在 IP over ATM 下支援網路服務品質[1]

Support QoS in IP over ATM

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摘要

本論文提出一種優先等級的方法讓 IP 封包在利用 IP over ATM 傳過 ATM 網路時也能有服務品質的提供。

關鍵字：架構於非同步傳輸網路的網際網路協定，服務品質

Abstract

This paper describes a priority scheme for providing IP packets with quality-of-service over ATM switched virtual circuits (SVCs) to get better performance of packet delivery in IP over ATM networks.

***Keywords:** IP over ATM, QoS (Quality of Service)*

1. Introduction

Asynchronous Transfer Mode, commonly known as ATM, is the mostly widely studied and implemented form of cell networking [13]. ATM began as a technology designed specifically to address the needs of the international telecommunications carrier community. It has evolved over the past few years and various protocols and interfaces are defined in a set of standards created by the International Telecommunications Union (ITU). This gives network designers a solid base on which to build ATM networks. ATM is the underlying transmission system for ITU's next-generation ISDN, Broadband ISDN. B-ISDN is designed to provide subscriber communications services over a wide range of bit rates from a few megabits to several gigabits. The current ATM standards are designed to allow subscribers access to the telephone networks at speeds of up to 622 megabits/s and it is expected that eventually, gigabit speeds will also be supported, as the underlying ATM transmission system is clearly capable of gigabit speeds.

However, in the very competitive market, ATM can not be the sole technology used. It is going to cooperate with existing network technologies in Internet environment. The combined networks are hoped to provide the guarantees of QoS, which is required by network users and for the performance of Internet. These QoS guarantees, however, come at a price. Contrary to common misconceptions, ATM is a very complex technology [1], perhaps the most complex ever developed by the networking industry. While the structure of ATM cells and cell switching do facilitate the development of hardwired and high performance ATM switches, the deployment of ATM networks requires an infrastructure which consists of layers of highly complex protocols and softwares. Therefore, one of the challenges that ATM faces is to interoperate with the vast number of TCP/IP networks. Using IP and ATM together presents some interesting problems because they differ in fundamental ways, from their respective models of data forwarding (connectionless vs. connection-oriented) to support for the preferential treatment of packets (no support vs. the potential for support guarantees). In this paper, we will introduce some strategies and propose a priority scheme to support QoS for IP datagrams carried over the interconnected ATM and TCP/IP networks in IETF IP over ATM [6,7,14]. The implications of various IP-over-ATM strategies on network performance, particularly the aspects relating to quality of service, virtual circuit multiplexing, and virtual circuit management are also addressed.

The following is the structure of this paper. In Section 2, the protocol design principles are described. In Section 3, the protocol implementation for using the ATM virtual circuits with guarantee of performance to carry IP datagrams is shown. Finally, conclusions and further studies are stated in Section 4.

2. Protocol Design Principles

Our goal is to extend the QoS features of an ATM network to IP applications. Although, IP in its current form has no provision for QoS support, the underlying

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ATM subnet has the capability to offer performance guarantees. We would like, therefore, for Internet applications to gain some of the benefits of ATM performance guarantees, without end-hosts or applications necessarily being aware of this capability.

As shown in Figure 1, there is only one SVC between each host-pair in Classical IP over ATM. These SVCs provide "Best Effort" service. They did not guarantee any quality of service. To improve this, we provide a priority scheme to support QoS.

The idea is to group different application types into different virtual circuits. For example, different FTP sessions can be aggregated into one FTP virtual circuit and so do Telnets and HTTPs. Each virtual circuit is used by one application type. As shown in Figure 2, the same applications share the same virtual circuit because they have the same characteristic of resource requirements. For example, HTTPs care response time and Telnets focus on delay. All of these VCCs are Switched Virtual Circuits (SVC). These VCs are created on demand. On the contrary, real time traffic would like to have their own VC to transmit data, as shown in Figure 3, such that the other packets can't disturb them. Using the above idea, we propose a priority scheme by using the precedence bits in the Type of Service (TOS) field of IP header to determine whether a flow should initiate a new VC or join an existing one. In contrast, traditional IP over ATM networks uses only one SVC to transmit IP packets. There is no bandwidth or delay guarantee in classical IP over ATM networks.

3. Protocol Implementations

In this section, we introduce the proposed priority scheme. It uses the Type of Service (TOS) [2] field in the IP datagram header and is backward compatible with existing IP implementation. These newer options need only be implemented on the end systems that want to take advantage of them.

