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M. Wang, Ed.  
J. Chen  
Huawei  
R. Gu  
China Mobile  
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Information Model of Control-Plane and User-Plane separation BNG  
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Abstract

To improve network resource utilization and reduce the operation expense, the Control-Plane and User-Plane separation conception is raised [draft-gu-nfvrg-cloud-bng-architecture-01]. This document describes the information model for the interface between Control-Plane and User-Plane separation BNG. This information model may involve both control channel interface and configuration channel interface. The interface for control channel allows the Control-Plane to send the user's information table to the User-Plane, and the User-Plane to report the statistics information to the Control-Plane, etc. The interface for configuration channel is in charge of the version negotiation between the CP and UP, the configuration for the devices of CP and UP, and the report of UP's capabilities, etc. The information model defined in this document enable defining a standardized data model. Such a data model can be used to define an interface to the CU separation BNG.

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## 1. Introduction

The rapid development of new services, such as 4K, IoT, etc, and increasing number of home broadband service users present some new challenges for BNGs such as:

Low resource utilization: The traditional BNG acts as both a gateway for user access authentication and accounting and an IP network's Layer 3 edge. The mutually affecting nature of the tightly coupled control and forwarding planes makes it difficult to achieve the maximum performance of either plane.

Complex management and maintenance: Due to the large number of traditional BNGs, a network must have each device configured one at a time when deploying global service policies. As the network expands and new services are introduced, this deployment mode will cease to be feasible as it is unable to manage services effectively and rectify faults rapidly.

Slow service provisioning: The coupling of control planes and data planes, in addition to a distributed network control mechanism, means that any new technology has to rely heavily on the existing network devices.

To address these challenges, cloud-based BNG with C/U separated conception is raised [draft-gu-nfvrg-cloud-bng-architecture-01]. The main idea of Control-Plane and User-Plane separation method is to extract and centralize the user management functions of multiple BNG devices, forming an unified and centralized control plane (CP). And the traditional router's Control Plane and forwarding plane are both preserved on BNG devices in the form of a user plane (UP).

This document describes the information model for the interface between Control-Plane and User-Plane separation BNG. This information model may involve both control channel interface and configuration channel interface. The interface for control channel allows the Control-Plane to send the user's information table to the User-Plane, and the User-Plane to report the statistics information to the Control-Plane, etc. The interface for configuration channel is in charge of the version negotiation between the CP and UP, the configuration for the devices of CP and UP, and the report of UP's capabilities, etc. The information model defined in this document enable defining a standardized data model. Such a data model can be used to define an interface to the CU separation BNG.

## 2. Concept and Terminology

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in [RFC2119].

### 2.1. Terminology

BNG: Broadband Network Gateway. A broadband remote access server (BRAS, B-RAS or BBRAS) routes traffic to and from broadband remote access devices such as digital subscriber line access multiplexers (DSLAM) on an Internet service provider's (ISP) network. BRAS can also be referred to as a Broadband Network Gateway (BNG).

CP: Control Plane. The CP is a user control management component which support to manage UP's resources such as the user entry and forwarding policy

UP: User Plane. UP is a network edge and user policy implementation component.

## 3. Generic Control Plane and User Plane separation BNG Overview

Briefly, a C/U separated BNG is made up of a CP and a UP. The CP is a user control management component which support to manage UP's resources such as the user entry and forwarding policy, for example, the access bandwidth and priority management. And the UP is a network edge and user policy implementation component. It can support the forwarding plane functions on traditional BNG devices, such as traffic forwarding, QoS, and traffic statistics collection, and it can also support the control plane functions on traditional BNG devices, such as routing, multicast, etc.

In CP's view, the UP provides the control management network resources such as user's formation, access bandwidth, etc. The CP manages these resources and according to specific service's requirements to generate several tables which contains a set of rules. And then CP sends these tables to UP.

In UP's view, the CP generates tables and provides the rules. The UP receives these tables, parses it, matches these rules, and then performs corresponding actions.

## 4. Information Model

This section describes information model that represents the concept of the interface of CU separation BNG which is language and protocol neutral.

