# An Admission Control Mechanism in a Distributed Multimedia System

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**Abstract**

The rate at which people watch video this day is very high, especially now that people were locked down as a result of Convid-19 pandemic. As many are streaming for educational training and knowledge acquisition, some are watching it just to relax and gain energy for another work. The thirst for video consumption by people, this day, seems to be voracious. Basically, streaming comes from multimedia server and there is possibility of it being overloaded. Admission control algorithm is therefore needed to prevent server overload. Different approaches have been proposed in the past to achieve admission control which can highly guarantee a quality of service (QoS) in distributed multimedia systems, yet, this paper propose a new method for admission control in distributed multimedia systems by using a logistic regression method on the processors' busy values of a typical multicore server. The result of the proposed method shows 96% of accepted requests with 4% in rejected requests. The method was implement on Linux with kernel 4.0.2 version.

***Keywords:*** *Admission Control, Logistic Regression, Quality of Service, Multimedia Server, Convid-19 Streaming.*

## 1. Introduction

Video is ubiquitous on the internet, hence its accessibility from anywhere in world. Presently, CISCO forecasted that by 2022, 60 percent of the global population will be internet users and more than 28 billion devices with connections will be online [1]. Video will make up 82 percent of all internet protocol (IP) traffic [1]. This was forecasted in 2015 that online video consumption will grow from 64% of global internet traffic to 80% by 2019 [2] as shown in Fig 1.

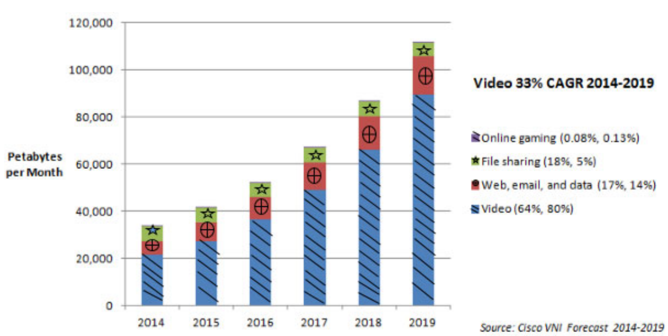


Fig. 1 Consumer internet Traffic, 2014-2019

Video traffic is driven by online video services such as Netflix and YouTube and more than thousands of them exist worldwide. Millions of websites monetize video through advertisement (ads) or subscriptions. Examples include: websites with educational videos that show people how to use a specific software such as Photoshop, gaming platforms that show live games and walkthroughs, websites where people can learn how to cook or fix a car.

Video is heavily used in marketing and 81% of companies are already producing video content for their website. Many companies are using this form of technology to explain appearance of their products, display the manuscript for the usage of the products and the story of customers on their business. Some use it for cross collaboration among company workers, which leads to better performance and improved business transactions. A business can now use video communication to establish a real-time connection with clients, suppliers and partners. It's basically something that any business, regardless of its size, should adopt with the experience of Convid-19 pandemic lock down.

## 2. Effect of streaming on marketer and consumer

A report by ".comScore" shows that visitors who have watched a video on a product are 64% more likely to buy an online product and stay 2 minutes longer on the average, so marketers use video as it is the future of content and product marketing [2]. Also, the study from Usurv, a United Kingdom (UK) market research company shows

IJCSI International Journal of Computer Science Issues, Volume 17, Issue 1, January 2020
ISSN (Print): 1694-0814 | ISSN (Online): 1694-0784
www.IJCSI.org https://doi.org/10.5281/zenodo.3987108 

that users are much more likely to share 39% of online video, comment on 36% of it and 56% of online video are naturally being watched. There are many studies that show similar effects when using video on website [2].

