A Mechanism for Resource Control and Functional Architecture of Overlay Multicast for IPTV Service in NGN

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Abstract — **Within the NGN architecture, the resource and admission control functions (RACF) act as the arbitrator between service control functions and transport functions for QoS related transport resource control within access and core networks. The decision is based on transport subscription information, SLAs, network policy rules, service priority and transport resource status and utilization information. This paper provides a mechanism for resource control and functional architecture of overlay multicast for IPTV service in NGN.**

Keywords — **RACF, RCF, Overlay Multicast, IPTV, Overlay node, SCF.**

1. Introduction

The resource control procedure complying to ITU-T standards in the NGN is related to NGN implementation to achieve high quality services. Therefore, an efficient control procedure and mechanism is required and there are many researches on this. To support end-to-end QoS, the RACF has important role to control resource in NGN. With the development of digital technology and network extent, new media service for broadcasting, multicasting and communication through various devices have been developing.

IPTV service is the most important part. IPTV is an abbreviation of 'Internet Protocol Television'. It is a service for offering various additional services with digital TV by using high speed internet network. We can use many contents such as searching, broadcasting, electronic trade, VoIP and so on by using IPTV service.

More specific techniques are required for offering various IPTV services. IPTV service must consider high speed capability offering and high quality program as compared with existing broadcasting TV service. So overlay networking mechanism is very important to offer IPTV service. Overlay Network is virtual communication structure in physical network that is established by using logical link. And overlay network is achieved in application layer. Overlay nodes provide flexible services for transmitting contents and controlling information. Overlay multicast means routing and data transmission in the application layer, which is much easier to implement and deploy. However, it is less efficient. Overlay multicast mechanism for IPTV service in NGN must support requirements of users and End-to-End QoS. This paper considers IPTV application environment based on overlay multicast by using resource control structure in RACF (It is renamed 'RCF' in this paper.) in NGN. In order to manage resources of overlay multicast for IPTV service, RCF supports resource management, resource policy and multicast group management for multicast users. This paper provides a mechanism for resource control and functional architecture of overlay multicast for IPTV service in NGN. This mechanism supports End-to-End QoS for IPTV service using overlay multicast in NGN.

2. Related Works

2.1 Structure of Resource Control in NGN

In the NGN architecture, the RACF (Resource and Admission Control Functions) acts as the arbitrator between SCF (Service Control Functions) and TF (Transport Functions) for QoS related transport resource control within access and core networks [5]. The RACF makes the policy decisions based on transport resource status and utilization information. As illustrated in figure 1, The RACF executes policy-based transport resource control upon the request of the SCF, determines transport resource availability, makes admission decisions, and applies controls to transport functions for enforcing the policy decisions. The RACF interacts with transport functions for the purpose of controlling one or more of the following functions in the transport stratum: bandwidth reservation and allocation, packet filtering; traffic classification, marking, policing, and priority handling; network address and port translation; firewall. The RACF consists of two types of resource and admission control functional entities, the PD-FE (Policy decision functional entity) and the TRC-FE (Transport resource control functional entity). This decomposition of PD-FE and TRC-FE enables the RACF to support a variety of access and core networks (e.g. fixed and mobile access networks) within a general resource control framework. [5].

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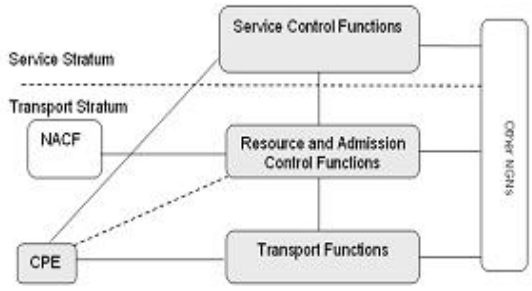

Figure 1. RACF Within the NGN Architecture

- **PD-FE**

The PD-FE provides a single contact point to the SCF and hides the information of trasport network to the SCF. And PD-FE makes the final decision regarding network resource and admission control based on network policy rules, SLAs, service information requested by the SCF. PD-FE controls the gates in the PE-FE at a per flow level[5]. PD-FE has the resource and admission control functions as following table 1.

