IP기반 통합서비스를 위한 QoS가능 차세대 LAN

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QoS-enabled Next Generation Local Area Network for IP-based Convergence Services

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요 약

인터넷의 활성화와 인트라넷 구축을 통한 그룹웨어의 확산과 함께 LAN의 초고속화 기술이 급진적으로 발전되어 왔으며, 이러한 발전은 고품질의 실시간 서비스에 대한 사용자의 요구에 의해 새로운 형태의 통합네트워크 형태로 발전되어 가고 있다. 통합네트워크는 데이터, 음성 및 영상 응용 서비스가 함께 제공될 수 있는 통신망으로서 궁극적으로는 통합된 단일 네트워크 플랫폼으로 발전해 갈 것으로 보인다. 본 논문에서는 IP기반의 통합서비스를 제공하기 위하여 실질적인 QoS 제공 기술, 프로그래머블 스위치 네트워크 구조 기술과 통합 호 제어 처리 기술을 포함하는 차세대 통합 LAN에 관한 연구결과를 제시하고자 한다.

ABSTRACT

This paper presents a quality-of-service-enabled next generation local area network architecture which can provide efficiently convergence services over the Internet protocol. The basic concept of the architecture is to combine such three principle technologies as programmable switched network, quality-of-service resource management and Internet protocol based network convergence. We discuss system entities and technologies development, which constitute the proposed network. The architecture of the network is then described. Implementation of systems verifies the proposed technologies. The network, as a next generation local area network, can provide quality-of-service-enabled real-time communication services as well as existing data traffic, and the open programmable interface can facilitates to adopt cost-effectively emerging new services or functionalities.

키워드

Next Generation Network, Network Convergence, IP, QoS(Quality of Service), Call Control, LAN, Protocol

I. Introduction

A tremendous growth of internet traffic and expansion of collaborative environment results in accelerating network speed, which can be a foundation of high quality services. As such, users require real-time services over the local area network. Such requirements result that multiple medium types of application services are gradually converging over one network platform. The Internet Protocol (IP) based single network in convergence of the local area can give a sound platform for creating various new multiple media application services.

There exist a few skepticisms for accepting such emerging new requirements in the conventional local area network. The

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network aiming so far mainly at connectionless data communication services has to employ a new architecture suitable for multimedia-based real time application services in order to meet such requirements. In addition, lack of flexibility in the existing network brings that it is a difficulty and expensiveness to adopt a new control, management, or application services.

In this area, additionally, multi-vendors have supplied various products not only being less-verified of interoperability but also having different control mechanisms for the networking elements. Thus, the emerging network especially in the local area requires an open programmable network platform, which can provide flexibility for adopting cost-effectively such lacks of standardization and interoperability, and differences in network control mechanisms.

One important issue is quality-of-service (QoS) for providing emerging multiple medium types of services, especially real-time traffic. Insufficiency in quality and availability become a main obstacle for providing such real-time traffic as real voice and video services over IP. Therefore the network requires a well-tuned QoS provision mechanism coinciding with an effective resource management algorithm.

This paper presents a sound QoS-enabled next generation local area network architecture which can provide efficiently IP-based convergence services. The basic concept of the architecture is to combine such three principle technologies as programmable switched network, QoS resource management and IP-based network convergence.

In Section 2, we discusses three principle technologies to exploit a new concept of network architecture. Section 3 introduces a new protocol enabling QoS programmability. We present the local area network established with such a concept and describe operations in Section 4, and conclude in Section 5.

Ⅱ. Principle of Technology

Three technological principles that we consider for establishing a concept of next generation local area network are, as described above, programmable switched network, enabling QoS and IP-based network convergence.

It is generally accepted that the IP network is a usual platform to deploy emerging converged services. Since the IP network is connectionless, however, a call controller is required to realize connection-oriented voice and video application services over the IP network. Co-existing multiple protocols for call processing, different kind of calls have also to be coordinated each other. A softswitch, as an essential element, is in charge of those in the next generation network [1].

In order to coordinate different protocol calls in the local area network, we introduce a Convergence Call-control System (CCS) as a LAN-specific softswitch. Several CCS architectural models are possible with respect to given protocols and network constraints. We developed a model which is as general as it adopts easily protocol update or new protocol. The ultimate goal of CCS is to coordinate calls independently from protocols. This can give users fully interoperable services, whatever types of protocol user's terminal has.

