Chapter 19
Optimizing the Delivery of Services Supported by Residential Gateways:
Virtualized Residential Gateways

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ABSTRACT

The Residential Gateway (RGW) is a key device, located on the customer premises, that stands between the home network and the access network. It imposes a considerable cost for the NSP and constitutes a single point of failure for all the services offered to residential customers – such as Internet access, VoIP, IPTV and Video-on-Demand. As such, the RGW constitutes an ideal candidate for virtualization, potentially relieving the NSP from such problems while also providing benefits to end-users. This chapter discusses the rationale and proposes an architecture for a virtualized Residential Gateway (vRGW) that physically removes the RGW from the customer premises, moving it into the operator data center or other logical point-of-presence, as a virtualized entity. This solution potentially reduces deployment, maintenance and operation costs, whilst improving overall performance, flexibility, reliability and manageability – both for the access network infrastructure and for the services provided over this infrastructure.

INTRODUCTION

As the access network gradually evolves towards a broad deployment of Fiber-To-The-Premises (FTTx) network topologies or cable (this is especially true, if considering the imminence of DOCSIS 3.1 (CableLabs, 2014) deployments), with DSL (Digital Subscriber Line) being progressively phased out. This trend spells the end of an era, where the decline of the old copper-based last mile paradigm with separated vertical service infrastructures gave place to a converged service

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delivery model, with operators rethinking their service offers in order to reduce costs and improve flexibility and manageability, going well beyond the obvious performance benefits of upgrading the physical transport infrastructure.

Despite the evolution of the access network in terms of its role and underlying physical transport technologies, some components of the legacy access network model still persist, maintaining or even increasing their critical role in modern infrastructures. The Residential Gateway (RGW) is one of those components. Considering the present technology developments, the RGW starts to look like an anachronism, as it constitutes a device that mostly embodies the legacy access network model, surviving almost unchanged to the present day. As such, there is an opportunity to ponder alternative approaches. It is obviously impossible to completely remove the RGW physical device functionality from the customer premises, since it will always be necessary to bridge the local network devices (computers, set-top-boxes, telephones, etc.) with the access network. But beyond that, there is a whole array of RGW functionalities that can be moved outside the physical RGW and closer to the operator's infrastructure, thanks to advances in virtualization and access network technologies.

Virtualization technologies have become one of the main driving forces behind the evolution of the Network Service Provider (NSP) infrastructures, also proving instrumental for the introduction of cost-effective services to end-users, able to leverage the return on investment in the infrastructure. This is a natural outcome of the trend towards the convergence of technical advances in the field of virtualization, that has enabled the consolidation and scaling of resources in a cost-effective way and which has also found its way into the telecommunication operator infrastructure foundations, from data centers to networks alike. This evolution is slowly outgrowing the scope of the data center or the core network, as it reaches towards the edge of the infrastructure and into the access network (Xia, Wu & King, 2013). In this perspective, the vRGW (Virtual RGW) is a logical next step.

In this chapter we leverage the technical advances in the field of virtualization (from network to services) to propose a vRGW architecture that can be implemented on current NSP infrastructures. The proposed vRGW concept is also a departure from the conventional operator rationale about the customer premises network environment that considers it as a service consumer "island" populated by devices, going instead for an approach that extends the reach of the home network outside the physical boundaries of the home LAN. This means that the access network role might be somewhat converted from a simple connectivity pipe to an extension of the home LAN. This has a significant potential, especially considering how it can affect the way customers invoke services.

While recent developments in terms of Network Function Virtualization (NFV) and Software-Defined Networking (SDN) have prompted the industry to start developing standards and solutions to incorporate their benefits within NSP infrastructures, most of the work, including specifications, is still in its early stages. The vRGW solution hereby proposed was developed based on existing standards, namely Broadband Forum's (BBF) TR-101 (Anschutz, 2011) and TR-156 (Ooghe, 2013) broadband aggregation scenarios for DSL and GPON (Gigabit Passive Optical Networks) technologies and off-the-shelf hypervisor technologies, in order to enable a virtualized vRGW appliance that can be hosted on the NSP's network (e.g., in a data center). This deployment scenario is in line with use cases proposed by the main standardization bodies, including the NFV approach of replacing dedicated and proprietary hardware with virtual appliances implementing Virtualized Network Functions (VNF) with service chaining that allows the enforcement of differentiated traffic forwarding policies, as described in the European Telecommunications Standards Institute (ETSI) VNF-FG use case (ETSI NFV002, 2013), that