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Resource Management and Control in NGN Transport

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Abstract **— Next generation network (NGN) is IP based broadband and integrated network of existing communication networks. This paper defines requirements of management information to perform resource admission and path computation for single-phase resource control scheme in NGN transport stratum. We also propose high-speed resource control mechanism based on parallel and single-phase scheme to minimize delay overhead between centralized resource admission control functions and transport functions.**

I. INTRODUCTION

ITU-T SG 13 has been a main study group to standardize next generation network (NGN) which is IP based broadband and integrated network of various existing communication networks [1]. SG 13 is defining NGN requirement [2] and architecture [3], and SG 11 is designing resource management and control protocols for transport network as its role of standardize signaling requirements and protocols [4]. As shown in Fig 1, NGN architecture consists of service and transport strata, which adopt various functional entities in each stratum to support more flexibility in network operation.

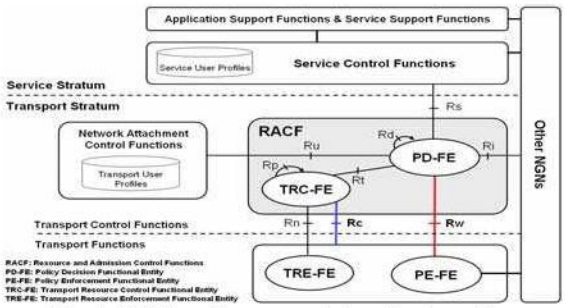

Fig. 1. NGN architecture and functional entities

There are service support functions and service control functions (SCF) in the service stratum to provide various application services in NGN environment, and transport control functions and transport functions in the transport stratum to transfer IP traffic through access and core networks. Resource management and control functions for transport network are mainly performed by resource admission control functions (RACF). Policy decision functional entity (PD-FE) in RACF decides final admission about network resources, and commands policy enforcement functional entity (PE-FE) through Rw interface to commit or release resources. Transport resource control functional entity (TRC-FE) collects information about topology and resource status through Rc interface, and performs resource admission control of transport network level [2][3].

There are three resource control states in RACF which are authorization, reservation and commitment states, and RACF may use single-phase scheme or two-phase scheme to control resources in transport network. PD-FE requests PE-FE to commit resources after reservation in two-phase scheme, but on the other hand PD-FE requests PE-FE to reserve and commit resources simultaneously [3]. As shown in Fig. 1, NGN architecture adopts various functional entities in each stratum to support more flexibility in network operations, but distributed functional entities may cause control processing overhead between centralized RACF and switches in transport network.

Single-phase scheme is required to guarantee high-speed resource control, because RACF is capable of requesting switch resource reservation and commitment at the same time in this scheme. RACF collects topology and resource status information of transport network through Rc interface, and then single-phase scheme makes use of this information for resource admission and path computation. The current version of RACF recommendation, Y.2111 in ITU-T SG 13 [3] does not clearly define detailed requirements for Rc interface.

This paper defines requirements of management information exchanged through Rc interface to perform resource admission and path computation for single-phase scheme. We also propose high-speed resource control mechanism based on parallel [5][6] and single-phase resource control scheme to minimize delay overhead between centralized RACF in transport control functions and switches in transport functions.

II. MANAGEMENT INFORMATION OF Rc INTERFACE

There are no clear and detailed requirements in the current version of RACF recommendation. Resource management protocol in SG 11 [7][8] based on common open policy service (COPS) or simple network management protocol (SNMP), defines some management information, but this information is not enough to perform resource admission control and path computation in RACF. The functional requirements of Rc interface are to collect topology and resource status information from transport network [3]. This section defines requirements of management information exchanged through Rc interface. To perform resource admission and path computation, RACF should collect management information such as system, neighbor, configuration and performance of interface, traffic engineering (TE) link, component link and connection information from transport network.

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A. System and Neighbor Node Information

System information is collected from a target node to be managed in the transport network, and this information requires an identifier to identify a system, system type, representative IP address, uptime to represent the elapsed time from the latest initialization, and so on.

Neighbor nodes are adjacent to a target node to be managed in the transport network. Neighbor node information has to include identifiers to identify neighbor nodes, representative IP addresses of neighbor nodes, administration and operation statuses of neighbor nodes, and so on.

B. Interface Configuration and Performance Information

Interface configuration information includes an identifier to identify an interface, interface type, IP addresses of its own interface and an adjacent interface, total bandwidth, administration and operation statuses of interfaces, and so on. Interface performance information requires message transmitting and receiving sizes, number of unicast and non-unicast packets, available bandwidth, number of error and discarded packets, and so on.

