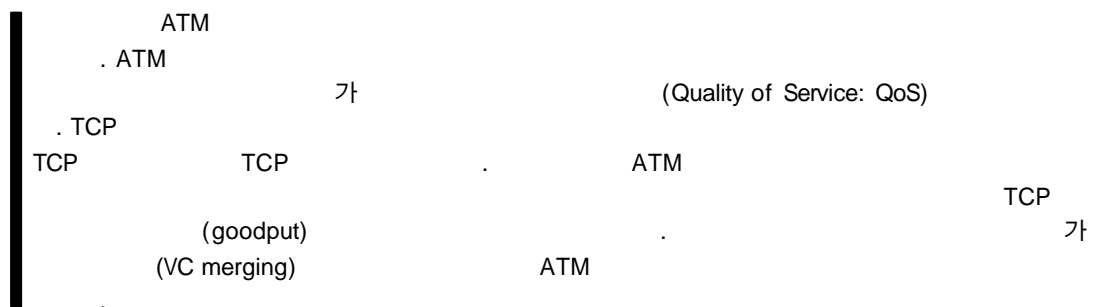




# ATM

## Buffer Management for Non-real Time Traffic in ATM Switching Systems

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(D.Y. Kim)



I.

QoS ATM 가 가  
 QoS ATM 가  
 ATM Constant Bit ATM QoS  
 Rate(CBR), Variable Bit Rate(VBR), Available  
 Bit Rate(ABR), Unspecified Bit Rate(UBR)  
 Guaranteed Frame Rate(GFR)

[1, 2].



ATM

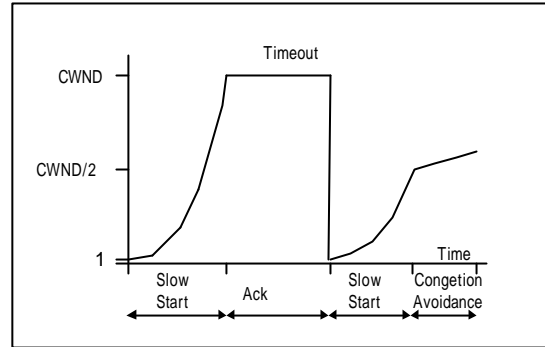
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ATM				TCP
QoS			ITU-T, ATM Forum, IETF	
	ATM	ATM	QoS	
	ATM	ATM	QoS	
가		ATM		VC
		ATM		
		가	II. TCP	
			1. Slow Start and Congestion Avoidance	
TCP	ATM	TCP		
. TCP	가	가	(CWND)	가
				(RCVWND)
ATM	[3-6].	TCP	CWND 1	(acknowledge)
		가	1	가 RCV
			WND CWND가	가 ( ,
			min{RCVWND, max(CWND)}).	
		EPD(Early		
Packet Discard), SPD(Selective Packet Discard)	[7-10].			
	ATM		가	가
VC	VC	slow start	. Slow start	
가	가 VC	CWND가	(Round Trip Time: RTT)	
	[17].	2	가	가



(duplicate acknowledge)

가  
TCP  
가



( 1) TCP Slow Start and Congestion Avoidance

TCP  
(SSTHRESH) CWND 1/2

, CWND

. CWND 1

SSTHRESH

1 가 (slow start

). CWND 1

가 ,

가 .

$$CWND = CWND + \frac{SegSize \times SegSize}{CWND} + \frac{SegSize}{8}$$

SegSize =

CWND가 가  
(congestion avoidance)

. ( 1) TCP slow start

TCP

가

. 가,

CWND 1 가

가 RTT

Fast Retransmission and Recovery(FRR)가 [11].

TCP가

TCP가 3

가 가

SSTHRESH CWND 1/2

, CW

ND SSTHRESH 3

CWND 1 가

## 2. FRR Avoidance

TCP

500 msec

(fast retransmission)

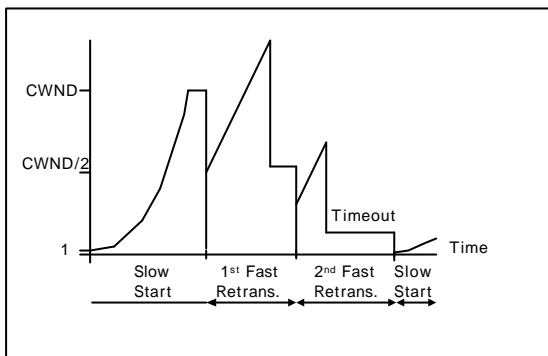
1/2

RTT

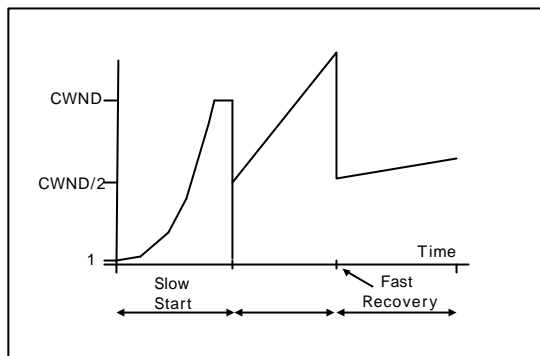
1



ATM



( 2) TCP Fast Retransmit and Recovery



( 3) TCP Selective Acknowledgement

CWND  
 1 CWND가 Ssthresh  
 가 slow start  
 TCP CWND Ssthresh  
 recovery) ( 2) 2

