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Architecture for Control Plane and User Plane Separated BNG  
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## Abstract

This document defines an architecture for Broadband Network Gateway (BNG) devices with control plane (CP) and user plane (UP) separation. A BNG-CP is a user control management component while a BNG-UP takes responsibility as the network edge and user policy implementation component. Both BNG-CP and BNG-UP are core components for fixed broadband services and are deployed separately at different network layers.

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Table of Contents

<a href="#">1.</a>	<a href="#">Introduction.....</a>	<a href="#">3</a>
<a href="#">1.1</a>	<a href="#">Motivation.....</a>	<a href="#">3</a>
<a href="#">2.</a>	<a href="#">Terminology.....</a>	<a href="#">4</a>
<a href="#">3.</a>	<a href="#">CU Separated BNG Architecture.....</a>	<a href="#">5</a>
<a href="#">3.1</a>	<a href="#">Internal Interfaces Between the CP and UP.....</a>	<a href="#">7</a>
<a href="#">4.</a>	<a href="#">Usage of the CU Separation BNG.....</a>	<a href="#">8</a>
<a href="#">5.</a>	<a href="#">Security Considerations.....</a>	<a href="#">10</a>
<a href="#">6.</a>	<a href="#">IANA Considerations.....</a>	<a href="#">10</a>
	<a href="#">Normative References.....</a>	<a href="#">11</a>
	<a href="#">Informative References.....</a>	<a href="#">11</a>
	<a href="#">Authors' Addresses.....</a>	<a href="#">12</a>

## 1. Introduction

A Broadband Network Gateway (BNG) device is defined as an Ethernet-centric IP edge router, and the aggregation point for user traffic. It performs Ethernet aggregation and packet forwarding via IP/MPLS, and supports user management, access protocols termination, QoS, policy management, etc.

This document describes an architecture for BNG devices with control plane (CP) and user plane (UP) separation. A BNG-CP is a user control management component while a BNG-UP takes responsibility as the network edge and user policy implementation components. Both BNG-CP and BNG-UP are core components for fixed broadband services and are deployed separately at different network layers in the network.

### 1.1 Motivation

The rapid development of new services, such as 4K TV, IoT, etc., and increasing numbers 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 plane and forwarding plane makes it difficult to achieve the maximum performance of either plane.

**Complex management and maintenance:** Due to the large numbers of traditional BNGs, configuring each device in a network is very

tedious 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 plane and forwarding plane, 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 for fixed networks, the framework for a cloud-based BNG with CU separation conception is defined in [\[TR-384\]](#). The main idea of Control-Plane and User-Plane separation is to extract and centralize the user management functions of multiple BNG devices, forming a 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). Note that the CU separation concept has also been introduced in the 3GPP 5G architecture [\[3GPP.23.501\]](#).

## [2](#). Terminology

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "NOT RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in [BCP 14](#) [\[RFC2119\]](#) [\[RFC8174\]](#) when, and only when, they appear in all capitals, as shown here.

The following acronyms are used as specified below:

AAA: Authentication Authorization Accounting.

BNG: Broadband Network Gateway. A broadband remote access server (BRAS (Broadband Access Server), B-RAS or BBRAS) that 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 manages the UP's resources such as the user entry and user's QoS policy

DHCP: Dynamic Host Configuration Protocol.

EMS: Element Management System.

IPoE: IP over Ethernet.

MANO: Management and Orchestration.

NFV: Network Function Virtualization.

NFVI: NFV Infrastructure.

PPPoE: Point-to-Point Protocol over Ethernet.

UP: User Plane. UP is a network edge and user policy implementation component. The traditional router's Control Plane and forwarding plane are both preserved on BNG devices in the form of a user plane.

### [3.](#) CU Separated BNG Architecture

The functions in a traditional BNG can be divided into two parts: one is the user access management function, the other is the router function. In a cloud-based BNG, we find that tearing these two functions apart can make a difference. The user management function can be centralized and deployed as a concentrated module or device, called the BNG-CP (Control Plane). The other functions, such as the router function and forwarding engine, can be deployed in the form of the BNG User Plane. Thus, the Cloud-based BNG architecture is made up of control plane and user plane.

