Solution Brief

Deploying an Agile, Cost-Efficient Cloud BNG

Introduction

In telecommunications networks, the Broadband Network Gateway (BNG) is a network device that establishes and manages subscriber sessions and terminates fixed broadband subscriber traffic. It connects to Customer Premise Equipment (CPE) enabling customers to access various broadband subscription services such as the Internet, Voice over Internet Protocol (VoIP), or Internet Protocol television (IPTV), which are aggregated through a single connection from various access networks, such as Digital Subscriber Lines (xDSL) or Fiber-to-the-X (FTTX).

The BNG is a mature technology and supports many functions, such as providing authorization, policing, traffic filtering, and Quality of Service (QoS), as well as routing within the service network. Traditionally, BNGs were implemented as hardware-based platforms on the edge of telecom networks, usually in a regional location. Current internet traffic trends demonstrate increasing load on BNGs, with increased throughput on the access side on subscriber lines and increased volume generated by consumers. This is related to an increased usage specifically of video internet services. Hence, telecom operators now have to consider how to implement new cost-efficient solutions for further network expansion taking into account these new and increasing volume and throughput demands. Hrvatski Telekom (HT) as market leader in Croatia chose the route of cloudification by implementing a virtualized BNG solution.

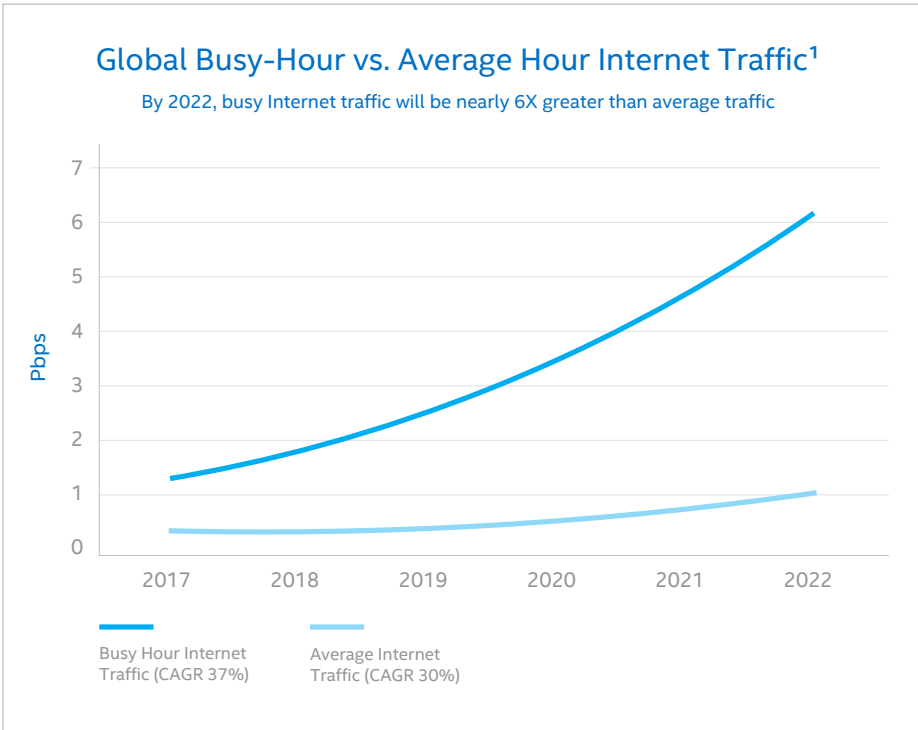

Figure 1. Global IP Traffic Growth

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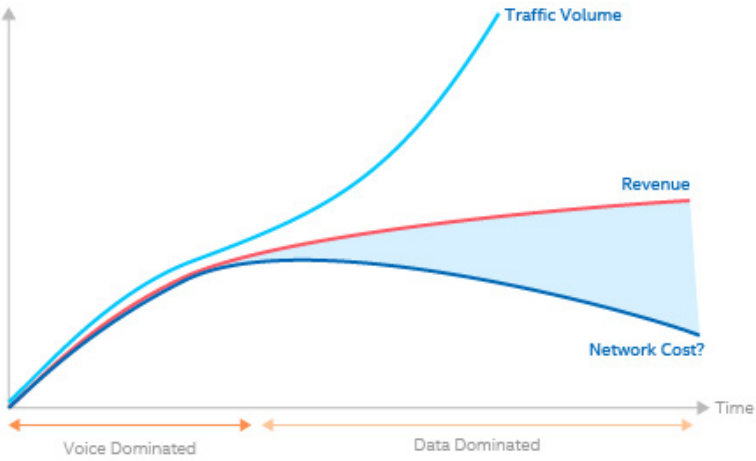

Figure 2. The Decoupling of Traffic v Revenue

A recent Cisco VNI report suggests that IP traffic growth will continue unabated at a compound annual growth rate (CAGR) of ~30%. This trend presents an additional problem for broadband operators in that the busy hour internet traffic CAGR of ~37% outpaces the average traffic growth rate. Broadband networks must be provisioned and built to take busy hour traffic into account.

