Results of RabbitMQ vs Apollo

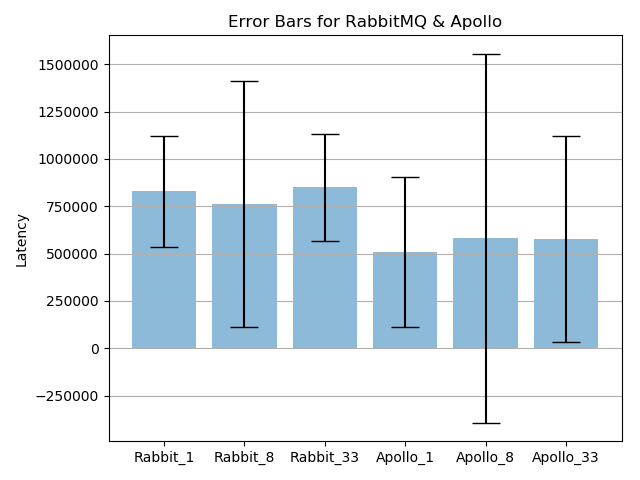


Fig 1-Displaying Error Bars in RabbitMQ and Apollo MQTT

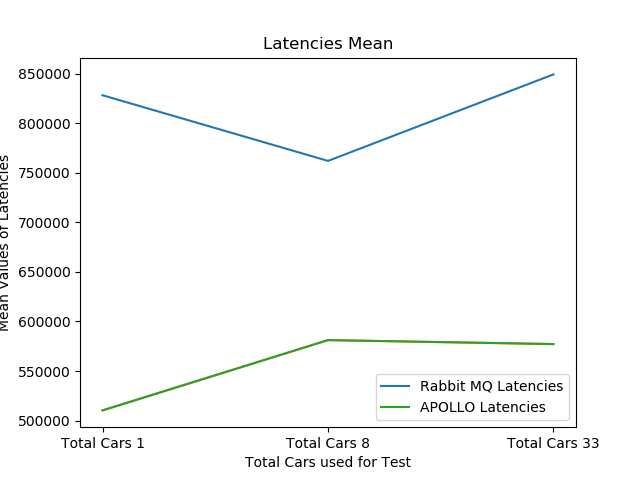


Fig 2- Mean of Latencies calculated during the experiments

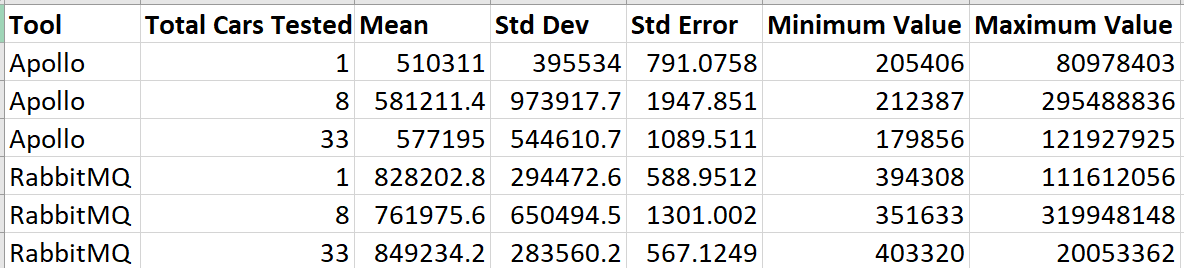


Fig 3 shows the Mean, Standard Deviation, Standard Error , Minimum Value, Maximum Value of the Latencies in Nano Seconds.

