

A Resource Control Mechanism on NGN based Home Network for IPTV Service

Yangjung Kim, Ilyoung Chong

Hankuk University of Foreign Studies. Dept, of Information & Communications
{zeroplus, ilychong}@hufs.ac.kr

Abstract — In this paper, We propose a resource control mechanism for NGN based home network. Multimedia services such as HD/SD IPTV service and VOD service require an available bandwidth without loss, delay and jitter as well as efficient data transport technologies. In order to support end-to-end QoS, plenty of technology has been introduced mainly to the access and core network. But this trend is moving toward the home network, which includes desktops, laptops, IPTV STB, digital AV appliances, Wi-Fi phones, PDA, home gateway and server and so on. There exists many congestion points in home network, therefore home network needs to support end-to-end dynamic QoS control. The proposed mechanism can increase user's QoS satisfaction in NGN based home network. This paper aims at providing a dynamic resource control mechanism and procedures in the NGN based home network.

Keywords — HN (Home Network), HGW (Home Gateway), RACF (Resource and Admission Control Functions), IPTV (IP television), NGN (Next Generation Network), CGPE-FE(CPN Gateway Policy Enforcement Functional Entity), DNG (Delivery Network Gateway).

I. Introduction

Home network is the collection of elements that process, manage, transport, and store information, thus enabling the connection and integration of multiple computing, control, monitoring, communication and entertainment devices in the home. Home devices include many devices such as desktop, laptop, IP television (IPTV) set-top box (STB), digital Audio/Visual (AV) appliances, Wi-Fi phones, Personal Digital Assistant (PDA), home gateway and home server and so on. Currently, IPTV users require High Definition (HD) streaming service and real-time traffic. For this reason, there are a number of potential congestion points in the home network as shown in Figure 1. In particular ADSL, the upstream rate is much less than the rates of the home network technology. In case of Fiber to the Home (FTTH), the access physical layer capacity is greater than that of the home network technology [7].

To solve the problem, home network requires a mechanism to manage resource dynamically. Although home network needs end-to-end dynamic resource control, excellent technology is still in development. Network entities in the home network have no capabilities to dynamic resource control between the home network and policy control entities in the access network. So the home network needs a special

network interface which delivers some information for Next Generation Network (NGN) based dynamic policy control and NGN based network entities for policy installation. The interface and NGN-supported home network entities can help to overcome serious congestion in the home network and increase user's service satisfaction.

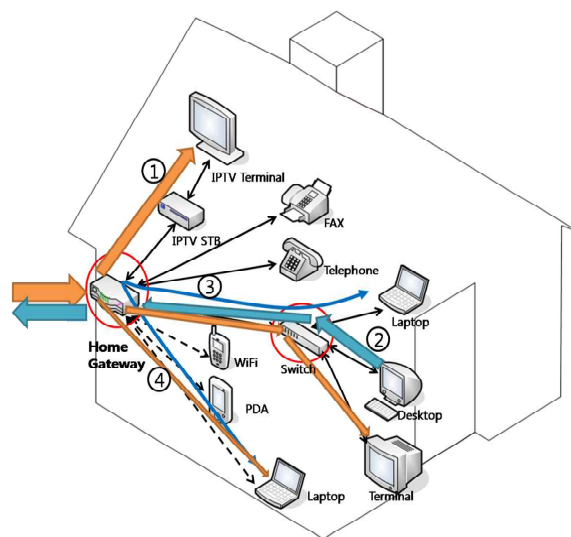


Figure 1. Potential Congestion Points in the Home Network

The International Telecommunication Union Telecommunications Standardization Sector (ITU-T) has been developing the Resource and Admission Control Functions (RACF) based on the early work of the Third Generation partnership Project (3GPP) and the Telecoms and Internet converged Services and Protocols for Advanced Networks (TISPAN)[6]. In the ITU-T NGN, dynamic policy control is a basic requirement. So home network side should be also considered for NGN based end-to-end QoS. For this, we propose a resource control mechanism on ITU-T NGN based home network for IPTV service and provide the procedure for resource negotiation between the home network and the access network. By using the mechanism, bandwidth efficiency is improved and end-to-end QoS is guaranteed. The proposed procedure reduces signaling burden between the home gateway in the home network and the Policy Decision Functional Entity (PD-FE) in the access network for dynamic resource control.

