

Recommendation

ITU-T Q.4070 (02/2023)

SERIES Q: Switching and signalling, and associated measurements and tests

Testing specifications – Testing specifications for IMT-2020 and IoT

Test suite for interoperability testing of virtualized broadband network gateways

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Recommendation ITU-T Q.4070

Test suite for interoperability testing of virtualized broadband network gateways

Summary

Recommendation ITU-T Q.4070 specifies the interoperability testing of virtualized broadband network gateway (vBNG), including an overview of the test suite and test cases for interoperability testing of vBNG.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T Q.4070	2023-02-13	11	11.1002/1000/15255

Keywords

Interoperability, test suite, testing, virtualized BNG.

* 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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Recommendation ITU-T Q.4070

Test suite for interoperability testing of virtualized broadband network gateways

1 Scope

This Recommendation gives:

- An overview of the test suite for interoperability testing (IOPT) of virtualized broadband network gateway (vBNG).
- Test cases for IOPT of vBNG between vBNG and customer premises equipment (CPE)/ virtual customer premises equipment (vCPE).
- Test cases for IOPT of vBNG between vBNG and BNG/vBNG/PE.
- Test cases for IOPT of vBNG between vBNG and management system.

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.3315] Recommendation ITU-T Q.3315 (2015), *Signalling requirements for flexible network service combination on broadband network gateway*.

[ITU-T Q.4064] Recommendation ITU-T Q.4064 (2020), *Interoperability testing requirements for a virtualized broadband network gateway*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 broadband network gateway (BNG) [ITU-T Q.3315]: The access point to the provider's IP network for wireline broadband services.

3.1.2 virtualized broadband network gateway (vBNG) [ITU-T Q.4064]: A virtualized solution of a broadband network gateway, attained by using virtualization technologies, which is responsible for user access and traffic forwarding to realize broadband services.

3.2 Terms defined in this Recommendation

None.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

AAA Authentication, Authorization and Accounting
ACL Access Control List

ARP	Address Resolution Protocol
BGP	Border Gateway Protocol
BGP-FS	BGP-Flow Specification
CE	Customer Edge
CHAP	Challenge Handshake Authentication Protocol
CPE	Customer Premises Equipment
CPU	Central Processing Unit
CVLAN	Customer Virtual Local Area Network
DDoS	Distributed Denial of Service
DHCP	Dynamic Host Configuration Protocol
DNS	Domain Name System
DoS	Denial of Service
EBGP	External Border Gateway Protocol
FW	Fire Wall
GRE	Generic Routing Encapsulation
HQoS	Hierarchical Quality of Service
ID	Identify
IGMP	Internet Group Management Protocol
IGP	Interior Gateway Protocol
IOPT	Interoperability Testing
IP	Internet Protocol
IPoE	IP over Ethernet
IPP	IP Precedence
IPv6	Internet Protocol version 6
IS-IS	Intermediate System-Intermediate System
L2TP	Layer 2 Tunneling Protocol
L3VPN	Layer 3 Virtual Private Network
LAC	L2TP Access Concentrator
LDP	Label Distribution Protocol
LNS	L2TP Network Server
MIB	Management Information Base
MLD	Multicast Listener Discovery
MPLS	Multi-Protocol Label Switching
MSDP	Multicast Source Discovery Protocol
MTU	Maximum Transmission Unit
NAT	Network Address Translation
OSPF	Open Shortest Path First

PAP	Password Authentication Protocol
PBR	Policy Based Routing
PC	Personal Computer
PE	Provider Edge
PIM-DM	Protocol Independent Multicast-Dense Mode
PIM-SM	Protocol Independent Multicast-Sparse Mode
PPP	Point-to-Point Protocol
PPPoE	Point-to-Point Protocol over Ethernet
QinQ	802.1Q-in-802.1Q
QoS	Quality of Service
RADIUS	Remote Authentication Dial-In User Service
RR	Round Robin
SID	Segment Identifier
SNMP	Simple Network Management Protocol
SP	Strict Priority
SR	Segment Routing
SR-TE	Segment Routing-Traffic Engineering
SRv6	IPv6-based SR
SVLAN	Service Virtual Local Area Network
SYN	Synchronous
TCP	Transmission Control Protocol
UDP	User Datagram Protocol
URPF	Unicast Reverse Path Forwarding
VAS	Value-Added Service
vBIT	vBNG Interoperability Tester
vBNG	virtualized Broadband Network Gateway
vCPE	virtual Customer Premise(s) Equipment
vFW	virtual Fire Wall
VLAN	Virtual Local Area Network
VLL	Virtual Leased Line
VM	Virtual Machine
VNF	Virtualized Network Function
VPLS	Virtual Private Local area network Service
VPN	Virtual Private Network
WRR	Weighted Round Robin

5 Conventions

In this Recommendation:

The keywords "is recommended" indicate a requirement which is recommended but which is not absolutely required. Thus this requirement need not be present to claim conformance.

