Relationship between BAA and VOLTHA open source projects for automating the access network for any operator deployment.

With the next phase of broadband deployment on the horizon, new avenues for innovations in the broadband ecosystem are rapidly developing to create a promising landscape for broadband providers, operators and users alike. Operators are looking to interconnect different parts of their networks to offer this unique and seamless experience for their customers by utilizing open source, 3rd party applications and systems from various suppliers. Two initiatives that are part of this innovation to re-architect access technology are the BBF's Broadband Access Abstraction (BAA) and the ONF's Virtual OLT- Hardware Abstraction (VOLTHA) open source projects. BBF Cloud CO is an example of a Cloudified CO making use of a BAA layer. VOLTHA also has a strong relationship to other projects at ONF: SDN-Enabled Broadband Access (SEBA) and Central Office Rearchitected as a Datacenter (CORD).

Both projects are complimentary because they attack different carrier problems, yet both address the operators' increasing desire to move to agile, software-defined access networks via open source software development. This ensures that carriers can quickly and cost-effectively meet the demands of consumers and launch new revenue-generating services. For example, it's perfectly reasonable to imagine a carrier using one, the other, or both in a deployment or series of deployments.

Their names both include the term *abstraction*, but the projects do not abstract the same thing. BAA is a control and management abstraction of any Access Node (AN) as deployed in traditional or Cloudified Central Offices. BAA can control and manage complete OLT systems, from chassis down to micro-plug OLTs. VOLTHA is similarly used in compositions from elastic multi-rack systems to micro-plugs. However, VOLTHA is a subcomponent that provides control and management abstraction of low-level silicon typically used for composing Access Node functions in a cloud deployment. In other words, VOLTHA abstracts silicon to make it easier to use different hardware in a vendor-neutral and technology-neutral way. SEBA is an example of a cloud system that makes use of VOLTHA, in that it disaggregates the hardware from software and provides features and functions in a cloud-centric way.

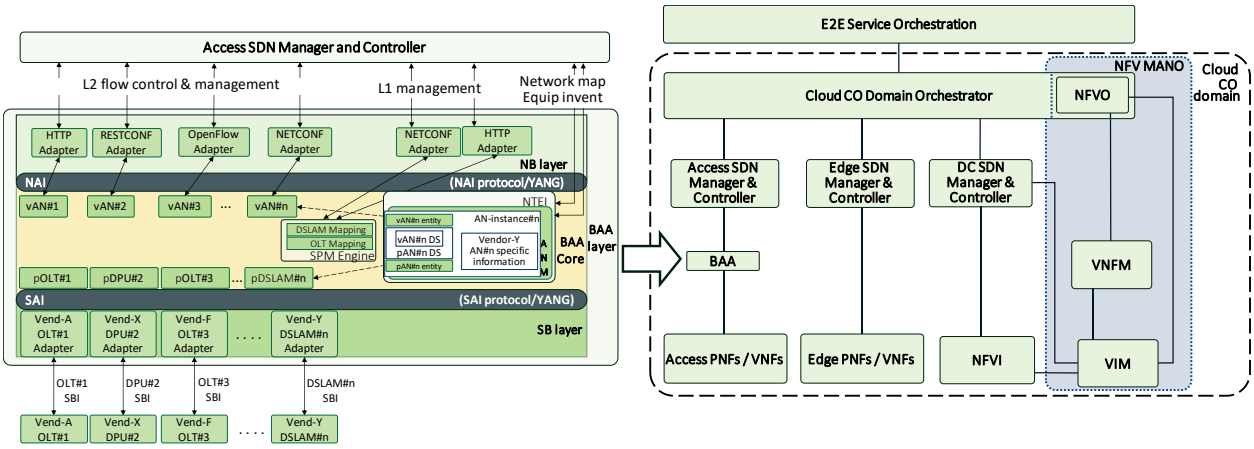

Figure 1- Broadband Access Abstraction layer architecture and role in Cloud CO

Figure 1 shows how BAA implements the SDN paradigm of moving the management and control of any AN type (e.g. an OLT) out of the PNF by creating a virtualized Management Entity (Datastores + pOLT and vAN processes) in its core and exposes its functions to an Access Manager & Controller.

