PRINCE OF SONGKLA UNIVERSITY
FACULTY OF ENGINEERING

Final Examination: Semester I | Academic Year: 2005
Date: 5 October 2005 | Time: 13.30 – 16.30
Subject: 240-543 Broadband Integrated Networks | Room: A401

- In this exam paper, there are four questions,
- All notes and books are not allowed,
- Answers could be either in Thai or English,
- Only un-programmable calculator is allowed,
- Answer all questions. Each question has the same score.

1. Figure 1, 2, and 3 show the scenario of how new AAL-2 multiplexes several voice traffic into one channel (one virtual channel (VC) in ATM context). Each 64 kbps voice channel is compressed by using the CS-ACELP scheme with silent suppression. During silent period there is no data to send. New AAL-2 is suitable for compressed wireline telephony, wireless telephony, and wireless data. Please describe how this scenario works. (20 Marks)

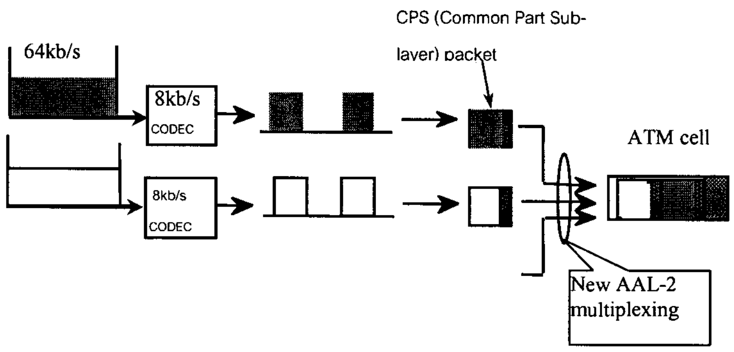

Figure 1 Voice and telephony multiplexing over ATM using AAL2.

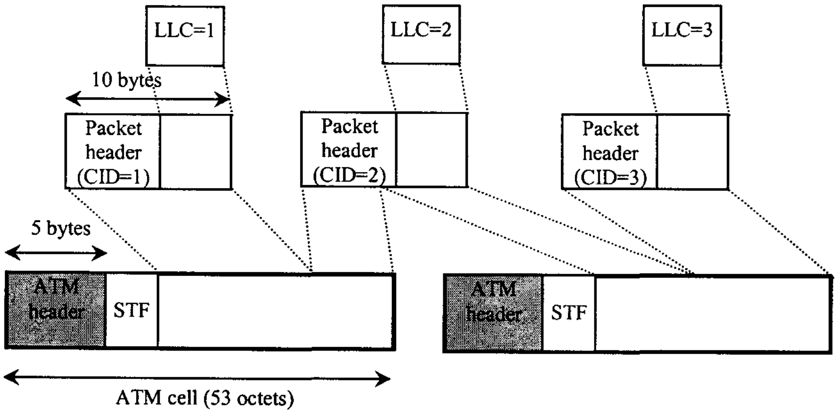

Figure 2 ATM cell structure for supporting AAL-2 multiplexer

CPS packet header (3 octets)

CID 8 bits	LI 6 bits	RES 5 bits	HEC 5 bits

Start Field (STF) 1 octet

Offset Field (OSF) 6 bits	Sequence Number (SN) 1 bit	Parity (P) 1 bit

CID=Channel Identifier LI=Length Indicator
RES=Reserved HEC=Header Error Check

Figure 3 Structure of packet header and start filed.

2. Leaky bucket

2.1 **Leaky bucket without data buffer Scheme** (10 Marks)

