Open BNG Operator Position Paper

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Abstract

Telecommunications operators need new, community-driven industry approach, leveraging disaggregation, softwarization and automation, to design, build and deploy next-generation broadband networks more effectively and efficiently. Open Hardware and Open Source Software with open, well-specified APIs offers the basis to meet the design principles with the desired significant reductions in OPEX and CAPEX. This position paper presents motivation, goals and key deployment scenarios of the operators, making a call to the industry to join, expand and strengthen the collaborative community building solutions meeting those goals.

Rethinking the IP Broadband Edge

We are a collection of individual network providers that operate and maintain extensive estates of broadband network gateways (BNG).

The BNG is the critical element that straddles our collective access and backhaul networks. On the one hand: it aggregates, terminates and imposes policy for several thousand broadband user sessions – both residential and business – across the *fixed access network*. On the other hand: it provides the gateway for connectivity across the *backhaul network*. It provides the platform that underpins our respective wholesale and retail products and services, both for ourselves individually, and for other operators.

The Broadband Forum[1] identifies how the BNG has evolved over the past three decades. From its initial manifestation as a broadband remote access server (BRAS) to support dial-up remote access services; to current configurations that embrace additional network functions. These functions include full IP network routing with Provider Edge (PE) capabilities for Mobile Backhaul (MBH) and enterprise services.

Each of us has evolved our respective BNG estates to address our individual, particular ***historical set*** of challenging objectives and goals. These determined the choices we made.

As we progressed along this journey we worked closely with our existing suppliers; jointly endeavouring to balance the many technical and commercial constraints we encountered. For example, how best to utilise our individual network topologies; whether a centralised, or a distributed, deployment was better suited to our requirements; also the need to address and satisfy regulatory oversight of our commercial activities that balances retail and wholesale. As a result, the choices we each have made over time have led to implementation divergences that our existing suppliers have accommodated.

Today as network providers - individually and collectively - we consider a ***future set*** of challenging objectives and goals that mandate **greater control over our operational expenditure (OpEx) and capital expenditure (CapEx)[2].**

Our intention with this positioning paper is to explain what will motivate the allocation of our CapEx and OpEx budgets towards the **refreshment** and deployment; maintenance and scaling of our next generation of BNG hardware and software estate – collectively referenced hereafter as the **Open BNG**.

Figure 1: Open BNG initiative

The hyperscale cloud operators have transformed the networking industry over the past two decades. So as network providers we collectively appreciate how coupling a continuous oversight of capital and operational expenditure together with development and operations (DevOps) disciplines provides necessary operational efficiencies.

[1] Broadband Forum, TR-178 Issue 2, available at https://www.broadband-forum.org/
[2] Arthur D. Little, Who dares wins!, available at https://www.adlittle.com/en/who-dares-wins

It is noteworthy how service efficiency improves by migrating from ***traditional*** operational practices through ***cloud-enabled*** (e.g. coarse-grained virtual machine applications like NFV) to ***cloud-native*** micro service applications (e.g. fine-grained container applications) with applications that are distinct from the underlying platform. These will **shorten the cycle time for the introduction of service enhancements** – from conception to revenue - and the maintenance of live services through the timely identification and resolution of faults.

But these efficiencies are contingent on **competitively sourced, openly specified modular, merchant-silicon outfitted Open BNG hardware** from original design manufacturers (ODMs.) We believe that splitting-apart ("disaggregating") the BNG software from the BNG hardware will lower the barrier-to-entry and attract the greater participation of both existing and new hardware vendors and software suppliers. Innovation will flow; development cadences will accelerate; all will benefit.

A useful corollary is how a complementary modular Open BNG software stack can be assembled from a parsimonious bundle of distinct software components - leveraging available and emerging open source software as applicable. Each assembly can be customized to our respective, particular technical choices for Open BNG applications. Crucially the **software stack remains decoupled** from our intention to specify requirements for a **common, open BNG hardware platform**.

The adoption of **open, application programing Interfaces (Open APIs); open control and management protocols; and common data models are necessary** to support disaggregation of **Open BNGs**. We reiterate: it will provide the commercial motivation for existing and emerging suppliers to direct their development effort and resource to a common, open BNG platform that we as operators will benefit.