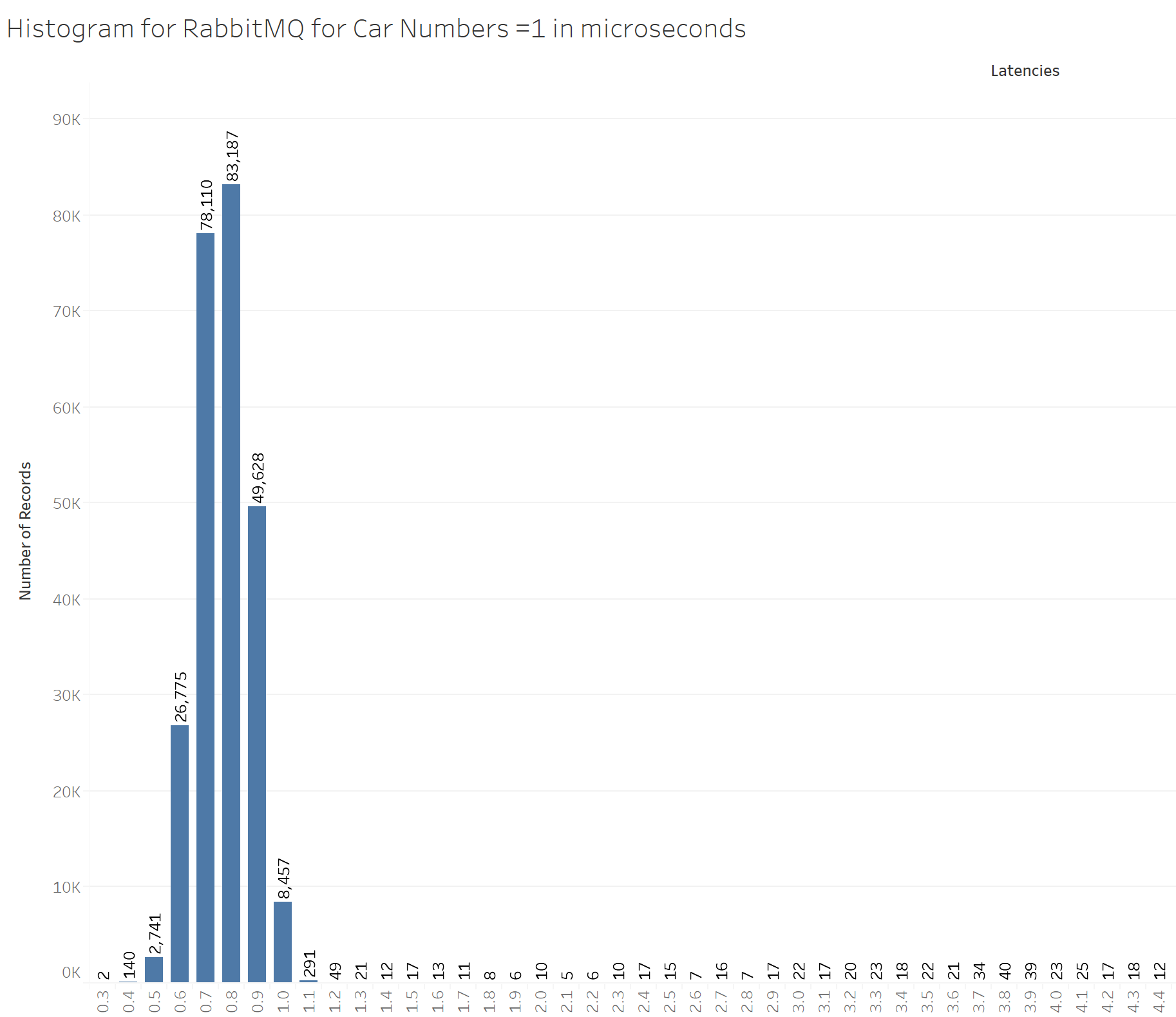


Fig 4 -Histogram of Latencies for RabbitMQ for Car Number =1

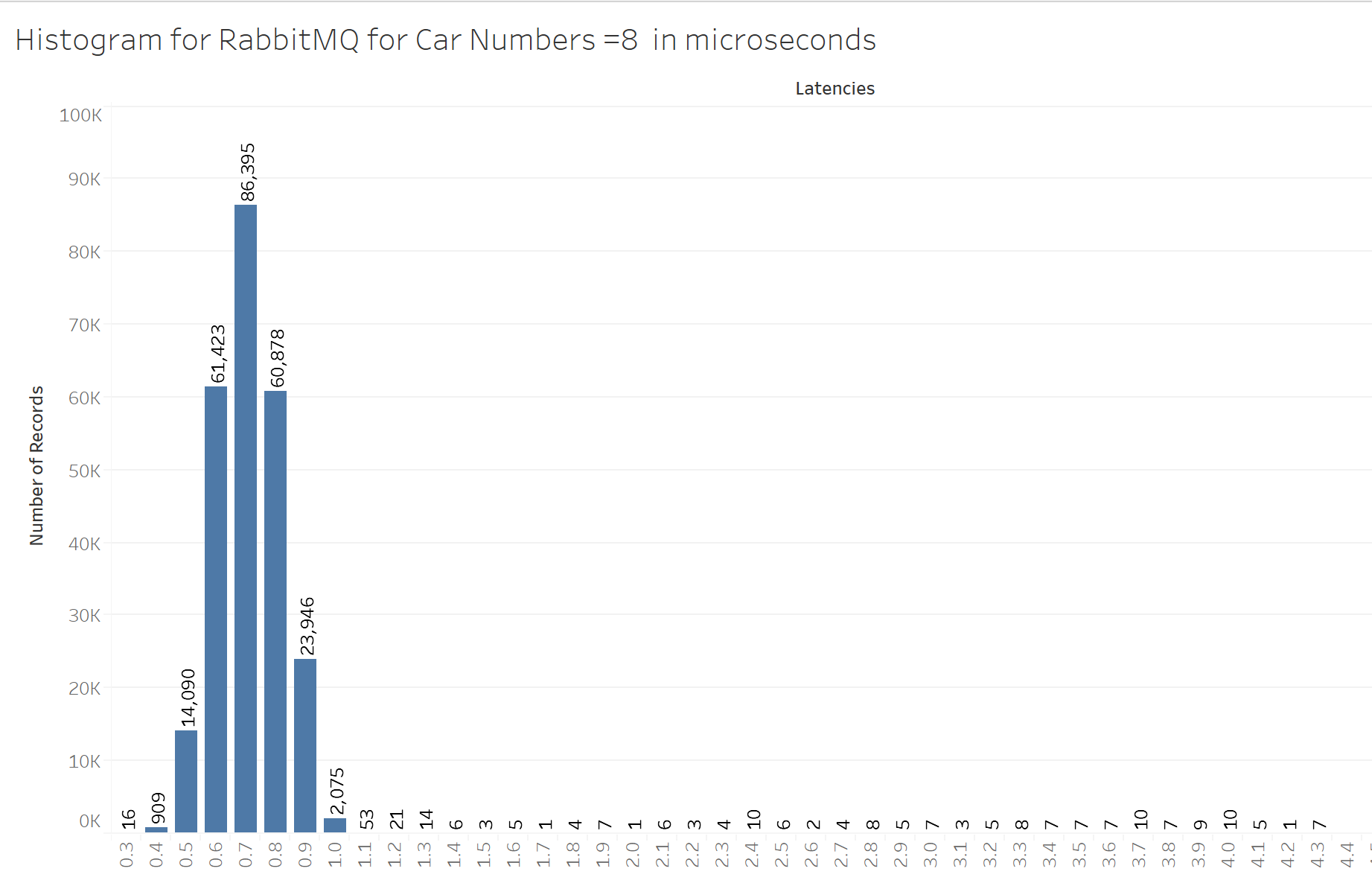


Fig 5-Histogram of Latencies for RabbitMQ for Car Number =8

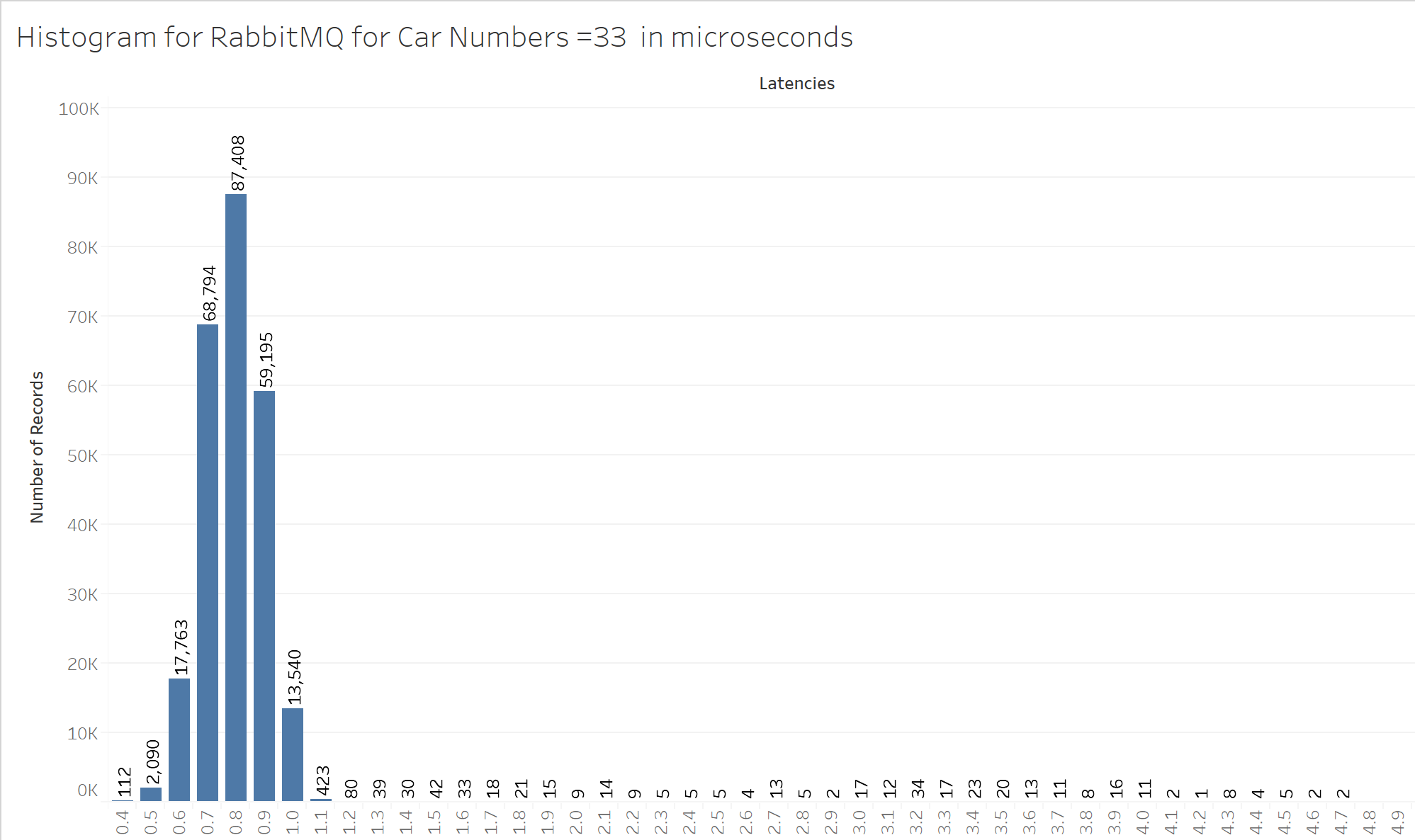


