Expected results	Step	Type	Description	Result
	1	Check	VM1 could telnet VM2 successfully.	
	2	Check	VM2 cannot telnet VM1.	
Notes				
Test verdict		If all checks described in the test case are successful, it is deemed successfully terminated. If at least one check is successful but at least one check is failed, the test is deemed partially passed. If no checks are successful, the test is deemed failed.		

7.2.2 Test case: Security group

Table 7.2-2 shows the test case for security group.

Table 7.2-2 – Test case: Security group

Security group test description				
Test purpose		To verify that the virtual switch supports a security group, which is a group of traffic filtering rules used to simplify management.		
Reference		[ITU-T Q.4043] clause 8.1.2		
Test procedures	Step	Type	Description	
	1	Stimulus	VSIT login to the configuration interface of the virtual switch.	
	2	Stimulus	Create VLAN1 on virtual switch, add virtual port1 and virtual port2 in VLAN1.	
	3	Stimulus	Create two virtual machines, VM1 and VM2, to connect to port1 and port2, respectively. Configure VM1 with IP1 and VM2 with IP2.	
	4	Stimulus	Create security group1. Add security group rule1 in security group1, which enables packet from IP1 to IP2 with port number 22. Add security group rule2 in security group1, which disables packet from IP2 to IP1 with port number 22. Apply security group1 to VM1.	
	5	Stimulus	From VM1, telnet VM2 with port number, which should produce expected result1.	
	6	Stimulus	From VM2, telnet VM1 with port number 22, which should produce expected result2.	
Expected results	Step	Type	Description	Result
	1	Check	VM1 could telnet VM2 successfully.	
	2	Check	VM2 cannot telnet VM1.	
Notes				
Test verdict		If all checks described in the test case are successful, it is deemed successfully terminated. If at least one check is successful but at least one check is failed, the test is deemed partially passed. If no checks are successful, the test is deemed failed.		

7.2.3 Test case: Anti MAC spoofing

Table 7.2-3 shows the test case for anti MAC spoofing.

Table 7.2-3 – Test case: Anti MAC spoofing

Anti MAC spoofing test description				
Test purpose		To verify that the virtual switch allows only incoming and outgoing frames with a specific MAC address. Frames with an inspected MAC address will be blocked.		
Reference		[ITU-T Q.4043] clause 8.1.2		
Test procedures	Step	Type	Description	
	1	Stimulus	VSIT login to the configuration interface of the virtual switch. Enable anti MAC spoofing.	
	2	Stimulus	Create VLAN1 on virtual switch1, add virtual port1 and virtual port2 in VLAN1.	
	3	Stimulus	Create two virtual machines, VM1 and VM2, to connect to port1 and port2, respectively. Configure VM1 with IP1 and VM2 with IP2.	
	4	Stimulus	Use VM1 to ping IP2, which should produce expected result1.	
	5	Stimulus	Manually modify the MAC of VM1.	
	6	Stimulus	Use VM1 to ping IP2, which should produce expected result2.	
Expected results	Step	Type	Description	Result
	1	Check	VM2 receives packet from VM1.	
	2	Check	VM2 does not receive any packet.	
Notes				
Test verdict		If all checks described in the test case are successful, it is deemed successfully terminated. If at least one check is successful but at least one check is failed, the test is deemed partially passed. If no checks are successful, the test is deemed failed.		

7.2.4 Test case: Network security

Table 7.2-4 shows the test case for network security.

Table 7.2-4 – Test case: Network security

Network security test description			
Test purpose		To verify that the virtual switch provides network-layer-based security protection for IPv4, IPv6 and dual stacks, such as preventing a request for IP from the source, limiting the number of concurrent requests generated by each source IP address.	
Reference		[ITU-T Q.4043] clause 8.1.2	
Test procedures	Step	Type	Description
	1	Stimulus	VSIT login to the configuration interface of the virtual switch.
	2	Stimulus	Create VLAN1 on virtual switch1, add virtual port1, virtual port2 and virtual port3 in VLAN1.
	3	Stimulus	Create three virtual machines, VM1, VM2 and VM3, to connect to port 1, port 2 and port 3, respectively. Configure VM1 with IP1, VM2 with IP2 and VM3 with IP3.
	4	Stimulus	Create network security rule1, which enables the request from IP1 and prevents the request from IP3.

