**Simulation 3 – Project Report**

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**Description:**

The objective of this project is to find the 95th percentile and its confidence level of the end to end delay of the packet from video server to the client server.

**Technology Used:**

The language used to code the simulation: C++. No external libraries are used and everything is made from scratch.

**Algorithm:**

* The code for the Simulation Project 2 remains intact.
* Modifications:
  + ID was associated with each packed.
  + In all the 3 events packet’s time delay was updated using its id.
  + At the end the all the packets delays time were divided into different batches.
  + Mean was calculated for each batch.
  + Then total mean for all the batches was calculated = Tmean.
  + Standard Deviation is calculated = s.
  + Confidence interval at 95% is calculated using below formula



**Calculations:**

Values: N- 90000, DH- 1, DL- 2, Mean service time in the infinite server queue- 10, Mean service time in the client queue- 1.5, TL- 3, TH- 6.

Total No of Packets: 90000

Batch Size: 3000

Total No of Batches: 90000/3000 = 30.

Mean of Batches found:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| 13.282 | 13.283 | 13.294 | 13.147 | 12.966 | 13.173 | 12.863 | 12.857 | 13.230 | 13.349 |
| **11** | **12** | **13** | **14** | **15** | **16** | **17** | **18** | **19** | **20** |
| 13.171 | 13.138 | 12.954 | 13.166 | 13.197 | 13.124 | 13.126 | 12.936 | 13.182 | 12.999 |
| **21** | **22** | **23** | **24** | **25** | **26** | **27** | **28** | **29** | **30** |
| 13.583 | 13.108 | 13.184 | 13.127 | 13.336 | 13.006 | 13.513 | 13.274 | 13.122 | 13.070 |

Total Mean: Sum (All Means) / Total No of Batches = 13.1591

Standard Deviation: 0.164767

Confidence Level at 95th Percentile = (13.0991, 13.219)

**Observations:**

* It was observed that 95th percentile confidence level is almost equal to mean of all the batches.

(13.0991, 13.219) ~ 13.1591

**Validations:**

If you set DH = DL = 2, then it is possible to estimate the mean end-to-end delay using queueing theory. In particular, this mean is equal to DH + 1/μd + the mean time in an M/M/1 queue with λ=1/DH and μ = μq.

For DH = DL = 2,

* Mean of All Batches = 14.1741
* Confidence Level at 95th Percentile = (13.9483, 14.3999)

Using M/M/1 Queue,

* Mean = DH + 1/μd + ρ2/(1- ρ) where ρ = λ/ μ and λ = ½ and 1/μ = 1.5.
* Mean = 2 + 10 + 2.5 = 14.5

We can see 14.1741 and 14.5 are almost equal so our result has been validated.

**Graph:**

The below graph shows delay time for each packet. Y-Axis represents delay time and X-Axis represents packet number.