The remaining question is how to set the "user priority" field? Table 1 describes the priority values for various Internet applications. The 3-bit "User Priority" field yields 8 different service classes with value 7 = highest priority and 0 = lowest priority. Table 2 defines the semantics of the User Priority field values. 0 is referred as the default User Priority. The next step is to determine the type of applications. We distinguish between different applications by the well-known port numbers. This port number is included in the TCP or UDP protocol header [16]. Most of the TCP or UDP applications have the property that they are assigned "well-known" ports. Assigning fixed port numbers to certain applications enables client processes to easily located server processes. For example, a telnet client application knows that it can locate telnet servers on remote hosts on TCP port 23. An ATM-attached router can check the source and destination port numbers of a TCP packet; if it sees a well-known port number in the TCP source port field, the packet is likely transmitted by a server process to a client process. Conversely, if a well-known port number appears in the TCP destination port field, the packet is likely transmitted by a client process to a server process. For non-default port numbers, a configuration table can be built first into IP over ATM.

4. Conclusions and Future Works

In this paper, we proposed a priority scheme (named "User Priority") by extending the IP datagram header. The goal is to enable the better packet delivery performance in traditional IP over ATM networks with QoS guarantees. Today's networks is mostly IP traffic. Then can be benefited by applying the method when passing through ATM networks.

Currently, the User Priority scheme does not support dynamic change of QoS. There are several common reasons for a change of reserved QoS. First, an existing receiver can request a new larger QoS. Second, a sender may change it traffic specification, which can trigger a change in the reservation requests of the receivers. Finally, a new receiver can make a reservation that is larger than existing reservations. Since ATM service, as currently defined in UNI 3.x [5] and UNI 4.0, does not allow renegotiating the QoS of a VC, dynamically changing the reservation means creating a new VC with the new QoS, and tearing down an established VC. Tearing down a VC and setting up a new VC in ATM are time-consuming.

Furthermore, we need an enhanced signaling protocol. Set up a connection is a hop-by-hop process in UNI 3.x and 4.0. A possible candidate is the Connection Request Protocol (CRP) [17]. It uses a parallel connection set up and resource management scheme. Its key feature is that it combines address resolution with connection set up to improve performance. Further, it eliminates the need for IP end points to support ATM signaling protocols, thereby significantly simplifying their configuration and management.

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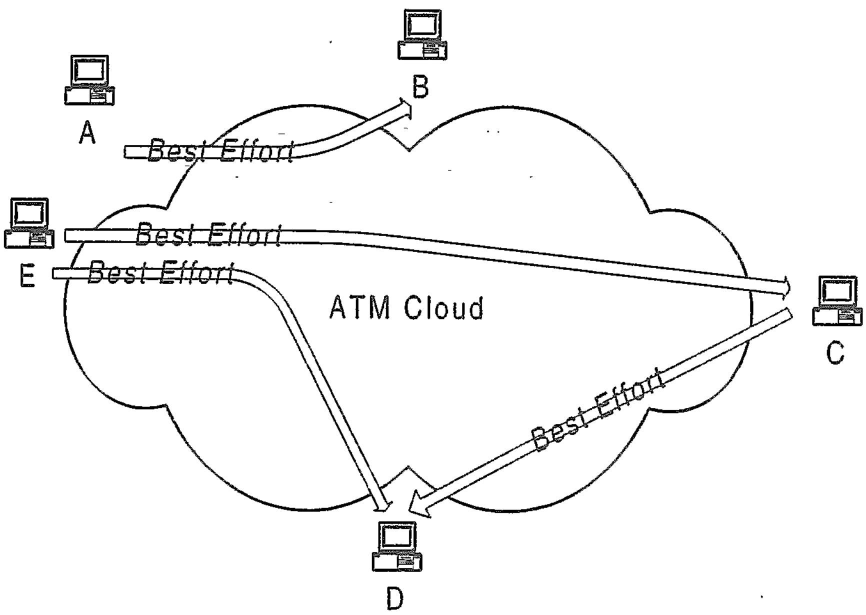

Figure 1. Virtual Circuit Connection in Classical IP over ATM.