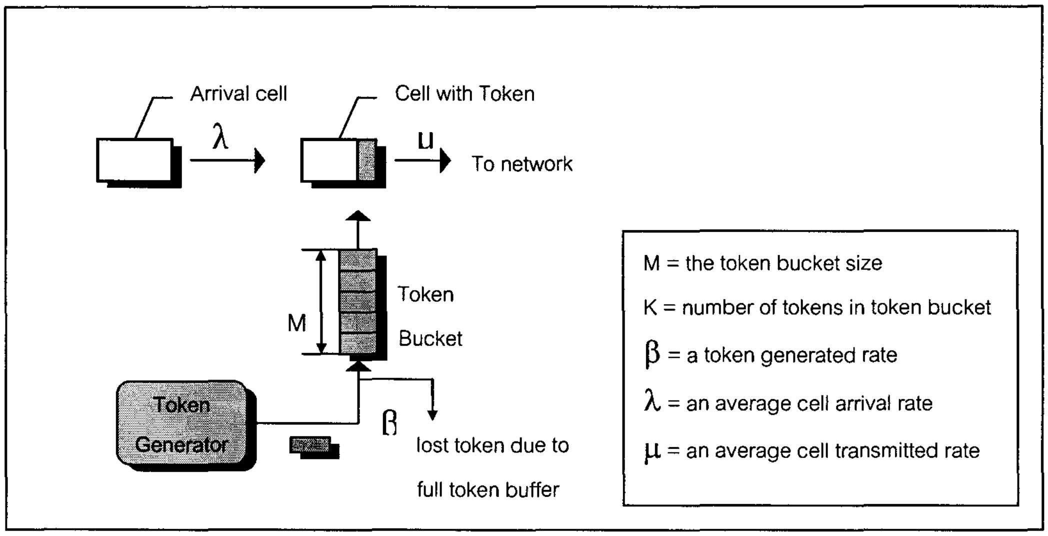

Figure 4 Buffered leaky bucket without data buffer Scheme

Figure 4 shows a *leaky bucket without data buffer or unbuffered leaky bucket without data buffer scheme.* Tokens are generated with rate β and stored in the token bucket which has finite capacity *M*. If the token bucket is full ($\beta T \geq M$) then next token is discared. An arrival cell is placed with a token from the token bucket if the token bucket is not empty otherwise the cell is discarded.

The below figure show arrival cell and token in leaky budget, please draw transmitted cells in the given time slots.

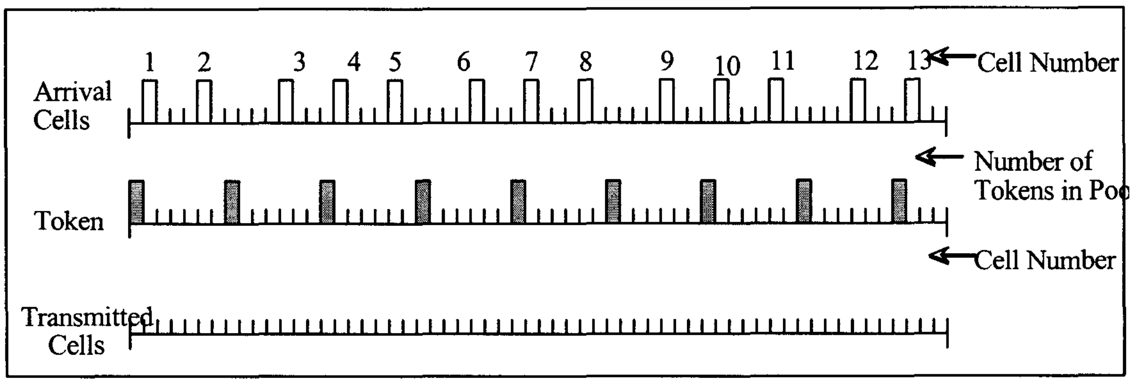

Figure 5 for question 2.1

2.2 Leaky Bucket with data buffer (10 Marks)

Figure 6 shows *leaky bucket with data buffer* or *buffered leaky bucket with data buffer scheme* [A01][A06]. Tokens are generated with rate β and stored in the token bucket which has finite capacity M. If the token bucket is full ($\beta T \geq M$) then next token is discared. An arrival cell from the data buffer is placed and transmitted with μ rate with a token from the token bucket if the token bucket is not empty otherwise the cell is stored in the data buffer which has a finite capacity M if it is not full ($N < M$)and dicareded when it is full ($N \geq M$).

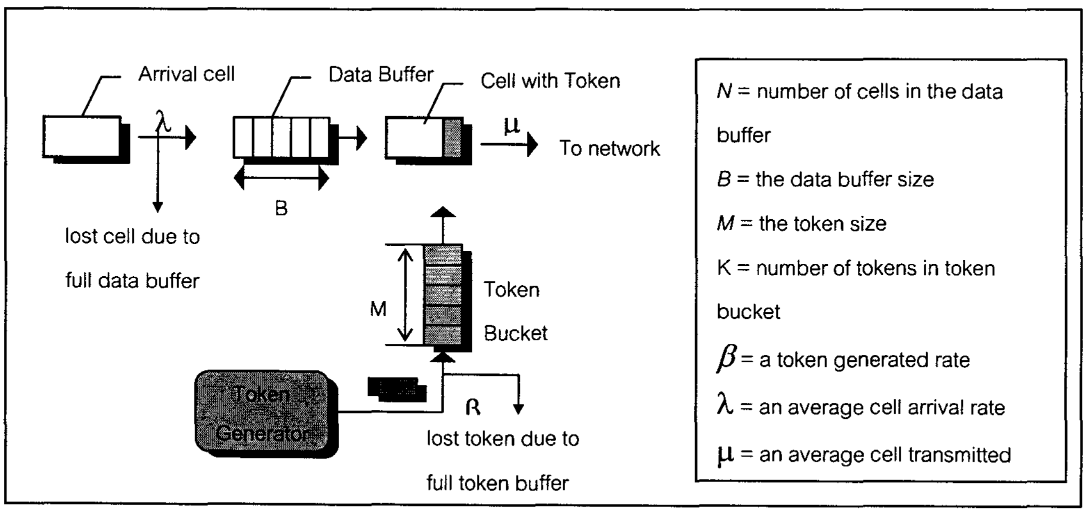

Figure 6 Leaky Bucket with data buffer

The below figure show arrival cell and token in leaky budget, please draw transmitted cells in the given time slots.

