An Overview of

Open Broadband-Broadband Access Abstraction

1 Standardized, automated deployment for Cloud-based Access Services

This is an introduction to the Broadband Access Abstraction project - an open source project within the Broadband Forum's "Open Broadband" initiative that provides standardized, automated deployment for Cloud-based Access Services.

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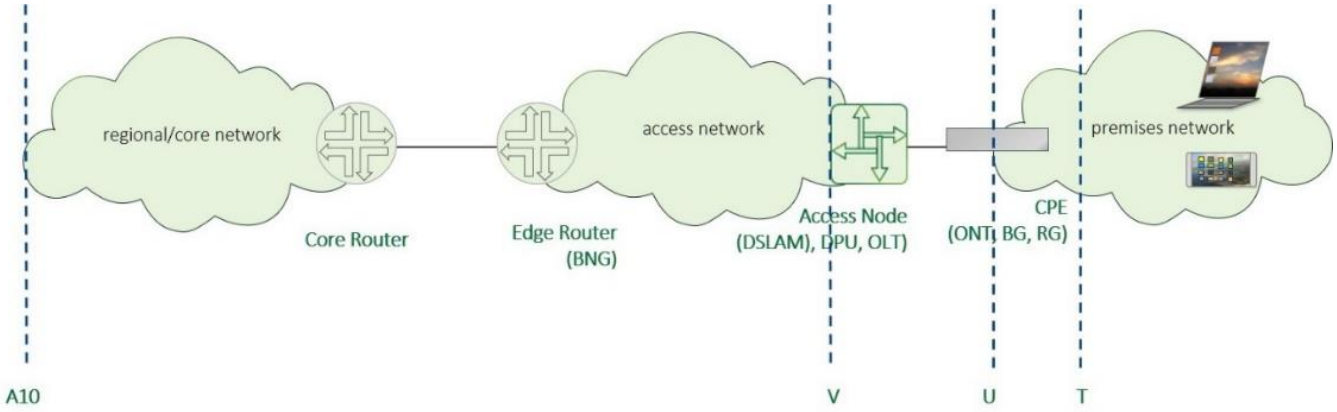
The Broadband Access Abstraction (OB-BAA) project addresses key business, operational and technical challenges and opportunities at a time of rapid change when confidence in decision-making is paramount. To understand how OB-BAA will impact service and access network operations it is necessary to consider how and why changes are taking place across the network ecosystem.

2 Background and Motivation

Today's access/edge network segments form a collection of application specific, purpose-built devices. While this has been the foundation for massive successful deployment, emergence of new technologies and approaches has resulted in a re-examination of the deployed network in the quest for a more responsive, agile ecosystem to better enable new revenue opportunities and operational cost savings.



The advent of Cloud, virtualization (NFV) and SDN-based automation of ultra-fast access technologies and open source are at the heart of the revitalization of the Broadband ecosystem. These are the enablers of OB-BAA and other related industry initiatives touched upon later in the paper.

Open and more agile broadband is overlaid with continued massive growth, the impending arrival of 5G, and IoT/Connected Home. Naturally, these also form important, related key Broadband Forum projects. As we take advantage of innovative developments, the Forum's mission remains constant: build on the success of what has been achieved, focus on revenue generation and cost savings.

2.1 Movement from Telco to Data Center Practices

The conventional Central Office or Exchange is transforming to a new architecture, separating – or disaggregating – embedded software functions from the network equipment and moving them into the Cloud whenever necessary to improve network reliability and customer service while reducing operational costs. In the Cloud, network functions are virtualized and are created by a few simple clicks in a user interface, or by invoking a Northbound Interface that uses a combination of orchestrators (e.g., NFVO, CloudCO Domain Orchestrator) and controllers.

This provides

- Flexible deployment options with virtualized rather than physical network functions
- Dynamic scaling for better capacity utilization
- Easier on-boarding & upgrading of network functions
- Decoupled evolution of virtual and physical network functions
- Increased automation, agility leveraging specialized VNFs, open interfaces, modular practices

2.2 From Network Management to Network Automation

Integral to the movement from Telco to Data Center is the transformation from Network Management to Network Automation enabling multidomain orchestration and domain control.