SACK  
 1  
 ( 3)  
 (fast SACK

III. ATM

3. SACK

FRR  
 FRR  
 (selective ac-  
 knowledge: SACK)[12]  
 SACK TCP  
 가  
 가 SACK  
 TCP

ITU-T ATM (ATM  
 Transfer Capability: ATC) Deterministic Bit  
 Rate(DBR), Statistical Bit Rate(SBR), ABR  
 (ATM Block Transfer), ABR, UBR GFR  
 , Controlled  
 Transfer(CT) 가  
 ATM Forum ATM CBR,  
 real time Variable Bit Rate(rt-VBR), non-  
 real time Variable Bit Rate(nrt-VBR), ABR,  
 UBR GFR  
 QoS

3

ATM

CWND 가

< 1 > , CBR



< 1 > ATM [ 12 ] 가

		ATM					
		CBR	rt-VBR	nr-t-VBR	UBR	ABR	GFR
	PCR&CDVT	O			O <sup>2</sup>	O	O
	SCR, MBS CDVT	N/A				O	N/A
	MCR	N/A	N/A	O		N/A	
	MCR, MBS, CDVT, MFS	N/A				O	
QoS	p-t-p CDV	O	X				
	MaxCTD	O	X				
	CLR	O	X	*1	*3		
		X			O	X	

O: X: N/A: Not Applicable  
 \*1: CLR  
 \*2: CAC UPC  
 \*3: CLR

UBR  
 (Peak Cell Rate: PCR)  
 (Cell Delay Variation Tolerance: CDVT)  
 가 QoS  
 TCP  
 GFR VBR  
 ATM  
 GFR

rt-VBR

(Maximum Frame Size: MFS)  
 (Maximum Burst Size: MBS)  
 (Minimum Cell Rate:  
 MCR)  
 가

ABR ATM  
 ABR  
 QoS

[15,16].  
 IETF ATM Forum  
 PNNI v2.0  
 VC VC N  
 N<sup>2</sup>

ABR  
 ABR  
 가

IV. ATM  
 ATM  
 (fairness)

ER(Explicit Rate)  
 EFICI(Explicit Forward Congestion Indication)  
 ABR  
 ER ER (IP)



ATM

TCP  
155.520 Mbps  
가 512

STM-1  
TCP

ATM

EPD(Early Packet Discard)  
(Partial Packet Discard: PPD) . EPD

PPD

512  
+ 20 TCP  
+ 20 IP  
+ 8 LLC  
+ 8 AAL5  
= 568

12 ATM

TCP ATM 12 x 53 = 636  
가

(per - VC queuing),  
(per - link queuing)

512/636 = 80.5% 125.2 Mbps가

(per - class queuing)  
ATM

(fairness)  
(fairness index) 가

$$\text{Fairness index} = \frac{(\sum_{i=1}^n x_i)^2}{n \times \sum_{i=1}^n x_i^2}$$

1. TCP

ATM

$x_i = i$  TCP ,  $n = \text{TCP}$

ATM TCP  
가

가

max\_min fair share

TCP (efficiency)

= TCP / 가 TCP

2.

TCP TCP ATM 가 가



가 가 ,  
 가 . 가 1/2 , 1/2 RTT  
 TCP  
 FRR .  
 가 . TD  
 ATM 가  
 가 .  
 QoS . (Early discard)  
 가 가 가  
 가 QoS  
 RED(Random Early Discard)  
 가 EPD . RED 가  
 Tail Drop(TD) , EPD  
 , (drop from front)  
 . TD 가 가 . PPD  
 가 , EPD  
 TCP  
 TCP 가  
 AAL5 EPD  
 EOM(End - of - Message) 가 가  
 CRC  
 PPD  
 TCP  
 가 가 가  
 가 (가  
 ) . BS Th  
 TCP .



ATM

$$Th = \max \{ 0.8, [BS - 3 \quad ]/BS \}$$

가 50k , 80% , .  $Y_i$  ,  $i$   
 100k가 , 가 500k ,  $i$   
 가  $= Y_i \times Nz / X$

$$Th = BS - MSS \times k$$

(MSS)

( 4) SPD

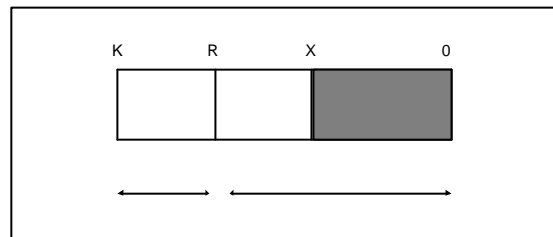
. K , R

, X

. EPD

. SPD

가



( 4) SPD FBA

CWND

CWND

가

$j$   $Q_j$ ,

(Selective Packet

$Q$ ,

$Th$ ,

$K$ ,

Dropping: SPD)[13]