The following figure describes the architecture of CU separated BNG:

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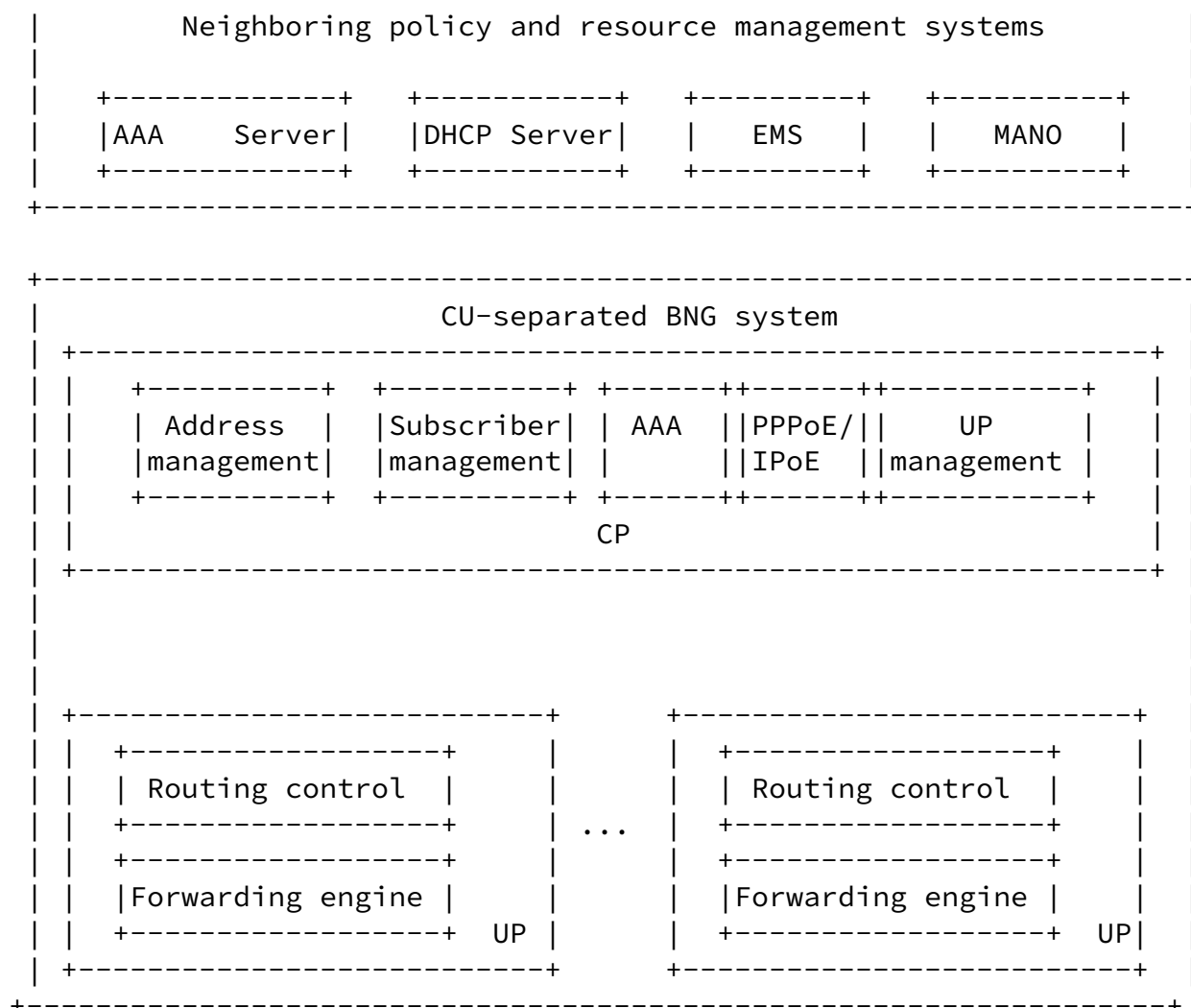


Figure 1. Architecture of CU Separated BNG

As in Figure 1, the BNG Control Plane could be virtualized and centralized, which provides significant benefits such as centralized session management, flexible address allocation, high scalability for subscriber management capacity, and cost-efficient redundancy, etc.

The functional components inside the BNG Service Control Plane can be implemented as Virtual Network Functions (VNFs) and hosted in a Network Function Virtualization Infrastructure (NFVI).

The User Plane Management module in the BNG control plane centrally manages the distributed BNG User Planes (e.g. load balancing), as well as the setup, deletion, and maintenance of channels between

Control Planes and User Planes. Other modules in the BNG control plane, such as address management, AAA, etc., are responsible for the connection with outside subsystems in order to fulfill those services. Note that the User Plane SHOULD support both physical and virtual network functions. For example, BNG user plane L3 forwarding related network functions can be disaggregated and distributed across the physical infrastructure. And the other control plane and management plane functions in the CU Separation BNG can be moved into the NFVI for virtualization [[TR-384](#)].

