Artificial Traffic Generation For A Multi Service Network

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Summary:
Artificial traffic generation for networks is a necessary, to an extent difficult and probably the most important task for planning and/or designing the futures aspects of the networks. This task is further difficult if the network provides different type of services. The selection of the appropriate source models for such a multiservice network (such as ATM), is really a daunting task. In the current paper, traffic the source models for different classes of service in a network have been identified. Based on these identified and a technique has been discussed to generate an aggregated source traffic consisting of the packets from various service classes. The effort has been done to generate the traffic, which meets certain conditions (as per the predefined parameters), in order to represent a composite multiservice (or multi class) traffic sources.
Keywords: Multi service Network, ATM, source model, Markovian models, Service Categories

Notations:

ABR	Absolute Bit Rate
ATM	Asynchronous Transfer Mode
CLR	Cell Loss Ratio
BT	Burst Tolerance
CBR	Continuous Bit Rate
CDVT	Cell Delay Variation Tolerance
CTD	Cell Transfer Delay
CAC	Call Admission Control
GFR	Guaranteed Frame Rate
IBM	Input Buffer Module
MCR	Minimum Cell Rate
MBS	Maximum Burst Size
PCR	Peak Cell Rate
QoS	Quality of Service
rt/nrt	Real Time/Non Real Time
SCR	Sustainable Cell Rate
SE	Switching Element
UBR	Unspecified Bit Rate
VBR	Variable Bit Rate
F-GCRA	Frame Based Generic Cell Rate Algorithm
GOP	Group of Pictures
CoV	Co-efficient of Variation
MMPP	Markov Modulated Poisson Process
SM	Source Model
SBBP	Switched Batch Bernoulli Processes

1.0 Introduction:

Traffic modeling is a vital aspect of any network simulation study. The output of any simulation is highly dependent on the inputs provided to the model. In the absence of an appropriate input workload model, the simulation results are of little or no use.

It is general practice to use synthetic network traces (generated with the help of an appropriate source model), instead of actual network data. This approach offers flexibility, scalability, tenability, and reproducibility in the generated traffic [30].

In this paper efforts have been done to identify and implement the representative workload model to be used as inputs for a multi service network (e.g. ATM network). An approach has been adopted in this paper to identify the most appropriate traffic source models, representing the traffic source behavior of each class of service and combine the output of traffic source models (as per their percentage contribution in the aggregated network traffic) to generate the stream of traffic.

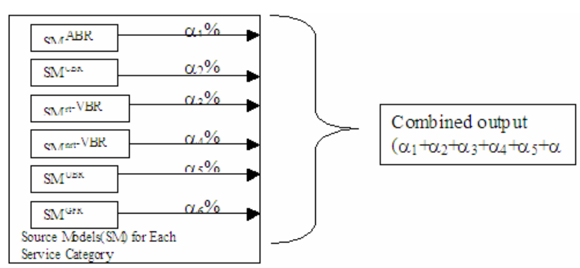


Figure 1:Aggregated output from various service Class

As shown in the figure-I, the output from each type of source is combined (as per their percentage contribution which is allowed for that particular service) to form an aggregated source model.

This paper explain the various kind of service categories, in case of a multiservice environment, their requirements for QoS and Traffic Descriptor parameters and an appropriate source model for representing the traffic behavior of that particular class of service.

2.0 Service Categories in a multiservice network and their source models:

In case of a multi service networks (considering ATM Networks), parameters such as communication

- Real Time Connection Services
  - Constant Bit Rate(CBR)
  - Real-Time Variable Bit Rate(rt-VBR)

Table-1: Various Service clases

Assurance is treated as quality of service parameters. As a result, the possible classes of service have been defined [35] in Table-1.

These service categories relate traffic characteristics and QoS requirements to network behavior. Functions such as routing, Connection Admission Control (CAC), and resource allocation are, in general, structured differently for each service category.

