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RESEARCH ARTICLE

Application of Unified Network Management in LAN for Load Shedding

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ABSTRACT

The differentiated services (DiffServ) model has been proposed as a scalable traffic management mechanism to ensure Internet QoS without using per-flow resource reservation and per flow signaling, but it sacrifices the ability to accurately configure the network devices and efficiently utilize the network resources. In this thesis, the DiffServ model is augmented with traffic engineering tools, per-flow call admission control (CAC), dynamic resource sharing schemes to improve resource utilization efficiency. Specifically, an advanced two-tier resource management (ATTRM) model is proposed for efficient resource allocation over DiffServ networks, which manages network resources based on the "first plan, then take care" principle. By proper boundary service level agreement (SLA) arrangement and path-oriented internal resource mapping, the Internet service provider (ISP) can optimally plan the network resources to achieve the maximum long-term network revenue. To efficiently utilize the well-planned network, novel effective bandwidth techniques are developed for packet- and call-level QoS control in DiffServ networks.

Keywords:-CAC; ATTRM; QoS; SLA; ISP; Internet Engineering Task Force.

1. INTRODUCTION

Recently, there has been increasing research activities in the area of network management in an effort to produce effective maintenance of both LANs (local Area networks) and WANs (wide area networks) that include a proliferation of networks and associated equipment supporting various communication services. The IETF (Internet

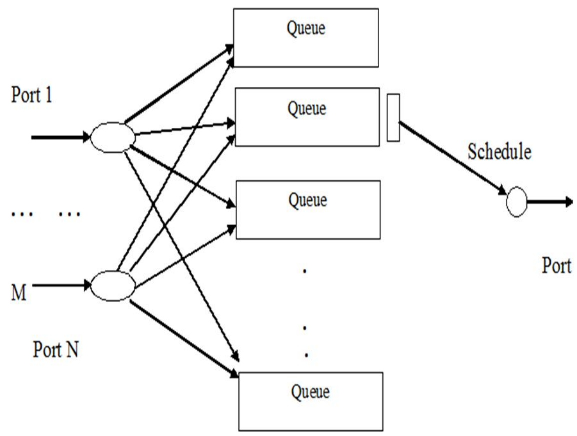
Engineering Task Force) has recommended SNMP (Simple Network Management Protocol) as the standard network management protocol for LANs, because SNMP is a simple management procedure and it is used frequently on the Internet. It has been recommended by the ISO as the standard network management protocol for WANs. However, until now most management systems use the proprietary network management protocol that is supplied by the associated equipment vendors to maintain existing WANs. Therefore, to maintain an existing WAN and LAN, it is necessary to either update an existing network management system and the associated equipment using a standard network management protocol or develop an integrated network management system (Terplan, 1992). In heterogeneous networks with a variety of systems of many kinds, the activity of network maintenance and supervision is a difficult task involving a large number of operators with a diversity of skills. In such environment the time to diagnose network problems and correct faults usually is high and subject to many errors, due to the fact that traditionally most of network management activities have been performed with direct human involvement (Aidarous et al., 1990). However, the network becomes increasingly large, these activities as they become more demanding and data intensive.

1.1 IP Quality of Service

In the simplest sense, QoS means providing consistent and predictable data delivery services, in other words, satisfying customer application requirements. More accurately, QoS is a set of technologies that enable network administrators to manage the effects of congestion on application traffic by using network resources optimally, rather than by continually adding capacity [11]. This requires adding some “smarts” to the network to distinguish traffic flows with strict timing requirements from those that can tolerate delay, jitter and loss. The Internet Engineering Task Force (IETF) has proposed many service models and mechanisms to meet the demand for QoS. Notably among them are the integrated services (IntServ)/Resource Reservation Protocol (RSVP) model [18,19], the differentiated services (DiffServ) model [14], multiprotocol label switching (MPLS) [3, 90], traffic engineering [7, 98], and QoS routing or constraint-based routing [2, 27, 50]. In the IntServ/RSVP architecture, the level of QoS provided is programmable on a per-flow basis. Before data are transmitted, the applications must first set up paths and reserve resources.

1.2 Resource Management

The QoS technologies could not create resources; it is impossible for a network to give what it does not have. QoS only manages network resources according to application demands and network management settings so they can be used effectively to meet the wide range of application requirements. Traditional best-effort IP networks use a very simple resource management scheme. Traffic from all IP conversations are buffered in the same queue with a certain size and served according to the *first-in first-out* (FIFO) rule. This scheme cannot provide any bandwidth and delay guarantees to an IP conversation.



