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

Signalling requirements and protocols for SDN – Resource
control protocols

**Procedures for a programming protocol
independent packet processor switch-based
virtual border network gateway**

Recommendation ITU-T Q.3721

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Recommendation ITU-T Q.3721

Procedures for a programming protocol independent packet processor switch-based virtual border network gateway

Summary

Recommendation ITU-T Q.3721 specifies the architecture, interfaces and procedures for a programming protocol independent packet processor switch-based virtual border network gateway.

History

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The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

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In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

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Recommendation ITU-T Q.3721

Procedures for a programming protocol independent packet processor switch-based virtual border network gateway

1 Scope

This Recommendation specifies the architecture, interfaces and procedures for a programming protocol independent packet processor (P4) switch-based virtual border network gateway (vBNG).

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.3719] Recommendation ITU-T Q.3719 (2019), *Signalling requirements for the separation of control plane and user plane in a virtualized broadband network gateway (vBNG)*.
- [IETF RFC 6241] IETF RFC 6241 (2011), *Network configuration protocol (NETCONF)*.
- [IETF RFC 7348] IETF RFC 7348 (2014), *Virtual extensible local area network (VXLAN): A framework for overlaying virtualized layer 2 networks over layer 3 networks*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

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

3.1.2 virtual BNG [b-ITU-T Q.3715]: The virtual BNG is the broadband network gateway of which all features or some features are directly implemented as virtual network function(s) (VNF(s)) running on the network function virtualization infrastructure (NFVI). It is used to either augment or replace the existing traditional BNG.

3.2 Terms defined in this Recommendation

None.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

AAA	Authentication Authorization Accounting
ACL	Access Control List
AN	Access Node
ASIC	Application Specific Integrated Circuit

BNG	Broadband Network Gateway
CFI	Control Forwarding Interface
CGN	Carrier-Grade Network address translation
CHAP	Challenge Handshake Authentication Protocol
D	Dropped
DHCP	Dynamic Host Configuration Protocol
DPDK	Data Plane Development Kit
DS	Domain Specific
F	Flow
FPGA	Field Programmable Gate Array
gMNI	gRPC Network Management Interface
gRPC	Google Remote Procedure Call
I	Intermediate
ID	Identifier
IDL	Interface Define Language
INT	In-band Network Telemetry
INT-MD	In-band Network Telemetry – embed Data
INT-MX	In-band Network Telemetry – embed instructions
INT-XD	In-band Network Telemetry – export Data
IOAM	<i>In-situ</i> Operations, Administration, and Maintenance
IP	Internet Protocol
LCP	Link Control Protocol
MD	Metadata
NFVI	Network Function Virtualization Infrastructure
P4	Programming Protocol independent Packet Processor
PADI	PPPoE Active Discovery Initiation
PADO	PPPoE Active Discovery Offer
PADR	PPPoE Active Discovery Request
PADT	PPPoE Active Discovery Termination
PPP	Point-to-Point Protocol
PPPoE	Point-to-Point Protocol over Ethernet
Q	Queue
QoS	Quality of Service
Rsvd	Reserved
RG	Residential Gateway
SR-IOV	Single Root Input/Output Virtualization
TLV	Type Length Value

vBNG	virtual Border Network Gateway
vBNG-CP	Virtual Border Network Gateway-Control Plane
vBNG-UP	Virtual Border Network Gateway-User Plane
VNF	Virtual Network Function
VNFM	Virtual Network Function Management
VxLAN-GPE	Virtual Extensible Local Area Network-Generic Protocol Extension
YANG	Yet Another Next Generation

5 Conventions

In this Recommendation:

The phrase "is required" indicates a requirement that must be strictly followed and from which no deviation is permitted, if conformity to this Recommendation is to be claimed.

The phrase "is recommended" indicates a requirement that is recommended but which is not absolutely required. Thus, this requirement need not be present to claim conformity.

The phrase "can optionally" indicates an optional requirement that is permissible, without implying any sense of being recommended. This term is not intended to imply that the vendor's implementation must provide the option, and the feature can be optionally enabled by the network operator or service provider. Rather, it means the vendor may optionally provide the feature and still claim conformity with this Recommendation.

6 Overview

Network function virtualization has emerged as the leading transformative technology that will allow service providers to move to a truly virtualized infrastructure. A broadband network gateway (BNG) is deployed at the edge of the metro area network of an operator and aggregates user sessions from the access network, providing access control by interworking with an authentication authorization accounting (AAA) server. BNG is also evolving into vBNG, which can be implemented in different types of hardware including dedicated equipment based on a network processor, application specific integrated circuit (ASIC) or [b-ITU-T X.86]. In order to improve forwarding efficiency and maintain flexibility, acceleration technologies can be used, e.g., data plane development kit (DPDK), single root input/output virtualization (SR-IOV) and ASIC, field programmable gate array (FPGA) acceleration card or P4 switch.

P4 is a high-level language for data-forwarding programming, whose design is based on protocol independence, object independence and re-configurability. P4 is a southbound protocol, although its scope is large. It can not only guide the data stream to be forwarded, but also program the data processing flow of the forwarding device such as switch through software programming to guide how to process packets.

Traditional vBNG is suitable for low-traffic scenarios. Although it can decouple software and hardware, it enhances development flexibility greatly and achieves the desired performance with the support of acceleration technologies, e.g., DPDK, SR-IOV. However, in the scenario of high-throughput complex service, vBNG faces many challenges. It requires more hardware investment, but the performance does not increase linearly with the rise in hardware costs.

In order to solve these problems, P4 switch-based vBNG is proposed. Through P4 programming, iterative development can be completed in a short time, and device independence can be realized, which avoids the long period of development and commissioning to physical hardware necessary in the traditional vBNG forwarding plane.