Latest Developments and Problems in Standardization of Resource Control Technologies for NGN

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Abstract:
As a hot spot of next generation network, research over resource control has been carried out for years both in China and abroad. With a gradual progress in standardization, this field presents new development trends and features. Based on latest progresses in standardization promoted by ITU-T, TISPAN and 3GPP, new technologies concerned with resource control are introduced. Considering the problems faced in standardization deployment, relevant resource control functions are also analyzed in this article.

1 Goals and Significance of Resource Control

Telecom networks have been developing quickly. On one hand, terminals tend to be diversified, intelligent and multi-access-mode integrated. On the other hand, telecom networks are offering more diversified services, from legacy voice services to multimedia services and value-added services. During the service diversification process, the third-party Service Providers (SPs) have been penetrating into the telecom industry, and they keep enhancing their cooperation with telecom operators. Meanwhile, telecom operators are facing keener competition and challenges because telecom networks and the Internet are offering more homogeneous services.

Under such conditions, telecom operators will probably become pipe operators with only revenue from network traffic, if they continue providing best-effort IP bearing and following the existing mode for Internet bearing offering. With network resources in hand, telecom operators should develop their capabilities of refined control and operation on the network resources in future, so as to obtain good benefit shares by offering network resource differentiated services to users and the third-party SPs.

2 Overview of Standardization of Resource Control Technologies

Having realized the importance of resource control for IP bearing, many operators, vendors, research institutes, and standardization organizations, including International Telecommunication Union-Telecommunication Standardization Sector (ITU-T), ETSI Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN), and 3GPP, have put great efforts into its research.

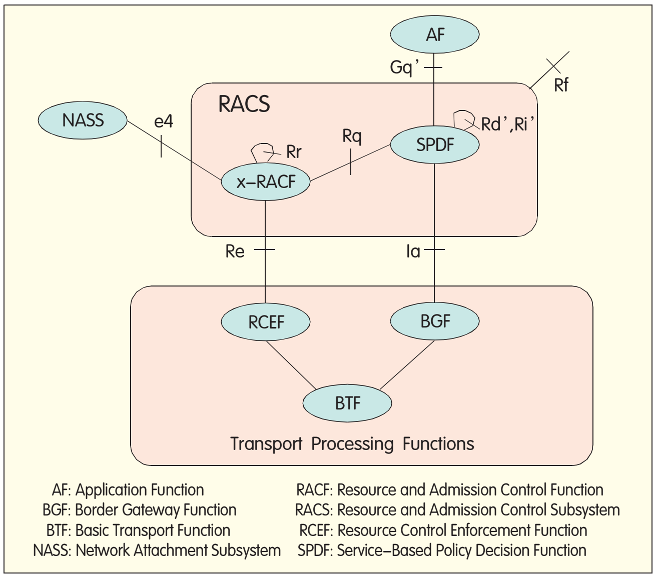
TISPAN has studied resource control issues based on fixed access, while 3GPP's research focuses on mobile access; ITU-T has got involved into the resource control research based on both fixed and mobile access, but its current research is mostly based on fixed access.

With regard to the research of QoS, all the three leading standardization organizations centralize their studies on control mechanism for QoS guarantee, but do not centralize on specific QoS mechanisms of access technologies and bearing technologies; their unified idea is to add a resource and admission control function between service control layer and access/bearer layer in order to make control of functions and resources of access/bearer nodes.

Resource and admission control function is located between the service control layer and the access/bearer layer, and aims to shield specific technologies and topologies of the access/bearer layer from the service control layer. After receiving a service relevant QoS requirement from service control layer, resource control function combines it with the admission control strategies and network topologies, converts the service relevant QoS requirement into the IP QoS requirement, and then sends the IP QoS requirement to related access nodes,

▼Table 1. Multicast-related transport functions defined in TISPAN RACS R2

Functional Entities	Basic Transport Function (BTF)	Elementary Forwarding Function (EFF)	Elementary Control Function (ECF)	Resource Control Enforcement Function (RCEF)	Resource and Admission Control Functions (x-RACF)
Functions	Including both EFF and ECF functions	Packet duplication	Processing or enforcing multicast protocols, forwarding events to trigger policy evaluation	Enforcing multicast traffic policy and forwarding events to trigger policy evaluation	Multicast policy evaluation



◀Figure 1. Functional architecture of TISPAN RACS R2.

bearer nodes and service gateway nodes. These nodes will implement requested QoS according to received messages and their functions.

The current developments of standardization for resource control by the three standardization organizations are as follows:

(1) ITU-T

ITU-T defines the Resource and Admission Control Function (RACF) entity to fulfill QoS control on the access network and core transport network, including resource reservation, admission control, and gate control. ITU-T has released the related specifications in RACF R1[1], and will complete RACF R2 in September 2008.