The following figure describes the Overview of Information Model for CU separation BNG.

```

+---CP: (generate Tables, which including several rules)
|
|   +---PORT information: rule 1, 2, 3 ...
|   |
|   +---User Infor: rule 1, 2, 3 ...
|   |
|   +---IPv4 Infor: rule 1, 2, 3 ...
|   |
|   +---IPv6 Infor: rule 1, 2, 3 ...
|   |
|   +---QoS: rule 1, 2, 3 ...
|   |
|   +---Address field distribute: rule 1, 2, 3 ...
|
+---UP
|
|   +---Case 1:(report resources and statistical information)
|   |
|   |   +---PORT RESOURCES of UP
|   |   |
|   |   +---Traffic statistics
|   |
|   +---Case 2:(match rules then perform corresponding actions)
|   |
|   |   +---PORT information: match rules then action
|   |   |
|   |   +---User Infor: match rules then action
|   |   |
|   |   +---IPv4 Infor: match rules then action
|   |   |
|   |   +---IPv6 Infor: match rules then action
|   |   |
|   |   +---QoS: match rules then action
|   |   |
|   |   +---Address field distribute: match rules then action

```

#### 4.1. Information Model for Control-Plane

This section describes information model for the interface of Control-Plane (CP). As mentioned in section 3, the CP is a user control management component which support to manage UP's resources and forwarding policy, and base on these resources and specific requirements of user's service, generate several tables which contains a set of matching rules.

#### 4.1.1. User-Related Information

##### 4.1.1.1. User Information Model

The User Information Table contains a set of User's information. Base on above information CP generates corresponding table and matching rules. And then sends it to UP.

The Figure below illustrates the User Information Table of Control-Plane:

```
+---CP: (generate Tables, which contains several rules)
|
+---User-Infor
|
+---SubId
|
+---SubMac
|
+---AccessType
|
+---SessionID
|
+---InnerVlanId
|
+---OuterVlanId
|
+---SubIf
```

User Information may include:

SubID: Identifier of user.

SubMac: MAC address of user.

AccessType: Indicate the access type, for example PPPoE, IPoE, etc.

SessionID: The Session Identifier, for example PPPoE session ID.

InnerVlanID: Identifier of inner VLAN.

OuterVlanID: Identifier of outer VLAN.

SubIF: Index of user's interface.

#### 4.1.1.2. IPv4 Information Model

The User-IPv4 Information Table contains a set of User's information and corresponding IPv4 address information. Base on above information CP generates corresponding table and matching rules. And then sends it to UP.

The Figure below illustrates the IPv4 Information Table of Control-Plane:

```
+---CP: (generate Tables, which contains several rules)
|
+---IPv4-Infor
|
+---UserID
|
+---SubIPv4
|
+---MaskLen
|
+---GateWay
|
+---VRF
```

IPv4-Infor includes:

UserID: Identifier of User.

SubIPv4: IPv4 address of user.

MaskLen: Mask Length.

GateWay: Gate Way information of user.

VRF: Identifier of VRF.

#### 4.1.1.3. IPv6 Information Model

The User-IPv6 Information Table contains a set of User's information and corresponding IPv6 address information. Base on above information CP generates corresponding table and matching rules. And then sends it to UP.

The Figure below illustrates the IPv6 Information Table of Control-Plane:

```
+---CP: (generate Tables, which contains several rules)
|
+---IPv6-Infor
|
+---UserID
|
+---SubIPv6
|
+---IPv6MaskLen
|
+---PAddr
|
+---PDMasklen
|
+---Vrf
```

IPv6 Infor includes:

UserID: Identifier of User.

SubIPv6: IPv6 address of user.

IPv6MaskLen: Mask Length.

PAddr: PD address.

PDMaskLen: PD Mask Length.

VRF: Identifier of VRF.

#### 4.1.1.4. QoS Information Model

In CU separation BNG information model, the Control-Plane (CP) generates the QoS Table base on managed UP's bandwidth resources and specific QoS requirements of user's services. This table may contains a set of QoS matching rules. The CP sends this table to UP, UP receives and parses this table, matches these QoS rules, and then performs corresponding actions.

