

SDN and NFV

Mission Statement:

This Work Area focuses on the introduction of Software Defined Networking (SDN) and Network Functions Virtualization (NFV) in conjunction with general purpose hardware to create the basis for cloud-based, edge and access networks. Building on this framework, projects address migration and coexistence of physical and virtual elements, into the broadband network, define interfaces, test cases Use Cases and scenarios, reference implementations and automation. Activities work with and coordinate with Open Broadband (OB) program regarding open source, like Open Broadband-Broadband Access Abstraction (OB-BAA) and testing Open Broadband Laboratories (OBLs).

Work Area Directors: Bruno Cornaglia (Vodafone) and Mengmeng Li (China Mobile)

Business Impact:

The migration to SDN and NFV in the broadband network facilitates agile deployment of new customized distributed broadband services and applications. This enables new revenues and provider differentiation while managing Capex and OpEx both in the access network and in single and multi-tenant residential and business locations by implementing an agile network and enabling autonomous and automated operations.

Scope:

The scope includes migration to and deployment of SDN/NFV-enabled implementations across all aspects of the broadband network. The scopes are:

- the definition of a new cloud-based environment with its related requirements, called Cloud-based Central Office (CloudCO)
- the architectural requirements, the interface specification among all the components with their related data models including the control-user plane separation interface for disaggregated access nodes
- the specification of virtual network functions and interface with their related data models
- the definition of requirements, interfaces and data models for autonomous and automated networks

Project Streams

Project Stream	Description
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SDN and NFV Work Area Email Lists

- sdn-nfv@broadband-forum.org: SDN and NFV meeting notification, agendas, discussion, etc.
- memgen@broadband-forum.org: All BBF Members, general information.
- [Join or Leave BBF Groups and Email Lists](#)
- Go to your [JIRA profile page](#) to see all of your current BBF group memberships.

See also:

- [Approved Technical Reports](#)

Non-PS Assigned	Projects that don't fit under the scope of an existing Project Stream or if they fit under the scope of more than one Project Stream, are developed under the Non-PS Assigned category.
Leadership: Mengmeng Li China Mobile	

Project Stream	Description
Cloud in the Central Office (Cloud CO) Leadership: Haomian Zheng , Huawei	This project stream is developing a next generation Central Office (CO) System that is part of BBF Open Broadband, which incorporates Software Defined Networking and Network Function Virtualization with SDN control & management running on a cloud-like infrastructure deployed at Central Offices. By 'cloud-like', it is meant that the infrastructure leverages commodity network switches and commodity compute nodes with virtualization software to host various virtualized network functions (VNFs). Infrastructure operators can offer these functions to 3rd parties and 3rd party network functions can be inserted into the platform, allowing Value Added Services. The goal of this project is building on the architectural framework for such a Cloud CO (TR-384), with appropriate abstracted functional modules, and interfaces, eventual API and protocol choices and/or definitions. The architectural framework allows interconnecting these functional modules in an interoperable manner. A secondary goal is to figure out and shows how standards organizations and open source projects can collaborate. This project will also establish a reference implementation of the Cloud CO framework, creating a platform for innovation and potential open source upstreaming into other organizations, as well as a platform for industry interoperability testing (OBL) and certification of NFs and the components that implement the aforementioned functional modules. TR-384: Cloud Central Office (CloudCO) Reference Architectural Framework

TR /WT /MR /MD /SD#	Projects	Abstract	Related Contributions	Editor (s)
TR-384 WT-384 Issue 2	Cloud Central Office (CloudCO) Reference Architectural Framework	This Cloud Central Office (CloudCO) document helps drive a key element of the BBF's strategy in enabling new revenue generating-services. It defines a platform that serves as a platform for both wireline and wireless networks. Operators will have the opportunity to run a single network with all varieties of access technologies, and flexibly deploy innovative services. Issue 1 is the first phase in a multiphase project defining the high level architectural framework. Related specs include migration, detailed interface definitions, test cases & application notes, use cases & scenarios and reference implementations.	Contributions	Issue 1 Ding Hai (China Unicom) Georgios Karagiannis (Huawei Technologies) Issue 2 Ding Hai (China Unicom) Aihua Guo (Futurewei)