(2) TISPAN

TISPAN defines the Resource and Admission Control Subsystem (RACS) to fulfill the resource and admission control function. It has released related standards in RACS R1[2] and R2[3], and is undertaking the standardization work for RACS R3. RACS R1 focuses on QoS control mechanism for fixed access networks, while RACS R2 adds resource control functions to multicast.

(3) 3GPP

3GPP R7 names the resource and admission control functional entity as Policy Control and Charging (PCC)[4], which has a goal of implementing certain QoS control on mobile access networks. PCC's biggest feature is to integrate policy control and charging control. 3GPP has been working on its R8 standards.

3 Latest Standardization Hot Spots for Resource Control Technologies

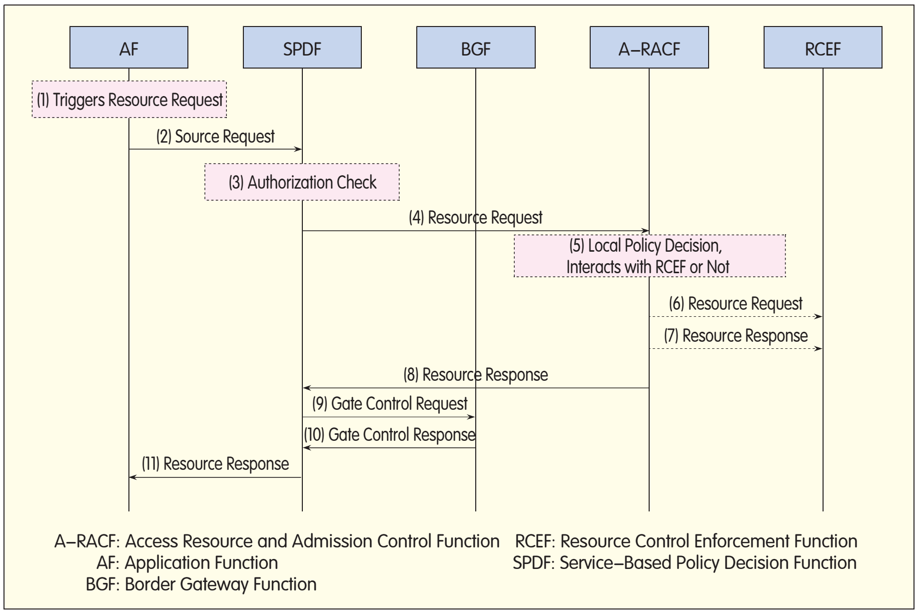
According to the relevant research of three leading standardization organizations, the study of resource control standards is focusing on the following four aspects.

3.1 Multicast Resource Control

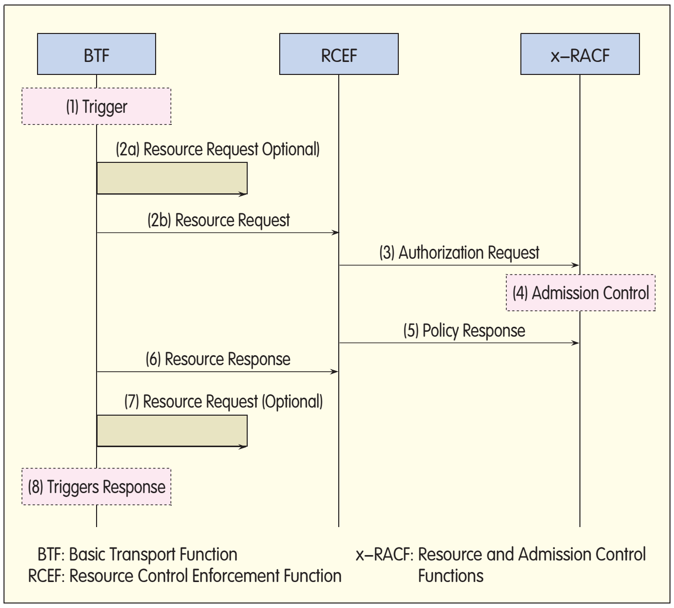
In order to support IPTV services, multicast resource control function has to be defined besides resource control mechanism for point-to-point connections. Both of ITU-T and TISPAN have already defined multicast resource control capabilities in their resource control R2 specifications. This article will give some introduction about multicast resource control mechanism defined in TISPAN RACS R2.

Based on RACS R1, RACS R2 adds Pull mode, and the scenario that certain bearer-layer node may participate in multicast resource control are also considered. New multicast-related functions defined in R2 are shown in Table 1, while functional architecture of TISPAN RACS R2 is shown in Figure 1.