However, with the benefit pose by this technology, most clients requesting multimedia streams prefer not to initiate a video request than the unexpected termination of Quality of Service (QoS) level while the request is being processed. This usually occur when there is problem with the real-time properties of the server resources while delivering. Conviva conducted a study in March 2015 and asked 400 UK consumers about their attitude towards watching TV delivered over the Internet. The study shows that 6 out of 10 viewers do pay for a subscription of video on demand (VoD) service and the key differentiator for the decision of which video file to choose is based on viewing experience of the viewer. This is represented in Fig 2.

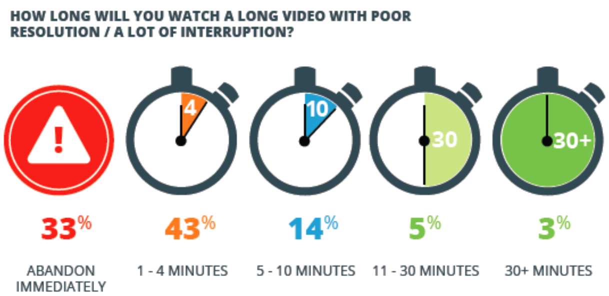


Fig 2 Viewers' attitude towards watching TV delivered over the Internet (Source:https://bitmovin.com/video-problem-3-reasons-users-leave-website-badly-implemented-video/)

Conviva asked the customers in the study "how long a viewer would watch a video with poor video quality". For short videos (less than 3 minutes) 33% of the viewers would abandon immediately and after one minute 84% of all viewers are gone. For long form videos (15 minutes or more) the same proportion as for short videos, i.e., 33% would abandon immediately and after 4 minutes 77% of viewers are gone and after 10 minutes less than 1 out of 10 are still watching [2].

The problem then becomes "how best to make efficient use of computing resources while satisfying QoS requirements for a dynamically changing and complex mix of simultaneously running applications". Traditionally, this problem was reduced to scheduling threads which could actually look more like the problem of a resource allocation optimization where the system must figure out how to give just enough of a variety of system resources (e.g., nodes, processor cores, cache slices, memory pages, various kinds of bandwidth) to applications to meet their performance requirements consistently. Many current systems address this problem by ensuring that the required applications request for a specific number of resources for the task to oversubscribe the system seeks and degrade performance fairly [3, 4, 5, 6]. This paper tackles the problem of continuous responsiveness provisioning of the already processing requests via admission control mechanism thereby providing a good QoS even with the underlying hardware resources.

## 3. Responsiveness provisioning via admission control

For many years, admission control of client requests in distributed multimedia systems has been classified among the active research areas [7,8]. Different solutions have been proposed to provide a good QoS to end users while maximizing resource utilization. Almost all of such solutions are hampered by the difficulty of knowing all necessary parameters (e.g., nodes, processor cores, cache slices, memory pages, various kinds of bandwidth) for admitting clients' requests. Even though the innumerable quest for continuous multimedia today has contributed to users' expectancy for snappy operation from high-quality multimedia and interactive applications which call for responsive user interfaces and stringent real-time guarantees from the systems that host them, the fact still remains that responsiveness provision is a growing need for all types of systems, ranging from webservers and databases running on cloud systems, through interactive multimedia applications on mobile clients, to emerging distributed embedded systems. This paper propose an admission control mechanism for multimedia system as a way of providing responsiveness from the hardware underlying.

## 4. Admission control architecture

The main components of the architecture in the media server, as shown in Figure 3 , are Platform Manager (PM), Admission Control Unit (ACU), Resource Manager (RM) and Monitor. User interacts with the system through PM which acts as front end that helps user to send a video file request to the server. ACU works on the request from PM by passing it to RM for our designed logistic regression algorithm to determine if resources that will guarantee this request are available or not and the response determines whether the request is going to be passed to machine scheduler or not. RM is responsible for maintaining the record of available resources, frequently updating it and providing it to the ACU. After a machine is given to a user, monitor maintains the state of the machines and responds back to the RM. Each component of the architecture is explained in detail.