The Figure below illustrates the QoS Table of Control-Plane:



```
+---CP: (generate Tables, which including several rules)
|
+---PORT-infor
|
+--- UserId
|
+--- QosSubCarCir
|
+--- QosSubCarPir
|
+--- QosSubCarCbs
|
+--- QosSubCarPbs
```

UserId: Identifier of user.

QosSubCarCir: Committed Information Rate.

QosSubCarPir: Peak information rate.

QosSubCarCbs:Committed Burst Size.

QosSubCarPbs:Peak Burst Size.

#### 4.1.2. Port Related Information

##### 4.1.2.1. Port Information Model

The Port is a logical construct that identifies a specific process or a type of network service. In CU separation BNG information model, the Control-Plane (CP) generate the Port-Infor table base on the port-resources, which are received from the User-Plane (UP), and the specific requirements of user's services. This table contains a set of Port's matching rules. And then the CP sends this Port-Infor to UP

The Figure below illustrates the Port Information Table of Control-Plane:

```

+---CP: (generate tables, which contains several rules)
|
+---PORT-infor
|
+---IfIndex
|
+---BasEn

```

IfIndex: Index for interface.

BasEn: Enable the Bas Port.

#### 4.1.3. Device Related Information

##### 4.1.3.1. Address field distribute Table

In CU separation BNG information model, the Control-Plane (CP) generates and sends this Address field distribute Information table to UP. The UP receives and parses this table, matches corresponding rules presented in Address-field-distribute, and then performs actions

The Figure below illustrates the Address field distribute Table of Control-Plane:

```

+---CP:(generate Tables, which including several rules)
|
+---PORT-infor
|
+---AddressSegment
|
+---AddressSegmentMask
|
+---AddressSegmentVrf
|
+---NextHop
|
+---IfIndex
|
+---MaskLen

```

AddressSegment: The address segment information.

AddressSegmentMask: The address segment mask information.

AddressSegmentVrf: The address segment VRF.

NextHop: The next hop.

IfIndex: The index of the outing interface.

MaskLen: The Mask length.

#### 4.2. Information Model for User Plane

This section describes information model for the interface of User-Plane (UP). As mentioned in section 3, the CP is a network edge and user policy implementation component. It supports: Forwarding plane functions on traditional BNG devices, including traffic forwarding, QoS, and traffic statistics collection Control plane functions on traditional BNG devices, including routing, multicast, and MPLS.

In CU separation BNG information model, the CP generates tables and provides the rules. The UP plays two roles:

1. It receives these tables, parses it, and matches these rules, then performs corresponding actions.
2. It reports the resources and statistical information to CP.

##### 4.2.1. User Related Information

###### 4.2.1.1. User Information Model

The User Information Table contains a set of User's information. In CU separation BNG information model, the CP generates and sends this Information table to UP. The UP parses this table, matches corresponding rules, and then performs next step of actions.

The Figure below illustrates the User Information Table of User-Plane:

```

+---CP: (generate Tables, which contains several rules)
|
+---User-Infor Table
|   .....
|   Sends it to UP
V
+---UP: (Match Rules, then perform corresponding actions)
|
+---User-Infor (Match Rules)
|
+---SubId (Match Rule 1)
|
+---SubMac (Match Rule 2)
|
+---AccessType (Match Rule 3)
|
+---SessionID (Match Rule 4)
|
+---InnerVlanId (Match Rule 5)
|
+---OuterVlanId (Match Rule 6)
|
+---SubIf (Match Rule 7)

```

The user information models are presented in section 4.1.1.1.

#### 4.2.1.2. IPv4 Information Model

The IPv4 Information Table contains a set of User's information and corresponding IPv4 address information. In CU separation BNG information model, the CP generates and sends this Information table to UP. The UP parses this table, matches corresponding rules, and then performs next step of actions.