The Internet Engineering Task Force (IETF) presents two different standard QoS protocols regarding to provide quality service for multimedia traffic. They are RSVP (Resource Reservation Protocol) [2] and DiffServ (Differentiated Service) [2][3], for the IP network. Since any of these inherently depends on transport resources such as bandwidth, buffer, etc., however, a resource management algorithm becomes a basis for providing a good quality of service in the network.

A QoS control path, moreover, is established between CCS and router system in order to provide quality real time services. CCS can manage to reserve QoS resources in the router if any request, like a real time voice or video service, requires higher grade of QoS. Any QoS manager or controller can request CCS to use such a path. We weave a multi-layered QoS model from standard QoS protocols, a policy-based QoS managing technology and a QoS control connection between CCS and router systems. This considers not only requirement of the converged local area network but also existing standard

QoS protocols.

An open programming switching architecture gives an ultimate solution for emerging convergence network. The open programming switching system consists of hierarchically decomposed function blocks and open interfaces between them. The interface is so standardized as to easily employ non-homogeneous products from different vendors. Providing an open standard control protocol and standard API's, a programmable switched network is flexible for accepting new functions and application services. It is possible in such network to adopt cost-effectively different control mechanisms and non-homogeneous network elements supplied from different vendors.

There exist several programmable switching systems, which are developed for the purpose of PSTN telephony applications. Lucent's Excel Switch[4] and Cisco's VCO[5] are typical examples. They have open programmable interfaces, but not standardized control protocol like qGSMP. MSF (Multi Switch Forum) leads an ATM-based programmable switch employing the General Switch Management Protocol (GSMP) its control protocol to an completion step of standardization[6]. The same activity for the IP switch is under progress in IEEE PIN [7] by Singapore's Kent Ridge Digital Labs[8], Hitachi America and etc.

q-GSMP is an extension of GSMP Version1.1 with ATM switch scheduler model and algorithms[6]. qGSMP supports new messages that enable the selection of QoS constraints, buffer management and scheduling algorithms, that were not supported by GSMP. This has envisioned us to develop eGSMP (enhanced GSMP) that can control and manage IP as well as ATM switches. We devised an eGSMP protocol by modifying the qGSMP for IP network device such as router ant ATM switch[9][10].

III. Enabling QoS Programmability

3.1. eGSMP

eGSMP provides QoS services over a primarily IP network. The framework for the development of this protocol is on the lines of GSMP and qGSMP. eGSMP defines two types of entities namely, the eGSMP master and the eGSMP slave. The eGSMP master is the host application, which interacts with the eGSMP slaves and the end user through a set of well defined eGSMP messages. The eGSMP slaves are the network nodes that actually process the packets. They may be routers or switches. Each eGSMP slave may be connected to at least one eGSMP master which in turn is connected to the user interface. The eGSMP architecture is shown in Figure 1.

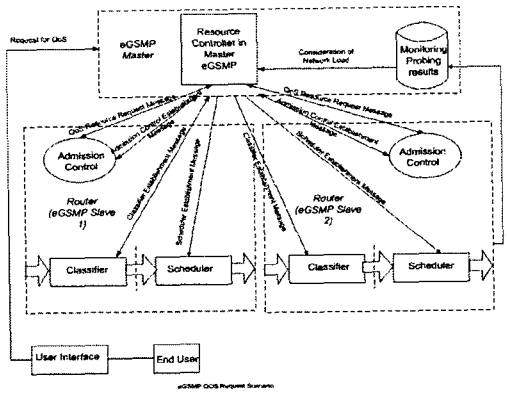

Fig. 1. eGSMP Resource Model

Based on the type of QoS scheme that is supported by the service level agreement and the classification of the packets, the eGSMP messages can setup the appropriate classifier, buffer management and scheduling schemes. As IP packets use variable length data packets, the scheduler and the buffer management algorithms should be capable of providing the agreed QoS irrespective of the variation in the size of the packets. The application developer can develop the same QoS algorithm to maintain the QoS service of its application independently of the underlying switching technology (IP, ATM, Frame Relay, MPLS, etc.).