The remainder of the paper is organized as follows. In section II, We explain concepts and functional architecture for resource control of ITU-T NGN. Then, in Section III, we present the proposed architectural model and procedures to

support resource control in NGN based home network. Finally, Section IV provides a conclusion of the presented mechanism in this paper.

II. Related Work

2.1 ITU-T activities related to the Home Network

ITU-T has several joint coordination activities such as JCA-CIT, JCA-IdM, JCA-NID, JCA-IPTV, JCA-Mgt, JCA-AHD, JCA-HN and JCA-ICT. Objectives of Joint Coordination Activities (JCAs) are to coordinate and harmonize among each SGs (Study Group) under similar issues. The Joint Coordination Activity on Home Networking (JCA-HN) was established in March 2005. The JCA-HN has partnership with standards organizations such as ISO/IEC, ATIS, ETSI, Broadband forum, HGI[10], UPnP, DVB, HomePNA, IEEE 1901 and so on. This JCA monitors relevant draft recommendations in each SG. H.622[4] describes a generic home network architecture with support for multimedia services. As shown in Figure 2, Many types of user devices will be connected to the home network for exchanging information with other devices or creating services together with other devices. Home network extends the access network and interconnecting devices in home. And the home network contains two types of terminal devices and network domains as well as the gateway functionality as called the access gateway. Primary Terminal is a terminal device that can interact with the Access Network or service functionality beyond the Access Network without the assistance of another Terminal and is the service end-point where the service from the service provider is terminated. Secondary Terminal is a terminal device that has no direct interactive capability with network side entities or needs to rely on another terminal to do so. Primary Domain is the logically defined area of the Home Network that interconnects the Primary Terminal and the Access gateway. Secondary Domain is a logically defined area of the Home Network that interconnects Terminals. The devices and traffic dedicated to Secondary Domain do not need to be configured to be reachable to/from Access Network[4].

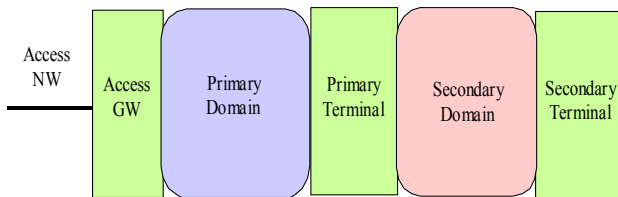


Figure 2. Application model of the Home Network

In order to offer streaming based multimedia services on the IP network, the functionality that realizes QoS on the IP network is important to achieve stable quality. J.190 (ITU-T) and UPnP describes class-based QoS. But TR-094 (DSL Forum) and HGI describe class based QoS. For examples of QoS solution using session based QoS are NSIS and UPnP QoS mechanism. And session-based QoS has the following problems[5]:

- Additional session set-up time introduced by the resource reservation process
- Some network devices are unaware of signalling protocol.
- Network devices need a complicated mechanism.

Class based QoS has merits such as less complexity to the home network than the session based QoS mechanism. So it can process without additional signaling among the terminal and network devices.

2.2 Resource Control Mechanism in ITU-T

ITU-T has been developing the Resource and Admission Control Functions (RACF) based on the early work of the 3GPP and the TISPAN. The RACF is aimed at providing real-time application-driven and policy-based transport resource management for a wide range of services and for a variety of transport technologies [1]. The RACF executes policy-based transport resource control upon user request through the Service Control Functions (SCF). The entity determines transport resource availability and makes admission decisions. Then, the RACF enforces policy decision to Transport Functions (TF).