Projects Building on CloudCO

TR /WT /MR /MD /SD#	Projects	Abstract	Related Contributions	Editor (s)

TR-408	Cloud CO Migration and Coexistence	This Cloud Central Office (Cloud CO) document provides guidance to Service Providers as they transform their existing Multi Service Broadband Networks (MSBN) toward a Cloud CO based network that is more adaptable, agile, scalable and dynamic than the existing MSBN, while reducing costs by retaining investments that the Service Provider has made in their MSBN. This document identifies considerations that Service Providers need to consider when determining the deployment strategy of either migrating the existing network or deploying a Cloud CO based network that coexists with the existing MSBN. It also provides transformation assistance by identifying approaches to migrating their existing MSBN and discusses when and how to introduce the Cloud CO infrastructure or leverage their existing IT infrastructure. Finally, the document provides examples of how functionality in the management, control and user planes can be migrated toward Cloud CO.	Contributions	Ding Hai (China Unicom) Tim Carey (Nokia)
TR-411	Definition of interfaces between Cloud CO Functional Modules	This work will define the Interfaces between the Functional Modules in the Cloud CO Architectural Framework, as well as the Cloud CO Northbound API. Network Transport Protocols will be defined to carry the interface attributes. Furthermore the data models, schemas or APIs that are signaled across them will be defined as well. Existing Open Interface works, as described in Standards and Open Source work will be leveraged as much as possible. This project is based on and will grow incrementally, driven by a series of Cloud CO Application Notes (APPNs). Cloud CO Application Notes will detail how a certain service is instantiated, maintained and consumed across the Cloud CO Architecture and will detail the necessary interactions between the different Functional Modules in the Architectural Framework, as well as the interactions with the Cloud CO Northbound API in order to achieve the necessary end result.	Contributions	Tim Carey (Nokia) Wei Lin (Huawei)

TR-412	Test Cases for Cloud CO Applications	This work will define Test Cases for Cloud CO Applications. Cloud CO scenarios are described in Cloud CO Application Notes as well as TR-416. The Cloud CO Application Notes will detail how a certain service is instantiated, maintained and consumed across the Cloud CO Architecture. The Test Cases will be consumed by the Open Broadband Labs (OBLs), effectively validating the Cloud CO Application Note. The development of WT-411 Interfaces, WT-412 Testing and Application Notes are inter-dependent.	Contributions	Ding Hai (China Unicom)
TR-413 WT-413 Issue 2	SDN Management and Control Interfaces for CloudCO Network Functions	In the Cloud CO context, WT-413 specifies the management and control framework of Network Functions and a formalism to specify their NBIs to identify the supported macro functionalities and link them to existing/to-be YANG DMs. This work primarily enables the migration from SNMP/MIB towards NETCONF/YANG interfaces and potentially other protocols to exercise not only traditional FCAPS management functions but also fine grained flow control across VNFs and PNFs network service graphs. This is a key step towards Software Networking introduction and in turn the automation and Orchestration of PNFs and VNFs in a Cloud CO type of architecture. The development of this Working Text shall also shape the thinking on the way Cloud CO interfaces, especially for VNFs, are modeled and the opportunity to reuse/extend existing YANG work for that.	Contributions	Issue 1 Mauro Tilocca (Telecom Italia) Haomian Zheng (Huawei) Issue 2 Mauro Tilocca (Telecom Italia)
TR-435	NETCONF requirements for Access Nodes and Broadband Access Abstraction	This project will develop the NETCONF requirements for the NETCONF/YANG Northbound interfaces (NBIs) of Access Physical Network Functions (PNFs) and the CloudCO BAA layer towards the Management and Control (M&C) elements that interact with them.	Contributions	Ken Kerpez (DZS) Mauro Tilocca (Telecom Italia)