IJCSI International Journal of Computer Science Issues, Volume 17, Issue 1, January 2020
ISSN (Print): 1694-0814 | ISSN (Online): 1694-0784
www.IJCSI.org https://doi.org/10.5281/zenodo.3987108 

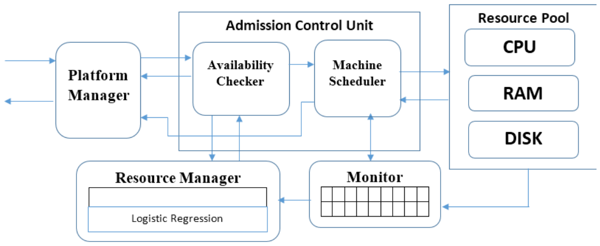


Fig 3 Admission control mechanism in a media server.

4.1 Platform manager (PM)

Platform Manager (PM) manages communication between the user and the system. Users can initiate request and define user's specific resource requirement. The later function of PM is divided into two parts namely: host requirement and environment requirement.
The host requirement gives the details of the type of processor, number of Central Processing Unit (CPU) cores, Random Access Memory (RAM) size and Internet Protocol (IP) address. The environment requirement takes care of the type of Operating System (OS), runtime environment and so on. Once these information are obtained, PM forwards it to the Admission Control Unit (ACU). PM is the only way to communicate with the user hence the system responds back to the user with the status of request. Any further communication related to the platform, like scaling or stopping the machine, is done through this interface.

4.2 Admission control unit

The work of Admission Control Unit (ACU) is to pass message to the user as to whether the request can be accepted or not. As the request comes from the PM, the availability checker passes the information to Resource Manager (RM) to check for available resources that fit-in the demand of the user's hardware. If the user's required resources are available and compatible with the required environment, RM sends back the marked resources to ACU. Furthermore, the Availability Checker Unit forwards these marked resources and runtime environment requirement to the Machine Scheduler. Machine Scheduler is responsible for dispatching the job to the best-fit resource, earlier picked to process the request. Once a desired machine with required platform is obtained, Machine Scheduler sends status and machine ID to the PM informing about the successful allocation of the platform. It also informs the monitor to record the chosen resources in its table thereby keeping track of running systems.

4.3 Resource manager

The Resource Manager (RM) is responsible for maintaining information about the available resources. The resources being considered for the admission control in this paper is the logical processors within the system. Meanwhile, RM generally maintains a list of all free machines in a table populated with information such as RAM size, capacity of CPU cores, and size of disk and runtime environment. These entries are maintained by the Monitor in the table. RM gets requests from the ACU to check for required resources. RM matches the request with the available resources. The reason to check for the availability is to ensure that there is no notion of virtualization present because the resources are finite in number. Hence availability of resources is checked using logistic regression technique.

4.4 Monitor

Monitor keeps track of all the activities and maintains the current status of the compute cluster until the machines are freed. Monitor is also responsible for updating the free list of machines maintained by the RM. Once a machine or group of machines is (are) freed by a user, Monitor adds those machines in the free list again.

## 5. Description of the admissibility method

This paper is focusing on admissibility of video file request at the media server. It is likened to a dichotomous data which can be modelled using logistic regression technique because of its flexibility and interpretability. Logistic regression can be expressed as:

$$logit(y) = \ln(odds) = \ln\left(\frac{p}{1-p}\right) = \alpha + \beta x \qquad (1)$$

where p is the probability of desired outcome and x is the explanatory/independent variable and $y \in \{0,1\}$, this is called binary classification. In this research, zero (0) depicts rejected request while one (1) depicts accepted request. The parameters of the logistic regression are α and β. Equation 2 is the simple way of representing logistic model in which the odds of an event are the ratio of the probability that an event will occur to the probability that it will not occur. If the probability of an event occurring is p, the probability of the event not occurring is (1-p). Then the corresponding odds is a value given by

$$odds\ of\ \{Event\} = \frac{p}{1-p} \qquad (2)$$

IJCSI International Journal of Computer Science Issues, Volume 17, Issue 1, January 2020
ISSN (Print): 1694-0814 | ISSN (Online): 1694-0784
www.IJCSI.org https://doi.org/10.5281/zenodo.3987108 