Table 7.2-4 – Test case: Network security

Network security test description				
	5	Stimulus	Use VM1 to ping IP2 and use VM3 to ping IP2, which should produce expected result1.	
	6	Stimulus	Create network security rule2, which limits the request number generated by IP1 to 100 per second.	
	7	Stimulus	From VM1, use virtual instrumentation to send packet 80 times per second with destination IP2, which should produce expected result2.	
	8	Stimulus	From VM1, use virtual instrumentation to send packet 180 times per second with destination IP2, which should produce expected result3.	
Expected results	Step	Type	Description	Result
	1	Check	VM2 receives packet from VM1 and does not receive any packet from VM3.	
	2	Check	VM2 receives packet from VM1 80 times per second.	
	3	Check	VM2 receives packet from VM1 100 times per second.	
Notes				
Test verdict		If all checks described in the test case are successful, it is deemed successfully terminated. If at least one check is successful but at least one check is failed, the test is deemed partially passed. If no checks are successful, the test is deemed failed.		

7.2.5 Test case: Access control list (ACL)

Table 7.2-5 shows the test case for access control list (ACL).

Table 7.2-5 – Test case: ACL

ACL test description				
Test purpose		To verify that the virtual switch supports IPv4, IPv6 and dual stack ACL, based on quintuple (source/destination IP address, source/destination port, protocol type).		
Reference		[ITU-T Q.4043] clause 8.1.2		
Test procedures	Step	Type	Description	
	1	Stimulus	VSIT login to the configuration interface of the virtual switch.	
	2	Stimulus	Create VLAN1 on virtual switch, add virtual port1 and virtual port2 in VLAN1.	
	3	Stimulus	Create two virtual machines, VM1 and VM2, to connect to port1 and port2, respectively. Configure VM1 with IP1 and VM2 with IP2.	
	4	Stimulus	Create ACL rule1, which enables packet from IP1 to IP2 with port number 21 and protocol TCP. Create ACL rule2, which disables packet from IP1 to IP2 with port number 69 and protocol UDP.	
	5	Stimulus	From VM1, FTP VM2, which should produce expected result1.	
	6	Stimulus	From VM1, TFTP VM2, which should produce expected result2.	
Expected results	Step	Type	Description	Result
	1	Check	VM1 can FTP VM2, and download file from VM2.	

Table 7.2-5 – Test case: ACL

ACL test description				
	2	Check	VM1 cannot TFTP VM2.	
Notes				
Test verdict		If all checks described in the test case are successful, it is deemed successfully terminated. If at least one check is successful but at least one check is failed, the test is deemed partially passed. If no checks are successful, the test is deemed failed.		

7.2.6 Test case: Anti-DOS/DDOS

Table 7.2-6 shows the test case for anti-DOS/DDOS.

Table 7.2-6 – Test case: Anti-DOS/DDOS

Anti-DOS/DDOS test description				
Test purpose		To verify that the virtual switch supports traffic restrictions and filtering for specific protocols to prevent DOS/DDOS attacks.		
Reference		[ITU-T Q.4043] clause 8.1.2		
Test procedures	Step	Type	Description	
	1	Stimulus	VSIT login to the configuration interface of the virtual switch. Enable anti-DOS and anti-DDOS.	
	2	Stimulus	Create VLAN1 on virtual switch1, add virtual port1 in VLAN1.	
	3	Stimulus	Create virtual machine VM1 to connect to virtual port 1. Configure VM1 with IP1.	
	4	Stimulus	Use virtual instrumentation with IP2, which is in the same VLAN as IP1, to send SYN flood, UDP flood, ping flood, land attack, teardrop and ping of death packet to VM1, which should produce expected result1.	
	5	Stimulus	Use virtual instrumentation to pretend to be configurated with several IPs that are in the same VLAN to send SYN flood, UDP flood, ping flood, land attack, teardrop, ping of death packet to VM1, which should produce expected result2.	
Expected results	Step	Type	Description	Result
	1	Check	VM1 does not receive any packet.	
	2	Check	VM1 does not receive any packet.	
Notes				
Test verdict		If all checks described in the test case are successful, it is deemed successfully terminated. If at least one check is successful but at least one check is failed, the test is deemed partially passed. If no checks are successful, the test is deemed failed.		