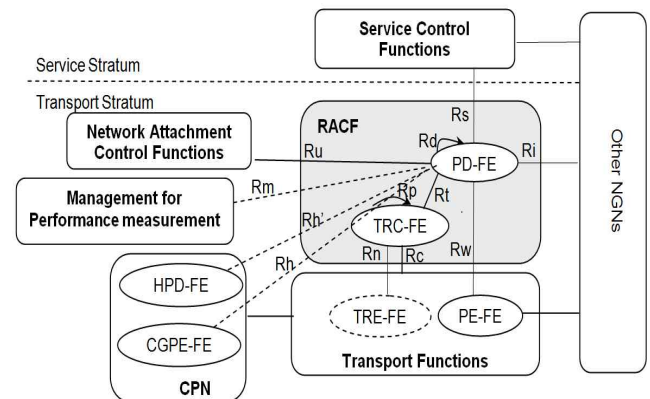


Figure 3. Overall RACF architecture in NGN

As shown in Figure 3, the RACF consists of two entities: the Policy Decision Functional Entity (PD-FE) and the Transport Resource Control Functional Entity (TRC-FE). The PD-FE makes the final decision regarding network resource and admission control based on network policy rules, SLAs, service information provided by the SCF. The TRC-FE deals with the diversity of underlying transport technologies and provides the resource-based admission control decision results to the PD-FE[1]. The TRC-FE collects the network information such as resource status information, and maintains network topology information and network resource information. Before the PD-FE makes final decision, the PD-FE sends the request message for resource availability check to the TRC-FE[1]. After received the response message from the TRC-FE, the PD-FE makes final policy decision based on the result of TRC-FE. Figure 4 shows a basic procedure for QoS resource reservation. A reservation request is triggered by a service establishment event in the SCF. The SCF sends a reservation request message with the media flow description and its QoS parameters to the PD-FE. Then, the PD-FE is required to authorize the required QoS resource for

the media flow and sends a message for resource availability check to the TRC-FE. After the TRC-FE checks resource status, the entity sends a response message to the PD-FE to support final decision. The PD-FE makes final decision based on the result from the TRC-FE. Then, PD-FE sends a resource reservation message to install the final admission decisions to the Policy Enforcement Functional Entity (PE-FE).

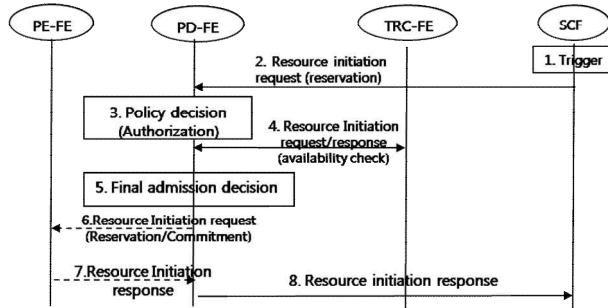


Figure 4. Basic procedure for QoS resource reservation

2.3 Considerations of the Home Network

The draft recommendation Y.RACF (Y.2111) defines the network entity and reference points related to the home network. The CGPE-FE is defined in Customer Premises Network (CPN) gateway and a functional entity enforcing the network policy rules instructed by the PD-FE via the *Rh* reference point[1]. That is, the *Rh* reference point is the interface between the CGPE-FE in the home network and the PD-FE in the access network and the *Rh'* reference point is the interface between the Home Policy Decision Functional Entity (HPD-FE) in the home network and the PD-FE in the access network as shown in Figure 5. The *Rh* reference point allows the PD-FE to enforce the admission decisions to the CGPE-FE, and the CGPE-FE requests the admission decision and sends a message for resource availability check to the TRC-FE in the access network. After the TRC-FE checks, the TRC-FE sends a response message to the PD-FE to support final decision. Such interactions and detailed information for the *Rh'* reference point are for further study.

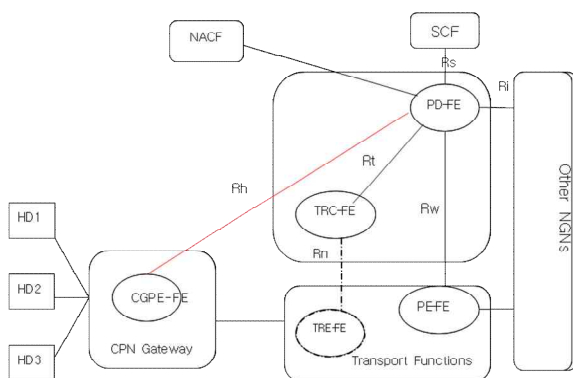


Figure 5. Architectural model for CPN gateway

In order to control the CPN gateway using the *Rh* reference point, the application in the home network requests a service request message to the SCF. A reservation request message (e.g, RIR: Resource Initiation Request) is triggered in the SCF.