Taking the antilog of equation (1) on both sides, the equation for the prediction of the probability of the occurrence of desired outcome is then expressed as

$$p = P(Y = desired\ outcome|X = x, a\ specific\ attribute)$$

$$= \frac{e^{\alpha + \beta x}}{1 + e^{\alpha + \beta x}} = \frac{1}{1 + e^{-(\alpha + \beta x)}} = \ln \frac{\pi(x)}{1 - \pi(x)} \quad (3)$$

By extending the logic of the simple logistic regression to multiple predictors in equation (3) then:

$$logit(y) = \ln(odds) = \ln \frac{\pi(x_i)}{1 - \pi(x_i)} = \alpha + \beta_1 x_{i1} + \dots + \beta_k x_{ik} \quad (4)$$

$$= P(Y = desired\ outcome|X = x_{i,1}, \dots, x_{i,k}\ are\ specific\ attributes)$$

$$\pi(x_i) = \frac{e^{\alpha + \beta_1 x_{i1} + \dots + \beta_k x_{ik}}}{1 + e^{\alpha + \beta_1 x_{i1} + \dots + \beta_k x_{ik}}} = \frac{1}{1 + e^{-(\alpha + \beta_1 x_{i1} + \dots + \beta_k x_{ik})}} \quad (5)$$

where α is a constant term; $\beta_1, \dots, \beta_k$ represent regression coefficients and $x_{i,1}, \dots, x_{i,k}$ are independent variables and $i$ is the counter for the request such that $i \geq 1$ and $k \geq 1$.

## 5. Application of the propose model

In this research, a typical multimedia server with four (2) logical cores is used for the experimentation. These cores are referred to as the independent variables. In other to achieve the aim of this paper, the busy values of the cores are used as the independent variables say- $[\ x_{1,1}\quad x_{1,2}\quad x_{1,3}\quad x_{1,4}\ ]$. From equation (5), $\ln(odds) = \log(\frac{p}{1-p})$ goes either to -∞ for y=0 or ∞ for y = 1. An added difficulty is that the variance in this model depends on $x$

Let $Z = \alpha + \beta_j x_{i,j} + \dots + \beta_k x_{n,k}$ (6)

where $i \geq 1 \leq n$ and $j \geq 1 \leq k$. $n$ is taking to be the population size (number of rows) and k is the number of cores (logical processors in the multimedia server).

The variance $V$ is then calculated from the busy values and put in a matrix form such that

$$V[\,Z|X = x]$$

Table 1: Extract from generated core's busy values

| PROCESSORS/CORES | | | | | |
|---|---|---|---|---|---|
| **Variance** | **Core 0** | **Core 1** | **Core 2** | **Core 3** | Total |
| 0 | 18.2100 | 18.6900 | 18.1000 | 18.4200 | **73.4200** |
| 1 | 18.2100 | 21.7100 | 20.1200 | 18.4200 | **78.4600** |
| 1 | 18.2300 | 21.7300 | 20.1500 | 18.4500 | **78.5800** |
| 0 | 18.2600 | 17.7600 | 18.1700 | 18.4700 | **72.6600** |
| Total | **72.9100** | **79.8900** | **76.5400** | **73.7600** | **303.1200** |

From equation (5),

$$p = \frac{1}{1 + e^{-(\alpha + \beta_1 x_{i1} + \dots + \beta_k x_{ik})}} \quad (7)$$

where $x_i$ represents the observation of the cores, it is 1 if there exist at least one core which can guarantee the starting of the streaming and 0 otherwise. Obviously it is known that the following four equations hold respectively when X=1 and when X=0 with the data shown in Table 1.