4. We consider an analytical model for explicit rate flow control as shown in Figure 8. This scenario is used for the equal *ICR* case. The following conditions are used:

- There are 2 source groups: *S1* and *S2*.
- The round trip time between *S1* and its destination, and *S2* and its destination are 0.015 sec and 0.0005 sec respectively.
- All sources start transmitting data at 3 Mbps (*ICR*=3 Mbps) at time 0.
- The switch service rate is 155 Mbps. The switch allocation bandwidth is 95% of its full rate.

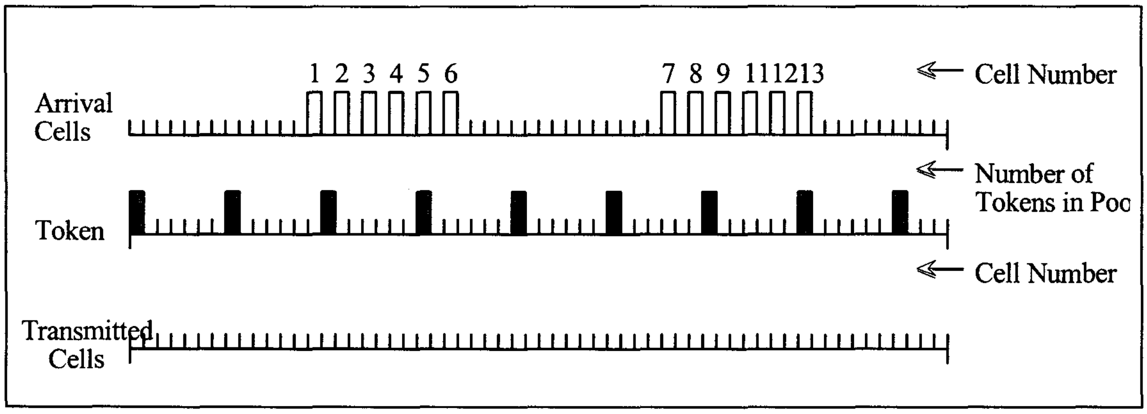

Figure 7 For question 2.2

3 (20 Marks) The following steps are the rule for worst case allocation for VBR VCs:

1. Assume that all connections are compliant with GCRA(1/PCR,0) and GCRA(1/SCR,τ_s),
2. Determine N, the maximum number of source NxSCR ≤ PCR,
3. Find out the worst case for one source with MBS = integer [1+τ_s/(1/SCR – 1/PCR))],
4. Assume that all sources are synchronised and transmit their worst case traffic,
5. Find the buffer size to avoid any overflow Req_Buf= (N-PCR_o/PCR) x MBS,
6. Compute the maximum delay D ≤ Req_Buf/PCR_o.

In our system the out-going link bandwidth is 155 Mbps. There are four types of sources tested in out system with the following source traffic parameters:

Type A: MSB = 200 cells, SCR = 5,000 cells/sec, PCR = 25 MBPS
Type B: MSB = 200 cells, SCR = 5,000 cells/sec, PCR = 155 MBPS
Type C: MBS = 1,000 cells, SCR = 15,000 cells/sec, PCR = 59,000 cells/sec
Type D: MBS = 1,000 cells. SCR = 15,000 cells/sec, PCR = 367,000 cells/sec

The following contact parameters are given
For peak rate: GCRA(1,0) and
For average rate: GCRA (3,8)

Please determine (you must show how you get the answer).:

a) Maximum number of connections
b) Minimum buffer size
c) Maximum queueing delay

4. We consider an analytical model for explicit rate flow control as shown in Figure 8. This scenario is used for the equal *ICR* case. The following conditions are used:

- There are 2 source groups: *S1* and *S2*.
- The round trip time between *S1* and its destination, and *S2* and its destination are 0.015 sec and 0.0005 sec respectively.
- All sources start transmitting data at 3 Mbps (*ICR*=3 Mbps) at time 0.
- The switch service rate is 155 Mbps. The switch allocation bandwidth is 95% of its full rate.

- The following parameters are used: *PCR*=155 Mbps, *RIF*=1/256.
- All sources are saturated sources, e.g. always send data as high as requested by the network.