3.2. eGSMP Schedulable Algorithm

e-GSMP is a master- protocol controlling the core and edge routers within a domain. The schedule algorithm in this section drfines the steps involved in the execution of the algorithm.

```
e-GSMP Master algorithm

1. Initialize the event list to configure the slaves.
2. Broadcast QoS configuration messages to the slaves.
3. While (network_ state != down) do
4. Begin
5.      for each slave router do
6.      begin
7.      for time_period = T do
8.      begin
9.            receive router_statistics
11.         end.
12.     end.
13.  end.
14. average_bandwidth_network =
Sum_of_bandwidths/number_of_packets.
15.average_delay_network =
sum_of_queueing_delays/number_of_packets.
16. Broadcast the computed network_statistics.
17. end.
```

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e-GSMP Slave Algorithm

1.Accept initialization message from Master.
2.Configure classes and queueing disciplines.
3.while ( router_state!=down) do
4.begin
5.      for each class_of_service do
6.      begin
7.        for time_period = t do
8.         begin
9.average_bandwidth=Sum_of_bandwidths/number_o
f_packets.
10.average_delay=sum_of_queueing_delays/number_
of_packets.
11.         end.
12.     end
13.  Send router_statistics
14.  receive network_statistics.
15.  while (packet_arrival=true) do
16.begin
17.If packet_QoS_requirements < QoS_available then
18.     packet_schedulable = true
19.      begin
20.        forward packet to scheduler.
21.      end.
22.   else
23.     begin
24.conform to scheduling policy of SLA.
25.     end.
26. end.
27.end.
```

Ⅳ. Network Architecture

4.1. Constitution of Network

The basic concept of the next generation local area network is, as described above, to combine such three principle technologies as programmable switched network, QoS resource management, and IP-based network convergence. Figure 2 shows a conceptual model of enabling QoS for the network, which we proposed in this paper. The network can provide not only data but also QoS-eanbled real-time data communication services, and the open programmable interface can facilitates to adopt cost effectively new services or functionalities.

Switched Router (SR) systems, Convergence Call-control System (CCS), QoS Control Server (QCS), Network Management Server (NMS), etc. are introduced to build the network. The transport layer of the network is established mostly of SRs and network switches connecting various kinds of user terminals. CCS takes charge of controlling incoming call signaling, authenticating users information, authorizing authenticated users, keeping accounting logs, and routing calls with destination addresses[11][12].

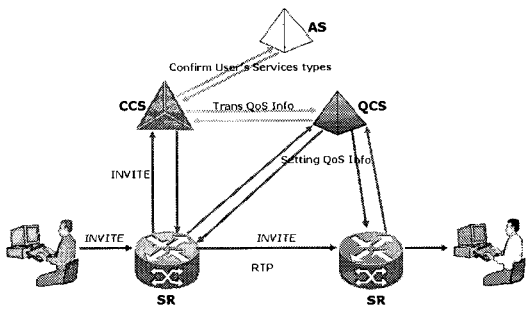

Fig. 2. Concept of QoS-enabled Network

4.2. QoS-Enabled Network

A set of switched router systems establish a transport layer of the network. We implemented a system which is capable of performing up to 40Gbps switching and routing protocols. The system has 8 line connection slots which can load up to 2.5Gbps wirespeed packet forwarding. Gateway and WAN-connection functionalities can also be mounted in any location of these slots. The system is programmable with the eGSMP protocol.

Figure 3 shows a proposed programmable network

architecture with providing an eGSMP enabled QoS mechanism for the next generation converged network. The architecture consists basically of such components as a QoS control server, i.e. QCS, eGSMP master/slaves, and the eGSMP protocol. CCS, as a converged call control system, controls such a real time call as voice over the IP network.