RACS R2 supports both of Push resource and admission control mode and Pull resource and admission control mode. The procedure of Push mode and



▲Figure 2. Resource request by Push mode.



▲Figure 3. Resource request by Pull mode.

Pull mode is given in Figures 2 and 3. The actions of RACS in the two modes are a bit different. In Push mode, Application Function (AF), which generally refers to the upper-layer application control function sending resource control request (e.g. Proxy Call Session Control Function (P-CSCF) in IP Multimedia Subsystem (IMS)), directly pushes the multicast control list to the Resource Control Enforcement Function (RCEF) through the Access Resource and Admission Control Function (A-RACF); and RCEF directly enforces authorization to a user's request on joining a multicast group (such as Internet Group Management Protocol (IGMP) Join request). In Pull mode, AF pushes the multicast control list to A-RACF, and RCEF sends the authorization request (received through Basic Transport Function (BTF)) to A-RACF after receiving a user's multicast group joining request.

Based on RACS R1, RACS R2 expands relevant reference points to support multicast list.

3.2 Extension of Resource Control into Home Network

In order to fulfill end-to-end QoS guarantee, the resource control of home network has become a research point, besides resource control of the access network and the core transport network. In ITU-T Draft Recommendation Y.2111 for RACF[5], ITU-T defines the Rh interface between the Policy Decision Functional Entity (PD-FE) and the Customer Premises Network Gateway Policy Enforcement Functional Entity (CGPE-FE). Figure 4 shows the ITU-T RACF functional architecture.

CGPE-FE can be treated as a home gateway, which is required to have the policy enforcement function. PD-FE pushes resource and admission control decision messages to the home gateway (CGPE-FE in Figure 4) through the Rh interface, while the home gateway can send an admission control decision request to PD-FE through the same interface. CGPE-FE has the following functions:

- Gate control;
- Rate restriction and bandwidth allocation;
- Traffic classification and marking;
- Traffic policing and shaping;
- Mapping of IP-layer QoS;

information onto the link layer based on pre-defined static policy rules;

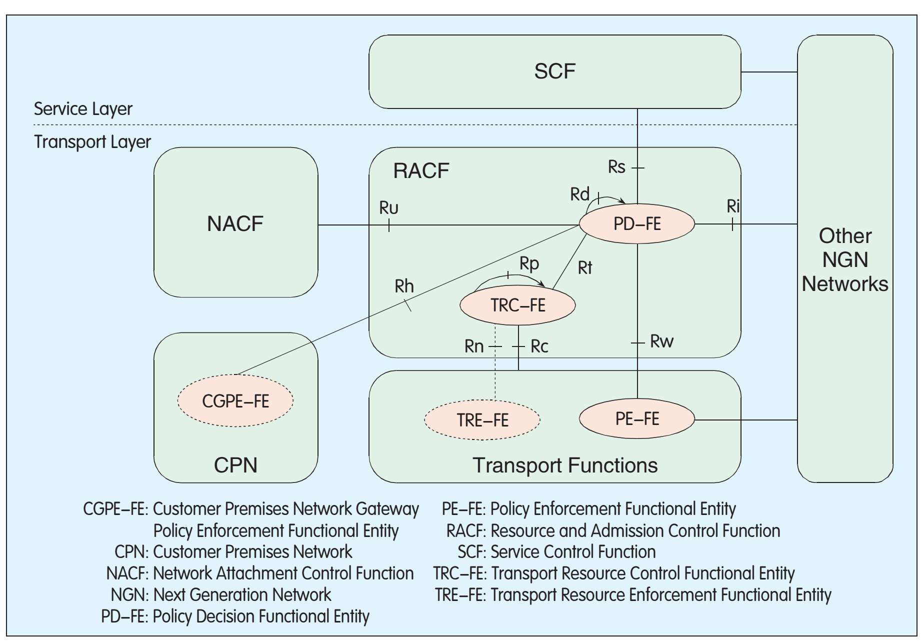
- Collecting and reporting Resource Usage Information.

Another mechanism to provide the resource control of home network is to deploy CGPD-FE function into the home network, which interacts with PD-FE through the Rh' interface. However, ITU-T SG13 does not accept this recommendation while taking into account of current requirements and research maturity, and only deploys PD-FE into home network. ITU-T SG11 is undertaking the standardization of Rh and Rh' interfaces[6]. More discussion between SG13 and SG11 is necessary.