The Figure below illustrates the IPv4 Information Table of User-Plane:

```

+---CP: (generate Tables, which contains several rules)
|
+---IPv4-Infor Table
|   .....
|   Sends it to UP
V
+---UP: (Match Rules, then perform corresponding actions)
|
+---IPv4-Infor (Match Rules)
|
+---UserID (Match Rule 1)
|
+---SubIPv4 (Match Rule 2)
|
+---MaskLen (Match Rule 3)
|
+---GateWay (Match Rule 4)
|
+---VRF (Match Rule 5)

```

The IPv4 Information Models are presented in section 4.1.1.2.

#### 4.2.1.3. IPv6 Information Model

The IPv6 Information Table contains a set of User's information and corresponding IPv6 address information. In CU separation BNG information model, the CP generates and sends this Information table to UP. The UP parses this table, matches corresponding rules, and then performs next step of actions.

The Figure below illustrates the IPv6 Information Table of User-Plane:

```

+---CP: (generate Tables, which contains several rules)
|
+---IPv6-Infor Table
|
| .....
| Sends it to UP
V
+---UP: (Match Rules, then perform corresponding actions)
|
+---IPv6-Infor (Match Rules)
|
+---UserID (Match Rules)
|
+---SubIPv6 (Match Rules)
|
+---IPv6MaskLen (Match Rules)
|
+---PDAAddr (Match Rules)
|
+---PDMasklen (Match Rules)
|
+---Vrf (Match Rules)

```

The IPv6 Information Models are presented in section 4.1.1.3.

#### 4.2.1.4. QoS Information Model

In CU separation BNG information model, the Control-Plane (CP) generates the QoS Table base on managed UP's bandwidth resources and specific QoS requirements of user's services. This table contains a set of QoS matching rules. The CP sends this table to UP, UP receives and parses this table, matches corresponding QoS rules presented in the table, and then performs corresponding actions.

The Figure below illustrates the QoS Table of User-Plane:

```

+---CP: (generate Tables, which including several rules)
|
+---QoS-infor Table
|   .....
|   Sends it to UP
V
+---UP: (Match Rules, then perform corresponding actions)
|
+---QoS-infor (Match Rules)
|
+---  UserId (Match Rules)
|
+---  QosSubCarCir (Match Rules)
|
+---  QosSubCarPir (Match Rules)
|
+---  QosSubCarCbs (Match Rules)
|
+---  QosSubCarPbs (Match Rules)

```

The QoS Information Tables are presented in section 4.1.1.4.

#### 4.2.1.5. Traffic Statistics Infor

Another role of User-Plane is to report the available network resources and statistical information. This section describes the information model of UP's traffic statistics report. The User-Plane captures run time traffic statistics, generates the traffic-statistics infor table, and then reports it to Control-Plane.

The Figure below illustrates the Traffic Statistics Infor Table of User-Plane:

```

+---UP:(report Traffic statistics)
|
+---UP-Traffic statistics
|
+--- UserID
|
+--- StatisticsType
|
+--- IngressStatisticsPackets
|
+--- IngressStatisticsBytes
|
+--- EgressStatisticsPackets
|
+--- EgressStatisticsBytes

```

UserID: The Identifier of User.

StatisticsType: Traffic types such as IPv4, IPv6.

IngressStatisticsPackets: Ingress Statistics Packets

IngressStatisticsBytes: Ingress Statistics Bytes.

EgressStatisticsPackets: Egress Statistics Packets

EgressStatisticsBytes: Egress Statistics Bytes.

#### 4.2.2. Port Related Information

##### 4.2.2.1. Port Information Model

The Port is a logical construct that identifies a specific process or a type of network service. In CU separation BNG information model, the Control-Plane (CP) generate the Port-Infor table base on the port-resources, which are received from the User-Plane (UP), and the specific requirements of user's services. This table contains a set of Port's matching rules. And then the CP sends this Port-Infor to UP

The Figure below illustrates the Port Information Table of User-Plane:



```

+---CP: (generate tables, which contains several rules)
|
+---PORT-infor
|
+---IfIndex
|
+---BasEn

```

IfIndex: Index for interface.

BasEn: Enable the Bas Port.