Then, the SCF sends request message for policy decision to the PD-FE. On receipt of the reservation request message, the PD-FE is required to authorize the required QoS resources for the media flow. The PD-FE makes the final admission decisions based on the results from the TRC-FE and sends reservation message to install the final admission decisions in the PE-FE and the CGPE-FE. The PE-FE and the CGPE-FE sends response message with result of the policy installation to the PD-FE. Finally the PD-FE sends a response message (e.g, RIP: Resource Initiation Response) back to the SCF as shown in Figure 6.

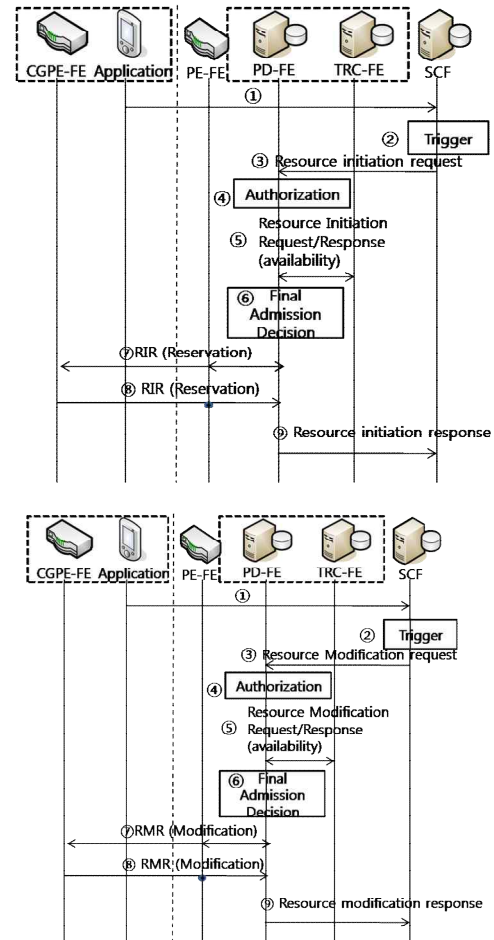


Figure 6. QoS reservation/Modification procedure using the *Rh* interface

III. Proposed Architectural model and Procedure using the *Rh'* reference point

3.1 IPTV service issues in the NGN based Home Network

As mentioned in the previous section, NGN based home network has two reference points for dynamic resource control: the *Rh* reference point and the *Rh'* reference point. The *Rh* reference point is a standard interface of the draft recommendation Y.2111 Rev2[1], but the *Rh'* interface is not included yet. By using this, the PD-FE can reduce signaling

flows between the home gateway and the PD-FE in network side. When a large number of IPTV users change the quality of streaming data depending on mobility, resource modification request and response messages can be additional burden to the PD-FE. To solve the problem, it's very important to control network equipments with policy in home network side via the *Rh'* interface. If IPTV users request QoS control for reservation to the PD-FE using the *Rh'* interface, network efficiency can be increased by eliminating the complicated procedures, and potential congestion points problem will be solved using dynamic policy control via the *Rh'* reference point. For this, We present the proposed architectural model and procedures to support resource control in NGN based home network.

3.2 Architectural model and procedure for NGN based Home Network

The CGPE-FE has capabilities to support QoS control in NGN environment. As shown in Figure 7, a large number of IPTV users in NGN home network receive HD IPTV streaming service across the NGN based home gateway. The home gateway has several capabilities for end-to-end QoS such as service control and resource policy control per flow or user. In order to increase IPTV user's satisfaction and reduce the burden from signaling messages such as reservation modification request/response, the *Rh'* reference point can help to support dynamic resource control to IPTV users under such circumstances. Because of direct interactions between the HPD-FE in the home network domain and the PD-FE in the access network domain, network efficiency will be better than NGN-based home network using the *Rh* reference point and none NGN-based home network.