This trend relates back to the well-understood industry phenomenon wherein telecom operators are seeing a decoupling of their revenues from the traffic volumes they must continue to service.

This demands a new approach to broadband provisioning. The application of cloud technologies to the fixed access network will provide telecom operators with a new platform approach and the opportunity to reduce costs while increasing opportunities at the network edge.

The Business Drivers toward Cloud BNG

In the autumn of 2019, HT decided to embark in this new direction towards addressing their fixed access network transformation goals.

HT embraced a software-defined telco strategy, which included the cloudification of all wireless core and wired access network functions. They applied NFV and cloud principles to their legacy fixed-access hardware the same innovative and disruptive approach that had been applied to their core network transformation. This gave way to a new cloud BNG approach – Cloud BNG.

This strategy would ensure that HT would be able to meet their flexibility goals of scaling capacity and to meet increased traffic demands around horizontal software scaling. This approach would allow HT to achieve ever-increasing dynamic performance and throughput improvements on a more optimized, cost-efficient model.

It was also envisioned that this approach would greatly improve HT's capital efficiency. One of the program's key goals was to understand if commercial off-the-shelf (COTS) hardware coupled with a move to a software/cloud-based approach, would enable substantial savings-per-gigabit on broadband traffic.

The software-centric approach would allow HT to flexibly deploy a new software scale-out model, replacing the previous capital-intensive approach they had been using while deploying hardware.

Finally, HT also understood that this new simplified and centralized deployment approach would enable even more operational cost savings from the perspective of in-field service upgrade and service uptimes/redundancy.

The Solution – Moving to a Cloud BNG

HT's infrastructure was designed as an implementation across regional data centers in Zagreb, Rijeka and Split.

To realize their business goals, HT partnered with the independent software vendor 5x9 Networks (5x9) and Intel to implement a new cloud BNG solution.

As the basis of their BNG design, 5x9's solution leveraged the Intel founded Data Plane Development Kit (DPDK), an open-source software development kit (SDK) optimized for packet processing workloads. This enabled 5x9 to build a fully-featured BNG from scratch using the foundational libraries provided by DPDK.

The software solution stack was built on Hewlett Packard Enterprise (HPE) servers and based on the Intel® Select Solutions Forwarding Platform concept. This platform approach provides the requisite server design guidelines for optimal packet processing on an Intel based COTS server.

The virtual broadband network gateway (vBNG) solution was deployed with Control and User Plane Separation (CUPS), which was required to implement a disaggregate BNG solution which allows for independent scaling of user plane and control plane functions.

Using these open-source components, 5x9 developed a turnkey broadband edge solution which HT began testing in a live network within two quarters of commencing development. In a mere twelve months from concept inception they deployed a highly optimized solution on a broadband network. The solution addressed all of HT's business goals enabling them to meet their primary intent of moving away from expensive dedicated network-edge hardware to a uniform cloud infrastructure with the required efficiency, flexibility and cost characteristics.

The 5x9 solution consists of three essential components, as shown in Figure 3 below:

1. Virtual BBRAS Forwarder (vBF)
2. Virtual BBRAS Controller (vBC)
3. Virtual Dashboard (vDB)

The vBF was built using the Cloud BNG DPDK foundations and dedicated to primary BNG forwarding plane-related tasks – Point-to-Point Protocol over Ethernet (PPPoE) and Internet Protocol over Ethernet (IPoE), user session termination, Ethernet and IP traffic forwarding, QoS, and the generation of low-level user statistics.

The vBC performs tasks related to the control plane. It is responsible for system provisioning and management, internal system component and external user IP addressing, routing, redundancy, scalability, and elasticity.

The vDB is an application with a web frontend and underlying Software-Defined Networking (SDN) capabilities dedicated to system configuration, management, and load/health overview. It is the single point of configuration and management for the whole system. Multiple APIs (Netconf/YANG, REST) also offer possibilities for easy integration with third-party platforms.