. SPD

VC

X

$Na$

(fair alloca-

tion)

$$\text{Fair allocation} = X / Na$$

```

j
if the cell is the first cell of a packet
  calculate  $Th = K \times Q/N$ 
  if  $Q \geq Th$  and  $Q_j \geq Th$ 
    discard the cell
  else
    accept the cell into the FIFO queue
     $Q_j = Q_j + 1$ 
else
  if any cell of packet has been discarded
    discard the cell
  else
    if  $Q \geq Q_{max}$ 

```





```

discard the cell
else
  accept the cell into the FIFO queue
Qj = Qj + 1
  
```

```

accept the cell into the VCj's queue

Qj = Qj + 1
Else
  if any cell of a packet has been discarded
    discard the cell
  else
    if Q > = Qmax
      discard the cell
    else
      accept the cell into the VCj's queue
Qj = Qj + 1
  
```

SPD 가 , 가

FBA

Fair Buffer

Allocation(FBA)[14]가

Z

SPD

ATM

가

가

$(X > R)$  and  $(Y_i \times Na / X > Z(K-R) / (X-R))$

가

QoS

가 가

X가

R

TD

TCP

X / Na

TCP

TD

VC  
 $\times ((K-R) / (X-R))$

가 가

EPD

TD

Y<sub>i</sub> 가

(X / Na)

PPD가

TCP

가

```

j
if the cell is the first cell of a packet
  calculate Th = K x Q / N
  if Q > = Th and Qj > = Th
    discard the cell
  else
  
```

SPD + EPD

FBA + EPD

SPD + EPD



ATM

1) CLR

TCP FRR WAN TCP 가 가  
 , WAN . TCP  
 . FFR slow  
 start LAN 3)  
 TCP , TCP VBR 가 가  
 . FFR EPD TCP .  
 . SACK TCP UBR  
 slow start TCP . LAN 가 . GFR  
 SACK TCP  
 . WAN SACK UBR MCR 0 , MCR  
 . SACK TCP 0 GFR UBR .

EPD

2) 가 가  
 TCP , 가  
 가 가 TCP  
 가 가 .

TCP TCP 가 ABR  
 UBR ,  
 TCP ABR UBR + EPD  
 ABR  
 UBR . ABR  
 가 ATM

(Cell Loss Ratio: CLR)  
 . CLR ABR . GFR  
 TCP MCR UBR  
 . TCP .



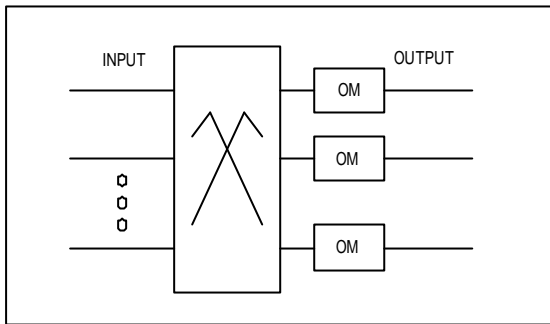
. VC MID(Message Identifier) 가  
 ATM CRC AAL5가 .  
 . N 가 가  
 N<sup>2</sup> 가  
 N 가 . AAL5 EOP(End Of Packet)

MPLS (merged connection)  
 . VP VC 가 . ATM Forum  
 VP PNNI v2.0 가 ,  
 VC , ATM 가  
 VPI VCI VC  
 VPI VCI VP 가  
 , ATM ( )  
 VPI 가 4,096 5)  
 (Output Module: OM)  
 . ( 6)  
 VCI ( 5) VC  
 VC VCI ATM VC  
 VCI EOF(End Of  
 File)  
 VCI . ATM N,  
 VCI VCI E VC  
 (reassembly)  
 = N x E  
 N 32, E가 10  
 가 . 가 320

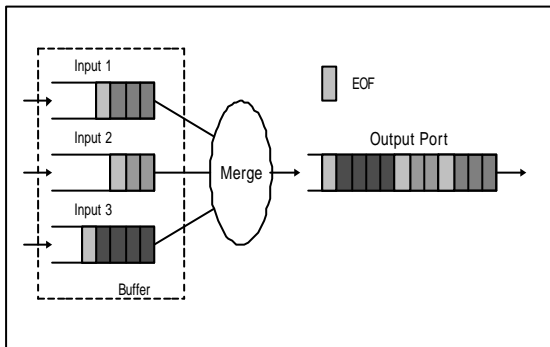
AAL3/4



ATM



( 5) VC



( 6)

put non-VC EPD VC good-

, 가

VI.

QoS TCP , ATM . VC

TCP

TCP가

ATM

VC

VC

EOF  
가

. VC

가

가

ATM

가

. TCP  
가  
slow start  
가  
slow start  
FRR . Slow start CWND 1  
ATM 가

. TCP  
TCP 가 가  
EPD ,  
FBA  
. EPD EPD  
가  
FBA



UDP

TCP,

QoS

가

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