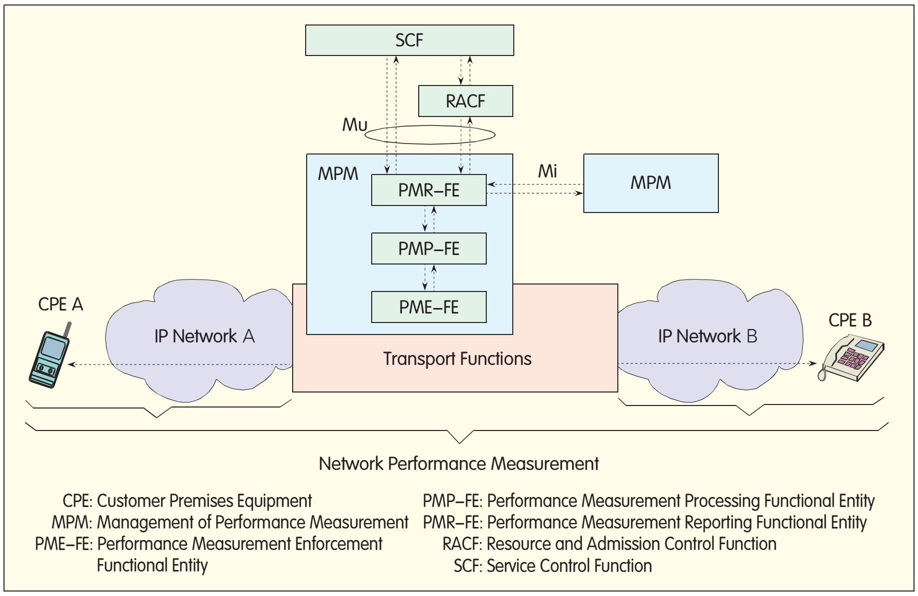
3.3 Combination of Resource Control and Bearer-Layer Performance Measurement Technology

Dynamic network resource information, besides static ones, is very useful for precise resource control.

ITU-T has proposed the concept of Management of Performance



▲Figure 4. ITU-T RACF functional architecture.



▲Figure 5. MPM architecture and application.

Measurement (MPM) for NGN in its Y. 2173[7]. This specification defines an MPM module for performance measurement and control, as shown in Figure 5. This module interacts with other NGN functional entities, and it can initiate one or more measurement tasks based on certain policies. Moreover, it can collect and manage Quality of Experience (QoE) information from terminal equipment by using Real-Time Control Protocol (RTCP) packets sent by network nodes.

Performance Measurement Enforcement Functional Entity (PME-FE) is responsible for three groups of functionality: measurement execution, single measurement processing, and measurement device configuration; Performance Measurement Processing Functional Entity (PMP-FE) is responsible for two groups of functionality: measurement processing and network-wide measurement configuration; Performance Measurement Reporting Functional Entity (PMR-FE) collects rollup metrics from PMP-FE, and provides reports to MPM applications (e.g., RACF).

RACF can trigger the MPM module to enforce measurement tasks, and obtain precise real-time network resource status and usage by using MPM. However, to consider the impacts on RACF performance, RACF R2 has not presented the corresponding extension, such as providing Mu interface.

3.4 Fixed and Mobile Convergence: Unified Resource Control

TISPAN studies resource control technologies from fixed access aspect and proposes the RACS, while 3GPP studies resource control from mobile access aspect and releases the PCC architecture. However, the differences between the two architectures and the relevant interfaces will have great impact on equipment manufacture, and also influence network deployment, especially the Gq' interface between RACS and upper-layer control (such as P-CSCF) and the Rx interface between PCC and upper-layer control. These two interfaces have little association with under-layer transport technologies, and if they can shield the differences to upper-layer application control, it will be very useful for fixed mobile converged networks and will also be the first step to accelerate fixed and mobile convergence at the resource control technology aspect.

TISPAN and 3GPP held an Ad-hoc meeting in November 2007, and established work items for Gq'/Rx convergence respectively. The 3GPP work item is 23.822[8] (Framework for Gq'/Rx Harmonization), while in TISPAN the work item is MI2054[9] initiated in the March 2008 meeting.

The 23.822 has proposed the convergence solutions to the following issues:

(1) Unique Global Address

The solution is to expand the Rx reference point and use the unique global address at Gq' to replace the originating user IP address. Domain descriptions are recommended to ensure backward compatibility.

(2) Network Address and Port Translation (NAPT) Control

The solution is to expand the Rx reference point, adds NAPT binding creation and modify procedure, and use the same binding functional parameters as used on Gq' reference point.

(3) Soft State Model

The reservation life cycle is commended to add on the Rx reference point to support the soft state.