Fig 6-Histogram of Latencies for RabbitMQ for Car Number =33

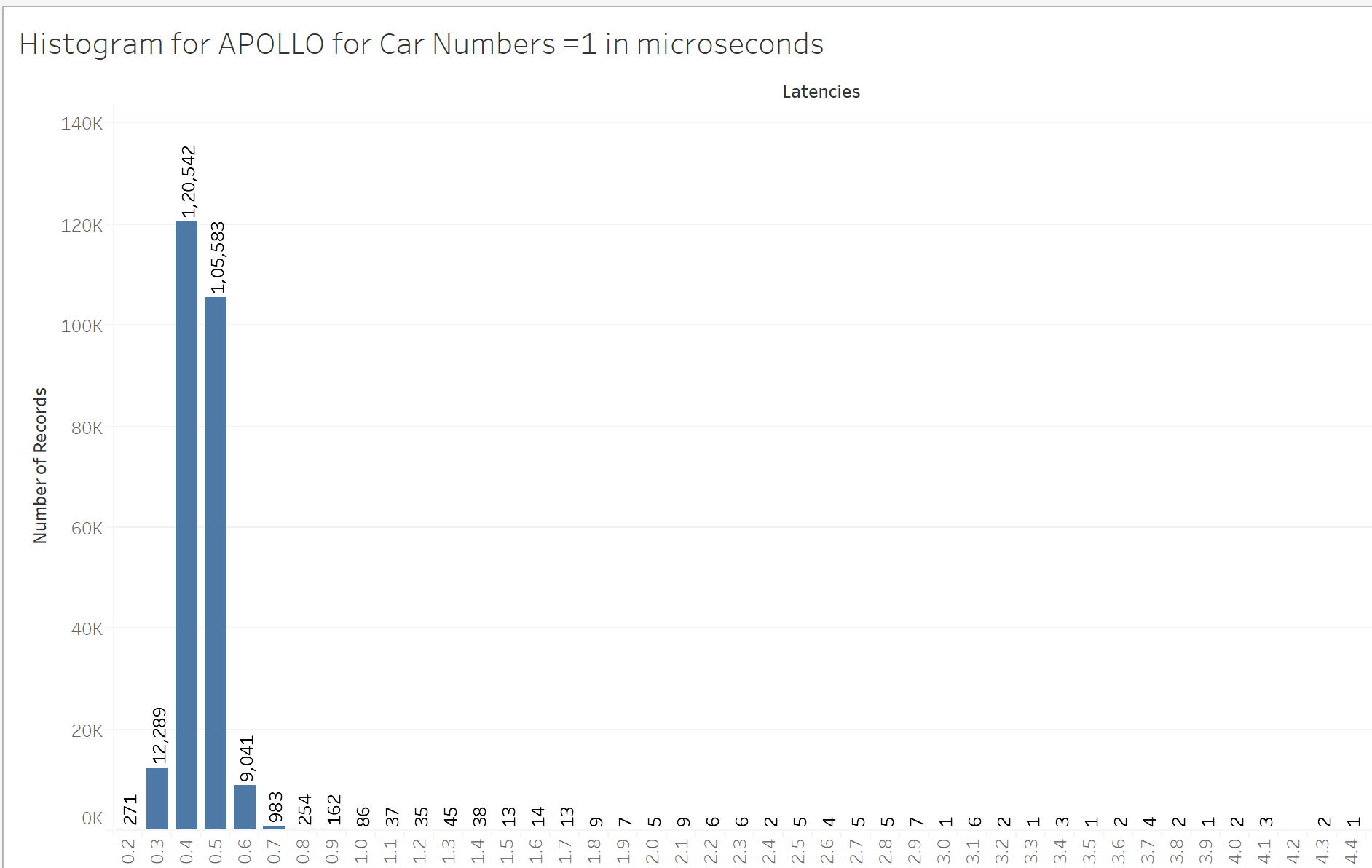


Fig 7-Histogram of Latencies for APOLLO for Car Number =1

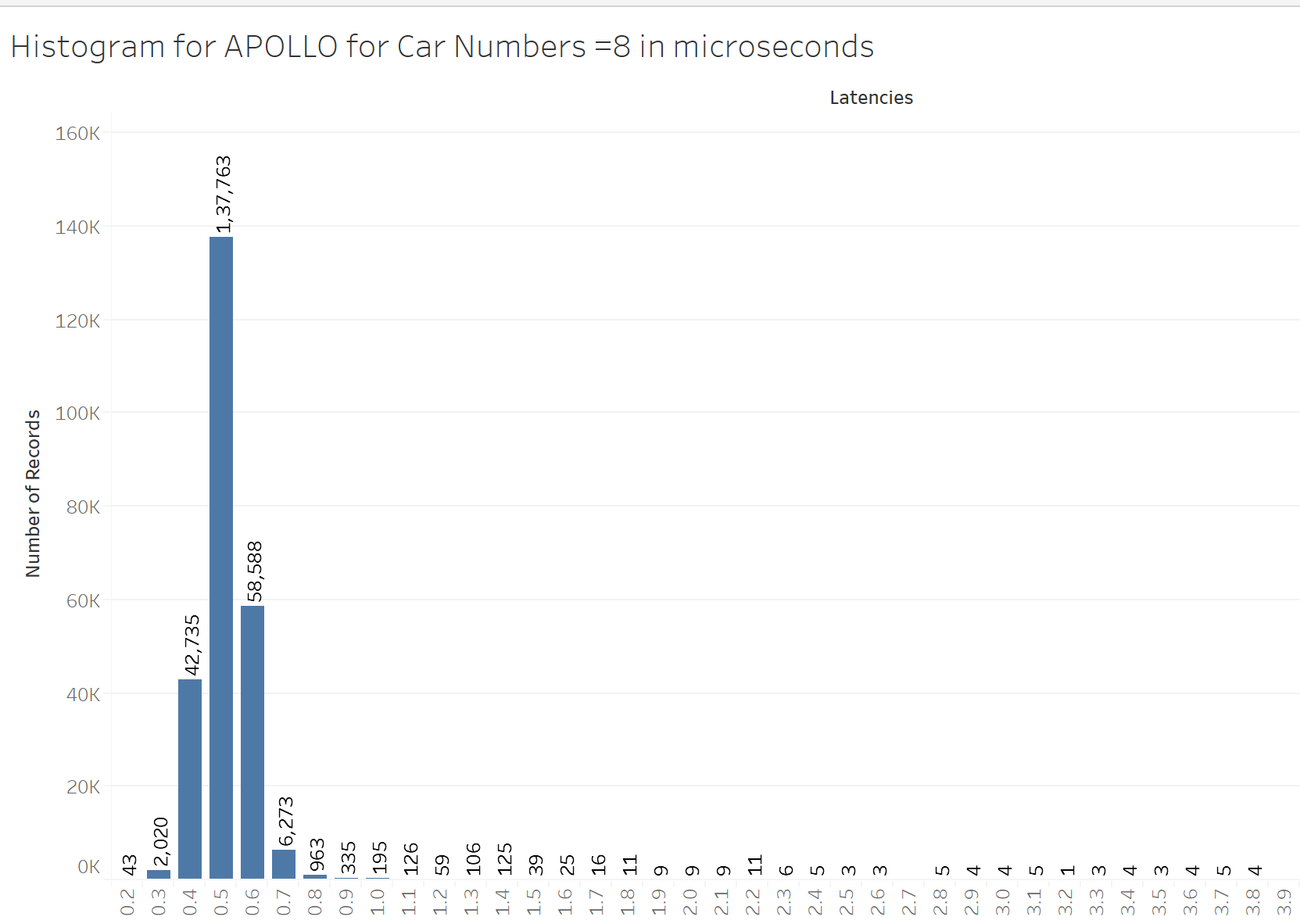


