NBBS Service Module Architecture

A Complete Solution for Multi-Service Remote Management
in the Connected Home Environment

Technical White Paper

Mowaffak Midani
Director of Network Solutions Architecture

Gabriel Rubinsky
Product Line Manager
Enterprise

netopia

Table of Contents

Introduction

Netopia offers a powerful remote management system, the Netopia Broadband Server (NBBS), that manages residential gateways (RGWs) and enterprise routers (ER) based on the auto-configuration architecture defined in the DSL Forum's TR-069 specifications [1].

Moving forward, Netopia is expanding this remote management model and demarcation point from device-level management to network- and service-level management. This enhancement to the basic remote management model allows Netopia to offer the most comprehensive remote management solution in the industry today, arming carriers with the necessary tools to offer and manage the broadest range of services in the connected home environment.

The objective of this technical white paper is to describe the multi-service remote management architecture supported by Netopia. This architecture is referred to as the **Service Module Architecture.** It is based on the creation of intelligent service modules (software components) on the core NBBS platform, addressing the specific needs of key services such as IPTV and gaming.

Basic Needs and Requirements for Remote Management

In the connected home and triple-play service environments, the service/network provider has profound interests and business needs that require extending the edge demarcation point and managing some home devices **remotely** from a centralized management system[1]. The objective is to minimize the cost of service activation and to assist in resolving technical problems encountered by the end user while using the service.

The range of problems that the network provider must deal with today is not restricted to the RGW anymore, but rather extends to the home network located behind the RGW and to the variety of customer premises equipment (CPE) devices used by the end user. Moreover, with the increased sophistication of devices and services, the intelligence level of remote management must be raised to address specific networking and services needs.

It is therefore becoming clear that remote management must evolve from today's **device-centric** management to **network-** and **service-level** management, and Netopia has the knowledge and components that enable carriers to manage their networks and value-added services efficiently.

The key requirements for a complete remote service management solution are:

- Identity management and authentication of devices and end users [2]
- Image (firmware) download management
- Provisioning of some key parameters of home devices, network segments (LAN and WAN), and a multitude of services upon service activation

[1] Typically located in a Network Operation Center (NOC).

[2] Identity management is a key issue of debate in the standard, especially in relation to mobile services.

- Granular monitoring of performance at the device, network level, and service level, with an elaborate and easy-to-use user interface (UI)
- Diagnosing and predicting potential problems within the home environment, even before they are discovered by the end user
- Resolving most of the problems remotely by tuning critical device, network, and service parameters
- Managing legacy devices that are not TR-069 capable via a combination of local proxying (within the home network) and flexible data models on the auto-configuration server
- Facilitating the migration from current network architecture(s) to Fixed Mobile Convergence (FMC) architecture(s) supporting IP Multimedia Services (IMS) via flexible standards-based remote management

It should be noted that not all home networking and service problems can be fixed remotely, but the objective is to make it possible to fix most of them through the deployment of a complete, intelligent, and multi-layered remote management solution.

Service Module Architecture – a Solution for Multi-service Remote Management

NBBS is evolving from a system that supports remote ***device*** management to a system that supports remote ***network*** and ***service*** management. Consequently, Netopia is pursuing a three-layer remote management architecture, as shown in the figure below.