C. Link and Connection Information

Established links between adjacent nodes are classified into logical and physical links. A TE link is a logical and grouped link with more than one component links which are physical links with similar characteristics. Information for these links should include IP addresses of its own side and an adjacent side consisting of a link, maximum bandwidth, encoding type, protection information, administration and operation statuses of links, and so on.

Connection information keeps allocated resource information and status between two nodes. This information requires identifiers for interfaces and ports, available QoS information, administration and operation statuses of connections, and so on.

D. Extraction and Definition of Management Information

To manage topology and resource status of transport network, it is required to collect management information such as system, neighbor, interface, link and connection information. The detailed definition for management information could be extracted from existing MIBs shown in Fig. 2.

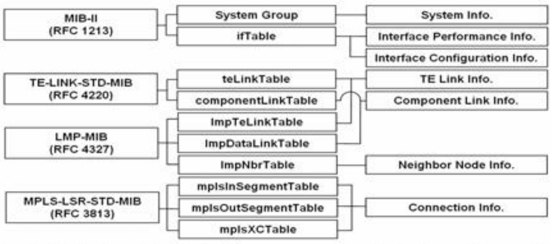

Fig. 2. Relationship between management information of Rc interface and standard MIBs

System information could be extracted from system group of MIB-II, RFC 1231, and neighbor node information could be defined from the neighbor node table in link management protocol (LMP) MIB, FFC 4327. The interface table in interface group of MIB-II could be used to define interface configuration and performance information. TE and component link information could be extracted from link tables in TE-LINK-STD-MIB, RFC 4220 and LMP-MIB. Segment and cross connect tables in MPLS-LSR-STD-MIB could be used to define connection information.

III. HIGH-SPEED RESOURCE CONTROL IN NGN STRATUM

A. Resource Control Mechanism

This section describes high-speed resource control mechanism based on parallel [5][6] and single-phase scheme in NGN transport stratum. RACF collects topology and resource status information of transport network through Rc interface, and single-phase scheme makes use of this information for resource admission and path computation.

Fig. 3 shows RACF functions, which are policy decision, admission decision and resource control executed after resource initiation request (RIR) message from service control functions, SCF. Rw interface between PD-FE in RACF and PE-FE in transport function adopts parallel resource control mechanism based on the single-phase scheme to achieve high speed resource control. PD-FE performs authorization, path computation and resource admission when it receives RIR message from SCF. PD-FE makes use of the computed path and admitted resource information, and it requests PE-FE to reserve and commit network resources at the same time by using single-phase scheme. PD-FE simultaneously sends RIR messages to several PE-FEs of switches on the computed path. PE-FE assigns resources and responds resource initiation response messages to RACF.

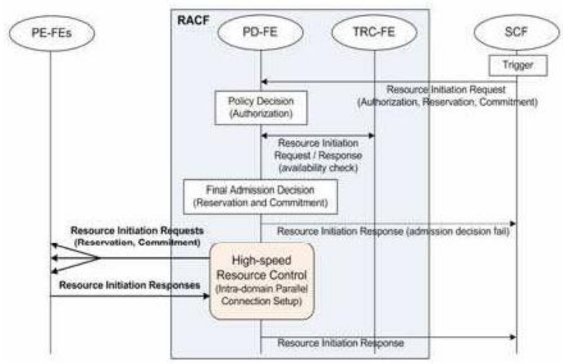

Fig. 3. Parallel resource control procedure based on single-phase scheme

B. Functional Architecture of RACF PD-FE

To support parallel resource control based on single-phase scheme in Rw interface, we propose internal functional architecture of RACF PD-FE, which consists of high-speed resource control sub-functional entity (HRC-SFE), authorization and admission control sub-functional entity (AAC-SFE), and path computation sub-functional entity (PAC-SFE) as shown in Fig. 4.

AAC-SFE checks the usage authorization of resources, and decides the final resource admission after it confirms the availability of resources by exchanging control messages with TRC-FE through Rt interface. PAC-SFE uses topology and link information maintained by TRC-FE, and then computes an optimal path of transport network. In Rw interface, HRC-SFE performs parallel resource control with several switches on the computed path by exchanging RIR messages of resource control protocols such as COPS, DIAMETER and MEGACO.