Fig 8- Histogram of Latencies for APOLLO for Car Number =8

Fig 9a showing the DB size while data is being loaded on Node 1-

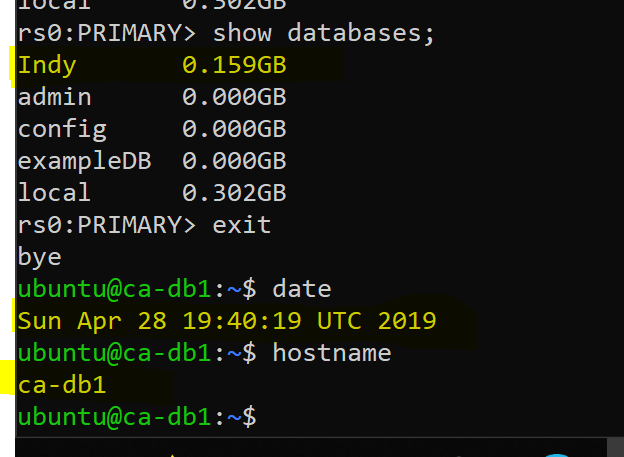


Fig 9b showing the DB size while data is being loaded on Node 2-

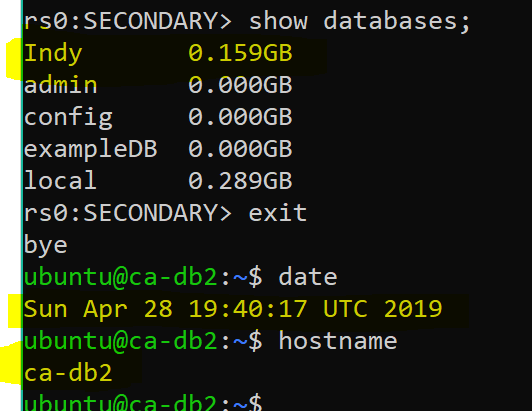


Fig 9c showing the DB size while data is being loaded on Node 3

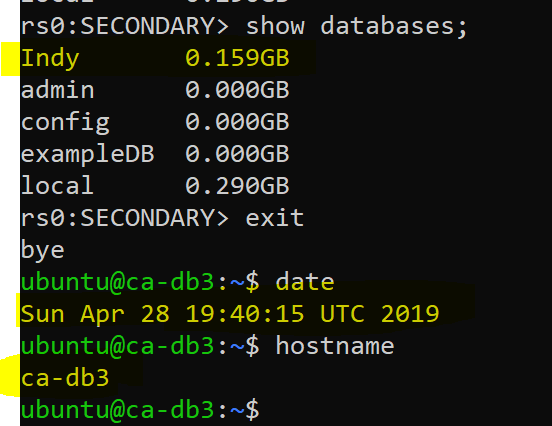


Fig 10a, 10b, 10c below show the same database size of Indy database on all 3 nodes after the Loading into DB is completed.