7.3 Interoperability test cases for testing between a virtual switch and a VM in the aspect of network QoS

The verification of network QoS includes the verification of traffic classification and rate limitation.

7.3.1 Test case: Traffic classification

Table 7.3-1 shows the test case for traffic classification.

Table 7.3-1 – Test case: Traffic classification

Traffic classification test description				
Test purpose		To verify that the virtual switch assigns a QoS priority tag in the header of the frame for the specified virtual port.		
Reference		[ITU-T Q.4043] clause 8.1.3		
Test procedures	Step	Type	Description	
	1	Stimulus	VSIT login to the configuration interface of the virtual switch.	
	2	Stimulus	Create VLAN1 on virtual switch1, add virtual port1 and virtual port2 in VLAN1.	
	3	Stimulus	Create two virtual machines, VM1 and VM2, to connect to port1 and port2, respectively. Configure VM1 with IP1 and VM2 with IP2.	
	4	Stimulus	Configure the QoS tag of virtual port1 as N. Use VM1 to ping IP2, capture packet in VM2, which should produce expected result1.	
Expected results	Step	Type	Description	Result
	1	Check	Packet received from VM1 has 802.1q header as N.	
Notes				
Test verdict		If all checks described in the test case are successful, it is deemed successfully terminated. If at least one check is successful but at least one check is failed, the test is deemed partially passed. If no checks are successful, the test is deemed failed.		

7.3.2 Test case: Rate limitation

Table 7.3-2 shows the test case for rate limitation.

Table 7.3-2 – Test case: Rate limitation

Rate limitation test description			
Test purpose		To verify that the virtual switch limits the uplink and downlink rate of the specified virtual port and flow to a specific value.	
Reference		[ITU-T Q.4043] clause 8.1.3	
Test procedures	Step	Type	Description
	1	Stimulus	VSIT login to the configuration interface of the virtual switch.
	2	Stimulus	Create VLAN1 on virtual switch1, add virtual port1, virtual port2 and virtual port3 in VLAN1.
	3	Stimulus	Create three virtual machines VM1, VM2 and VM3, to connect to port1, port2 and port3, respectively. Configure VM1 with IP1, VM2 with IP2 and VM3 with IP3.
	4	Stimulus	From VM1, use iperf to send packet to VM2 with rate S1. NOTE – iperf is a tool for network performance measurement and tuning that has client and server functionality, and can create data streams to measure the throughput between the two ends in one or both directions.
	5	Stimulus	From VM1, use iperf to send packet to VM3 with rate S2.
	6	Stimulus	Configure the uplink rate limitation of virtual port1 to S3(S3<S1+S2), which should produce expected result1.
	7	Stimulus	From VM2, use iperf to send packet to VM1 with rate S4.

Table 7.3-2 – Test case: Rate limitation

Rate limitation test description				
	8	Stimulus	From VM3, use iperf to send packet to VM1 with rate S5.	
	9	Stimulus	Configure the downlink rate limitation of virtual port1 to S6(S6<S4+S5), which should produce expected result2.	
Expected results	Step	Type	Description	Result
	1	Check	The error of the real time uplink rate and rate limitation configuration of virtual port1(that is, S1+S2 and S3) does not exceed 10%.	
	2	Check	The error of the real time downlink rate and rate limitation configuration of virtual port1(that is, S4+S5 and S6) does not exceed 10%.	
Notes				
Test verdict		If all checks described in the test case are successful, it is deemed successfully terminated. If at least one check is successful but at least one check is failed, the test is deemed partially passed. If no checks are successful, the test is deemed failed.		

8 Test cases for IOPT between a virtual switch and other network equipment

8.1 Interoperability test cases for testing between a virtual switch and other network equipment in the aspect of tunnelling

The verification of tunnelling includes the verification of the following abilities: tunnelling protocol, bridging tunnelling-based network and VLAN network.

8.1.1 Test case: Tunnelling protocol

Table 8.1-1 shows the test case for tunnelling protocol.