6 Overview of test suite for IOPT of vBNG

As virtualized broadband network gateway (vBNG), is the access point to the provider's IP network for wireline broadband services [ITU-T Q.3315], it is the access gateway to the Internet for subscribers. Consequently, vBNG must provide both Layer 2 and Layer 3 functions.

Interoperability of vBNG is the ability to interact with other entities. vBNG interoperability testing (IOPT) is used to verify whether the interactions are as expected and as described in [ITU-T Q.4064].

As described in [ITU-T Q.4064], there are six typical use cases of vBNG: point-to-point protocol over Ethernet (PPPoE) access, IP over Ethernet (IPoE) access, virtual private network (VPN) service, multicast service, segment routing and network management. The IOPT of vBNG should cover its service and management capability based on these six typical use cases.

Test suite for vBNG IOPT is a combination of vBNG IOPT test cases. The IOPT architecture of vBNG refers to clause 7 of [ITU-T Q.4064]. It is recommended to consider the following three testing areas:

- vBNG-CPE/vCPE: This refers to the IOPT between vBNG and CPE/vCPE.
- vBNG-BNG/vBNG/PE: This refers to the IOPT between vBNG and BNG/vBNG/PE.
- vBNG-management system: This refers to the IOPT between vBNG and the management system.

Test cases that should be provided in the suite for vBNG IOPT are listed in Table 6-1.

Table 6-1 – Test cases to be provided for the IOPT of vBNG

Testing area	Specific test cases
vBNG – CPE/vCPE	Point-to-point protocol over Ethernet (PPPoE)
	IP over Ethernet (IPoE)
	Multicast group management protocol
	Network address translation (NAT)
	Quality of service (QoS)
	Virtual local area network (VLAN)
	802.1Q-in-802.1Q (QinQ)
	Value-added service (VAS)
	Access control list (ACL)
	Address resolution protocol (ARP) proxy
	Domain name system (DNS)
	Access redirection
	Maximum transmission unit (MTU)

Table 6-1 – Test cases to be provided for the IOPT of vBNG

Testing area	Specific test cases
	Port aggregation
	Jumbo frame
	Anti-DOS/ distributed denial of service (DDOS)
	Unicast reverse path forwarding (URPF)
vBNG-BNG/vBNG/PE	Interior gateway protocol (IGP) routing protocols
	Border gateway protocol (BGP) routing protocol
	Multicast routing protocols
	Static route
	Multi-protocol label switching (MPLS) protocol
	Tunnelling protocols
	Segment routing (SR) protocols
	Policy-based routing
	Maximum transmission unit (MTU)
	QoS
	Port aggregation
	Jumbo frame
	Anti-DOS/DDOS
	Unicast reverse path forwarding (URPF)
vBNG-management system	Authentication, authorization and accounting (AAA)
	Dynamic host configuration protocol (DHCP) relay
	Simple network management protocol (SNMP)
	Flow sampling
	Port mirror
	Alarm
	Telemetry
	Virtualized resource management
	Basic device configuration
	Service configuration

7 Test cases for IOPT of vBNG between vBNG and CPE/vCPE

IOPT between vBNG and CPE/vCPE evaluates the interaction for user access control, network security and network QoS functions, etc. including the following abilities: PPPoE, IPoE, multicast group management protocol, NAT, QoS, VLAN, QinQ, VAS, ACL, ARP, DNS, Access

redirection, MTU, port aggregation, jumbo frame, anti-DOS/DDOS, and URPF. For a description of related functional requirements refer to [ITU-T Q.4064].

7.1 Test case: PPPoE

Table 7-1 shows the test case for the PPPoE access function.