The details of CU separated BNG's function components are as following:

The Control Plane should support:

- (1) Address management: unified address pool management.
- (2) AAA: This component performs Authentication, Authorization and Accounting, together with RADIUS/DIAMETER. The BNG communicates with the AAA server to check whether the subscriber who sent an Access-Request has network access authority. Once the subscriber goes online, this component together with the Service Control component implement accounting, data capacity limitation, and QoS enforcement policies.
- (3) Subscriber management: user entry management and forwarding policy management.
- (4) PPPoE/IPoE: process user dialup packets via PPPoE/IPoE.
- (5) UP management: management of UP interface status, and the setup, deletion, and maintenance of channels between CP and UP.

The User Plane should support:

- (1) Control plane functions including routing, multicast, and MPLS.
- (2) Forwarding plane functions including traffic forwarding, QoS and traffic statistics collection.

### 3.1 Internal Interfaces Between the CP and UP

To support the communication between the Control Plane and User Plane, several interfaces are involved. Figure 2 illustrates the internal interfaces of CU Separated BNG.

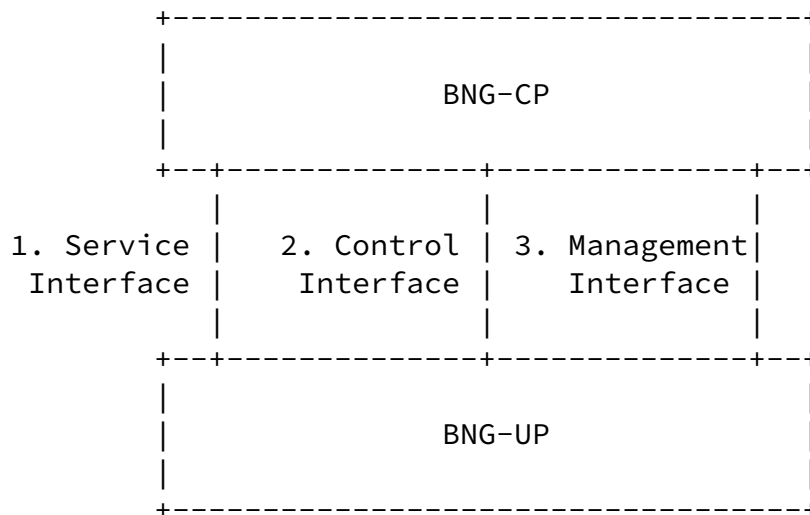


Figure 2. Internal Interfaces Between the CP and UP of the BNG

**Service Interface:** The CP and UP use this interface to establish tunnels with each other and transmit PPPoE and IPoE packets over those tunnels. VXLAN is commonly used for such tunnels as discussed in [hu-nvo3-vxlan-gpe-extension-for-vbng].

**Control Interface:** The CP uses this interface to deliver service entries, and the UP uses this interface to report service events to the CP. The requirements of this interface are introduced in [cuspdrtgtwg-cusp-requirements], and the carrying protocol is presented in [cuspdrtgtwg-cu-separation-bng-protocol] which specifies the Simple Control and User Plane Separation protocol (S-CUSP). The information model of this interface is presented in [cuspdrtgtwg-cu-separation-infor-model].

**Management Interface:** The CP uses this interface to deliver configurations to the UP. This interface uses NETCONF [cuspdrtgtwg-cu-separation-yang-model].



#### 4. Usage of the CU Separation BNG

In the CU separated BNG scenario, there are several processes when a home user accesses the Internet:

- (1) User dialup packets via PPPoE or IPoE from the BNG-UP are sent to the BNG-CP through the BNG-UP's Service Interface.
- (2) BNG-CP processes the dialup packet. Confirming the user's authorization with the outside neighboring systems in the management network, the BNG-CP makes the decision to permit or deny the user access.
- (3) After that, the BNG-CP tells the UP to do perform authorized forwarding actions with appropriate QoS policies.
- (4) If the user is certificated and permitted, the UP forwards the traffic into the Internet with appropriate QoS policies such as limited bandwidth, etc. Otherwise, the user is denied to access the Internet.