2.3 Access Network Migration

These changes enable and foster a regeneration of the Access Network characterized by the following attributes

Open and multi-vendor

- Modular and replicable architecture
- Open and standard interfaces
- Leveraging third party and open source innovation
- Integrate easily across systems, networks, and partners

Programmed and automated

- Program and control networks from the Cloud using SDN
- Add intelligence and open up powerful ways to exploit network data
- Streamline operations

Leverage Cloud & IT

- Transcend CPU/RAM node limitations
- Elastically scale in the data center
- Roll out new apps, capabilities quickly

3 Implementation Challenges

The fabric of today's global economy, information and personal communications is entirely dependent on the telecommunications industry. This vast multi-trillion-dollar infrastructure encompasses a billion broadband connected households and billions of connected devices (mobile, fixed, sensor, etc.). This means that, above all other considerations, the successful introduction of new technology and operational approaches must be done cost-effectively, while minimizing the risk, to ensure business viability and technical stability of the ecosystem. This is where the OB-BAA project plays a key role as discussed in the following sections.

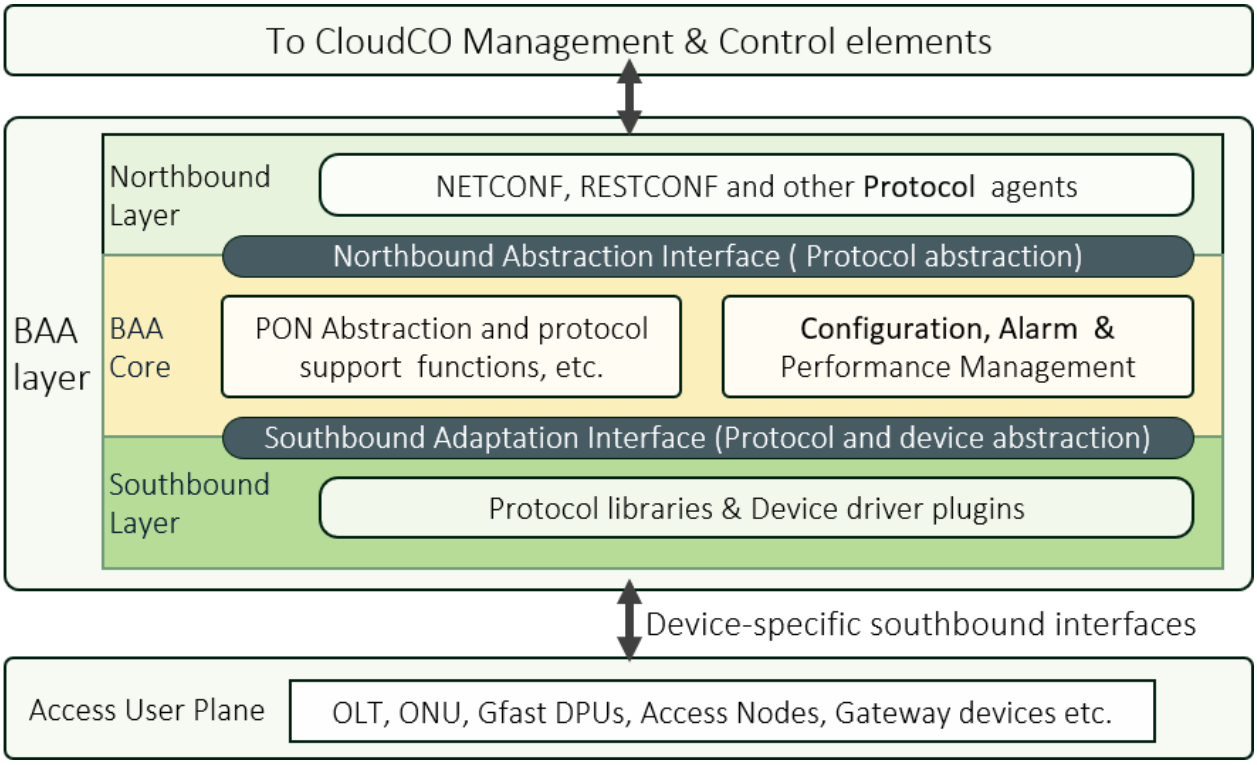
4 Introducing OB-BAA

The Forum's Open Broadband - Broadband Access Abstraction (OB-BAA) Project can be summarized as

- An open source project delivered as source code, and associated documentation
- Through its standards compliant interfaces, OB-BAA is a reference implementation of the Forum's CloudCO BAA layer
- Pulling together both new access node designs and already-deployed access device types to be provisioned, controlled and maintained by SDN Management and Control systems
- Reducing the risk of introducing new technologies or individual products and allowing investment in new systems and services to be incremental

4.1 The BAA Layer

This diagram introduces and locates the principal elements of the Broadband Access Abstraction layer.