Table 8.1-1 – Test case: Tunnelling protocol

Tunnelling protocol test description			
Test purpose		To verify that the virtual switch supports a tunnel protocol in order to encapsulate frames with tunnel header and recognizes and utilizes tunnel header information for forwarding, filtering and other functions. NOTE – There are different kind of tunnel protocols, such VXLAN, GRE, STT, NVGRE and so on; this test case uses VXLAN as a reference.	
Reference		[ITU-T Q.4043] clause 8.2.1	
Test procedures	Step	Type	Description
	1	Stimulus	VSIT login to the configuration interface of the virtual switch.
	2	Stimulus	Create VXLAN1 with network identifier VNI1 on virtual switch1, add virtual port1 in VXLAN1.
	3	Stimulus	Create VM1 and connect it to virtual port1. Configure VM1 with IP1.
	4	Stimulus	Create VXLAN1 on virtual switch2 of another host, add virtual port2 in VXLAN1.
	5	Stimulus	Create VM2 and connect it to virtual port2. Configure VM2 with IP2.

Table 8.1-1 – Test case: Tunnelling protocol

Tunnelling protocol test description				
	6	Stimulus	From VM1, ping IP2, capture packet in uplink of virtual switch1, which should produce expected result1.	
Expected results	Step	Type	Description	Result
	1	Check	The packet is encapsulated with VXLAN, and the network identifier in VXLAN header is VNI1.	
Notes				
Test verdict	If all checks described in the test case are successful, it is deemed successfully terminated. If at least one check is successful but at least one check is failed, the test is deemed partially passed. If no checks are successful, the test is deemed failed.			

8.1.2 Test case: Bridging tunnelling-based network and VLAN network

Table 8.1-2 shows the test case for bridging a tunnelling-based network and a VLAN network.

Table 8.1-2 – Test case: Bridging tunnelling-based network and VLAN network

Bridging tunnelling-based network and VLAN network test description				
Test purpose	To verify that the virtual switch bridges the specified tunnelling-based network and the VLAN network by maintaining the tunnelling ID and VLAN ID mapping and frame encapsulating and forwarding.			
Reference	[ITU-T Q.4043] clause 8.2.1			
Test procedures	Step	Type	Description	
	1	Stimulus	VSIT login to the configuration interface of the virtual switch.	
	2	Stimulus	Create VXLAN1 with network identifier VNI1 on virtual switch1, add virtual port1 in VXLAN1.	
	3	Stimulus	Create virtual machine VM1 and connect it to virtual port1. Configure VM1 with IP1.	
	4	Stimulus	Create VLAN1 on virtual switch2 of another host, add virtual port2 in VLAN1. Create virtual machine VM2 and connect it to virtual port2. Configure VM2 with IP2.	
	5	Stimulus	Add mapping between VNI1 and VLAN1 in two virtual switches. From VM1 ping IP2, which should produce expected result1.	
Expected results	Step	Type	Description	Result
	1	Check	VM2 receives packet from VM1, and the packet is not encapsulated with VXLAN.	
Notes				
Test verdict	If all checks described in the test case are successful, it is deemed successfully terminated. If at least one check is successful but at least one check is failed, the test is deemed partially passed. If no checks are successful, the test is deemed failed.			

9 Test cases for IOPT between a virtual switch and a management entity

9.1 Interoperability test cases for testing between a virtual switch and a management entity in the aspect of reference points

The verification of reference points includes the verification of the following abilities: reference points for network functions, reference points for network operation, reference point format and changing configuration remotely.

9.1.1 Test case: Reference points for network functions

Table 9.1-1 shows the test case for reference points for network functions.

Table 9.1-1 – Test case: Reference points for network functions

Reference points for network functions test description				
Test purpose		To verify that the virtual switch provides reference points for network functions including VLAN, QoS, speed limit, anti MAC spoofing, MTU, port aggregation and jumbo frame.		
Reference		[ITU-T Q.4043] clause 8.3.1		
Test procedures	Step	Type	Description	
	1	Stimulus	VSIT login to the configuration interface of the virtual switch.	
	2	Stimulus	Call network functions, including VLAN, QoS, speed limit, anti MAC spoofing, MTU, port aggregation and jumbo frame through corresponding reference points, which should produce expected result1.	
	3	Stimulus	There is expected result1.	
Expected results	Step	Type	Description	Result
	1	Check	The virtual switch can provide corresponding functions.	
Notes		This test case can be considered together with VLAN, QoS, speed limit, anti MAC spoofing, MTU, port aggregation and jumbo frame test cases; see clauses 7.1.2, 7.3.1, 7.3.2, 7.2.3, 7.1.3, 7.1.4 and 7.1.5.		
Test verdict		If all checks described in the test case are successful, it is deemed successfully terminated. If at least one check is successful but at least one check is failed, the test is deemed partially passed. If no checks are successful, the test is deemed failed.		