Fig 10a showing the DB size on Node 1

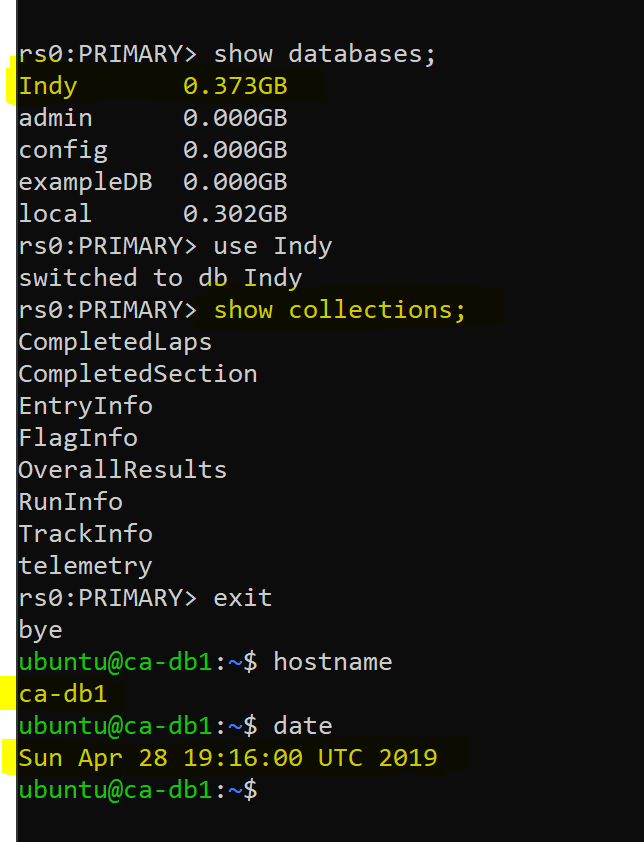


Fig 10b showing the DB size on node 2

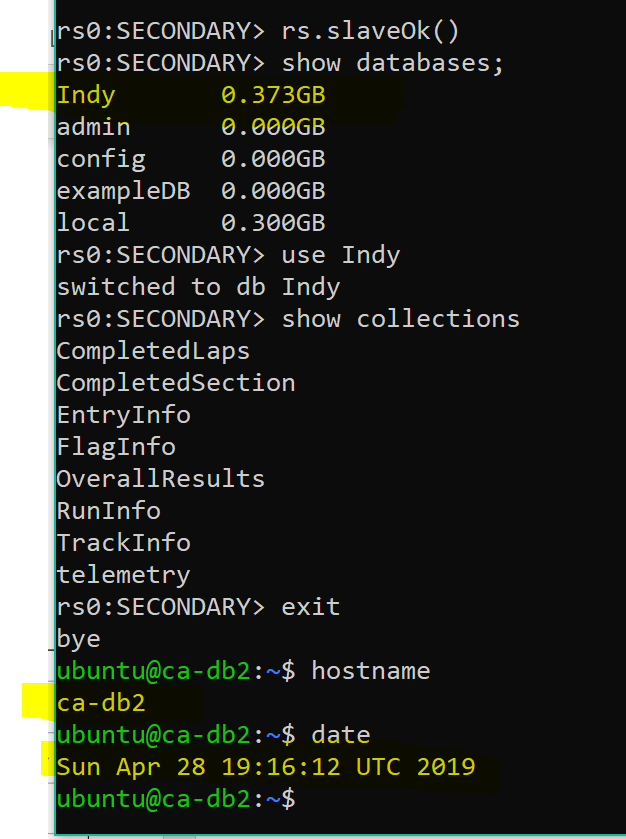
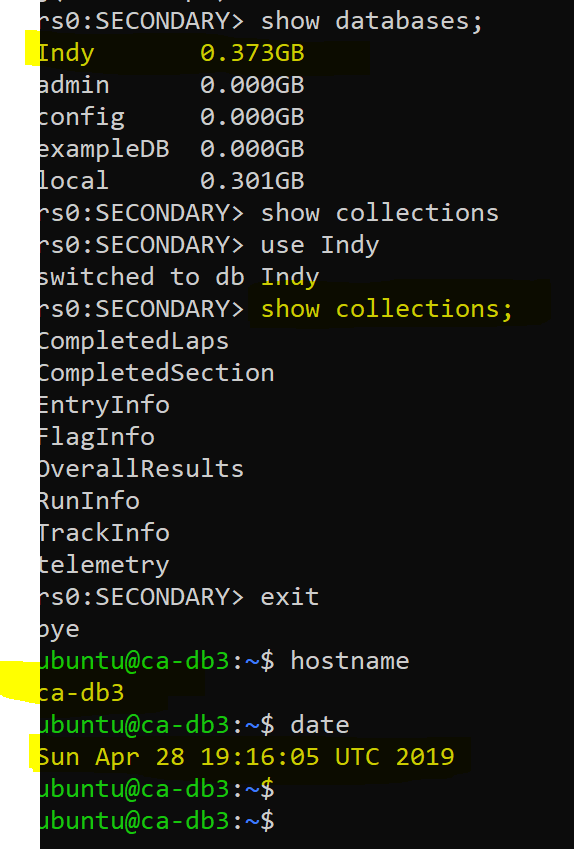