Abstraction has been a fundamental concept of layered telecommunications architectures for decades. It fosters independent solutions for devices, compute and network elements, security and software to coexist. The layered architecture shows how the BAA layer enables independence of the north and

southbound implementations. This removes the need for difficult deployment planning by decoupling the device and software implementation choices from business and market conditions. i.e., it facilitates service provider choices for local or system-wide implementation, co-existence, seamless migration and reduced implementation risks based on market demand, RoI, resources, etc.

While this layering, using standardized northbound interfaces, is what distinguishes OB-BAA initiative from others which may appear similar, the OB-BAA project is actively coordinating with related industry activities (e.g., ONF-SEBA/VOLTHA, ONAP). In many cases, OB-BAA can complement work being done elsewhere, for example, by providing management of existing access node types needed in brownfield migrations.

4.2 What OB-BAA provides

OB-BAA provides standardized, automated deployment for Cloud-based Access Services that enable

- A clear abstraction that isolates service functionalities from specific device implementations
- The functionality and flexibility needed to be used in different types of orchestration, management and control environments
- Multi-vendor innovation at the device and network service layers; allowing for easy interoperability via standardized interfaces

4.3 Why OB-BAA is important – what is the potential impact?

Section 3 above creates the business and operational context for the BAA layer. The following first lists the general benefits from deploying BAA

- Reduces the time it takes to deploy services by providing always available management and control for access devices, even when the access device is off-line
- Reduces the cost of operations by removing the need for the number of proprietary systems needed to manage and control access devices
- Reduces the risk of introducing new technologies or individual products by incorporating management and control of existing devices and use of standardized northbound data models
- Reduces the cost of validation, engineering and operations by providing a standardized interface which management systems can use
- Reduces the risk of introducing new technologies and architectures by utilizing Open Broadband for ongoing testing and deployment staging

The next section looks at stakeholder specifics.

4.4 Impact by Stakeholder

The concerns of users, service providers, equipment manufacturers, software and integrators vary.

The impact on the end-user or content providers for example will be dependent on their expectation and the way services are marketed. For instance, most will experience that new devices / software / videos / services etc., are now more reliable, faster, better quality but most have little understanding nor interest in how the network delivers content to them. “It’s the Internet, right?”

For the industry stakeholders, however, it’s not so simple since for new Cloud, NFV, SDN etc. systems and approaches to prove their anticipated reduced CapEx, OpEx, generation of new service revenues etc., they must actually be deployed. Of course this deployment must be accomplished with as little disruption as possible and then the services sold, and the results must be measured.

This is where the layered approach of BAA helps operators to

- Tune and optimize their decision-making process on the introduction of new or upgraded infrastructure based on demand and successful incremental deployment instead of being forced to a total replacement approach. This reduces the planning and execution time and allows investment on new systems and services to be incremental
- Deploy services more rapidly across the Access network as Abstraction enables interworking with all types and makes of Access Nodes instead of each vendor's implementation
- Use the BAA layer to migrate their existing access devices into their new programmable network environments and manage these access devices using the same data model

Equipment vendors and service providers can use and extend the software platform for their own service offerings, allowing them to differentiate themselves in their respective markets.

Equipment vendors are able to reduce the cost of development by implementing standard interfaces toward the service providers operational support systems instead of developing different, often custom interfaces for each service provider.

4.5 Why is this an Open Broadband Project?

This project is categorized as a BBF Open Broadband project since it combines Open Source practices with the Forum's goal of developing specifications that enable large-scale, revenue-generating, standardized solutions for the industry.