The HT solution was deployed on an OpenStack cloud computing platform using a Linux Kernel-based Virtual Machine (KVM) as the hypervisor. The underlying server hardware consists of HPE servers with two Intel® Xeon® Gold processors and eight 10/25 Gb Ethernet Network Adapters per compute node. This enables a theoretical platform throughput capability of 200 Gb per server.

Using 5x9's unique approach, and once the OpenStack API access was enabled and the necessary zero-day configuration was in place, the vDB automatically spun up all of the necessary virtual machines required for HT's fully redundant deployment.

The system was tested for scalability and flexibility and can scale virtual forwarding nodes up or down depending on the current number of connected customers and their varying throughput needs.

New nodes do not require manual configuration or IP addressing since this is done automatically by the vDB. An additional benefit over a traditional BNG solution is that 5x9's solution requires no IP pool redundancy, as the 5x9 algorithms manage this, and in the case of outages, the IP address allocation is automated and can redeploy IP address pools to new virtual machines.

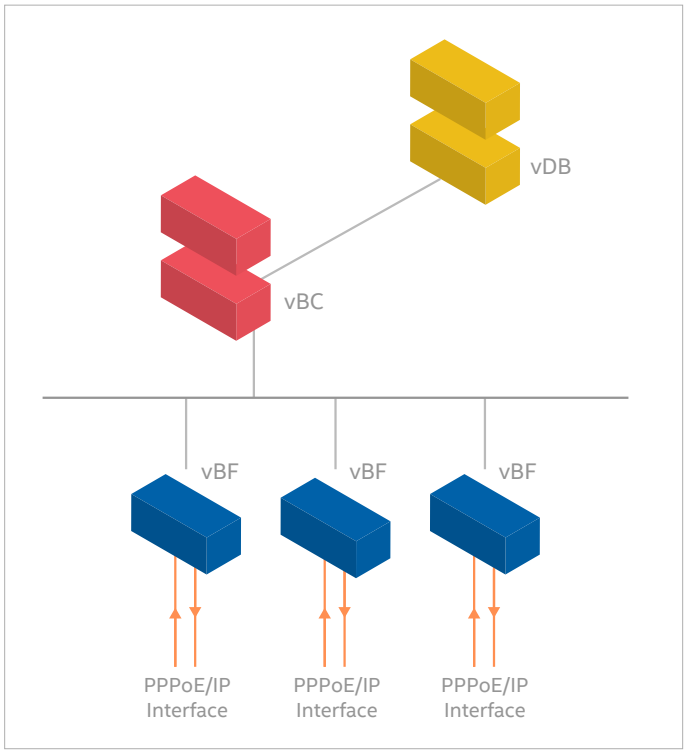

Figure 3. Cloud BG Architecture

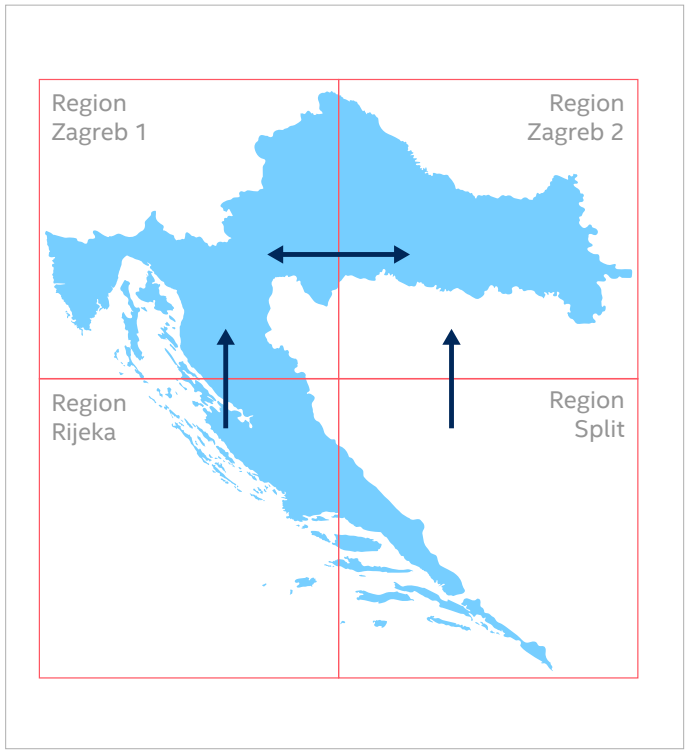

Figure 4. Cloud BNG Redundancy Model

The server can currently host 80,000 users and provides 80 Gbps (500-byte packets) throughput on a single server meeting HT's specific broadband requirements.