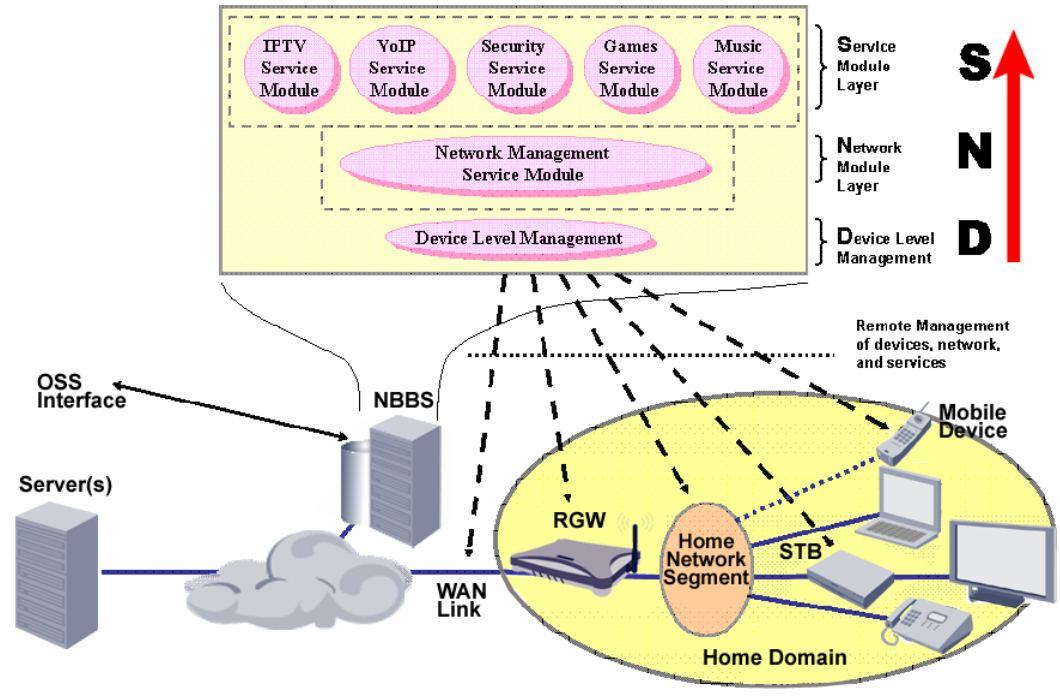

Figure 1: Multi-layer Multi-service Remote Management Architecture

The **Device Management Layer (DML)** is based on the current auto-configuration server (ACS) architecture, per the DSL Forum's TR-069 specification. Netopia is expanding the capability in this layer to cover more devices, such as set-top boxes (STBs), PCs, and handheld/wireless devices.

The **Network Management Layer (NML)** is a common layer supporting all devices and services since the network is a shared resource. This layer includes the home network segment[3] and the WAN link to the access network, be it copper-based, fiber-based, or wireless.

The **Service Management Layer (SML)** is service-specific, and has the potential to encompass a wide range of capabilities. Some key service modules in this layer will be described later on in this white paper.

Collectively this architecture could be referred to as the **"D-N-S Remote Management Architecture",** where,

- **"D"** stands for Device,
- **"N"** stands for Network, and,
- **"S"** stands for Service.

The level of intelligence in the management system increases as we move upward from the device level to the network level to the service level.

Description of the Device Management Layer

The Device management layer encompasses the identification of the physical device or the identification of a virtual device representing the end user in a mobile environment, and its ability to connect to the network up to the IP layer. Security keys and passwords for local and remote management of the device are best handled in this layer since they are usually tied to the MAC address of the device, or to the electronic signature embedded in a smartcard.

This layer also includes the management of CPE images (firmware) upon initial download and when an upgrade is deemed necessary by the network/service provider or by the end user. There will generally be different modules (subsystems) in this layer corresponding to different types of devices (Gateways, Set Top-Boxes, video and data storage, digital cameras, etc.).

Description of the Network Management Layer

Some level of network management for both the access/WAN side of the home and the LAN side of the home is becoming necessary for the network provider, taking into account end-user privacy needs. This layer of network management is becoming more prominent with the advent of triple-play services. In such a multi-service environment,

[3] There could be multiple home network segments in the home environment.

the network and the devices (RGW and CPE) must be **configured** and **tuned** to meet the needs of services with varying QoS requirements. The rationale is as follows:

- **Voice/VoIP services** require assured packet delivery and low latency delay for the user-plane traffic (encapsulated voice samples), without the need for excessively high bandwidth. VoIP call control is mostly based on the SIP protocol, which is a peer-to-peer acknowledged protocol. What is important for SIP operation in a VoIP service is that the control messages reach the other party. A delay in transmission for a second or two is not of major consequence in this control-plane layer. Delivery of messages and acknowledgement of received messages is important, and mechanisms have been designed into the protocol to support the necessary handshaking between parties across the network.
- **Video/IPTV services** are much more demanding for all planes. In the user plane, MPEG-encapsulated IP packets must be delivered without delay (in the millisecond range) to avoid pixelization problems at the receiving end. Given the tremendous bandwidth requirements of real-time video streaming, this is a challenging problem for any network and any router along the way, including the RGW.