9.1.2 Test case: Reference points for network operation

Table 9.1-2 shows the test case for reference points for network operation.

Table 9.1-2 – Test case: Reference points for network operation

Reference points for network operation test description			
Test purpose		To verify that the virtual switch provides operational reference points for network operation configuration and network operation data receiving including port traffic monitoring, port status monitoring, port mirroring, port traffic statistics, traffic alarm, fault alarm and running log.	
Reference		[ITU-T Q.4043] clause 8.3.1	
Test procedures	Step	Type	Description
	1	Stimulus	VSIT login to the configuration interface of the virtual switch.

Table 9.1-2 – Test case: Reference points for network operation

Reference points for network operation test description				
	2	Stimulus	Check network operation configuration and network operation data receiving information, including port traffic monitoring, port status monitoring, port mirroring, port traffic statistics, traffic alarm, fault alarm and running log through corresponding reference points. This should produce expected result1.	
	3	Stimulus	There is expected result1.	
Expected results	Step	Type	Description	Result
	1	Check	The virtual switch can provide corresponding information.	
Notes				
Test verdict		If all checks described in the test case are successful, it is deemed successfully terminated. If at least one check is successful but at least one check is failed, the test is deemed partially passed. If no checks are successful, the test is deemed failed.		

9.1.3 Test case: Reference point format

Table 9.1-3 shows the test case for reference point format.

Table 9.1-3 – Test case: Reference point format

Reference point format test description				
Test purpose		To verify that the virtual switch's reference points are implemented according to industry specifications. NOTE – Examples of virtual switch reference point industry specifications are OpenFlow protocol, OVSDB protocol and SNMP; this test case uses OpenFlow protocol as a reference.		
Reference		[ITU-T Q.4043] clause 8.3.1		
Test procedures	Step	Type	Description	
	1	Stimulus	VSIT login to the configuration interface of the virtual switch.	
	2	Stimulus	Use OpenFlow protocol to call the reference point of a network function such as VLAN, which should produce expected result1.	
	3	Stimulus	There is expected result1.	
Expected results	Step	Type	Description	Result
	1	Check	The virtual switch can provide corresponding functions through relevant reference points.	
Notes		This test case can be considered together with VLAN test cases; see clause 7.1.2.		
Test verdict		If all checks described in the test case are successful, it is deemed successfully terminated. If at least one check is successful but at least one check is failed, the test is deemed partially passed. If no checks are successful, the test is deemed failed.		

9.1.4 Test case: Changing configuration remotely

Table 9.1-4 shows the test case for changing the configuration remotely.

Table 9.1-4 – Test case: Changing configuration remotely

Changing configuration remotely test description				
Test purpose		To verify that the virtual switch provides the ability to change the configuration remotely and the associated authorization mechanism. NOTE – Examples of configurations which can be changed remotely are STP, jumbo frame, route configuration and so on. This test case uses STP as a reference.		
Reference		[ITU-T Q.4043] clause 8.3.1		
Test procedures	Step	Type	Description	
	1	Stimulus	VSIT login to the configuration interface of the virtual switch.	
	2	Stimulus	Change STP configuration remotely and enable STP. Check the STP function, which should produce expected result1.	
	3	Stimulus	Change STP configuration remotely again and disable STP. Check the STP function, which should produce expected result2.	
Expected results	Step	Type	Description	Result
	1	Check	The virtual switch can provide STP function.	
	2	Check	STP function is disabled.	
Notes		This test case can be considered together with STP test cases; see clause 7.1.9.		
Test verdict		If all checks described in the test case are successful, it is deemed successfully terminated. If at least one check is successful but at least one check is failed, the test is deemed partially passed. If no checks are successful, the test is deemed failed.		