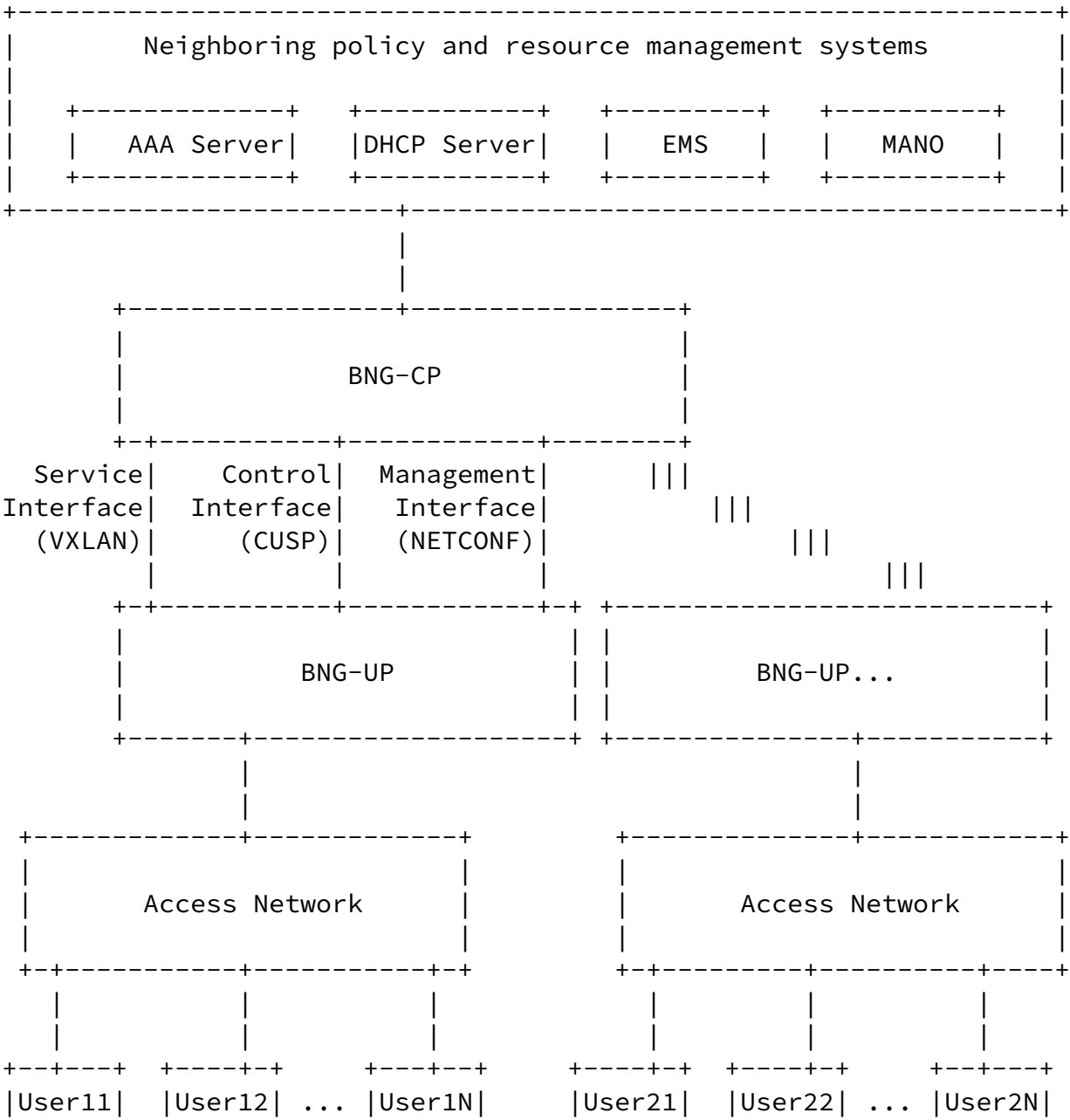
In actual deployments, a CU separated BNG device is composed of a CP and one or more UPs. The CP is usually centrally deployed and takes responsibility as a user control management component managing UP's resources such as the user entry and forwarding policy. The UPs are distributed and act as a network edge and user policy implementation component.

In order to fulfill a service, neighboring policy and resource management systems are deployed outside the BNG. In the neighboring systems, different service systems such as RADIUS/DIAMETER server, DHCP server and EMS are included. If a BNG-CP is virtualized as a NFV, the NFVI management system MANO is also included here. A BNG-CP has connections with the outside neighboring systems to transmit management traffic.

The deployment scenario is shown in the following figure:

INTERNET-DRAFT

Architecture for CU Separated BNG



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Figure 3. Deployment Example

## [5.](#) Security Considerations

The Service, Control, and Management Interfaces between the CP and UP might be across the general Internet or other hostile environment. Thus, appropriate protections **MUST** be implemented to provide integrity, authenticity, and secrecy of traffic over those interfaces. For example, the implementation of IPSEC, DTLS, or TLS as appropriate. However, such security protocols need not always be used and lesser security precautions might be appropriate because, in some cases, the communication between the CP and UP might be in a more benign environment.

## [6.](#) IANA Considerations

This document requires no IANA actions.

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INTERNET-DRAFT

Architecture for CU Separated BNG

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