- Non-Real Time Connection Services
  - Non-Real-Time Variable Bit Rate(nrt-VBR)
  - Unspecified Bit Rate(UBR)
  - Available Bit Rate(ABR)
  - Guaranteed Frame Rate(GFR)

		Attribute		
		Possible Applications	Simulation Type	Reference:
ATM Layer Service Category	CBR	Circuit Emulation, Video Conferencing	Fluid	[10][16] [17][27]
	Rt-VBR	Compressed Audio/Video	MMPP,SBBP	[1][2][4][6] [11] [12][14] [15][19][20] [21][23][25] [27][29].
	Nrt-VBR	Critical Data, Frame Relay, X.25	FGn, Self Similar Markov Modulated, Fractal Point Process	[16]
	UBR	LAN Interconnection, IP,SMDS	MMPP	[16]
	ABR	File Transfer, emails	MMPP with on/off	[16][5]
	GFR	Critical data transfer; RPC;Distributed Systems	Exponential On/off	[28]

Table 2: ATM Service Category Attributes [6]

3.0 Suggested Aggregate Source Model for a multiservice Network

Once the traffic has been generated (under each service category), further selection of the network traffic can be done by allocating the percentage of bandwidth for each service of category as shown in the following table and the packets (from appropriate service category) may be allowed to pass following the predefined statistics. If ‘B’ is the total bandwidth available then percentage share of each class of service category can be determined as explained in Table 3.

Service Category	Percentage share	Bandwidth allotted (out of 100%)
ABR	α_1%	b_1=B * α_1/100
CBR	α_2%	b_2=B * α_2/100
Rt-VBR	α_3%	b_3=B * α_3/100
Nrt-VBR	α_4%	b_4=B * α_4/100
UR	α_5%	b_5=B * α_5/100
GFR	α_6%	b_6=B * α_6/100

Table 3:Aggregated Bandwidth

If there are ‘k’ classes of service, b_i is the bandwidth available for service class ‘i’ and ‘B’ is the total bandwidth available, then the sufficient and necessary condition for aggregated bandwidth will be

$$b_1+b_2+b_3+b_4+b_{5+}\ldots\ldots\ldots+b_k<=B \qquad \ldots\ldots\ldots\ldots(1)$$

where as

$$b_i = (B * \alpha_i) / 100 \qquad \ldots\ldots\ldots\ldots(2)$$

∵ size of packets is fixed in our case (ATM packet length is 53 bytes)

∴ Total number of packets (n_i) in the network belonging to the class 'i'= b_i / 53

For Instance, if the total bandwidth available is 512MBPS, then (if p1=15%,p2=15%,p3=15%, p4=20%, p5=10%, p6=25%), the bandwidth available for each service category can be 76.8MBPS for ABR, 76.8 MBPS for CBR, 76.8 MBPS for rt-VBR, 102.4 MBPS for nrt-VBR, 51.2 MBPS for UBR and 128 MBPS for GFR.

Proposed Algorithm

1. For a given bandwidth calculate the total number of packets(n) to be generated. Besides for a given percentage share of each class of traffic calculate the number of packets(n_i) to be generated for each class (assuming a fixed packet size).
2. Generate n Inter-arrival times of packets (as per the simulation type, described in table-1) and save each of the 'n_i' inter arrival times in a file/table. Thought the traffic behavior follows the respective simulation type to the larger extent but their inter arrival times follow one or other form of poisson distribution. The individual class traffic streams follow a specific mean arrival rate which can be used to generate a stream of traffic for individual classes).
3. Now distribute the n_i^s randomly and uniformly, following a suitable form of poisson distribution associating them with the arrival times).
4. The output of the simulation run consists of information related to inter arrival times and along with the name of the priority class they belong to.

Here, Java because of its versatility has been used to generate such traffic, with the help of above information.

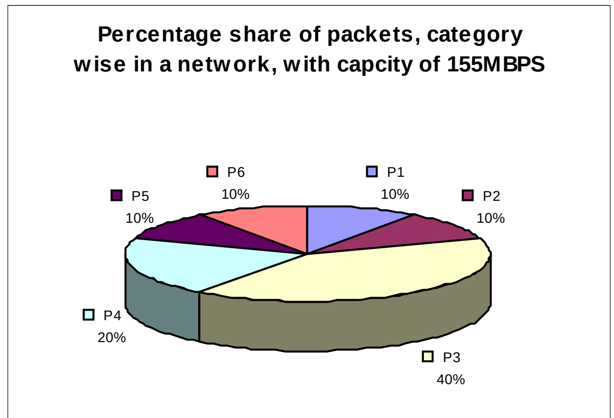
4.0 Results and Discussion

The number of packets in each service class requesting for transmission in a busy hour can be calculated from engineered peak usage for each class of traffic, while total channel capacity is 'b' and the size of the packet is fixed(53 bytes).