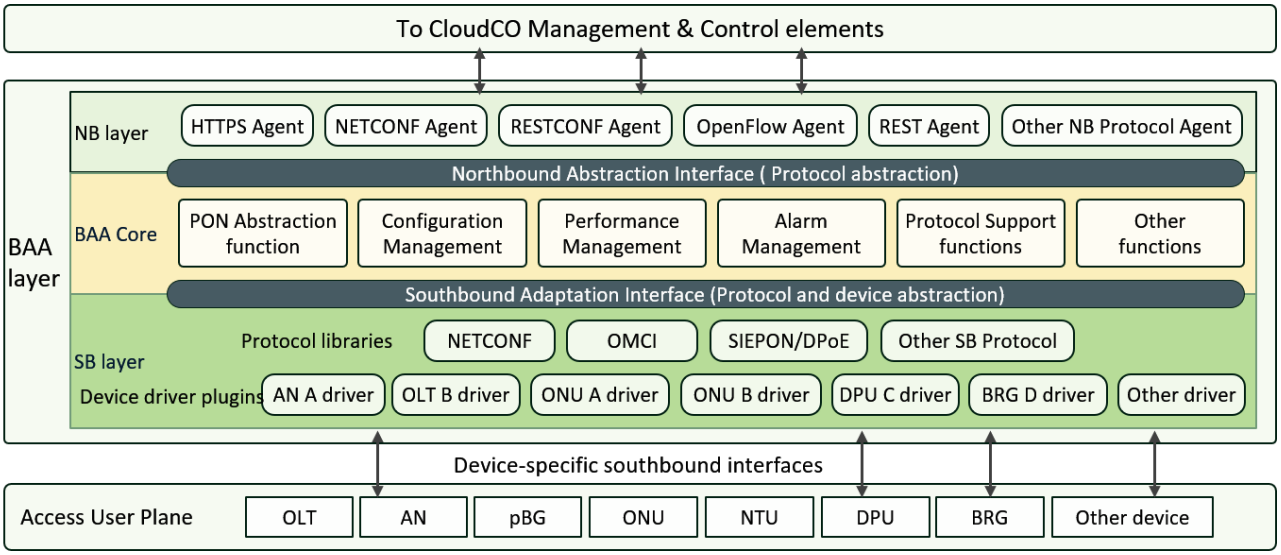
Unlike other Broadband Forum projects, the OB-BAA project is being developed under a simple collaborative agreement and it is open to both BBF members and representatives of other industry associations and industry parties including

- Uses the Apache 2.0 license for software (RANDZ)
- Uses the BBF IPR for non-software artifacts (RAND)
- Code, documentation and papers such as this are publicly available

For further information on Open Broadband and Open Broadband Labs including relationship to other industry initiatives visit https://www.broadband-forum.org/ob

5 Technical Overview

5.1 BAA Architecture: Layers and Interfaces



About the Layers and Interfaces

BAA Core

- The BAA Core provides functions needed to manage and control Access PNFs, either legacy or hardware disaggregated and needed in different types of orchestration, management and control environments.

Southbound (SB) layer

- The Southbound layer contains device adapters that support communication with the access devices in the network.

Southbound Adaptation Interface (SAI)

- The SAI is specified via the required data models and protocol, which in turn provide a first degree of adaptation between the BAA Core and the Access Nodes to the south. Provides clear abstraction that isolates core functionality from specific device implementation

Northbound (NB) layer

- Northbound the BAA layer communicates with one or more management and control systems which may include access network managers, SDN managers and controllers, and potentially directly with the CloudCO Domain Orchestrators. Provides for multi-vendor innovation at the device and network service layers.

Northbound Abstraction Interface (NAI)

- The NAI is specified via the required data models and procedures exposing, also a pure abstraction of the underlying network. Allows for easy interoperability via standardized interfaces and the appropriate protocol to communicate with the elements northbound.

Access User Plane

- Supports new access node designs and the already deployed/legacy devices.

5.2 Using BAA layer in SDN and NFV Ecosystems

Inherent in the OB-BAA project is the ability to pull differing access device types, including legacy implementations, together under a single network and service management and control umbrella to be exposed to management elements such as the SDN Manager and/or Controller.

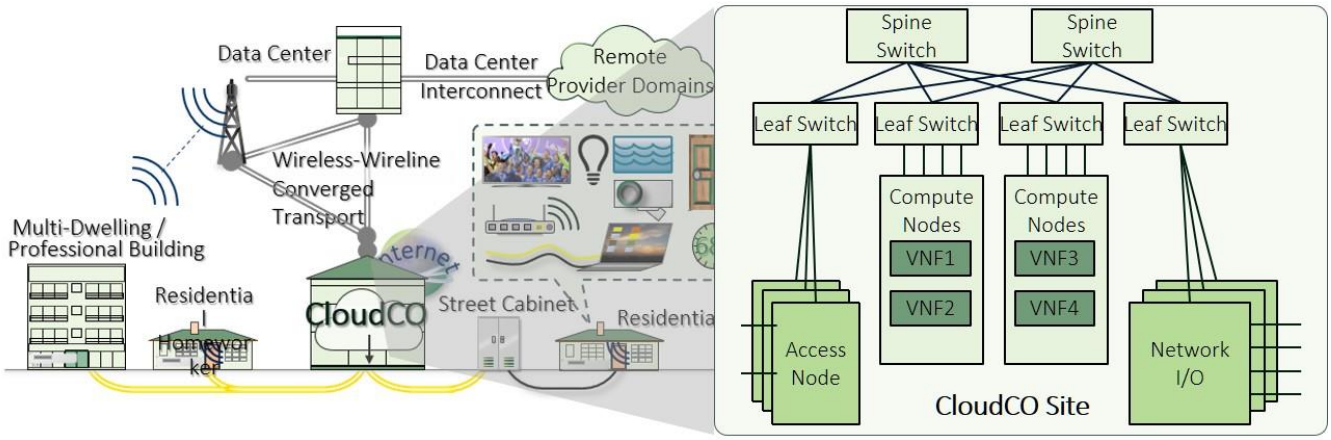
The OB-BAA project is designed to be deployed within the BBF's CloudCO environment as one or more virtualized network functions (VNFs). Because the NBI and SAI utilize standardized data models and the Core components of the OB-BAA project are designed as virtualized micro-services with specified interfaces, the components of the OB-BAA project can also be adapted and deployed in other virtualized environments.