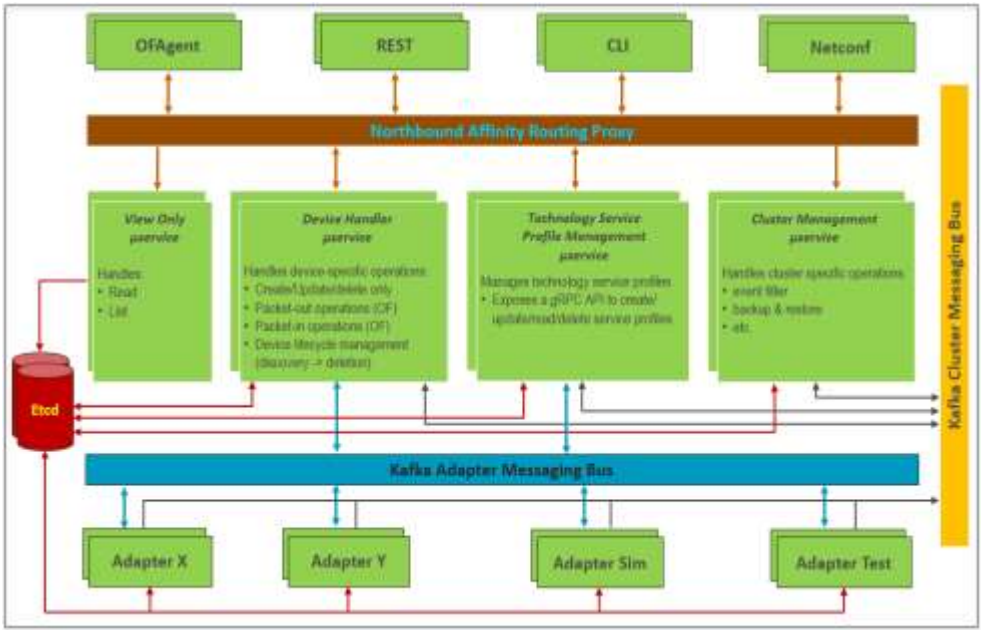

Figure 2 - VOLTHA Architecture

Figure 2 shows how in VOLTHA, merchant silicon APIs are mapped to a common core data model via southbound adapters, and how that is used to support both control and management functions northbound. The core data model also supports technology profiles (GPON, GE-PON, XGS-PON etc) that allow the northbound APIs to be independent of the particular access technology, and regard the PON simply as a quasi-Ethernet switch readily programmed by an SDN controller. VOLTHA is designed to provide hardware abstraction that is

agnostic to both orchestration and controller technologies. This means that the same benefits it provides to SEBA can be provided to similar non-ONF systems.