10 Test cases for IOPT between a virtual switch and computing virtualization

10.1 Interoperability test cases for testing between a virtual switch and computing virtualization in the aspect of computing virtualization

The verification of computing virtualization includes the verification of the following abilities: deploy on server virtualization platform, accessing the VM's virtual port, VM status awareness and monitoring resource allocation.

10.1.1 Test case: Deploy on server virtualization platform

Table 10.1-1 shows the test case for deploy on server virtualization platform.

Table 10.1-1 – Test case: Deploy on server virtualization platform

Deploy on server virtualization platform test description			
Test purpose		To verify that the virtual switch can be deployed on the mainstream implementation of computing virtualization technology. NOTE – Examples of mainstream implementation of computing virtualization technology are Red Hat Virtualization, VMware vSphere, Hyper-V and so on. This test case uses VMware vSphere as a reference.	
Reference		[ITU-T Q.4043] clause 8.4.1	
Test procedures	Step	Type	Description
	1	Stimulus	VSIT login to the configuration interface of VMware vSphere.
	2	Stimulus	Create a VM and deploy the virtual switch in the VM, which should produce expected result1.
	3	Stimulus	There is expected result1.

Table 10.1-1 – Test case: Deploy on server virtualization platform

Deploy on server virtualization platform test description				
Expected results	Step	Type	Description	Result
	1	Check	The virtual switch is successfully deployed.	
Notes				
Test verdict	If all checks described in the test case are successful, it is deemed successfully terminated. If at least one check is successful but at least one check is failed, the test is deemed partially passed. If no checks are successful, the test is deemed failed.			

10.1.2 Test case: Accessing the VM's virtual port

Table 10.1-2 shows the test case for accessing the VM's virtual port.

Table 10.1-2 – Test case: Accessing the VM's virtual port

Accessing the VM's virtual port test description				
Test purpose	To verify that the virtual switch supports the accessing of the VM's virtual ports while maintaining the isolation of each port.			
Reference	[ITU-T Q.4043] clause 8.4.1			
Test procedures	Step	Type	Description	
	1	Stimulus	VSIT login to the configuration interface of the virtual switch.	
	2	Stimulus	Create VLAN1 on virtual switch1, add virtual port1 and virtual port2 in VLAN1.	
	3	Stimulus	Create two virtual machines, VM1 and VM2, to connect to port1 and port2, respectively. Configure VM1 with IP1, and VM2 with IP2.	
	4	Stimulus	Access virtual port1 on the virtual switch, from virtual port1 ping IP2, which should produce expected result1.	
Expected results	Step	Type	Description	Result
	1	Check	VM2 receives packet from IP1.	
Notes				
Test verdict	If all checks described in the test case are successful, it is deemed successfully terminated. If at least one check is successful but at least one check is failed, the test is deemed partially passed. If no checks are successful, the test is deemed failed.			

10.1.3 Test case: VM status awareness

Table 10.1-3 shows the test case for VM status awareness.

Table 10.1-3 – Test case: VM status awareness

VM status awareness test description			
Test purpose	To verify that the virtual switch is aware of the status (start, stop, migrated, etc.) of the VMs on the computing virtualization platform so that it can adjust the network configuration according to the VMs' status.		
Reference	[ITU-T Q.4043] clause 8.4.1		
	Step	Type	Description

Table 10.1-3 – Test case: VM status awareness

VM status awareness test description				
Test procedures	1	Stimulus	VSIT login to the configuration interface of the virtual switch.	
	2	Stimulus	Create VLAN1 on virtual switch1, add virtual port1 and virtual port2 in VLAN1. Create two virtual machines, VM1 and VM2, to connect to port1 and port2, respectively. Configure VM1 with IP1, and VM2 with IP2.	
	3	Stimulus	Turn on the power of two VMs, check the status of them through virtual switch1, which should produce is expected result1.	
	4	Stimulus	Turn off the power of VM1, check the status of VM1 through virtual switch1, which should produce expected result2.	
	5	Stimulus	Migrate VM2 to another host, check the status of VM2 through virtual switch1, which should produce expected result3.	
Expected results	Step	Type	Description	Result
	1	Check	Virtual switch1 is aware of the VMs' status, which is start for VM1 and VM2.	
	2	Check	Virtual switch1 is aware of the VMs' status, which is stop for VM1.	
	3	Check	Virtual switch1 is no longer aware of VM2's status.	
Notes				
Test verdict		If all checks described in the test case are successful, it is deemed successfully terminated. If at least one check is successful but at least one check is failed, the test is deemed partially passed. If no checks are successful, the test is deemed failed.		