5.3 BAA and CloudCO

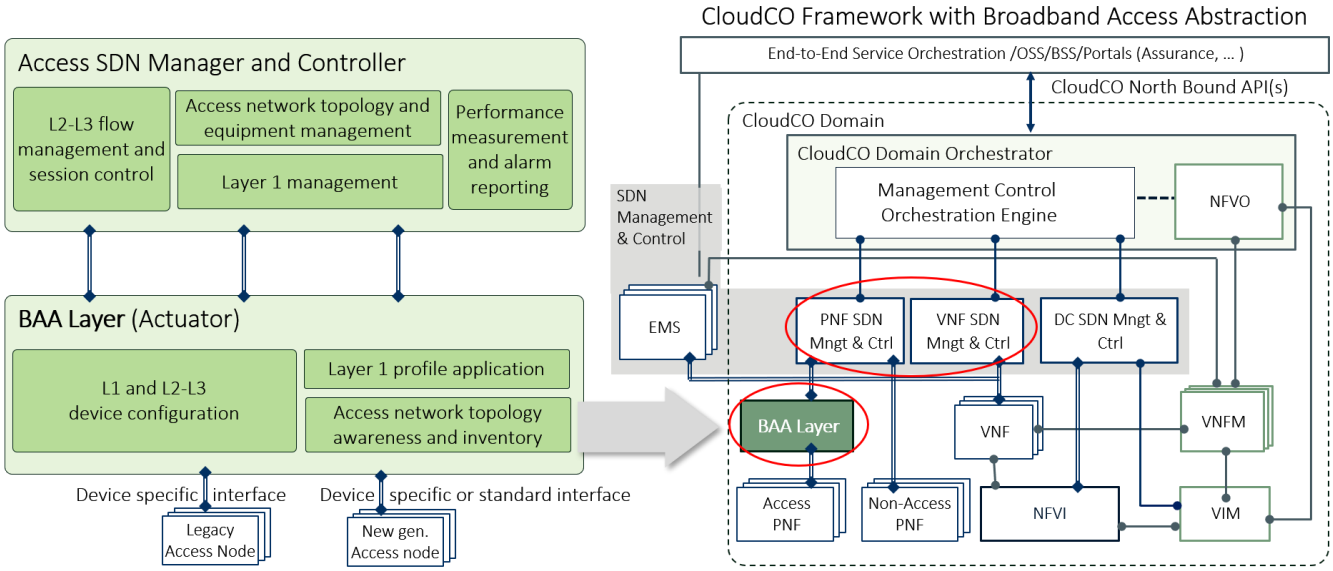
CloudCO is a major Broadband Forum project consisting of published specifications, use cases, application notes etc. Cloud Central Office (CloudCO) Reference Architectural Framework is published as TR-384. Further details are to be found at https://www.broadband-forum.org/cloudco.

This scenario clearly calls for an Open Access Abstraction – that is satisfied by the BAA layer

- In CloudCO the virtual network functions (VNFs) are deployed on a generic computing infrastructure, interconnected by a generic switching fabric with Access and Edge Network Elements.
- Access SDN Manager & Controller and BAA layer control the interaction to the Access Nodes



The BAA layer integrates into the CloudCO Framework as shown in the following diagram



The SDN Managers & Controllers are responsible for Fault, Configuration, Accounting, Performance, Security and Flow Control management functionalities for Cloud CO Network Functions. They implement the Management & Control Plane that governs the overall user plane represented by the service graphs that chain PNFs, VNFs and networking resources together within the CloudCO Domain.