Table 1. PD-FE elementary functions

Acronym	Function
FDP	Final Decision Point
QMTI	QoS and Priority Mapping - Technology Independent
GC	Gate Control
IPMC	IP Packet Marking Control
NAPTC	NAPT control and NAT traversal
RLC	Rate Limiting Control
FWMS	Firewall Working Mode Selection
CNPS	Core Network Path Selection
NS	Network Selection

- **TRC-FE**

The TRC-FE provides the resource based admission control decision results to PD-FE. PD-FE requests the TRC-FE through the Rt reference point to detect and determine the requested QoS resource along the media flow path. TRC-FE collects and maintains the transport network topology and the transport resource status information and authorize resource admission control of the transport network based on network information such as topology or connectivity, network and element resource availability[5]. TRC-FE has the resource and admission control functions as following table 2.

Table 2. TRC-FE elementary functions

Acronym	Function
QMTD	QoS Mapping - Technology Dependent
TDDP	Technology Dependent Decision Point
NTM	Network Topology Maintenance
NRM	Network Resource Maintenance
ERC	Element Resource Control

2.2 Definition and Concept of Overlay Network

IP Multicast is a technique that can transmit one copy of data traffic to multiple receivers at one time. Because it can greatly save the network bandwidth consumption. Overlay multicast mechanism has been an issue since the idea was proposed. However, it has not been widely deployed because of many reasons, such as management, security, inter-domain routing, etc. Recently, many researchers have studied overlay multicast. In overlay multicast, the data replication, multicast routing, group management, and other functions are all operated at application layer. Since it does not require changing the current Internet infrastructure, it can be easily deployed and many overlay multicast ideas have been proposed [9].

Overlay network is established through virtual communication structure in physical network by using logical link and it is achieved in application layer. Overlay nodes in overlay network are connected through virtual and logical link and they send packets including control information. Overlay network can provide efficient network service for IPTV service through maximizing existing network. Overlay network can be constructed though the way of making routing topology. Overlay network can also be used for internet routing improvement methods like streaming media service for ensuring QoS(Quality of Service). Routing multicast is also in overlay network.

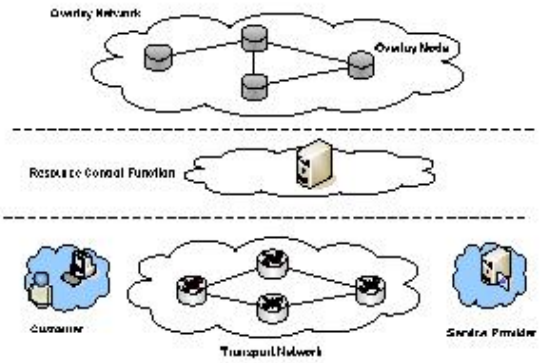

Figure 2. Service Architecture of Overlay Network

Overlay network has advantages as the follows[13].

- Overlay networks allow both networking developers and application users to easily design and implement their own communication environment and protocols on top of the Internet, such as data routing and file sharing management.
- Data routing in overlay networks can be very flexible, quickly detecting and avoiding network congestions by adaptively selecting paths based on different metrics, such as probed latency.
- The end-nodes in overlay networks are highly connected to each other due to flexible routing. As long as the physical network connections exist, one end-node can always communicate to another end-node via overlay networks. Thus, scalability and robustness in overlay networks are two attractive features.
- The high connectivity of increasingly more end-nodes to join overlay networks enables

effective sharing of a huge amount of information and resources available in the Internet.

2.3 IPTV Functional Architecture

There are many views of addressing control aspects of IPTV networks. This overall framework contains functional components related to IPTV network control aspects and aligns with IPTV functional architecture framework. As illustrated in Figure 3-1, IPTV functional architecture consists of application function, end-user functions, content delivery functions, service control functions, network transport functions, management functions and content provider functions. Some functional entities to support overlay multicast appended to the IPTV functional archtecture as shown in Figure 3-2. The function of IPTV overlay networking is performed under the control of Content Delivery Control Function of IPTV functional reference architecture, and service control function for IPTV overlay networking initiates and manages IPTV overlay sessions to configure service capability of IPTV overlay networking. The control of Content Delivery Control Function is performed with associated operation among overlay nodes, and the service control function for IPTV overlay networking is performed with Session Manager.