The solution has been verified by HT in a commercial traffic deployment. The system offers the flexibility to adjust these parameters based on subscriber density or throughput needs.

5x9 sees the potential for even higher throughput speeds of up to 200 Gbps at a 500-byte packet size and 160,000 subscribers per host and they are continuing to innovate with the user plane. The Intel DPDK enabled them to take advantage of the full capabilities of Intel's latest server technologies, achieving performance-per-dollar efficiencies far beyond traditional, physical BNGs. The Cloud BNG approach allowed them to deliver a product with unique features which decreases HT's total cost of ownership (TCO) while meeting the same stability and throughput requirements of physical BNGs.

In addition, the cloud-enabled central redundancy design was much simpler. Two sites in Zagreb each run 50% of the traffic for North, Central, and East Croatia and are redundant to one another. Zagreb also provides redundancy to Split and Rijeka (see Figure 4).

Data center migration is ongoing and to date 450,000 live customers are running on the BNG Cloud. The vDB GUI is used to monitor the system and Grafana is used to visualize performance KPIs. The solution has been fully integrated with the HT OSS layers.

Results and Conclusions

By adopting the Cloud BNG approach, HT took the primary step required to become a software-defined telco on cloud-based principles. Cloud BNG enables HT to introduce new services and meet capacity and flexibility requirements for increasing traffic while simultaneously reducing their capital outlay and reducing operational costs.

HT has also achieved critical investment efficiency goals and has measured 35% savings on the investment. The cloud implementation also enables additional advanced cloud automation possibilities which will be introduced in subsequent phases of the project.

Horizontal scaling was achieved by adding new Cloud BNG instances which are zero-touch automated installations that can be installed much faster and at a much lower cost when compared to bringing new physical BNGs into production.

The program has been a complete success and HT is now moving to a full migration of its broadband subscribers onto their Cloud BNG infrastructure.

Future enhancements will target the enabling of a more efficient solution for higher access bandwidth in accordance with HT's plans to increase FTTX speeds and coverage.

The virtualization of BNG function in cloud environment is important step towards converged 5G Core. 5G Fixed Mobile Convergence standardization effort brings new functionalities which should transform BNG to AGF Access Gateway Function to ensure unique control of both Fixed and Mobile Access.

Hrvatski Telekom

HT is the leading telecommunications company in Croatia, providing a full range of telecommunications services – fixed and mobile telephone services, data transmission, TV services, internet, and international communications. HT's vision is to deliver sustainable and profitable growth by connecting everyone in Croatia to the opportunities of digitization, enabling people to improve their lives.

5x9 Networks

5x9 Networks is a company founded by experienced network engineers with a mind and skills of a programmer. Collaborative and solution-oriented, our goal is to create products based on Network Functions Virtualization Infrastructure (NFVI) which will be simple to use, cost-effective, and valuable to our customers.

Intel

Intel is an industry leader, creating world-changing technology that enables global progress and enriches lives. Inspired by Moore's Law, we continuously work to advance the design and manufacturing of semiconductors to help address our customers' greatest challenges. By embedding intelligence in the cloud, network, edge and every kind of computing device, we unleash the potential of data to transform business and society for the better.

Acronyms

Term	Description
AGF	Access Gateway Function
BGP	Border Gateway Protocol
BNG	Broadband Network Gateway
CAGR	Compound Annual Growth Rate
COTS	Commercial Off-the-Shelf
CPE	Customer Premise Equipment
CUPS	Control and User Plane Separation
DPDK	Data Plane Development Kit
FTTX	Fiber-to-the-X
HPE	Hewlett Packard Enterprise
HT	Hrvatski Telekom
IPoE	Internet Protocol over Ethernet
IPTV	Internet Protocol television
KVM	Kernel-based Virtual Machine
OSS	Operations Support Sustems
PPPoE	Point-to-Point Protocol over Ethernet
QoS	Quality of Service
SDN	Software-Defined Networking
TCO	Total Cost of Ownership
vBC	Virtual BBRAS Controller
vBF	Virtual BBRAS Forwarder
vBNG	Virtual Broadband Network Gateway
vDB	Virtual Dashboard
VoIP	Voice over Internet Protocol
xDSL	Digital Subscriber Line

[1]Cisco VNI Global IP traffic Forecast, 2017-2022

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