Table 7-1 – Test case: PPPoE

PPPoE test description				
Test purpose		To verify that vBNG provides PPPoE access function, which includes providing point-to-point protocol (PPP) connection with CPE/vCPE and allocating an IP address for user to access the Internet.		
Reference		[ITU-T Q.4064] clause 8.1		
Test procedures	step	Type	Description	
	1	Stimulus	Login to the configuration interface of vBNG.	
	2	Stimulus	Configure user access domain name "pppoe" in vBNG. Create a PPPoE user account "test1@pppoe".	
	3	Stimulus	Configure the authentication mode as local, and configure the address allocation method as local assignment.	
Expected results	step	Type	Description	Result
	1	Check	User "test1" can obtain IP address and access the Internet.	
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 Test case: IPoE

Table 7-2 shows the test case for IPoE access function.

Table 7-2 – Test case: IPoE

IPoE test description			
Test purpose		To verify that vBNG supports IPoE service, including providing related access and control functions.	
Reference		[ITU-T Q.4064] clause 8.1	
Test procedures	step	Type	Description
	1	Stimulus	Login to the configuration interface of vBNG.
	2	Stimulus	Configure user access domain name "ipoe" in vBNG. Create a IPOE user account "test2@ipoe".
	3	Stimulus	Configure the authentication mode as local, and configure the address allocation method as local assignment.
Expected results	step	Type	Description
	1	Check	vBIT simulate as IPoE user "test2" dialling in through CPE/vCPE.

Table 7-2 – Test case: IPoE

IPoE test description				
Expected results	step	Type	Description	Result
	1	Check	User "test2" can obtain IP address and access the Internet.	
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 Test case: Multicast group management protocol

Table 7-3 shows the test case for multicast group management protocol.

Table 7-3 – Test case: Multicast group management protocol

Multicast group management protocol test description				
Test purpose		To verify that vBNG supports access and control functions of multicast users based on the Internet group management protocol (IGMP) [b-IETF RFC 3376] or multicast listener discovery (MLD) protocol [b-IETF RFC 3810].		
Reference		[ITU-T Q.4064] clause 8.1		
Test procedures	step	Type	Description	
	1	Stimulus	Login to the configuration interface of vBNG.	
	2	Stimulus	Configure user access domain name "multicast" in vBNG. Create two PPPoE user accounts "test3@pppoe", "test4@pppoe", and two IPoE user accounts "test5@ipoe", "test6@ipoe".	
	3	Stimulus	Configure the authentication mode as local, and configure the address allocation method as local assignment.	
	4	Stimulus	vBIT1 simulate user "test3", "test4", "test5" and "test6" dialling in through CPE/vCPE, The expected result is 1.	
	5	Stimulus	Configure two multicast group "group1" and "group2".	
	6	Stimulus	Add user "test3" and "test5" to the multicast group "group1", add user "test4" and "test6" to the multicast group "group2".	
	7	Stimulus	vBIT2 simulate multicast source and send traffic to the two multicast group, The expected result is 2.	
Expected results	step	Type	Description	Result
	1	Check	User "test3", "test4", "test5" and "test6" access Internet successfully, and obtain IP address.	
	2	Check	User "test3" and "test5" receive multicast packets from the multicast group "group1", User "test4" and "test6" receive multicast packets from the multicast group "group2".	
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.		

7.4 Test case: NAT

Table 7-4 shows the test case for network address translation (NAT).

Table 7-4 – Test case: NAT

NAT test description				
Test purpose		To verify that vBNG supports network address translation (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.4064] clause 8.1		
Test procedures	step	Type	Description	
	1	Stimulus	Login to the configuration interface of vBNG.	
	2	Stimulus	Configure user access domain name "private" in vBNG. Create a PPPoE user account "test7@private".	
	3	Stimulus	Configure the authentication mode as local. Configure the address allocation method as local assignment, and allocate user IP address from private address pool. Configure the public address pool corresponding to user domain.	
	4	Stimulus	vBIT1 simulate PPPoE user "test7" dialling in vBNG through CPE/vCPE. The expected result is 1.	
	5	Stimulus	vBIT2 is configured with IP address "IP2", vBIT2 and vBNG learn route from each other.	
Expected results	step	Type	Description	Result
	1	Check	User "test7" obtain a private IP address, and create a NAT forwarding item in vBNG.	
	2	Check	User "test7" receives packets.	
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.		

7.5 QoS

Verification of QoS including verification of following abilities: traffic classification, bandwidth guarantee, queue scheduling, congestion control and HQoS.

7.5.1 Test case: Traffic classification

Table 7-5 shows the test case for traffic classification.