(Include queue management and package discard function)

Figure 1.1: Classification, queuing, and scheduling architecture

2. REVIEW OF LITRATURE

2.1 Differentiated Services

The DiffServ model [14] has been proposed as an efficient and scalable traffic management mechanism to ensure Internet QoS without using per-flow resource reservation and per flow signaling. In DiffServ, traffic flows having similar QoS requirements is aggregated into a common service class at the edge and is forwarded using a certain PHB at the core routers. The PHB to be applied is indicated by a DiffServ code point in the IP header of each packet [74]. Detailed DSCP field structure is described in Appendix A. The structure of a core router is illustrated in Fig. 2.1. The BA (behavior aggregates) classifier uses only the DSCP to determine the queue to which the packet should be directed. Each queue executes a buffer management algorithm to determine whether an arriving packet should be stored in a queue or discarded. This decision is usually a function of the instantaneous or average queue occupancy, but also may be a function of the aggregate queue occupancy in a queue set, or of other parameters [10].

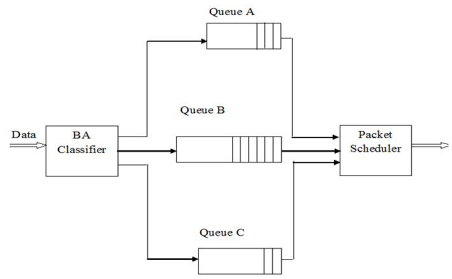


Figure 2.1: The structure of a DS core router

In this research, I will emphasize on these two services.

Assured Service

Assured service is intended for customers that need reliable services, even during network congestion. The assurance offered is relative and can only be verified by comparison. Assured service is built upon the *assured forwarding* (AF) PHB defined by IETF in [51], which can be implemented as follows. Firstly, classification, DSCP marking, and policing are done at the ingress routers of the ISP networks. If the assured service traffic does not exceed the bit rate specified by the SLA, it is considered *in* profile; otherwise, the excess packets are considered *out* of profile. One bit in the AF DSCP can be used to differentiate the *in* and *out* packets. Secondly, all packets, both *in* and *out*, are put into the same queue to avoid out of order delivery.

Premium Service

In [53], a particular PHB called *expedited forwarding* (EF) is described. The EF PHB can be used to build a low loss, low latency, low jitter, assured bandwidth, end-to-end service through DiffServ domains. Such a service appears to the endpoints like a point to point connection or a “virtual leased line”. This service has also been described as the premium service [75], which requires that customers generate traffic with a fixed peak bit rate specified by the SLA. The customer is responsible for not exceeding the contracted peak rate; otherwise, excess traffic will be dropped.

Service Level Agreement

In a DiffServ environment, a *service* is defined as “the overall treatment of a defined subset of a customer’s traffic within a DS1-domain, or end-to-end” [14]. Although PHBs are at the heart of the differentiated services architecture, it is the service obtained as a result of marking traffic for a specific PHB that is of value to the customer. PHBs are merely building blocks for services. Service providers combine PHB implementations with traffic conditioners, provisioning strategies and billing models which enable them to offer services to their customers. Providers and customers negotiate agreements with respect to the services to be provided at each customer/provider boundary. These are commonly referred to as service level agreements. Many aspects of SLAs (such as payment terms) are beyond the scope of the technical standards; the subset of the SLA which provides the technical specification of the service will be referred to as the *service level specification* (SLS).

3. BASE WORK

3.1AdvancedTwo-TierResource Management

Deficiencies of the Two-Tier Architecture

The two-tier architecture (referring to the common parts of ATTRM and TTRM models) for resource management, has two main characteristics [93]: (a) Individual administrative domains manage their internal resources with approaches that best match their own needs; (b) At domain boundaries, two neighboring domains allocate resources for each other's border-crossing traffic in the form of SLAs. The inter-domain SLA serves as an interface between neighboring domains and makes the intra-domain resource allocation scheme transparent to each other. This ability provides great convenience to concatenate domains with different internal resource management schemes. However, the SLAs in the TTRM model cannot guarantee resource availability within the network. In the model, the transit domain shares its resources among several SLAs. Each ingress router uses one SLA to accept all the input traffic belonging to the same service class from the neighboring upstream domain, although the traffic may head toward various final destinations far away. After agreeing to carry the client traffic, the transit domain needs to discover where traffic is headed to, check resource availability and allocate resources on the path from the ingress (where traffic enters) up to the egress (where traffic exits the transit network). To do so, each ingress router measures the amount of traffic sent towards each egress router and uses RSVP to inquire about resource availability and allocate resources on the domain paths towards each egress router. At this time, the resource allocation may succeed, however, may also fail. If RSVP fails, those data transmitted before RSVP are not allocated with their required resources and the expected QoS is not achieved. This can also affect those already admitted traffic.