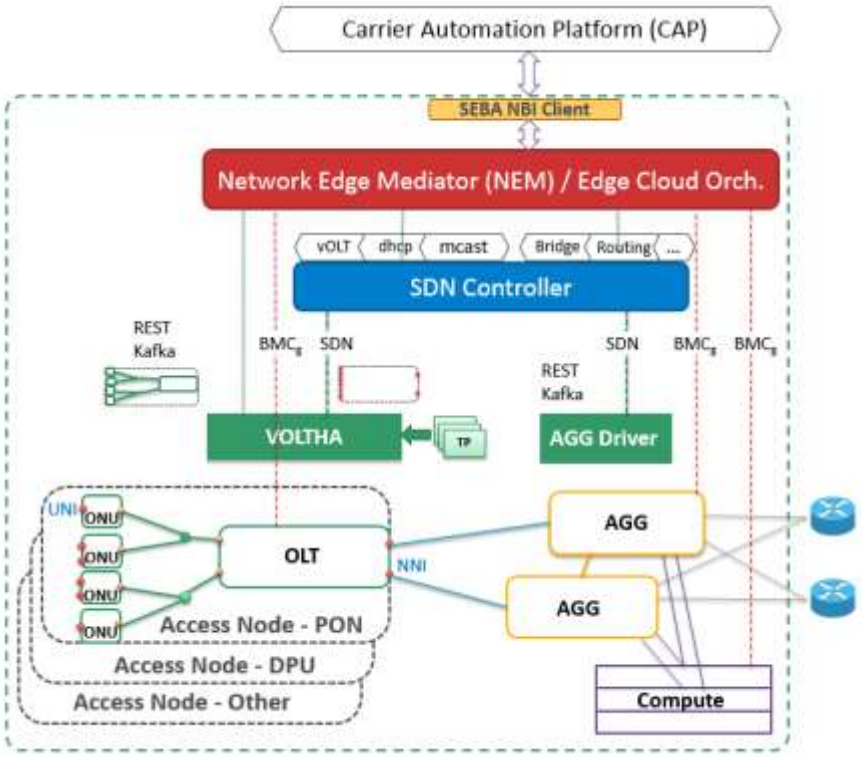

Figure 3- VOLTHA in the SEBA Software Architecture

Figure 3 shows VOLTHA as part of the cloud-based SEBA architecture built on the CORD platform. It also shows how the control plane features and functions are supported as SDN controller applications. Management plane functions are similarly provided within the NEM. This disaggregation provides very high levels of feature and management consistency and re-use across different access technology types and different silicon and supplier choices. That, along with simplified northbound abstractions, significantly reduces IT work needed to adopt new technologies, suppliers, or revisions of silicon. Like VOLTHA, SEBA also includes a flexible Northbound Interface (NBI) client that can express the capabilities of the system as a cloud composition, or, alternately, as an emulation of a traditional PNF AN. This allows carriers to deploy infrastructure that will support cloud applications while still using their existing PNF-centric management stack and protocols to configure broadband access. In simple terms, SEBA enables a carrier to use their capital to deploy Edge Clouds rather than Access Nodes and to run a broadband access workload on that cloud that can continue to be managed from their existing OSS. Other workloads can be orchestrated with new systems, and the OSS can be replaced or retired at the carrier's convenience.

The relationship between BAA and VOLTHA is that they are largely independent and solve different problems. They can even function as co-operating parts in a carrier's network, with VOLTHA and SEBA embodying the PNF AN, and BAA embodying a management abstraction to attach SEBA and other PNF ANs to management and automation systems, like CloudCO.

If the carrier need is to configure PNF ANs, then BAA is an appropriate choice. If the carrier need is to disaggregate ANs and to use AN PHY white boxes with a cloud deployment, then VOLTHA is an appropriate choice. If a carrier is interested in both, then it is possible to choose both, as was just described.

BBF and ONF have noticed than many types of carrier deployments would benefit from the capabilities offered by BAA and VOLTHA. So, we have agreed to explore and collectively prescribe an effective, efficient path for the industry to take advantage of the innovations and benefits of the two projects.

This understanding is critical to move virtualized access platforms forward so that we all can gain the benefit of this modular architecture to ensure interoperability, high performance, scalability and most importantly reliability. We need to address the most important aspects of making such system operational by interconnecting our products with the existing OSS/BSS and future network automation and orchestration systems.

About BAA

BAA abstracts various AN types (e.g. OLTs, DPUs, DSLAMs) and different hardware designs, to make it easier to manage and control multi-vendor access resources for new and existing deployments utilizing a unique software layer leveraging standardized interfaces and open data models in a primarily NETCONF/YANG-orchestrated carrier network.

In Figure 1, BAA is shown both with an interior composition (on the left) and as a component of BBF CloudCO (on the right). BAA provides a number of benefits in this environment, but most importantly, it provides a common northbound view of a number of potentially different Access PNF (Physical Network Function) devices. This is achieved through the mapping of vendor-specific, multi-technology AN models to a standardised YANG interface on the southbound to a standard universal YANG abstraction interface along with the standard YANG models specific for each technology on the northbound. With this type of abstraction BAA can simplify and reduce development upstream in management and control software for PNFs and VNFs.

The support of a standardised Southbound Adaptation Interface provides the capability to connect existing ANs to BAA, provided adapters are developed for them. This in turn provides a reliable path for migration from legacy management to an automation environment as well as coexistence and migration of a mixed deployment of legacy and new generation ANs.

About VOLTHA

The VOLTHA project focuses on providing a small, re-usable component to allow cloud systems to support access as one of their workloads. The physical devices are simplified compared to traditional ANs and are programmed using VOLTHA southbound adapters. VOLTHA provides a common data model and a set of northbound APIs to manage and control many of the simple

devices at a low level. Its core purpose is to abstract the access device silicon, and make the access network look like a simple programmable Ethernet switch to an SDN controller.

A traditional PNF AN would not only host access ports, but also support aggregation of many such ports, while also implementing a set of control plane functions and a management agent. In contrast, in a typical cloud deployment that uses VOLTHA for the access, the aggregation functionality is embodied in fabric switches, the control plane applications are embodied as SDN controller applications, and the entire system is managed through a set of agents that interact with orchestration and other APIs. This supports the goal that service providers can write or choose their own features à la carte, adjust the management and orchestration to meet their existing systems, from OSS to ONAP, and only need to support what they use. This modularity is demonstrated in the SEBA reference design shown in Figure 3 above.