TR-454	YANG Modules for Access Network Map & Equipment Inventory	In a CloudCO architecture, the management of physical nodes requires interfaces to expose Access Network Map (ANM) and Equipment Inventory information to the SDN Management and Control and other CloudCO functional blocks. For the support of multiple tenants, it's also useful to expose to Tenants only relevant ANM and Equipment Inventory information over the NB API. The project is defining YANG data models for ANM and Equipment Inventory applicable to the BAA layer and the Access SDN Management and Control.	Contributions	Yang Wenle Huawei Technologies Jie Chen CAICT
TR-477 WT-477 Issue 2	Cloud CO Enhancement - Access Node Hardware Disaggregation	Operators want their networks to be adaptable, agile, scalable and dynamic, while reducing costs. Besides reducing CAPEX and OPEX, shortened time-to-market is much more desired. SDN and NFV in conjunction with general purpose hardware are two powerful tools that are exploited in the industry to optimize current networks. In BBF, the CloudCO re-architects the broadband network using the above mentioned technologies running on a cloud-like infrastructure, deployed at Central Offices. It encompasses the enabling work required for dramatically faster and more efficient provisioning of new revenue generating-services. On the other hand, Opensource organizations have a different life-cycle, focused on the implementation of reference features and using immediately available standards which can lead to incomplete, non-compliant and tightly integrated components. The scope of this project is to perform a gap analysis between Cloud-CO and Opensource solution(s) by defining the missing interface(s) between Disaggregated OLT and physical OLT.	Contributions	Issue 1 Bruno Cornaglia (Vodafone) Francisco de Carvalho (Reply) Issue 2 Antonio Marsico (Net Reply) Francisco de Carvalho (Reply)

TR-484	Access Network Abstraction, Softwarization, and Disaggregation	This Technical Report specifies a Broadband Access Abstraction (BAA) Layer as part of a Software Defined Access Network (SDAN) architecture capable of: • Seamlessly supporting a multi-vendor, multi-technology network of Access Nodes (AN) • Connecting different designs of physical ANs, e.g., traditional chassis-based and disaggregated ANs • Disaggregating Management Plane and Control Plane functions from the physical ANs and hosting the functions on centralized or distributed NFVI locations This Technical Report describes the key functional components of a SDAN architecture, specifies the BAA Layer system and complements the family of Broadband Forum's CloudCO specifications related to the access domain (e.g., TR-384 [9], TR-411 [12], TR-413 [13], TR-435 [14], TR-451 [15], WT-477 [18]).	Contributions	Mauro Tilocca (Telecom Italia)
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Applic ation Notes		Application Notes (APPN) use the TR-384 framework to describe an implementable Use Case for a CloudCO 'application'. APPN includes • Assumptions and Preconditions • System Description using TR-384 framework (components) + Drawing • Description of Actors • Interactions, which describe what information gets exchanged between the TR-384 functional elements and what happens as a result after an actor performs an 'action' i.e., an API call at the CCO NB API or a user plane packet that enters the system. A ladder diagram shows the various interactions between the functional elements. • Success Criteria for the interactions • Various <i>instances</i> can be instantiated which detail a given implementation of the individual components An Application Note <i>Instance</i> will then be created that details the exact components to be bootstrapped/installed onto an NFVI. ((i.e. it describes what VIM is chosen, etc, as well as e.g software releases etc). The APPN is then used to guide development of: • Interface Descriptions (WT-411) • Test Case Descriptions (WT-412)	Application Notes Under Development	Applicat ion Notes and how they relate to other work Coordin ated by PSL: Yves Hetogh s (VMWa re)
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Project Stream	Description
Cloud Component Project Stream Leadership: Ken Kerpez , DZS	Mission: The project stream's mission is to provide specifications and guidance for Cloud-based components us broadband network. The specification and guidance provided by this project stream help ensure that C Components are multi-vendor and inter-operable. Critical elements of the work provided by this project support the transition from existing architectures toward Cloud-based architecture and alignment, wher various Cloud-based architectural frameworks such as Cloud CO. Business Impact: The work of this project stream creates the necessary architectural and interface specifications and as: that enables a multi-vendor, inter-operable set of Cloud-based components that reduces the cost of deployment of Cloud-based components through standardized architectures, protocols, APIs and infor Projects:

Specifically the project stream covers the following projects and their associated work products:

- **Automated Intelligent Management (AIM):**

Description:

Enhance access and home networks with Cloud-based automation and intelligence, to achieve higher lower OPEX.

TR /WT /MR /MD /SD#	Projects	Abstract	F
TR-436 WT-436 Issue 2	Access & Home Network O&M Automation /Intelligence	Over the past decade, growth in the Telco industry's revenue has never outpaced growth in OPEX. As the scale of a network increases, OPEX increases with it. Therefore, it is expected that work needs to be done in order to reduce OPEX. This project will specify the logical framework of access & home network O&M automation, including necessary functional blocks, logical connection descriptions and information flows between the modules. In addition, this work will suggest possible applications of this framework to typical BBF service architectures. This identifies the information elements required in access & home network O&M automation, key use cases and KPIs, and analysis of the gaps with existing architectures to support these information elements. The project will describe what kinds of the information elements are required.	C
TR-486 WT-486 Issue 2	Interfaces for Automated Intelligent Management (AIM)	The TR-436 defines the Automated Intelligent Management (AIM) framework for access and home networks management with automation and intelligence,. The purpose of this work is to specify the AIM Interfaces, Interfaces Functions and Data Models (DM) that allow the interactions between the AIM components and subsystems.	C
WT-508	Interfaces for Automated Intelligent Management (AIM)	The purpose of this NPIF is to harmonize and unite the work done so far on this key subject and generalize the notion of Collection Function (or Feature or System or other noun to be chosen) to be available for many uses, including but not limited to AIM.	C

- **Metro Compute Networking (MCN):**

Description:

Considers the Edge Computing impacts on multi-service broadband network, reference architecture, in identify metro computing networking requirement,

TR /WT /MR /MD /SD#	Projects	Abstract	F
TR-466	Metro Compute Networking: Use Cases and High Level Requirements	This project provides a list of use cases with related high level requirements that provides a framework defining a new metro-compute networking architecture with in-depth integration of computing and network on top of the Cloud-based broadband networks, with the purpose of connecting isolated edge sites (e.g. Cloud CO) as one cloud to serve edge computing services, supporting the edge to edge collaboration, the edge to cloud collaboration, and load balancing among edge sites at network level. It includes recommendations for BBF Work Projects.	Cc
WT-491	Metro Compute Networking Architecture, Functional Modules and Interface Definitions	This project is follow-on work to TR-466 Metro Compute Networking (MCN): Use Cases and High Level Requirements technical report that defines the reference architecture for metro compute networking that includes specification of the functional modules and nodal requirements related to this architecture consistent with TR-466, TR-384 and TR-178, including the MCN control plane and the MCN data plane in context of MSBN based on both the MEC service functions and the non-MEC service functions, and the MCN integration into the CloudCO architecture for both the MEC service functions and the non-MEC service functions. Additionally the project specifies the interfaces and protocols of MCN in order to correlate the computing power information of edge sites (e.g. CloudCO in TR-384) and the network topology information, including the new interfaces or the reference points for the integration of MCN into the MSBN architecture, the new interfaces or reference points for the integration of MCN into the CloudCO architecture for both the MEC service functions and the non-MEC service functions.	Cc

- **Virtualized ONU Management (vOMCI):**

Description:

Provides the architecture, requirements and interface specifications for a virtualized OMCI (vOMCI) so the OMCI functionality that is traditionally embedded within Optical Line Termination (OLT) network element operator's Cloud-based network. The project supports various deployment models of the vOMCI solution (i.e., OMCI translation function, OLT & ONU management functions) of the architecture can be deployed network functions and are expected to be used within Access domain SDN management and control (Broadband Forum's CloudCO) or as a stand-alone process that can be deployed with existing management solutions.