The ATTRM Model

In order to overcome the above deficiencies of the TTRM, we make some modifications to it and propose the ATTRM model. Per-Class Per-Ingress/Egress Pair SLA to avoid the admission failure of the aggregate traffic induced by an improper traffic distribution to different exit points; we subdivide the SLA for one service class installed in an ingress router into several ones. Each ingress/egress pair will have one SLA to specify the resources allocated to those traffic travelling through them. Different service classes traversing the same ingress/egress pair have separate SLAs. In this context, the corresponding internal resources needed by an SLA are predictable and thus are relatively easy to allocate. For simplicity in this thesis, we consider only two service classes, the premium service (namely EF PHB) and the assured service (namely AF PHB). Correspondingly, an EF SLA and an AF SLA are installed for each ingress/egress pair. However, the schemes proposed in this chapter to support these two classes can be easily extended to a multiclass situation. By the SLA division, the bandwidth broker obtains more information to configure internal routers.

4. PROPOSED WORK

4.1. MATERIALS AND METHODS

4.1.1. Generic Network Model

In wide-area electronic commerce communication services and applications two types of provider are usually involved in order to complete the end to end service offering: the Service Provider and the Network Provider (Veeraraghavan, 1993). The first is responsible for the definition of the service characteristics and the maintenance of the customer premises equipment, while the latter provides the network infrastructure (i.e. high-speed network) used by the end users and the Service Provider. The Network Provider relieves the other parties involved in that arrangement of the cost and effort of network management by reducing labor cost and capital investment. In this situation the Service Provider is essentially a Customer of the Network Provider, while the Service Provider provides the service to its own customers or end users (usually multiple customers with small to medium size). Note that it is possible for the functions of Service Providers and Network Providers to be offered by the same provider or organization. It should be noted here that in general the providers could be either national or regional providers depending on the geographical coverage that they provide.

4.1.2. Unified network management architecture

Previous representative integrated network management architectures can be classified into two types: manager-of-managers or common platform. Manager-of-managers architecture is an upper and lower network management system that is layered vertically. The upper network management system collects and processes all the management information from each of the lower network management systems. These upper and lower network management systems transfer the management information using a standard protocol (Terplan, 1997). This architecture is used by NetView from IBM, and ACCUMASTER Integrator and UNMA (Unified Network Management Architecture) from AT&T etc. In common platform architecture, network management systems do not exist in each communication network. Instead, all network resources are managed using an API

(Application Program Interface). All of the network equipment uses a standard network management protocol, management information, and interface. This architecture is used by EMA (Enterprise Management Architecture) from DEC, SunNet Manager from SUN, and Open View from Hewlett-Packard, etc. Fig. 4.1 represents the manager-of-managers architecture that integrates a number of network management systems.

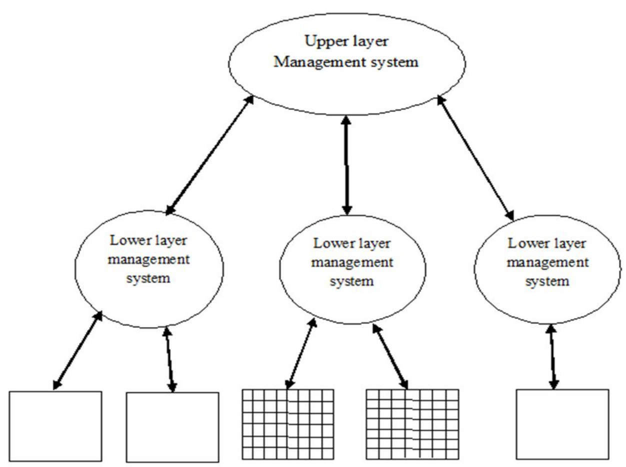
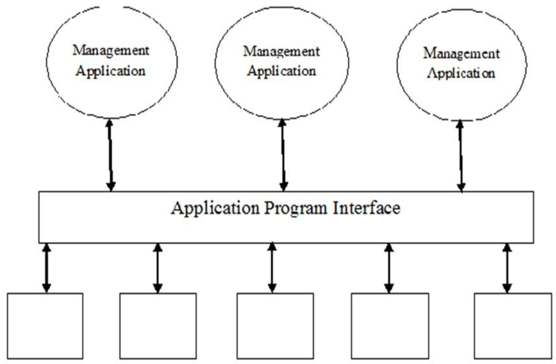


Fig. 4.1. Manager-of-managers architecture



Managed Equipments

Fig. 4.2. Common platform architecture

Application Program		
DBMS	X.11/MOTIF	C-Language
UNIX		
TCP/IP		
Network Interface		

Fig. 4.3. Implementation environment of the
Integrated network management system management system. Only a standard interface is required to connect the upper and lower network management systems and it has the merit that it can integrate an entire network.