  Routing gets much more challenging when multiple audio/video MPEG streams need to be supported intermixed with traffic from voice and data services, as is the case in any triple-play service environment. Channel-change signaling messages (also called "zapping" messages), which are based on the IGMP protocol, must be processed in tens or hundreds of milliseconds, not in seconds, so the timely delivery and processing of IGMP messages is of paramount importance for the IPTV service.

  Moreover, given that the IGMP protocol is not an acknowledged protocol (there are no ACK messages sent back by the server as a result of Join and Leave messages initiated by the clients), and that the IGMP messages are sent directly over IP and not over TCP, the assured delivery of these zapping messages is a challenge to the network layer since the network layer is not involved in the process of assuring the delivery of IGMP messages. (More about IPTV later in the IPTV service module.)
- **Internet data services** are best-effort kinds of services. TCP is widely used to guarantee the delivery of packets from one point to another across the network. Latency delay is not an issue unless video clips are being transported. In general this service is more tolerant of delay than the VoIP and IPTV services. This service is also characterized by the tendency to be bursty, especially in the case of large file downloads. Consequently, the network and devices on the network must be set appropriately to handle a burst of data traffic without adversely impacting other, more time-sensitive traffic.

The network management layer encompasses:

- the WAN interface to the access network, which is critical in the case of DSL/copper or wireless, and
- the local home network, which could itself consist of multiple segments, as defined by the IPTV Interoperability Forum (IIF) specifications. [2]

The network management layer therefore includes, among others, the following components:

- WAN interface management, including **spectrum management techniques** to optimize the performance of the DSL link or the wireless link/network
- Recognition of all CPE devices on the local network, and the creation of a **home network map**
- Provisioning of the **queuing structure** in the RGW to handle the needs of different services. Since the home environment is generally different from one residence to another, tuning of the parameters, and even changing of the queue structure altogether, might be needed for best results.

  The ability to perform this task remotely is highly desirable. One of the most attractive features in Netopia's combined offering of RGWs and NBBS is the ability to remotely set, change, and tune a multi-stage queue model in the RGW, right from NBBS. The sophistication of the queuing model already implemented on the RGW VGx[4] routing engine, along with the ability to construct and modify the RGW queuing model and to tune the parameters from NBBS, enables the network provider to tune the home network to fit the needs of multiple concurrent services.

  It is important to note that the VGx routing engine's queue management capability in the RGW affects all the services in the same way. That is, this network layer capability **is used by all services, and is not exclusive to any.**
- **NAT and firewall** settings on the RGW to protect the home network from the outside world. This functionality is necessary to protect the home in general and is not tied to any particular service or service model. Its scope is the home network domain at large.
- **Bandwidth management** and allocation of resources in the home network and connected devices. In a more advanced environment this layer could also perform Call Admission Control (CAC) functions on behalf of the end devices to protect the integrity of the home network. For example, in an IPTV service environment that offers linear TV (multicast) and video-on-demand (VoD) services, the bandwidth manager on the RGW, within this network layer, could reject (or block) the addition of yet another video stream to protect the streams already flowing.
- **Diagnostics** at the physical layer, data link layer, and IP layer. A good suite of tasks run in the background by the RGW and the CPE under the management of NBBS will provide the network provider with much-needed visibility. It is the hope that many of the potential problems can be detected and corrected by the network provider *before* being noticed by the end user.
- Another desirable capability is the ability to **optimize the local wireless network** based on some measurements performed by the RGW. This involves the

[4] "VGx" is an acronym refering to "Virtual Gateway Technology", an advanced classification, queuing, and routing architecture implemented in Netopia's ADSL and VDSL router and gateway products.

calibration of the transmitter and receiver circuits on the RGW and the wireless devices in the home.

The key to the network service module is the realization that it is managing shared network resources to resolve networking problems and to improve performance for both the WAN network and the LAN network.