We also believe that a common, open BNG platform – potentially harmonized with the needs of a 5G UPF – will pave the way towards the more permanent, necessary separation of the hardware platform from the software control and software applications across our collective network estates.

With the common, collective understanding we have outlined in mind, this document describes our technical considerations and transformation levers that underpin key use cases and deployment scenarios for Open BNG that culminate on our call to action to the industry.

High-level view on disaggregating a BNG

The BNG is the **aggregation point** for traffic flow between a customer, and a network service provider (NSP) / Application service provider (ASP.) It provides **policy management** of many discrete, bi-directional customer flows; where the resources consumed by each discrete flow can be moderated with fine-grained IP hierarchical quality of service (HQoS.)

Our existing **monovendor BNG hardware** is (typically) a big, heavy metal monolith. Each monolith comprises a collection of removable monovendor-specific elements that include line cards (uplink- or access-facing); processing cards; and control plane cards all mated to a backplane/mid-plane.

Our existing **monovendor BNG software** is a somewhat opaque monolith. It is likely modular and has separate components, but it is difficult for us (or others) to easily program, optimize and customize the components to our requirements.

Disaggregation liberates a monolith into several distinct parts, or components, or functions that were once opaquely coupled together. When it comes to disaggregating a BNG, we distinguish between horizontal disaggregation (i.e. functional decomposition) from vertical disaggregation (i.e. Hardware and Software; Control and Forwarding). This permits for flexible combinations of the parts, components and functions to be assembled particular to our respective operational needs.

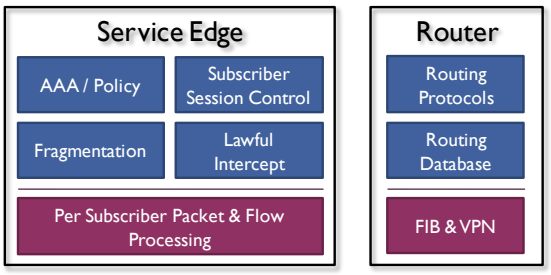

Figure 2: The two BNG building blocks: Service Edge and Router[3]

As service providers, we will – as outlined in this paper – then select & choose particular combinations of BNG software and BNG hardware components that best satisfy the opportunities that are presented to us in the marketplace. These are expressed as the deployment cases hereafter.

An **Open BNG** can be horizontally decomposed on the functional side into two major building blocks: Service Edge (SE) and Router. We identify the Service Edge (SE) as the access-facing building block where the subscriber sessions are terminated, services are applied and policies enforced. The Router building block that aggregates / disaggregates traffic is essentially an IP router providing protocols and encapsulations that include BGP/IS-IS and MPLS.

Each block is formed from several (independent) modules; each module contains and performs a specific task. This modular containment, for example, allows the Routing Protocol module to operate independently and concurrently from the Lawful Intercept module. Figure 2 shows the two building blocks and an exemplary and non-exhaustive list of modules per building block.

Figure 2 already indicated the vertical disaggregation option with separation of the lower, purple forwarding plane from the upper blue control plane. However, we envision a third plane, the forwarding hardware, as well. The vertical as well as the horizontal split and separation options of the disaggregated Open BNG are depicted in Figure 3.

The forwarding hardware provides chipset-near interfaces for the SE and router to program data paths throughout the chipset. The interface is provided by SDKs or for example by P4. We would encourage the adoption of suitable abstractions via Open APIs between the forwarding plane and the forwarding hardware.

On top of the forwarding plane is the control plane that instructs the forwarding plane on a higher level of abstraction to program "flows" as for example a PPPoE termination of a subscriber with services attached as well as an IP route.

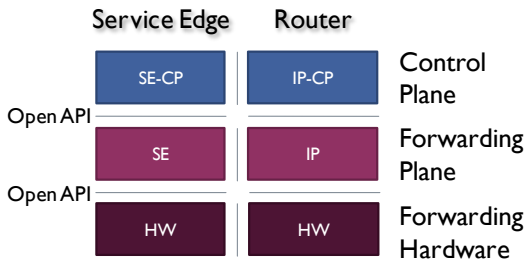

Figure 3: Principle options for BNG Disaggregation and Split

Now, as said, multiple combinations can be applied. The Figure 4 shows three examples of deployment scenarios where in each one, key aspects of the disaggregation are used while other components stay bound together.