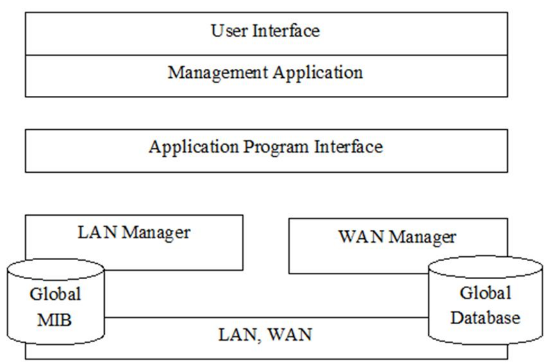


Fig. 4.4. Configuration of the integrated network management system

Management system in the short term. It should be noted, however, that since many lower network management systems depend on various kinds of networks, upper and lower network management systems need to be updated whenever a new network is inserted. Furthermore, additional hardware and communication circuits are needed for the upper network management system. If the upper network management system suffers a temporary congestion, this raises a significant problem for maintenance of the entire network.

4.2. RESULTS

4.2.1. Development of Integrated Network management system

So far, most network management systems employed in LANs and WANs have been separately developed. Recently, SNMP has been widely used as a standard network management protocol to manage LAN resources. The proprietary management protocol supported by the device manufacturer is used to manage WAN resources, and only a few devices support CMIP as the standard protocol. Under these circumstances, there is a need for integrated network management to efficiently construct and simultaneously maintain both LANs and WANs. Accordingly, a network management system using the proposed network management architecture has been developed to integrate the management of LANs and WANs.

4.2.2. Development procedure

The integrated network management system that can manage both LANs and WANs was developed on a hardware platform for stable development and efficient investment. Software engineering methods were applied to the development procedure including requirements analysis, design, and programming, test, and implementation steps. Most important, at the user's requirements analysis step, the requirements are arranged and a possible implementation environment is proposed. All associated equipment and communication lines are also managed (Fig. 4.2). From among the OSI network management functions, the main support is given to the configuration management function, performance management function, fault management function, and security management function. The other requirements are integrated in order to manage both LANs and WANs, and produce a convenient user interface. A workstation is used as a hardware platform to satisfy the user's requirements. UNIX and C language is used as the operating system and development program.

4.2.3. Design and implementation

The network management system managing the LAN and WAN includes LAN and

WAN managers as lower layer managers. The LAN manager collects management information about the equipment, terminals, and transmission lines in the standard

SNMP protocol used by the LAN. The WAN manager collects management information about the communication devices using a proprietary network management protocol. Two lower layer managers store the management information and transfer it to the application program interface. The application program interface connects the LAN and WAN managers, and transfers the management information to the integrated management application in an integrated form. The integrated management application can then manage both LANs and WANs, and support various management functions for users (Fig. 4.4).

4.2.4. Network management architecture

The network management architecture for supporting the model described in the previous subsection. The architecture is based on a client/server model. The central management system and the clients reside in the NOC. The element management systems which gather data on the health of different sets of network elements are connected to the network management server via a communication server box. The communication server converts the incoming data stream to the appropriate format to be exported to the network management server (i.e. incoming ASCII information into TCP/IP).

5. CONCLUSION

5.1. Conclusion

The DiffServ mechanism qualitatively differentiates the QoS of different service classes at each hop, and the resource allocation over DiffServ networks is still an open research area. This dissertation studies resource management architectures, CAC algorithms, and dynamic resource sharing techniques that can augment the DiffServ networks for efficient resource allocation, while quantitatively control the packet- and call-level QoS of different service classes.

This research has proposed integrated network management architecture for managing heterogeneous networks using an application program interface and lower layer manager. The proposed architecture can accept the existing networks of management systems. Also, an integrated network management system was designed and implemented that could manage both LANs and WANs using SNMP and a proprietary network management protocol according to the software development procedure. The implemented integrated network management system can support a unified user interface on a hardware platform and manage both LANs and WANs. In future work, a complete integrated network management system that can unify management information and adapt all associated equipment to a standard network management protocol will be developed.

5.2. Future Scope

This dissertation is an initial step to quantify the packet-level and call-level QoS control in DiffServ networks. For mathematical tractability, the effective bandwidth concept is proved theoretically only in the regime of large buffer and small packet loss probability for multiplexed homogeneous sources. Although numerical analysis and computer simulations demonstrate the applicability of the effective bandwidth for heterogeneous traffic, many challenging issues remain to be addressed to develop a more theoretically solid effective bandwidth for practical DiffServ networks. Application of the effective bandwidth for call-level QoS control in this thesis is mainly considered in an exponential distributed environment, which may not be the common case for the Internet. Furthermore, the capabilities of the powerful traffic engineering tool, the MPLS, are not fully exploited in this thesis. In addition to the load balancing capability, the MPLS can be used to further improve resource utilization by rerouting traffic flows to avoid congestions and network device failures in a certain path.

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