10.1.4 Test case: Monitoring resource allocation

Table 10.1-4 shows the test case for monitoring resource allocation.

Table 10.1-4 – Test case: Monitoring resource allocation

Monitoring resource allocation test description			
Test purpose		To verify that the virtual switch monitors the resource allocation information of the computing virtualization platform.	
Reference		[ITU-T Q.4043] clause 8.4.1	
Test procedures	Step	Type	Description
	1	Stimulus	VSIT login to the configuration interface of the virtual switch.
	2	Stimulus	Create VLAN1 on virtual switch1, add virtual port1 in VLAN1. Create virtual machine VM1 to connect to port1.
	3	Stimulus	From virtual switch1, check the resource allocation information of VM1, which should produce expected result1.

Table 10.1-4 – Test case: Monitoring resource allocation

Monitoring resource allocation test description				
Expected results	Step	Type	Description	Result
	1	Check	Virtual switch1 is aware of the CPU and memory resource allocation information of VM1.	
Notes				
Test verdict	If all checks described in the test case are successful, it is deemed successfully terminated. If at least one check is successful but at least one check is failed, the test is deemed partially passed. If no checks are successful, the test is deemed failed.			

Appendix I

Test case template

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

Table I.1 provides a test case template to describe interoperability testing between a virtual switch and other entities. The test case template is designed with reference to relevant technical specifications. As shown in the table, an interoperability test case consists of test purpose, reference, test procedures, expected results and test verdict.

– The test purpose specifies which test case to verify.

– The reference of the test case provides a list of references to the base specification clause(s), use case(s), requirement(s), etc. They are either used in the test or define the functionality being tested.

– The test sequences provide the stimuli required to perform the test. A stimulus corresponds to an event, it triggers a specific action on the object under test. There is no need to provide a result for a stimulus step.

– Expected results consist of check steps and are used to review whether the test phenomena of the test object are as expected. A result must be provided for every check step. If the object under test behaves as described in the description of the check step, the result should be recorded as OK, otherwise the result should be recorded as failed.

– The notes column can record any special conditions that occurred during the test which should be valued before test verdict.

– For every test case, test the verdict should be provided based on the result(s) of the check step(s) to indicate whether the test is passed, failed or partly passed.

Table I.1 – Test case template

Virtual switch interoperability test description				
Test purpose		A concise summary of the test reflecting its purpose and allowing readers to easily distinguish this test from any other test in the document.		
Reference		List of references to the base specification clause(s), use case(s), requirement(s), etc. They are either used in the test or define the functionality being tested.		
Test procedures	Step	Type	Description	
	1	Stimulus	A stimulus corresponds to an event, it triggers a specific action on the object under test.	
Expected results	Step	Type	Description	Result
	1	Check	A check is used to review whether the test phenomena of the test object are as expected. A result must be provided for every check step. If the object under test behaves as described in the description of the check step, the result should be recorded as OK, otherwise the result should be recorded as failed.	A result must be provided for every check step.
Notes				
Test verdict		If all checks described in the test case are successful, it is deemed successfully terminated. If at least one check is successful but at least one check is failed, the test is deemed partially passed. If no checks are successful, the test is deemed failed.		