Hint: The *S2* rate converts to *ER* before *S1* due to a shorter round trip time delay]. All necessary formulas are shown in Figure 9. The switch queue is not fully utilised since the total offered load is less than the service rate.

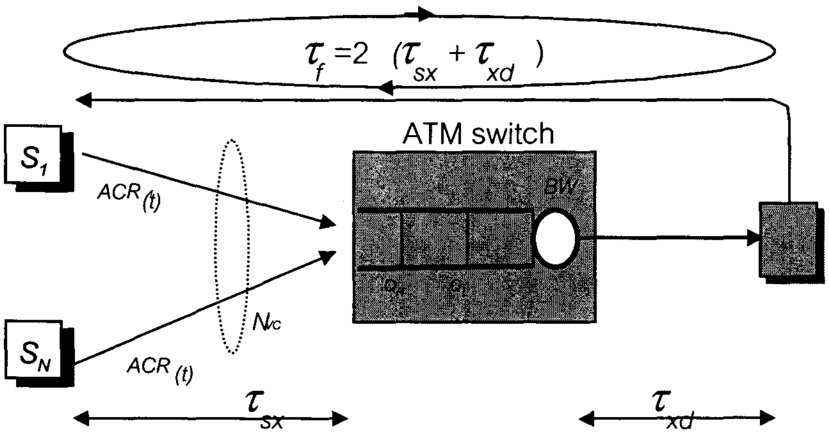

Figure 8 Analytical model for explicit rate flow control

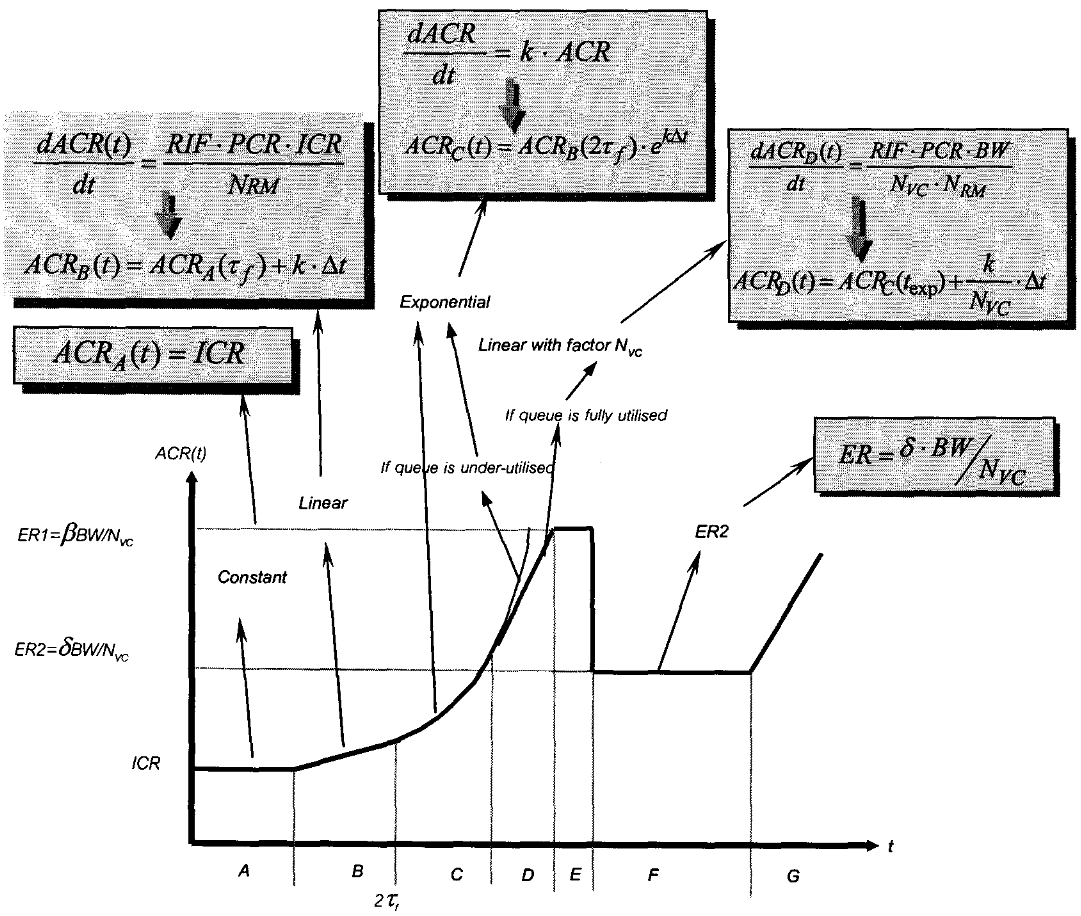

Figure 9 Source rate behaviour as a function of time with equal *ICR*