Fig 10c showing the DB size on node 3



Demo implementation of MongoDB queries and their results.

* Suppose there are two drivers in the series, the getAll function from the DriverService module-

indycarDBClient.drivers().getAll()

Output-

[["driver\_name" : "Conor Daly",  "driver\_id" : "580"],["driver\_name":"Alexander Rossi",  "driver\_id" : "522" ]]

* Suppose there are two drivers in a race, the getDriversByRace function from the DriverService module-

parameters- int race\_id

indycarDBClient.drivers().getDriversByRace(1)

Output-

[["driver\_name" : "Conor Daly",  "driver\_id" : "580"],["driver\_name":"Alexander Rossi",  "driver\_id" : "522" ]]

* getdriver function from the DriverService module-

parameters- String driver\_id

indycarDBClient.drivers().getdriver("747")

Output-

[["driver\_name" : "Gabby Chaves",  "driver\_id" : "747", "car\_number" : "88",  "engine" : "Chevy", "team" : "Harding Racing",  "team\_id" : "145", "hometown" : "Bogota Colombia",  "unique\_identifier" : "15" ]]

* search function from the DriverService module-

parameters- String partial\_string

indycarDBClient.drivers().search("sa"))

Output-

[Takuma Sato, Sage Karam]

* getLapRecords function in DriverService module-

parameters- int race\_id, String car\_num

indycarDBClient.drivers().getLapRecords(1,"23");

Output-

[[["car\_num" : "23",  "completed\_laps" : 0, "elapsed\_time" : "5EC0",  "last\_laptime" : "C5839", "lap\_status" : "T", "best\_lap\_time" : "0",  "best\_lap" : "0", "current\_status" : "Active", "pit\_stop\_counts" : "0",  "last\_pitted\_lap" : 0, "start\_position" : 15, "laps\_led" : "0", "run\_command" : "R",  "race\_id" : "1" ], . . .(more lap records)]

[["car\_num" : "23",  "section\_identifier" : "T1",  "elapsed\_time" : "1A535769", "last\_section\_time" : "3615",  "last\_lap" : 0, "run\_command" : "R", "race\_id" : "1", "unrelated\_counter" : 62 ],...(more section records)]]

* getAll function in RaceService module-

indycarDBClient.getRaceService().getAll()

Output-

[["event\_name" : "102nd Indianapolis 500",  "race\_id" : "1" ]]

* getRace function in RaceService module-

parameters- int race\_id

indycarDBClient.getRaceService().getRace(1)

Output-

[["event\_name" : "102nd Indianapolis 500",  "event\_round" : "IMS", "start\_time\_date" : "5B0AA2AC",  "race\_id" : "1" ]]

* getFlags function from RaceService module-

parameters- int race\_id

indycarDBClient.getRaceService().getFlags(1)

Output-

[["track\_status" : "G",  "lap\_number" : "0", "timeOfDay" : "16:04:19.",  "counter\_$F" : 101 ], ... (more FlagInfo records) ]

* getRanks function from RaceService module-

parameters- int race\_id

indycarDBClient.getRaceService().getRanks(1)

Output-

[["overall\_rank" : 1,  "no" : "12", "first\_name" : "Will",  "last\_name" : "Power" ], ["overall\_rank" : 2,  "no" : "20", "first\_name" : "Ed", "last\_name" : "Carpenter" ], .... (more records)]

* getsnapshot\_final function in RaceService module-

parameters- int hours, int minutes, double seconds, int race\_id,int threshold\_in\_seconds

indycarDBClient.getRaceService().getsnapshot\_final(16,24,0.5,1,1)