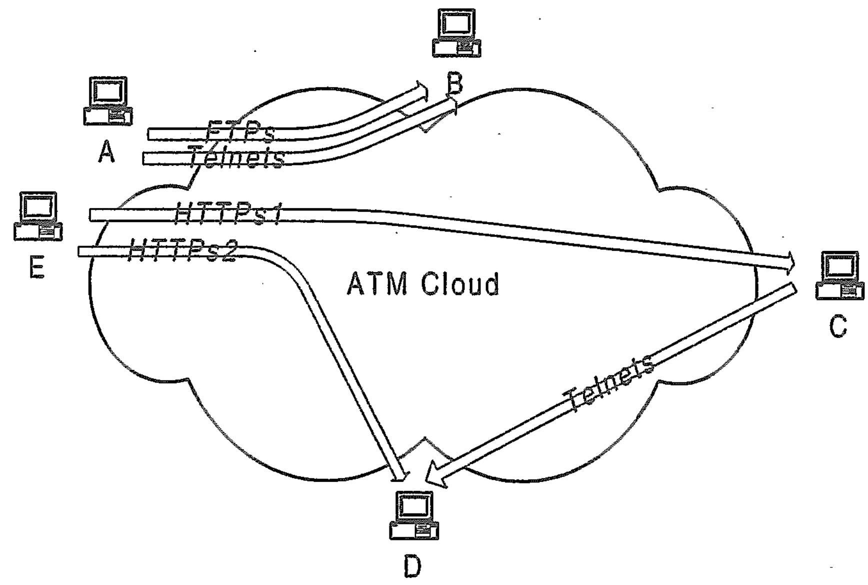

Figure 2. Sessiones in the same application type aggregate to one virtual circuit per host pairs.

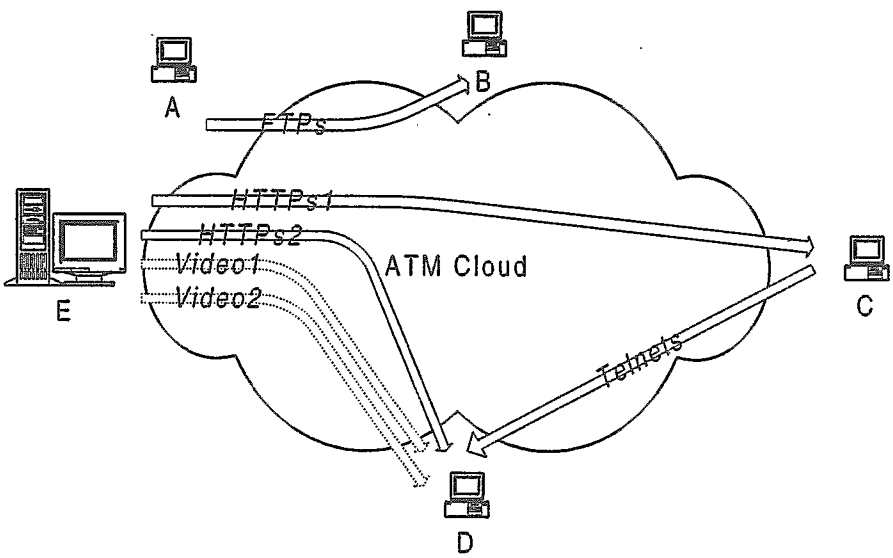

Figure 3. Two video flows have their own VCs, respectively.

Table 1. Recommended values for Type-of-Service field

Application	Minimize Delay	Maximize throughput	Maximize reliability	Minimize monetary cost	Hex value for TOS Octet
Telnet/Rlogin	1	0	0	0	0x10

FTP(control)	1	0	0	0	0x10
(data)	0	1	0	0	0x08
(any bulk data)	0	1	0	0	0x08
TFTP	1	0	0	0	0x10
SMTP (command phase)	1	0	0	0	0x10
(data phase)	0	1	0	0	0x08
DNS(UDP query)	1	0	0	0	0x10
(TCP query)	0	0	0	0	0x00
(zone transfer)	0	1	0	0	0x08
ICMP(error)	0	0	0	0	0x00
(query)	0	0	0	0	0x00
(any IGP)	0	0	1	0	0x04
SNMP	0	0	1	0	0x04
NNTP	0	0	0	1	0x02
BOOTP	0	0	0	0	0x00

Table 2. Recommendation values of User Priority

Priority	Service	ATM QoS	Application
0	Best Effort (BE)	UBR	unspecified traffic
1	Bulk transfer (background)	ABR	NNTP, SMTP
2	Bulk transfer	ABR	FTP, HTTP
3	Interactive traffic	ABR	Telnet, HTTP
4	Internet control message	ABR	ICMP
5	Non-real-time(VBR)	nrtVBR	nrt digital video
6	Real-time (VBR)	rtVBR	digital video
7	Real-time (CBR)	CBR	digital audio