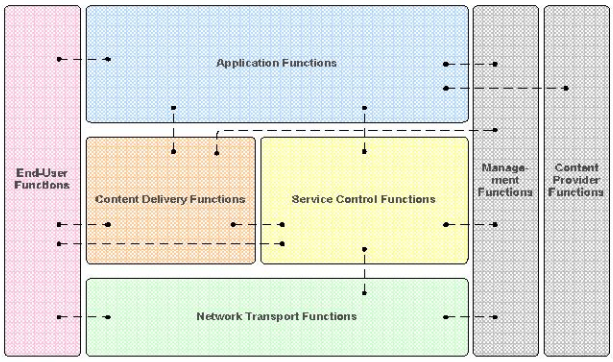

Figure 3-1. IPTV Functional Architecture

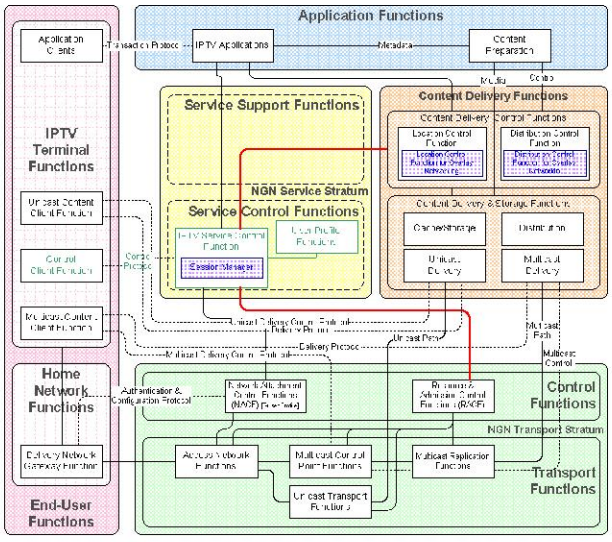

Figure 3-2. Functional mapping of IPTV Overlay network capability to IPTV Functional Architecture

3. Overlay multicast mechanism using RCF for resource control for IPTV service in NGN

3.1 Elements for the proposed mechanism

Overlay multicast is proposed as an alternative approach for providing multicast services in the Internet. A virtual infrastructure is built to form an overlay network on top of the physical Internet. Each link in the virtual infrastructure is a unicast tunnel in the physical network. The advantages of overlay multicast come at the cost of low efficiency of packet delivery and long delay. When constructing the virtual infrastructure, it is very hard to prevent different unicast tunnels from sharing physical links, which results in redundant traffic on the physical links[8]. This mechanism with the advantages of overlay multicast mechanism will be helpful to IPTV service in NGN. To support resource control, the proposed mechanism needs some elements for resource control such as session manager, overlay node, IPTV contents server and RCF (Resource Control Functions) as the following;.

- Overlay Node

Overlay node is a basic element for sending control information and data transmission in overlay network. .

- Session Manager

Session Manager maintains and controls many sessions for overlay IPTV service and users. It controls IPTV service information between Overlay node and RCF.

- RCF (Resource Control Functions)

RCF collects the information for QoS and available resource information for regular data transmission. RCF is composed of some entities such as PD-FE for making policy, NACF for authentication and TRC-FE for checking resource availability for the TF.

- IPTV Server

IPTV Server is an element to provide streaming contents traffic.

3.2 Structural Model of Overlay Node

Overlay node consists of overlay application function, overlay adaptation function and overlay node function as shown in figure 4. Overlay application function provides the interface for using TCP socket and overlay socket . Overlay adaptation function provides connectivity with another elements such as overlay node, session manager and end-user. Overlay node function provides two controller, location controller and distribution controller. Location controller manages topology information of the overlay multicast session, and location control collects the overlay multicast topology.

In order to manage resource of overlay multicast for IPTV service, RCF supports resource management, resource policy

and multicast group management for multicast users. Figure 4 shows the relation between session manager and the RCF.