#### 4.2.2.2. Port Resources of UP

Another role of User-Plane is to report the available network resources and statistical information. This section describes the information model of UP's port resources report. The User-Plane looks up the available ports, reports them to the Control-Plane. The Control-Plane can generate Port-Infor table base on these information and specific requirements of user's services.

The Figure below illustrates the Port Resources Information Table of User-Plane:

```

+---UP: (report network resources)
|
+---UP-PORT-RESOURCES
|
+---IfIndex
|
+---IfName
|
+---IfType
|
+---LinkType
|
+---MacAddr
|
+---IfPhyState
|
+---MTU

```

IfIndex: The Index of interface.

IfName: The name of interface.

IfType: The interface type.

LinkType: The link type.

MacAddr: The Mac address.

IfPhyState: The physical state of the interface.

MTU: Maximum Transmission Unit.

#### 4.2.3. Device Related Information

##### 4.2.3.1. Address field distribute Table

In CU separation BNG information model, the Control-Plane (CP) generates and sends this Address field distribute Information table to UP. The UP receives and parses this table, matches corresponding rules presented in Address-field-distribute, and then performs actions

The Figure below illustrates the Address field distribute Table of User-Plane:

```
+---UP:(match rules then perform corresponding actions)
|
+---PORT-infor
|
+---AddressSegment
|
+---AddressSegmentMask
|
+---AddressSegmentVrf
|
+---NextHop
|
+---IfIndex
|
+---MaskLen
```

AddressSegment: The address segment information.

AddressSegmentMask: The address segment mask information.

AddressSegmentVrf: The address segment VRF.

NextHop: The next hop.

IfIndex: The index of the outing interface.

MaskLen: The Mask length.

## 5. Security Considerations

None.

## 6. IANA Considerations

None.

## 7. Normative References

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, DOI 10.17487/RFC2119, March 1997, <<http://www.rfc-editor.org/info/rfc2119>>.

## Appendix A. Appendix: Yang Data Model for the configuration channel of CU separated BNG.

As mentioned in section 1, this information model may involve both control channel interface and configuration channel interface. The following appendix presents the yang data model for the configuration channel.

This yang data model extended the LNE model by adding some attributes which describe the information of QoS, ACL, Vlan, etc. And there are some mature models to describe the QoS, ACL and Vlan, etc. Therefore the schema-mount mechanism is used to extend the LNE model:

```
module exmaple-vbras{
  namespace "http://example.com/yang:ietf-vbras";
  prefix "vbras";

  import ietf-network-instance{
    prefix ni;
  }

  identity vbras-instance {
    base network-instance-type;
    description
      "Identity for vbras";
  }
}
```

As an example, consider the case where an LNE with a 'name' of "vbras-one" is defined on a network device. In this case the following structure might be made available:

```

.....
                                (network-device state)

+--rw yanglib:modules-state      [RFC7895]
+--rw lne:logical-network-elements [I-D. draft-ietf-rtgwg-lne-model]
  +--rw logical-network-element* [name]
    +--rw name="vbras-one"        string
    +--rw manged=true             boolean
    +--rw root                    yang-schema-mount
    |
    .....
                                (exposed LNE state if managed=true)
    +--rw yanglib:modules-state  [RFC7895]
    +--rw if:intefaces           [RFC7223]
    +--rw if-l3-vlan: ietf-if-l3-vlan [I-D. ietf-netmod-sub-intf-vlan-mo
del]
    +--rw policy: ietf-qos-policy [I-D. draft-asechoud-rtgwg-qos-model]
    +--rw acl: ietf-access-control-list [I-D. ietf-netmod-acl-model]
    +--rw vbras: example-vbras

```

#### Authors' Addresses

Michael Wang (editor)  
 Huawei  
 101 Software Avenue, Yuhua District  
 Nanjing, Jiangsu 210012  
 China

Email: wangzitao@huawei.com

Jie Chen  
 Huawei  
 101 Software Avenue, Yuhua District  
 Nanjing, Jiangsu 210012  
 China

Email: chenjie@huawei.com

Rong Gu  
China Mobile  
32 Xuanwumen West Ave, Xicheng District  
Beijing, Beijing 100053  
China

Email: gurong\_cmcc@outlook.com