[3] Based on ONF SEBA RDv1.0, available at https://www.opennetworking.org/

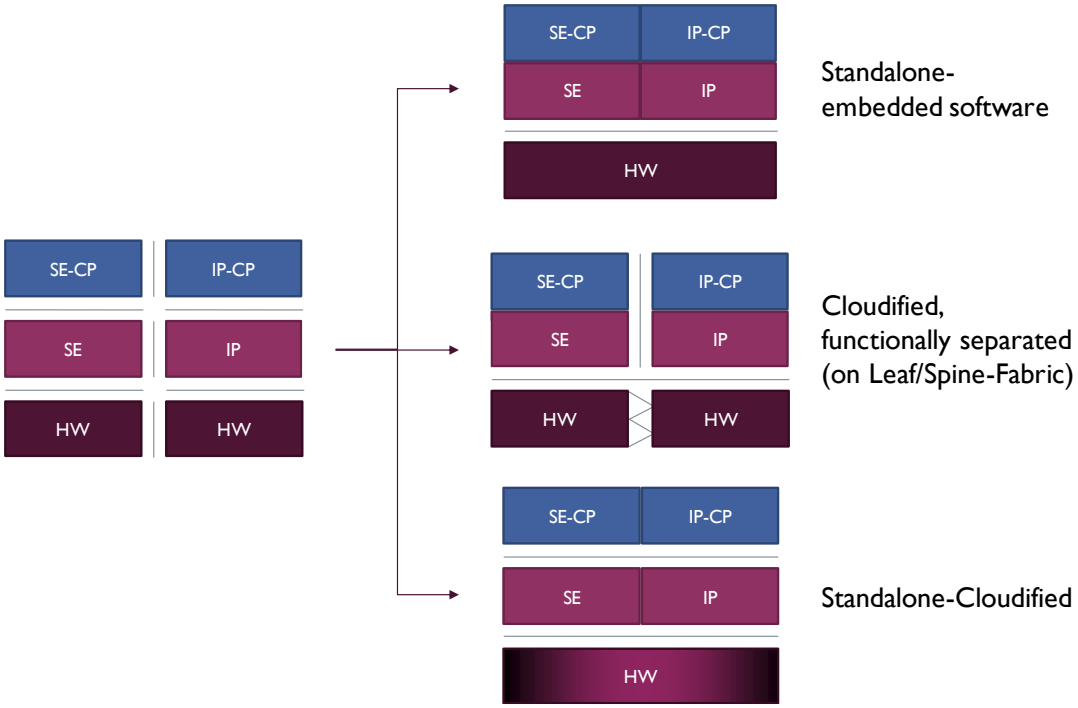

Figure 4: Deployment Cases based on Disaggregation

In the Standalone-embedded software scenario, BNG software is separated from the BNG hardware while the BNG software stack is deployed as a single entity, fulfilling the key principle of disaggregation. It is expected that hardware will be general-purpose white boxes and the software can be provided by various suppliers supporting the underlying devices.

In the scenario of a Cloudified, functionally separated BNG (embedded on Leaf/Spine-Fabric) a horizontal disaggregation comes into play. The routing tables towards the IP core, as well as the software building the Routing Information Base and triggering the installation of forwarding entries are handled by an IP routing control plane while the subscriber-facing control and forwarding plane runs separately. Further, the forwarding hardware is separated in different hardware devices. Usually, in such an aggregation-like scenario, a leaf-spine switching fabric architecture is used.

The Standalone-Cloudified BNG scenario also separates the BNG hardware from the BNG software but allows multiple hardware variants, ranging from ASIC-based *(merchant silicon)* white boxes to x86-based server solutions, requiring appropriate hardware abstraction. Further, the separated control plane is not hosted on the same physical box, but is distributed and hosted in a different, potentially centralized location. Still, the forwarding plane is hosted on the BNG hardware.