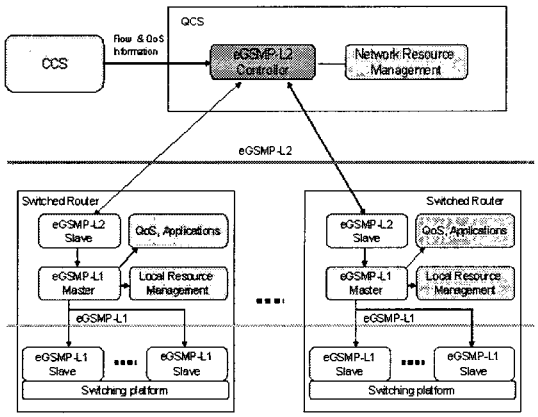

Fig. 3. Programmable Architecture Providing the eGSMP enabled QoS Mechanism

The eGSMP architecture consists of two levels, eGSMP-L1 and eGSMP-L2. eGSMP-L1 is primarily used as an internal control protocol of network nodes, i.e. Switched Routers. A switched router has a main processor unit, a switching unit and multiple line-cards. The main processor unit includes an eGSMP-L1 master and an eGSMP-L2 Slave. An eGSMP-L2 master which is resident in the QCS, communicates with CCS and sends a request message to control a given router. The eGSMP-L2 Slave receives QoS configuration policy, classification rule, etc. from the eGSMP-L2 master of QCS. The eGSMP-L1 master processes a request from the eGSMP-L2 master and performs a resource management of the switched router. It calculates schedule of a request flow and bandwidth in the router by a resource management algorithm, and decides whether the request can be accepted.

4.3. Operations

Figure 4 shows an initialization/termination procedure using eGSMP among CCS, switched routers (or routers), and QCS. First, in order to initialize, CCS issues a TCP connection to QCS with a well known address. If the TCP connection is established between QCS and CCS successfully, CCS sends an EGSMP_CCS_OPN_REQ message to QCS for initialization. And then QCS replies with a reply message. An initialization procedure in a switched router is the same way as in CCS.

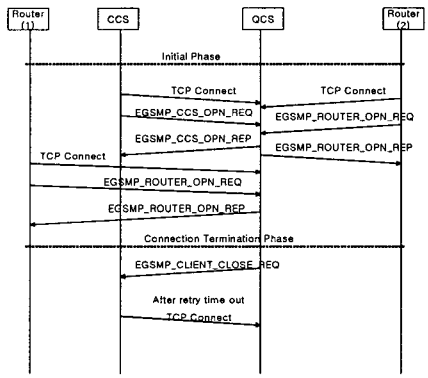

Fig. 4. Initialization/Termination Procedure

For the termination of control connection, a message either eGSMP_CLIENT_CLOSE_REQ or eGSMP_ SERVER_ CLOSE_REQ, or both are used. Figure 5 shows a QoS session establishment/release procedure using eGSMP among CCS, routers, QCS and UA(User Agent)'s. According to the proposed control mechanism, CCS provides voice call connection information such as "Add QoS Session Request message" or "Del QoS Session Request message" with routers, and using this, routers can recognize a QoS-required voice packet and provide DiffServ-based QoS. The eGSMP protocol is used for providing voice connection information to source and destination routers.

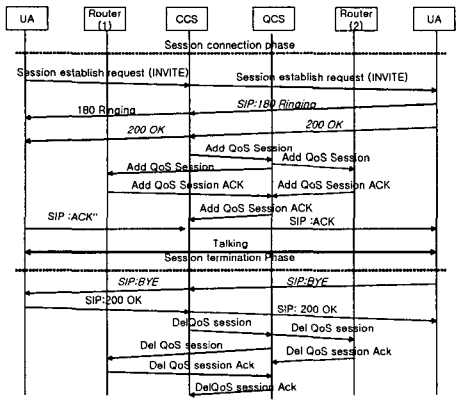

Fig. 5. Session Establishment/Release Procedure

V. Conclusion

A QoS-enabled next generation local area network was proposed. The network can be a sound infrastructure of emerging multiple types of media convergence services over the Internet protocol. The architecture of the proposed network is the basis of such principle technologies as programmable switched network, QoS resource management and IP-based network convergence.

We introduced a new protocol, eGSMP, enabling QoS programmability and developed system entities, such as switched routers, a convergence call control system, a QoS control server, etc. all of which constitute the proposed network.

Implementation of systems verified the proposed technologies. The network, as a next generation local area network, can provide QoS-enabled real-time communication services as well as existing data traffic. The open programmable interface can facilitates to adopt cost-effectively emerging new services and/or additionally requiring functionalities.

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