Output-

[["$oid" : "5cc207e3f1da2e31c4bc7bc3" },  "command" : "$P", "car\_num" : "9", "lap\_distance" : "986.14",  "time\_of\_day" : "16:24:00.526", "hours" : 16, "minutes" : 24, "seconds" : 0.526,  "time\_in\_seconds" : 59040.526, "ratio" : [118.081052, 0.0], "time\_for\_comparison" : 1,  "vehicle\_speed" : "215.970", "engine\_rpm" : "11267", "throttle" : "5", "date" : "2018-05-27",  "race\_id" : "1", "flag\_from\_$h" : "G", "run\_command" : "R], ...(more records)]

* getAll function in TrackService module-

indycarDBClient.getTrackService().getAll()

Output-

[Indianapolis Motor Speedway]

* getTrack function in TrackService module-

parameters- String TrackName

indycarDBClient.getTrackService().getTrack("Indianapolis Motor Speedway")

Output-

[["track\_name" : "Indianapolis Motor Speedway",  "venue" : "I", "number\_of\_sections" : "20", "race\_id" : "1",  "section\_information" : [{ "section\_name" : "S1", "section\_length" : "11856", "section\_start" : "SF", "section\_end" : "T1" }, { "section\_name" : "S2A", "section\_length" : "19800", "section\_start" : "T1", "section\_end" : "SS1" }, { "section\_name" : "S2B", "section\_length" : "19800", "section\_start" : "SS1", "section\_end" : "T2" }, { "section\_name" : "S3A", "section\_length" : "19800", "section\_start" : "T2", "section\_end" : "BS" }, { "section\_name" : "S3B", "section\_length" : "19800", "section\_start" : "BS", "section\_end" : "T3" }, { "section\_name" : "S4A", "section\_length" : "19800", "section\_start" : "T3", "section\_end" : "SS2" }, { "section\_name" : "S4B", "section\_length" : "19800", "section\_start" : "SS2", "section\_end" : "T4" }, { "section\_name" : "S5A", "section\_length" : "12672", "section\_start" : "T4", "section\_end" : "FS" }, { "section\_name" : "S5B", "section\_length" : "15072", "section\_start" : "FS", "section\_end" : "SF" }, { "section\_name" : "S2", "section\_length" : "39600", "section\_start" : "T1", "section\_end" : "T2" }, { "section\_name" : "S3", "section\_length" : "39600", "section\_start" : "T2", "section\_end" : "T3" }, { "section\_name" : "S4", "section\_length" : "39600", "section\_start" : "T3", "section\_end" : "T4" }, { "section\_name" : "S5", "section\_length" : "27744", "section\_start" : "T4", "section\_end" : "SF" }, { "section\_name" : "T1", "section\_length" : "1440", "section\_start" : "T1T", "section\_end" : "T1" }, { "section\_name" : "T2", "section\_length" : "1440", "section\_start" : "T2T", "section\_end" : "T2" }, { "section\_name" : "T3", "section\_length" : "1440", "section\_start" : "T3T", "section\_end" : "T3" }, { "section\_name" : "T4", "section\_length" : "1440", "section\_start" : "T4T", "section\_end" : "T4" }, { "section\_name" : "TSF", "section\_length" : "1974", "section\_start" : "SF", "section\_end" : "SFT" }, { "section\_name" : "WI1", "section\_length" : "16800", "section\_start" : "PT3", "section\_end" : "PSS2" }, { "section\_name" : "WI2", "section\_length" : "16800", "section\_start" : "PSS2", "section\_end" : "PT4" }, { "section\_name" : "WI3", "section\_length" : "15078", "section\_start" : "PT4", "section\_end" : "PI" }, { "section\_name" : "WO1", "section\_length" : "16800", "section\_start" : "PO", "section\_end" : "PSS1" }, { "section\_name" : "WO2", "section\_length" : "16800", "section\_start" : "PSS1", "section\_end" : "PT2" }, { "section\_name" : "P1", "section\_length" : "12690", "section\_start" : "PI", "section\_end" : "SFP" }, { "section\_name" : "P2", "section\_length" : "11874", "section\_start" : "SFP", "section\_end" : "PO" }, { "section\_name" : "PIC", "section\_length" : "5712", "section\_start" : "PIC", "section\_end" : "PI" }, { "section\_name" : "L2", "section\_length" : "24564", "section\_start" : "PI", "section\_end" : "PO" }, { "section\_name" : "L3", "section\_length" : "146544", "section\_start" : "PO", "section\_end" : "SF" }, { "section\_name" : "L4", "section\_length" : "145734", "section\_start" : "SF", "section\_end" : "PI" }, { "section\_name" : "L5", "section\_length" : "59400", "section\_start" : "PO", "section\_end" : "BS" }, { "section\_name" : "L6", "section\_length" : "74478", "section\_start" : "BS", "section\_end" : "PI" }, { "section\_name" : "L7", "section\_length" : "133878", "section\_start" : "PO", "section\_end" : "PI" }] ]]