As a case study following assumptions have been made

Sr.No.	Network bandwidth	155MBPS	
1.	priority classes	Percentage share	Mean Burst value
2.	P1	10%	5
3.	P2	10%	7
4.	P3	40%	40
5.	P4	20%	15
6.	P4	10%	16
7.	P6	10%	10
8.	Size of Packet	53 Bytes(fixed)	

Table –4 Assumed parameters



Graph-I: Percentage share of packets, category wise in a network with capacity of 155 MBPS

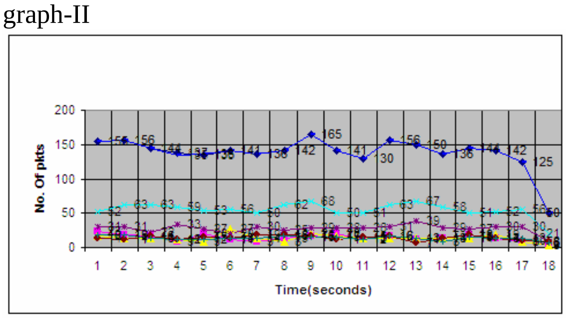
Using these values, the inter arrival times were generated, which was randomly and uniformly assigned to the various priority classes (following exponential distribution with given mean values for a particular class of traffic)

		No. of Pkts from each priority class					
Time (ms)	**No.Of Pks**	**P1**	**P2**	**P3**	**P4**	**P5**	**P6**
1000	155	23	16	52	31	14	19
2000	156	18	14	63	31	11	19
3000	144	16	13	63	22	16	14
4000	137	9	11	59	33	11	12
5000	135	20	9	53	27	15	12
6000	141	11	27	56	20	14	13
7000	136	9	14	50	30	19	14
8000	142	13	8	62	25	18	16
9000	165	16	21	68	29	16	15
10000	141	20	17	50	28	11	15
11000	130	11	13	51	28	15	12
12000	156	16	14	63	31	16	16
13000	150	11	13	67	39	7	13
14000	136	13	14	58	29	14	8
15000	144	18	14	51	27	19	15
16000	142	14	19	52	30	13	14
17000	125	8	8	56	30	10	13
18000	50	3	4	21	8	8	6
Mean	**138.06**	**13.83**	**13.83**	**55.28**	**27.67**	**13.72**	**13.67**
SD	**24.17**	**5.04**	**5.227**	**10.4**	**6.4**	**3.5**	**3.2**

Table – 6 calculated priority class traffic(packets) per 10 msec

Table –6, shows the count of the packets with in each service class in each time interval of 10 ms

The results have been shown with the help of table-5 and graph-II



Graph-II : Packets per second.

The generated inter arrival times along with their priority class packet type were tested for uniform distribution and the result was as per expectations.

The generated traffic in the form of inter arrival times with their priority class packet type can be used to feed in any discrete event simulator so as to emulate the behavior of source traffic.

The generated traces are in the form of a table containing service class type and the inter arrival time of packets.

5.0 Conclusion

For a multi service based network such as ATM, a number of source types have been indicated in the paper for describing the source model of each type of service class. Further a scheme for generation of aggregated traffic, for a multiservice network, has been suggested. The suggested scheme for Source modeling may differ for each new video codec, networks' interfaces, protocol stack, application & content (the effective bandwidth of compressed video depends on the degree of compression attained, which is based on compression algorithm and the contents). In-spite of these limitations, the suggested scheme will be able to generate more realistic traffic patterns as per the requirements. This will help the simulated switches in, responding to the complex network traffic QoS requirements (more accurately) , as defined for each service class.

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