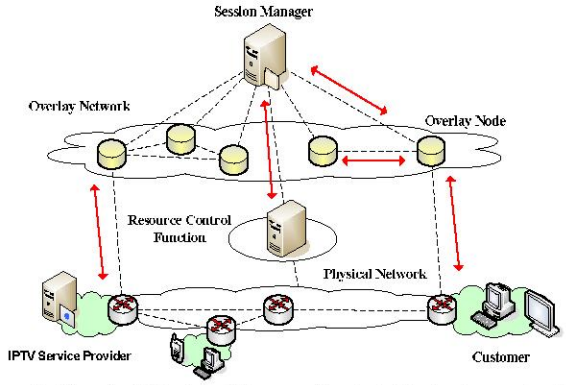

Figure 4. Structual Model of Resoure Control Mechanism using Overlay Multicast for IPTV Service

Overlay multicast end user requests to overlay node function for creating session and resource reservation. Overlay node function verifies the request message and sends the message to session manager for searching breakout point. If transport network has available bandwidth for the request, the RCF determines or derives the QoS requirement parameters for the overlay multicast in the TF (Transport Functions). Finally, the RCF sends a resource reservation request to install the final decision in the PE-FE (Policy Enforcement Functional Entity) as described in figure 5.

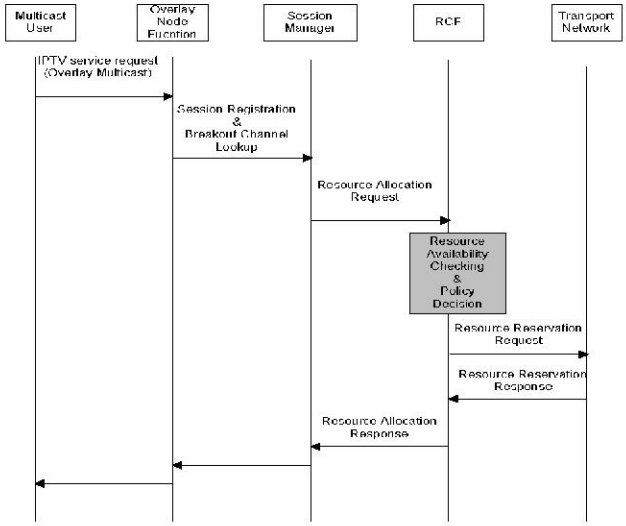

Figure 5. Simple Procedures to Allocate Resource

4. Conclusion

In this paper, we propose a mechanism for resource control and functional architecture, which supports end-to-end QoS using overlay multicast for IPTV service in NGN. Our mechanism is more flexible than other mechanism based on native IP multicast. Therefore, IPTV end user using this mechanism can use highly qualified bandwidth. We implemented the RCF using overlay multicast mechanism for resource control by subscriber's SLA and composed a testbed with separated domains, and configured the architectural model and mechanisms for IPTV service using overlay multicast.

REFERENCES

[1] ITU-T FG IPTV-C-0228, "Overlay Service Control Architecture for IPTV Services"
[2] ITU-T FG IPTV-DOC-0062, "Working Document: IPTV Architecture"
[3] ITU-T Recommendation Y.2001 (2004), General overview of NGN
[4] ITU-T Recommendation Y.2011 (2004), General principles and general reference model for Next Generation Networks
[5] ITU-T Recommendation Y.2111 (2006), Resource and Admission Control Functions
[6] ITU-T Recommendation Y.2012 (2006), Functional requirements and architecture of the NGN
[7] John Jannoti, David, K, Gifford, "Overcast: Reliable Multicast with an Overlay Network"
[8] Chao Gui and Prasant Mohapatra, "Efficient Overlay Multicast for Mobile Ad Hoc Networks", 2003
[9] Zhi Li and Yongjoo Shin, Survey of Overlay Multicast Technology
[10] P. Francis, Yoid: Extending the Internet Multicast Architecture, Unpublished at http://www.aciri.org/yoid/docs/index.htm, Apr. 2000
[11] S. Banerjee, B. Bhattacharjee, C. Kommareddy, Scalable Application Layer Multicast, Sigcomm 2002
[12] D. Anderson, H. Balakrishnan, F. Kaashoek, R. Morris, Resilient Overlay Networks, Infocom 2000
[13]http://www.cse.ohio-state.edu/hpcs/WWW/HTML/internet-p2p.html