TR /WT /MR /MD /SD#	Projects	Abstract	F
TR-451 WT-451a1	vOMCI Interface Specification	Considers the virtualization of the PON OMCI functionality traditionally residing in the OLT and the related standardization that is needed to achieve interoperability. The scope of this specification is to provide an architecture for the vOMCI solutions, providing requirements and interface specifications as shown in figure below: Legend - ONU commands and notifications - Transport of encapsulated OMCI messages - OMCI Annotations: - How information is conveyed between the vOLT Management, optional ONU Management Proxy and vOMCI functions. - How vOMCI messages are conveyed between the vOMCI function, optional vOMCI Proxy and OLT to the ONU. - How PLOAM notifications are defined for the vOMCI solution/ Management of the OLT's the vOMCI functionality.	C

• Fixed Access Network Sharing (FANS):

Description:

FTTx represents today a high-cost technology (in terms of Return on Investments) to enhance data rat customers, but it requires a huge effort, in terms of CAPEX and OPEX for access network deployment operators have recognized the need to partner in order to improve the return on investment of FTTx de

Sharing the access network infrastructure is a viable way to expand the network and achieve an effect technologies.

FANS delivers one network sharing model with high flexibility for forward looking broadband network d operations, facilitating the business innovation, enhancing the network efficiency and improving custom

FANS also addresses the virtualization of that shared infrastructure such that each operator could hav access node.

TR /WT /MR /MD /SD#	Projects	Abstract	F

TR-370 Issue 2	Fixed Access Network Sharing – Architecture and Nodal Requirements	This Technical Report specifies technical aspects associated with Fixed Access Network Sharing (FANS) that involve the access network (including access nodes and aggregation nodes). It focuses on the cases of Passive Optical Network (PON) and DSL and G. fast access technologies.	Cc
TR-386 WT-386 Issue 2	Fixed Access Network Sharing - Access Network Sharing Interfaces	This Technical Report specifies the system interfaces associated with FANS. This document provides details and the information required to define these interfaces as well as the rules for communicating with them. The interfaces described are defined in TR-370 “FANS – Architecture and Nodal Requirements”.	Cc
MR-432	Fixed Access Network Sharing	This paper examines the potential positive business and operational impact of Fixed Access Network Sharing (“FANS”). FANS enables broadband network infrastructure, and network management, to be shared amongst operators with resulting cost and standardization benefits along with the opportunity to handle a wider variety of service offerings.	
MR-453	Fixed Access Network Sharing (FANS) Technical Overview	Deep fiber deployments for ultra-fast broadband are technically challenging. Broadband Forum is defining Fixed Access Network Sharing (FANS), to offer a highly enhanced form of virtual unbundling of broadband access networks, enabling cost sharing and enhancing the dynamics of a competitive landscape. FANS automates and harmonizes data, control, and management interfaces among wholesale Infrastructure Providers (InPs) and retail Virtual Network Operators (VNOs). Standardized FANS interfaces can decrease operational expense (OpEx) while increasing customer satisfaction. FANS logically partitions and isolates network resources shared among the VNOs, and such sharing can split the cost of network upgrades among several entities. FANS works with virtualization, where control-plane functions are migrated from dedicated network equipment into software running on commodity hardware, with FANS providing Network as a Service (NaaS). This paper describes emerging Broadband Forum standards supporting FANS, use cases, FANS components, and details of the architectures supporting FANS.	

• **SD-WAN:**

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TR/WT/MR/MD /SD#	Projects	Abstract	Resources	
WT-495	Smart SD-WAN Architecture and Node Requirements	...	Contributions	Fe Mc