All three scenarios do have in common the specific set of functionalities of a BNG, and a clear separation of hardware and software ensuring multi-vendor deployments of the disaggregated Open BNG based on an open API based architecture and design as shown in Figure 4.

While not further detailed in this paper, it is worth to mention the need to extend the openness of the BNG architecture to the management plane, so that open, well-specified interfaces and data models for services and network resources support the required interoperability between network devices, SDN controllers, Management and Orchestration Systems, in order to reduce integration cost & time, and achieve a healthy and open ecosystem.

Call to the industry

As individual operators, we have expressed our collective need for the Open BNG solution based on: generic, common-off-the-shelf open hardware; modular software with well-defined, open APIs in between the layers (towards hardware / northbound towards control and management planes) preferably available as Open Source Software[4] where applicable and appropriate; all elements integrated/tested/validated and ready for production.

participation of new, emerging suppliers; promote cross-industry focused collaboration to address the key challenges of reducing power consumption and foster an open and healthy ecosystem.

There are several communities working already in the area such as BBF, OCP, ONF or TIP, each of them focusing in a set of specific topics. To prevent double work and inefficiencies, we, the publishing operators, agree to support existing communities in a well-coordinated effort. Our Open BNG opportunity, the refreshment of a key

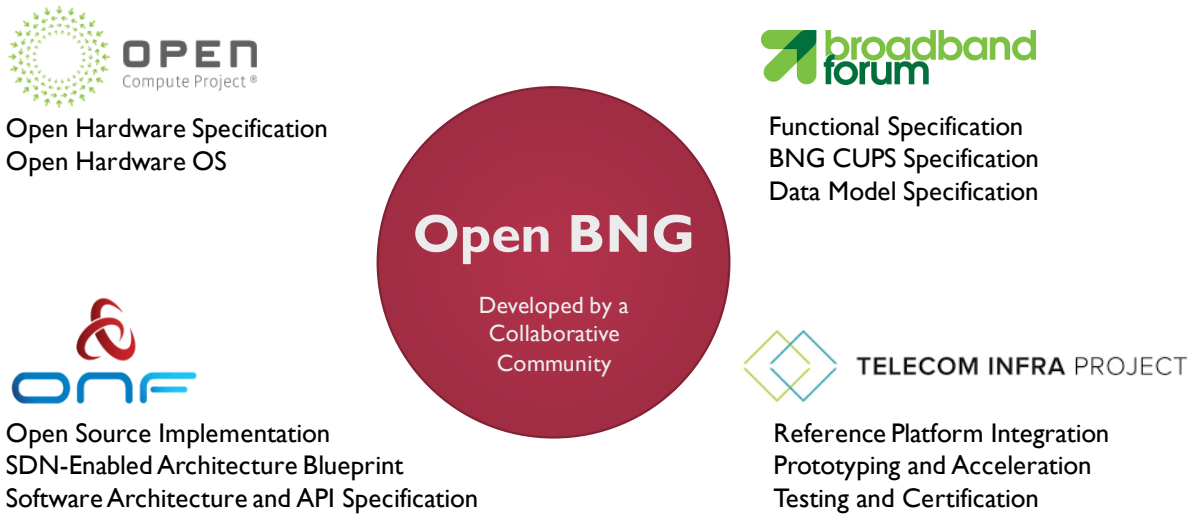

Figure 5 Open BNG Community

There are three areas of our CapEx and OpEx expenditure that we wish to optimize: bi-section bandwidth (Gb/s per € expended); electrical power consumed (watts per square meter) and thermal energy evolved (joules per cubic meter). We will manage these carefully as we will all benefit from a more diverse and scalable; agile; cost-effective and energy-sensitive eco-system of hardware and software suppliers.

Furthermore, we anticipate that it will engender a wider engagement of interested parties to work collectively. It will lower the barrier-to-entry to encourage the

component of today's broadband networks, can be re-applied to future opportunities e.g. 5G convergence, enhancing the overall Industry's ability to deliver on our connected future.

Join us.

[4] Open Source Software is not detailed in this position paper. We expect to leverage the commonly accepted and well-known community advantages of open source software like high level of security, faster introduction of new features and functions, reduced maintenance costs, etc.