4 Challenges Facing Technology Deployment

Although plenty of studies on resource control mechanism in NGN have been spread worldwide, and series of relevant standards have been released, some challenges are faced to deploy the resource control technologies .

Many network operators, equipment vendors and research institutes have put energy into the study of resource control technologies. However, the necessity of deploying complex resource control in networks is still on debate.

According to the resource control architectures specified by ITU-T and TISPAN, it not enough to only deploy edge gateway equipment in networks, such as Border Gateway Function in RACS. In fact, to realize perfect resource control, besides the functional entities which are defined in specification of resource control, many new requirements have also been added on the current data equipments in bearer network. These new requirements may lead to upgrading or even replacing existing data equipment in live networks, which may need huge investment.

In 3GPP PCC architecture, the resource control policy function can be configured statically at Gateway GPRS Support Node (GGSN) or Packet Data Gateway (PDG). Meanwhile, TISPAN RACS R2 points out that no resource and admission control functionality is necessary for best-effort networks and networks with static QoS differentiation capability. Accordingly, it is uncertain whether it is necessary to deploy dynamic resource control mechanism in networks.

In fact, in the IP transformation of operators' telecom networks, for voice services, twisted-pair access is retained to guarantee the quality of real-time services; for IPTV services, QoS is ensured by physical or logic separation of bearer layer.

Deployment of resource control function entities may not only require high Capital Expenditure (CAPEX), but also have all-around impacts on network Operating Expenditure (OPEX). Resource control mechanism introduces a new layer into the existing network architecture. The control, maintenance and management mechanism of network resource will greatly differ from current mechanism, which needs accumulation of related operational maintenance and management technology and experience.

The telecom industry is getting very competitive; on the other hand, telecom networks and Internet are competing and converging. In such situations, now telecom operators pay more attention to new service development and launch. In China, the telecom operators have established completed network infrastructure, so the operator would like to offer new services by fully using existing infrastructure or through simple network transformation.

Flexible and efficient scheduling and control of network resources will become more and more important for telecom operators in fierce competition. Along with emerging of various new services, resource control technologies may be deployed and popularized gradually.

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Biography

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Li Haihua received her master's degree from the Telecom Science and Technology Research Institute. She is a senior engineer of the Institute of Communication Standards Research, China Academy of Telecom Research of the Ministry of Industry and Information Technology (MIIT). She is engaged in the study of NGN technologies.

Roundup

ZTE, Qualcomm and Aircell Collaborate on Industry-First

ZTE USA, Inc., a subsidiary of ZTE Corporation, and Qualcomm Incorporated, a leading developer and innovator of advanced wireless technologies and data solutions, on November 18, 2008, announced their collaboration with Aircell to create the networking platform for Aircell's new Inflight Internet service, Gogo, which first began service in August on select American Airlines flights. Aircell's Air-to-Ground (ATG) service relies on ZTE's EV-DO Rev.A base stations and IP switching platform and Qualcomm's aircraft-mounted modems. ZTE, Aircell and Qualcomm's R&D groups worked closely to engineer a custom solution that would maximize the performance of the in-flight service.

ZTE's base stations are stationed across the U.S. to support service for Aircell's airline customers. While en route, subscriber's WiFi traffic is transmitted to ZTE's CDMA EV-DO Rev.A networking equipment via Qualcomm's aircraft-mounted modems. The technology was engineered to accommodate the high speed and high altitude of aircraft connecting with the base station. As a result, the service dramatically improves previous in-flight wireless services, which were slow, expensive and complex.

"At ZTE, we are committed to developing customized and flexible solutions that enable our customers and partners to offer their own customers the most innovative and desirable applications and services," said Dr. George Sun, CEO of ZTE USA, "In this instance, by working closely with Aircell and Qualcomm, we were able to tap into the brightest R&D minds available to create the most cutting-edge and flexible networking platform. We look forward to working with Aircell and Qualcomm to scale the platform to support increasing demand and future expansion of the service."

"Qualcomm was pleased to collaborate with Aircell and ZTE to help enable this unique wireless data innovation," said Ahmad Jalali, vice president of technology for Qualcomm, "EV-DO Rev.A was a clear choice for creating a powerful, spectrally efficient and high-speed data connection to carry the aircraft's passenger traffic to ZTE base stations."

"When designing our industry-first in-flight mobile broadband service, we were searching for companies that would work hand-in-hand with us to create a flexible and customized networking platform that was optimized for our unique ATG needs," said Joe Cruz, executive vice president and chief technology officer of Aircell, "We found those allies in ZTE and Qualcomm. As a result, we are able to offer our customers the best possible broadband experience on North America's only comprehensive Inflight Internet service."