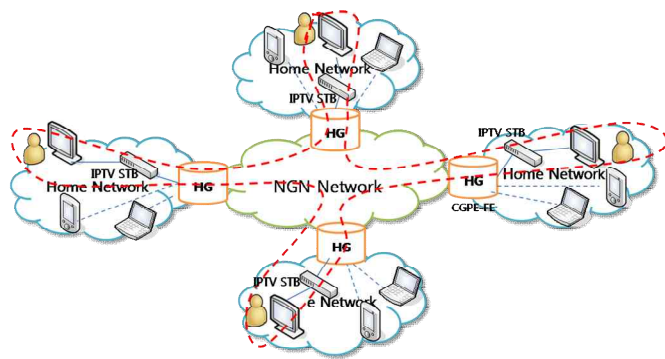


Figure 7. Architectural Model for NGN based Home Network

Many IPTV users change the reserved quality of streaming frequently for mobility or terminal changes. Resource modification request/response messages can be additional burden to the PD-FE in the access network domain. QoS reservation procedure for NGN-based home network is similar to the basic procedure of the Y.2111 as shown in Figure 6. When a user in home network requests reservation for IPTV service, the PD-FE authorizes the maximum threshold to serve the quality additionally. After then, when a user wants to modify the quality, the user just requests the service quality to the other home gateway directly. This procedure can

efficiently reduce additional signaling burden of the PD-FE, and allows the HPD-FE in A home network side to control another home network directly.

• Resource reservation procedure

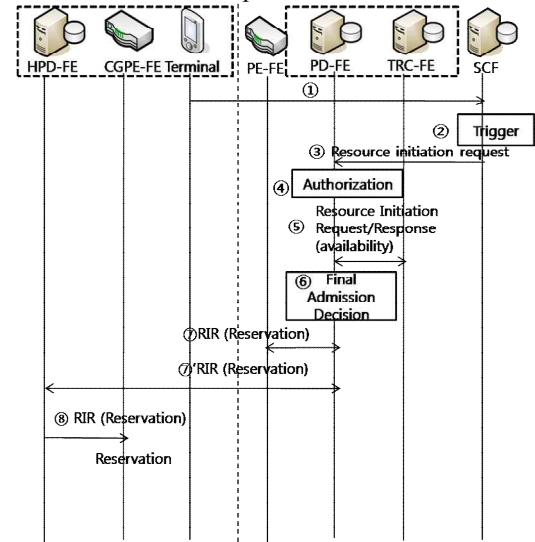


Figure 8. Resource reservation procedure using *Rh'*

In Figure 8, The Application in the terminal requests an application-specific service by sending a service request to the SCF. And the application in the home network requests reservation notification message to the HPD-FE. And then a Resource Initiation Request (reservation) is triggered in the SCF. The SCF determines or derives the QoS requirement parameters for the media flows of a given service. It then sends a Resource Initiation Request (reservation) with the media flow description and its QoS parameters to the PD-FE at the network side for QoS resource authorization and reservation. On receipt of the Resource Initiation Request (reservation), the PD-FE at the network side shall authorize the required QoS resources for the media flow.

The PD-FE determines which access networks and core networks are involved for the media flow. If there are TRC-FE instances in an involved network, the PD-FE sends a Resource Initiation Request (availability check) to one of the TRC-FE instances registered in the PD-FE to check resource availability in the involved network. The TRC-FE instance which received the Resource Initiation Request (availability check) shall send a resource initiation response back to the PD-FE. The PD-FE makes the final admission decisions based on the results of the previous procedure. The PD-FE authorizes the maximum bandwidth threshold for the requested service. The PD-FE may send a Resource Initiation Request to install the final admission decisions in the PE-FE and the home gateway. The HPD-FE allocates resource the authorized bandwidth to the home gateway. The PD-FE sends a Resource Initiation Response (RIP) back to the SCF