Description of the Service Management Layer

The service management layer is a very exciting layer to consider. There are new services being introduced every day by service providers, and some level of remote management by the network provider is very much needed. The following is a list of some key service modules, with basic descriptions of the entailed functions:

1. **IPTV Service Module:** There is no service getting more attention in the telecom industry today than IPTV service. IPTV is a matter of survival for Telcos in their battle with the MSOs. Some deployments are already in place and many trials are in progress. Network providers are experiencing the pain of trying to support the transport of video streams across networks that were designed to handle voice and data traffic. Moreover, since the initial (and most basic) video service is a linear video service based on multicast and IGMP signaling, the weaknesses and shortcomings of the IGMP protocol are sources of headaches for any network provider offering IPTV services.

   There are therefore two aspects to the IPTV Service Module: management of the control-plane (signaling) behavior and management of user-plane behavior in the network elements (RGW and STB).

   - Management of control-plane behavior:

     As was mentioned earlier, IGMP is not an acknowledged protocol. It is also not carried on top of TCP. Consequently it is almost transparent to the network layer, and thus to the network management layer. Simply stated, the loss of an IGMP message is not detected by the network layer. To remedy this situation, some intelligence at the IPTV service layer is needed to address the specific needs of IPTV service. These needs include:

     - The **provisioning** of some key IGMP parameters, such as the robustness variable(s) and other timers
     - The **collection** of measurements in relation to IGMP messages (Join and Leave messages and their latency delays)
     - The **tuning** of these parameters by NBBS to improve IPTV signaling performance

   - Management of user-plane behavior:

     Video traffic is carried from the video server to display devices in MPEG transport streams (MPEG-TS) encapsulated in RTP/UDP/IP packets. The monitoring of some key parameters related to the RTP, UDP, and MPEG layers, including the MPEG system information tables, is instrumental in

allowing the service/network provider to have some visibility into the delivery aspect of the service. Obviously MPEG layer functions relate more to the STB (and other display devices) than to the RGW since the RGW does not terminate or monitor the MPEG streams.

Note:

It should be clear that the IPTV service module, like all other service modules, rides on top of the network layer. A networking problem related to video is best resolved at the network layer first, whenever possible. This could be achieved via the tuning of the queuing model in the RGW. However, there are still some IGMP protocol-specific parameters that are not seen by the network. These parameters exist in the network elements (devices) themselves, that is, the RGW and the STBs (or PCs). The focus of this IPTV service module is to monitor all aspects of the MPEG layer, and to tune and optimize the relevant signaling and control parameters in the RGW and STBs.

2. **Gaming Service Module:** Gaming is a lucrative source of revenue for network providers and service providers alike. Some service providers are offering gaming services to their customers for a reasonable monthly charge. The service concept is based on creating a safe, parent-approved pool of video games to download and play. The service/network provider thus needs to manage the pool of games and their usage, but need not be in the user-plane flow.

   Netopia can add lots of value to this service model by managing the service remotely. Specifically, NBBS is positioned to keep a list of approved games, along with the networking means (address/port numbers) for accessing them through the firewall, on the RGW. With the addition of new games to the pool, the service/network provider need only update NBBS, which in turns updates the multitude of RGWs across the network. This model provides the network provider with the tools to offer a profitable managed gaming service.

3. **Home Security Service Module:** Some service providers are already offering home security services to their customers along with wireless cameras and software running on the RGW or another home device. The cameras feed the signal to the RGW, so remote monitoring of the house is possible with the proper login and password credentials. This service allows the customer to monitor what is happening in the house while he or she is at work or out of town. While the video streams are obviously not directed to NBBS, the management of the service, such as login credentials, alarms, software upgrades, etc., can easily be managed by NBBS.

There are many more service modules under consideration by Netopia. The objective of this white paper is to provide a sufficient overview to communicate the basic concepts and show the wide range of possibilities for the service/network provider.

End-to-End Network View of Layers and Functions

An end-to-end view of the network and the functions associated with the different layers is shown below. The functional boxes are shown vertically on top of the simple physical end-to-end network at the bottom.