Table 7-5 – Test case: Traffic classification

Traffic classification test description				
Test purpose		To verify that vBNG supports traffic classification by different rules and remark functions.		
Reference		[ITU-T Q.4064] clause 8.1		
Test procedures	step	Type	Description	
	1	Stimulus	Login to the configuration interface of vBNG.	
	2	Stimulus	Configure six traffic classification rules: traffic classification according to access interface, source and destination IP address, TCP/UDP port ID, protocol ID, VLAN and user ID.	
	3	Stimulus	Configure vBNG by labelling the IP Precedence(IPP) of the 6 streams as 6, 5, 4, 3, 2, 1 respectively.	
	4	Stimulus	vBIT1 is configured to create test streams matching six stream classification rules.	
	5	Stimulus	vBIT1 send traffic to vBIT2.	
Expected results	step	Type	Description	Result
	1	Check	Traffic is labelled correctly.	
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.		

7.5.2 Test case: Bandwidth guarantee

Table 7-6 shows the test case for bandwidth guarantee.

Table 7-6 – Test case: Bandwidth guarantee

Bandwidth guarantee test description			
Test purpose		To verify that vBNG supports bandwidth guarantee and rate limitation functions.	
Reference		[ITU-T Q.4064] clause 8.1	
Test procedures	step	Type	Description
	1	Stimulus	Login to the configuration interface of vBNG.
	2	Stimulus	Configure two VLAN "vlan1" and "vlan2" for user access in one port.
	3	Stimulus	Configure "vlan1" maximum bandwidth as 1 Gbit/s, and "vlan2" bandwidth maximum as 500 Mbit/s in vBNG.
	4	Stimulus	vBIT1 create two streams for "vlan1" and "vlan2" respectively.
	5	Stimulus	vBIT1 send traffic to vBIT2 as 2 Gbit/s for "vlan1" and "vlan2" respectively. The expected result is 1.
	6	Stimulus	vBIT1 send traffic to vBIT2 as 1 Gbit/s for "vlan1" and "vlan2" respectively. The expected result is 2.

Table 7-6 – Test case: Bandwidth guarantee

Bandwidth guarantee test description				
Expected results	step	Type	Description	Result
	1	Check	Traffic rate received by vBIT2 is 1 Gbit/s for "vlan1" and 500 Mbit/s for "vlan2".	
	2	Check	Traffic rate received by vBIT2 is 1 Gbit/s for "vlan1" and 500 Mbit/s for "vlan2".	
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.		

7.5.3 Test case: Queue scheduling and congestion control

Table 7-7 shows the test case for queue scheduling and congestion control.

Table 7-7 – Test case: Queue scheduling and congestion control

Queue scheduling and congestion control test description				
Test purpose		To verify that vBNG supports queue scheduling and congestion control functions.		
Reference		[ITU-T Q.4064] clause 8.1		
Test procedures	step	Type	Description	
	1	Stimulus	Login to the configuration interface of vBNG.	
	2	Stimulus	Configure stream classification rule on vBNG: create seven priority data streams, and the IP precedence was set as 7/6/5/4/3/2/1 respectively. The queue 7 is configured with bandwidth limitation of 1 Gbit/s. Queue 6/5/4 are configured with bandwidth insurance of 2 Gbit/s respectively. Queue 3/2/1 are configured as normal level. NOTE – In the case of congestion, the bandwidth exceeding the queue level will be discarded, and the low level will be discarded first. The bandwidth of the level 7 can guarantee priority forwarding in the case of congestion.	
	3	Stimulus	vBNG applies the rules in output interface. The interface bandwidth is 10 Gbit/s.	
	4	Stimulus	vBIT1 simulate seven streams corresponding to the seven queues, and send traffic to vBIT2. In the case of no congestion, the traffic rates are 1.1/2.1/2.1/2.1/0.8/0.8/0.8 Gbit/s. The expected result is 1.	
	5	Stimulus	vBIT1 simulate seven streams corresponding to the seven queues, and sends the traffic to vBIT2. in case of congestion, the traffic rates are 1/2.2/2.2/2.2/1/1/1 Gbit/s. The expected result is 2.	
Expected results	step	Type	Description	Result
	1	Check	Traffic of queue 7 have packet loss, others are received correctly.	
	2	Check	Traffic of queue 3/2/1 have packet loss, others are received correctly.	