Appendix II

Test topology

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

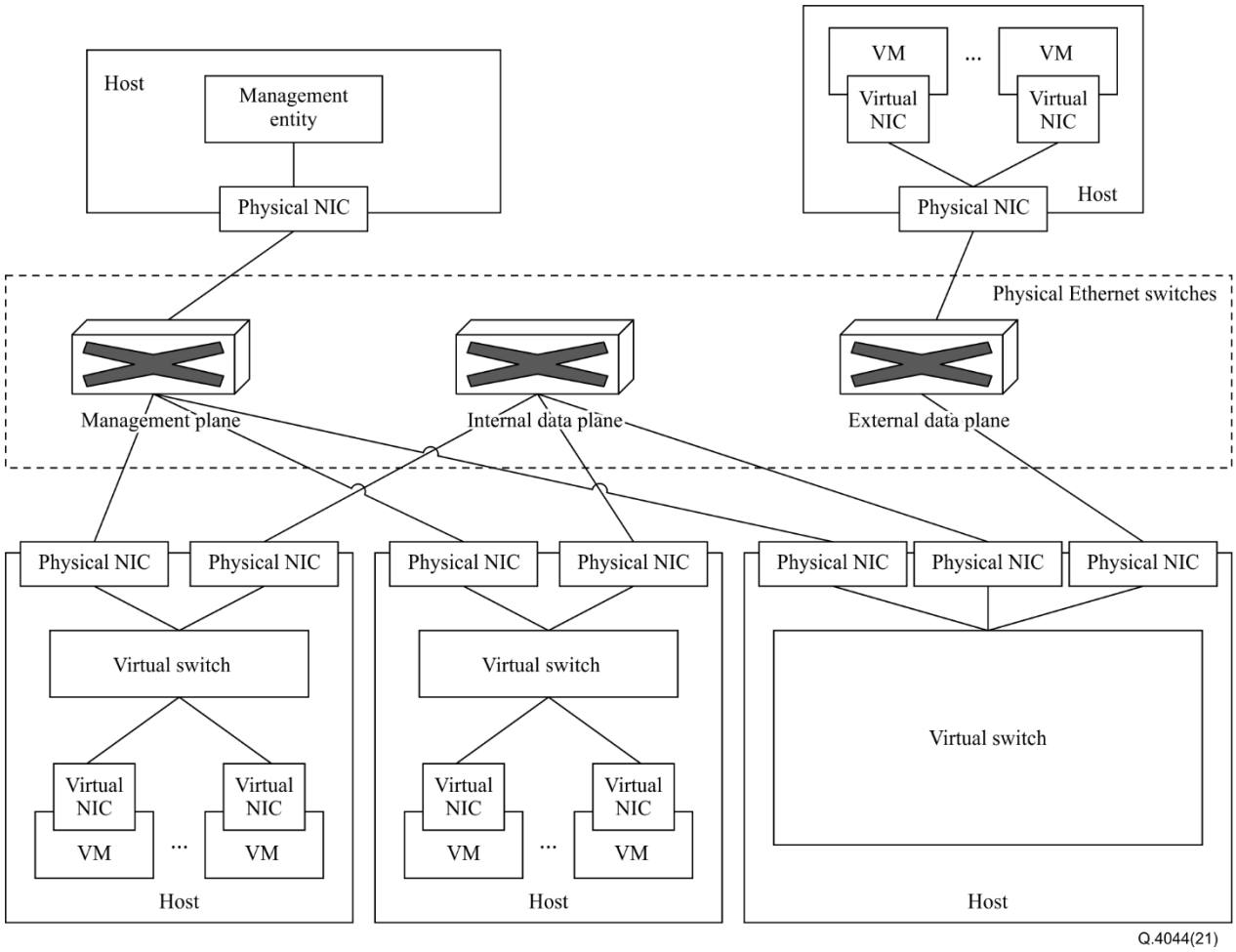

Figure II.1 – Test topology reference

Figure II.1 provides a test topology reference for interoperability testing between a virtual switch and other entities. A virtual switch can be deployed as a part of hypervisor or as a VM. This topology can be used in SDN, NFV and pure virtualization scenarios. Depending on the specific scenario, the management entity can be the SDN controller, virtualized infrastructure manager (VIM) or the virtualization management node. VMs connect to virtual switches through virtual NICs and virtual switches access the network of physical host through physic NICs. Those physical NICs are used as uplink ports of virtual switches. Physical Ethernet switches are used to provide network connection between different physical hosts. It is recommended to split the management plane, internal data plane and external data plane.

NOTE – Virtual switch refers only to those providing service for VMs in a virtualized environment. Some variant implementations of virtual switches that can be used in other technical areas, such as containers, are beyond the scope of this Recommendation.

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