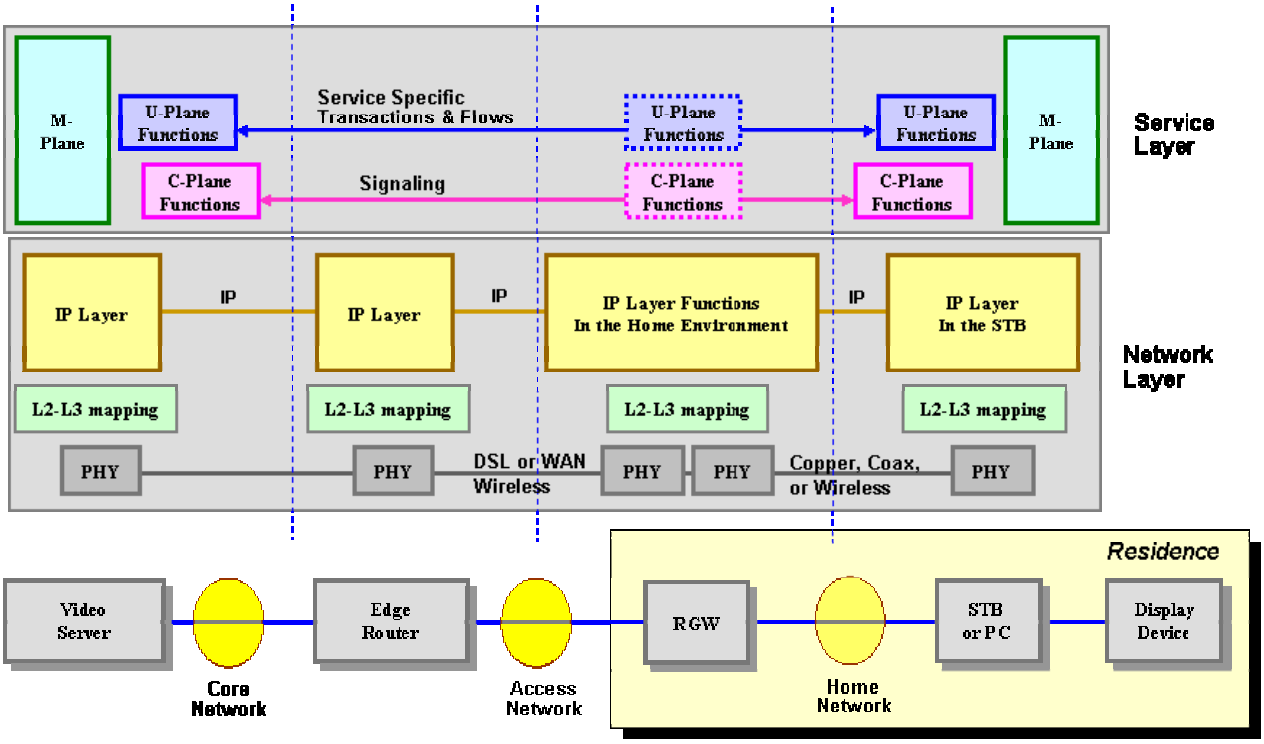

Figure 1: Network View of Layers and Function

Different devices support varying degrees of functionality for any particular layer. For example, the RGW is very involved in the network layer since it is effectively the router in the home, while the end devices (STB, PC, handheld devices) are more involved in the service layer since they are the terminating points for these services. Moreover, for some services there is very little involvement needed from the RGW at the service layer (shown in dotted lines above).

Conclusion

Netopia is leading the industry with a complete, standards-based remote management solution that covers devices, networks, and services. Netopia has taken the lead in both the DSL Forum and the IPTV Interoperability Forum in defining the necessary remote management parameters and functions for a well-managed IPTV service, including residential gateway and set-top box management.

Specifically, Netopia defined and introduced new objects in the DSL Forum set-top-box data model for the effective management and optimization of video surfing for linear

video service. Netopia holds a co-editorship position[5] of the Remote Management Working Text document of the IPTV Interoperability Forum.

Through its innovative multi-layer Service Module Architecture, flexible script-based service creation platform, and continuous leadership role in the standardization area, Netopia is positioned to be the prime remote management provider in the industry.

References

1. TR-069 Specifications, DSL Forum
2. IPTV Architecture Requirements Specifications, IPTV Interoperability Forum, ATIS, March 2006

[5] Mr. Midani is a co-editor of the IPTV Interoperability Forum (IIF) Remote Management Working Text document and an active contributor to IIF and DSL Forum standards bodies.