The following is a non-exhaustive set of functions performed by the each of these SDN Managers & Controllers exposed by means of interfaces and consumed by the CloudCO Domain Orchestrator

- Configuration, fault management and performance measurement
- Overall flows control across the user plane
- Usage accounting and security management

5.4 BAA Deployment Options

These deployment options include

- BAA layer deployed as an Actuator (BAA-Act)
  In deployments where the SDN Management and Control element(s) (that interface with the BAA layer) implements management and control plane functionalities specific to access networks, the BAA layer can be deployed as an Actuator. This can execute the inputs received from the Access SDN Management and Control element(s), exposing a virtual representation of access nodes acting as the authoritative source for interactions to and from them
- BAA layer Deployed as a Unified Access Manager (UAM)
  In deployments where the SDN Management and Control elements implement management and control plane functionalities for multiple domain segments (e.g., Edge, Access), the BAA layer can be deployed as a UAM. The UAM can incorporate functionality of the Access SDN Management and Control element (e.g., topology management) together with the Actuator to provide a unified set of functionality toward the Cross-domain SDN Management and Control element

In both cases, coexistence and migration in the management of the access segment is considered, providing management and control of new and existing types of access nodes and functions.

6 Project Status and Release 1.0

The OB-BAA began in January of 2018, with the first release available August 2018. Release documentation and links to OB-BAA code may be found at https://obbaa.broadband-forum.org.

To date, eleven participating companies: Broadcom, BT, Calix, CenturyLink, China Telecom, Huawei, Nokia, Telecom Italia, Tibit, UNH and ZTE have joined as participants providing a balanced mix of service providers, equipment vendors and testing organizations necessary to ensure a successful project.

7 Summary

This document was developed to

1. Introduce and raise awareness of this important project that will help the industry to quickly deploy new technologies and services with reduced risk and we believe bring new services to market faster, with reduced risk and simplified deployment and migration
2. Raise interest in the work with readers and encourage readers to actively participate in the work being developed by the Forum and those collaborating
3. Give sufficient technical information to give the reader new ideas on their own planning
4. Encourage adoption of the work in products and services
5. Pave the way for demonstrations being developed

We would encourage you to participate in the project and the work of the Broadband Forum. Please contact info@broadband-forum.org.

Information on further developments and planned demonstrations, OB-BAA webinars, etc. are available on the Broadband Forum public web site.

8 References and Abbreviations

The following is a limited list of references and abbreviations. Please download TR-384 for a complete list.

8.1 References/Links

OB-BAA-001	OB-BAA System Description – member log in required	BBF	2018
BAA on BBF site	Broadband Forum Public site – BAA home page	BBF	2018
TR-328	Virtual Business Gateway (vBG)	BBF	2017
TR-384	CloudCO Reference Architectural Framework	BBF	2018
BAA home page	OB-BAA project home page – members 'wiki	BBF	2018
GS NFV-MAN 001	NFV Management and Orchestration	ETSI ISG NFV	2014

For more on becoming a participant in the project please email info@broadband-forum.org

8.2 Abbreviations

AN	Access Node	OLT	Optical Line Termination
BAA	Broadband Access Abstraction	ONU	Optical Network Unit
CloudCO	Cloud Central Office	PNF	Physical Network Function
ETSI	European Telecommunications Standards Institute	SBI	Southbound Interface
NBI	Northbound Interface	VIM	Virtualized Infrastructure Manager
NERG	Networked Enhanced Residential Gateway	VM	Virtual Machine
NFVI	NFV Infrastructure	VNF	Virtual Network Function
NFVO	NFV Orchestrator	VNFM	VNF Manager

9 Acknowledgements

Editors	Tim Carey, Nokia, OB-BAA Chair, Broadband Forum Mark Fishburn, Broadband Forum

10 About the Broadband Forum

The Broadband Forum, a non-profit industry organization, is focused on engineering smarter and faster broadband networks. The Forum's flagship TR-069 CPE WAN Management Protocol has now exceeded 800 million installations worldwide.

The Broadband Forum's work defines best practices specifications and software for global networks, enables new revenue-generating service and content delivery, establishes technology migration strategies and service management for the connected home, Cloud, Access and 5G broadband ecosystem.

The Forum's Open Broadband strategy brings together open source agility and standards-based architecture to enable large-scale markets. We develop test interoperability and certification specifications and programs to accelerate deployment. Visit www.broadband-forum.org. Twitter @Broadband_Forum.

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