• Resource modification procedure

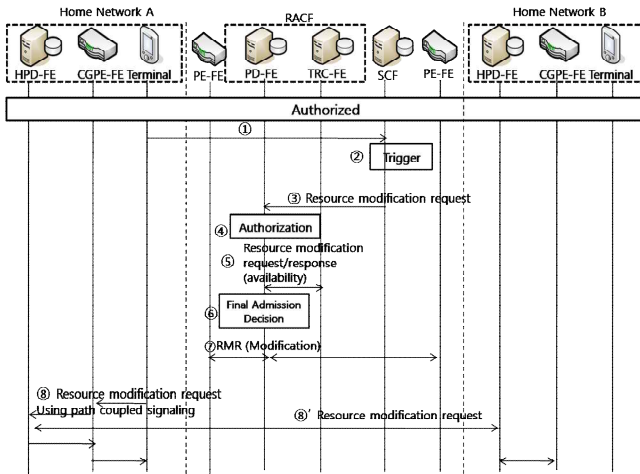


Figure 9. Resource modification procedure

As shown in Figure 9, The Application in the terminal requests an application-specific service by sending a service request to the SCF. A RMR (modification) is triggered in the SCF. The SCF determines or derives the QoS requirement parameters for the media flows of a given service. It then sends a Resource Modification Request (RMR) with the media flow description and its QoS parameters to the PD-FE at the network side via the Rs reference point for QoS resource authorization and modification. On receipt of the Resource Modification Request (modification), the PD-FE at the network side shall authorize the required QoS resources for the media flow. The PD-FE determines which access networks and core networks are involved for the media flow. If there are TRC-FE instances in an involved network, the PD-FE sends a Resource Modification Request (availability check) to one of the TRC-FE instances registered in the PD-FE to check resource availability in the involved network. The TRC-FE instance which received the Resource Modification Request (availability check) shall send a resource initiation response back to the PD-FE. The PD-FE makes the final admission decisions based on the results of the previous stage. The PD-FE may send a Resource Modification Request to install the final admission decisions in the PE-FE. Finally, the application in the terminal sends resource modification request using path coupled signaling to the HPD-FE. The HPD-FE in the home network A sends resource modification request with the maximum bandwidth threshold directly to the HPD-FE in the home network B. The HPD-FE in both sides allocates the modified bandwidth to the home gateway based on the authorized maximum bandwidth threshold.

IV. Conclusion

Home network has potential congestion points. To solve the problem, the home network needs dynamic resource control mechanism based on NGN. In this paper, We reviewed the concepts and architectural model of NGN based home network. Then, we presented the architectural model and procedures to support resource control in NGN based home

network. By using the proposed mechanism, additional burden from complicated procedure through the *Rh* interface can be reduced. When IPTV user requests policy control to the PD-FE in the access network domain, the PD-FE authorizes the maximum bandwidth for the requested service. If the user wants to modify the quality, the HPD-FE directly install or uninstall policy control with the authorized maximum threshold to the CGPE-FE. The proposed procedure uses the *Rh'* reference point. Of course, the procedure has no unnecessary signaling to modify the quality between the CGPE-FE and the PD-FE in the access network domain. Furthermore, the proposed mechanism can be used to control between home gateways without the SCF.

This paper proposes more efficient architectural model and procedure for resource control between NGN based home networks. Customized IPTV services using the proposed mechanism will support end-to-end QoS. The mechanism will be a solution for personal IPTV service under NGN environment.

ACKNOWLEDGMENTS

"This research was supported by the MKE(The Ministry of Knowledge Economy), Korea, under the ITRC(Information Technology Research Center) support program supervised by the NIPA(National IT Industry Promotion Agency)" (NIPA-2009-(C1090-0902-0036)) and the IT R&D program [2008-S-006-02, Development of Open-IPTV (IPTV2.0) Technologies for Wired and Wireless Networks]

REFERENCES

- [1] ITU-T Recommendation Y.2111 R2(2009.9), Resource and Admission control Functions
- [2] ITU-T Recommendation Y.2012 (2008), Functional requirements and architecture of the NGN
- [3] ITU-T Recommendation G.9970 (2009.1), Generic Home Network Transport Architecture
- [4] ITU-T Recommendation H.622 (2008.6), A generic home network architecture with support for multimedia services
- [5] ITU-T draft recommendation H.iptv-rm (2009), Architecture and functional requirements for remote management of home networks supporting IPTV services.
- [6] Christian Esteve Rothenberg, Andreas Roos, "A Review of Policy-based Resource and Admission Control Functions in Evolving Access and Next Generation Networks", March 2008
- [7] Gyunyoung Lee, Chaesub Lee, "Functional Architecture for NGN-based Personalized IPTV services", IEEE transactions on broadcasting, June 2009
- [8] Esteve Rothenberg, C. and Roos, A. "A Review of Policy-Based Resource and Admission Control Functions in Evolving Access and Next Generation Networks", J. Netw. Syst. Manage. 16, 1 (Mar. 2008)
- [9] Nasser, N. and Shang, M. "Policy control framework for IP Multimedia Subsystem", In Proceedings of ISTA '2009
- [10] <http://www.homegatewayinitiative.org>
- [11] <http://www.broadband-forum.org/>
- [12] <http://www.homegridforum.org>
- [13] <http://www.tta.or.kr>