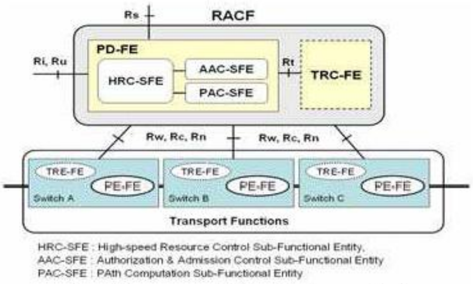

Fig. 4. Functional architecture of RACF for parallel resource control

C. Data Structure for Parallel Resource Control

RACF has to distinguish response messages from switches to map them with its own request messages, and it must check whether the number of response messages is equal to the number of switches on the path to complete resource control on the transport network. Fig. 5 shows data structure of path control table (PCT) and transaction mapping table (TMT) in HRC-SFE of PD-FE to support parallel resource control.

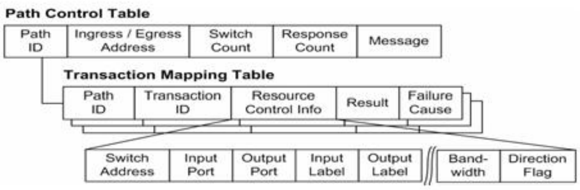

Fig. 5. Tables for parallel resource control

Each entry of PCT table consists of path identifier (ID) field, ingress and egress address field representing starting and ending switch addresses on the path of each domain, switch count filed representing the number of switches on the path, response count field representing the number of response messages from switches, and message field. Message field of this table keeps original resource initiation request message from SCF to recalculate a new path in case of resource control failure or to retransmit RIR message in the event of message loss. HRC-SFE creates one entry of PCT table and the same number of TMT table entries as the number of switches on the path. The association among PCT and TMT table entries is kept by using the same values in path ID fields.

Each entry of TMT table consists of transaction ID field to coordinate request and response messages in Rw interface, resource control information filed to assign and release resources, result field to represent the result of resource control request, and failure cause field to keep various reasons in case of resource control failure. Resource control information consists of switch address, port ID, label ID, bandwidth, direction flag, and so on, which are dependent on the transport network technology. Resource control information in Fig. 5 shows control information for a label switching network such as multi-protocol label switching (MPLS) network. HRC-SFE uses transaction ID and path ID in TMT table to correlate request and response messages, and completes resource control transactions for the path if response count value is equal to the switch count value in PCT table.

IV. CONCLUSION

High speed resource control mechanism requires single-phase control scheme in NGN transport stratum, which requests switch resource reservation and commitment simultaneously. It is required for RACF to manage topology and resource status information through Rc interface, and then single-phase scheme makes use of this information for resource admission and path computation. This paper defined requirements of management information exchanged through Rc interface, and guided extractions of detailed management information from existing MIBs. We proposed high speed resource control mechanism based on parallel and single-phase scheme to minimize delay overhead between centralized RACF in transport control functions and switches in transport functions. We also described internal functional architecture of RACF and related tables for the proposed high-speed resource control mechanism.

We will apply the proposed high-speed resource control into Rw resource control protocols such as COPS, DIAMETER and MEGACO to measure and analyze resource control overhead between RACF and switches.

REFERENCES

[1] Chae-Sub Lee and Dick Knight, "Realization of the Next-Generation Network," *IEEE Communication Magazine,* vol. 43, no. 10, pp. 34-41, October 2005.

[2] ITU-T, Recommendation Y.2012(formerly Y.NGN-FRA), "Functional requirements and architecture of the NGN of Release 1," September 2006.

[3] ITU-T, NGN-GSI/DOC-150, "Draft Recommendation Y.2111 (formerly Y.RACF)- Release 2 Version 0.2," NGN GSI Reporter Group Meeting, 8-12 January 2007.

[4] ITU-T, TD 502(GEN/11), "Q.5/11 Meeting Report," NGN GSI Rapporteur Group Meeting, 8-12 January 2007.

[5] Mun Choon Chan and Aurel A. Lazar "Designing a CORBA-Based High Performance Open Programmable Signaling System for ATM Switching Platforms," *IEEE Journal on Selected Areas in Communications,* vol. 17, no. 9, pp. 1537 - 1548, September 1999.

[6] InSang Choi, HyunWoo Lee, TaeHyun Kwon, ChoonHee Kim and YoungWook Cha, "Parallel Connection Control Mechanism of OBS Network with GSMP Open Interface," *Proceeding of COIN 2005,* pp. 226-229, May 2005.

[7] ITU-T, NGN-GSI/DOC-125, "Output draft of Q.3303.1 COPS Alternative," NGN GSI Rapporteur Group Meeting, 8-12 January 2007.

[8] ITU-T, NGN-GSI/DOC-129, "Output draft of Q.3304.2 SNMP Alternative," NGN GSI Rapporteur Group Meeting, 8-12 January 2007.