At Core 0

$$\frac{18.21 + 18.23}{72.91} = \frac{36.44}{72.91} = \frac{1}{1 + e^{-(\alpha + \beta_1 * 1 + \beta_2 * 1 + \beta_3 * 1 + \beta_4 * 1)}} \quad (8)$$

$$\frac{18.21 + 18.26}{72.91} = \frac{36.47}{72.91} = \frac{1}{1 + e^{-(\alpha + \beta_1 * 0 + \beta_2 * 0 + \beta_3 * 0 + \beta_4 * 0)}} \quad (9)$$

At Core 1

$$\frac{21.71 + 21.73}{79.89} = \frac{43.44}{79.89} = \frac{1}{1 + e^{-(\alpha + \beta_1 * 1 + \beta_2 * 1 + \beta_3 * 1 + \beta_4 * 1)}} \quad (10)$$

$$\frac{18.69 + 17.76}{79.89} = \frac{36.45}{79.89} = \frac{1}{1 + e^{-(\alpha + \beta_1 * 0 + \beta_2 * 0 + \beta_3 * 0 + \beta_4 * 0)}} \quad (11)$$

At Core 2

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www.IJCSI.org https://doi.org/10.5281/zenodo.3987108 

$$\frac{20.12+20.15}{76.54}=\frac{40.27}{76.54}=\frac{1}{1+e^{-(\alpha+\beta_1*1+\beta_2*1+\beta_3*1+\beta_4*1)}} \quad (12)$$

$$\frac{18.10+18.17}{76.54}=\frac{36.27}{76.54}=\frac{1}{1+e^{-(\alpha+\beta_1*0+\beta_2*0+\beta_3*0+\beta_4*0)}} \quad (13)$$

At Core 3

$$\frac{18.42+18.45}{73.76}=\frac{36.87}{73.76}=\frac{1}{1+e^{-(\alpha+\beta_1*1+\beta_2*1+\beta_3*1+\beta_4*1)}} \quad (14)$$

$$\frac{18.42+18.47}{73.76}=\frac{36.89}{73.76}=\frac{1}{1+e^{-(\alpha+\beta_1*0+\beta_2*0+\beta_3*0+\beta_4*0)}} \quad (15)$$

The equation 8 through 15 was solved in order to get the estimation value for all the intercept and the coefficient of all the independent variables. Each regression coefficient represents the change in the expected log odds relative to a one unit change in the respective independent variable, holding all the other predictors constant. Therefore, the antilog of an estimated regression coefficient, exp($\beta_i$), produces an odds ratio. By solving equation 8 through 15 using matrices form

$$\alpha = -2.3233; \beta_1 = -2.0386; \beta_2 = -2.0386; \beta_3 = -2.0386; \beta_4 = -2.0386$$

A new sample of busy value are generated and the estimated coefficients are applied to generate the outcome which will either be zero (0) or one (1). With one (1), the request is accepted otherwise, it is rejected.

Table 2 shows the report of 39 video files by viewers. Out of the 125 requests, it is noted that with the admission control mechanism-using logistic regression method, 120 requests were admitted while 5 requests were rejected.

Table 2: Admission Control Analysis on 39 distinct video files.

| Video Files | Total Requests | Number of Acceptance/Rejection | |
|---|---|---|---|
| | | Number of Accepted Request | Number of Rejected Request |
| akiyo_qcif | 5 | 5 | 0 |
| container_qcif | 2 | 2 | 0 |
| crew_qcif_15fps | 3 | 3 | 0 |
| deadline_qcif | 3 | 3 | 0 |
| flower_garden_422_qcif | 3 | 3 | 0 |
| football_422_qcif | 1 | 1 | 0 |
| football_qcif_15fps | 5 | 4 | 1 |
| foreman_qcif | 3 | 3 | 0 |
| galleon_422_qcif | 1 | 1 | 0 |
| hall_monitor_qcif | 2 | 2 | 0 |
| bowing_qcif | 4 | 4 | 0 |
| hall_objects_qcif | 3 | 3 | 0 |
| highway_qcif | 4 | 4 | 0 |
| husky_qcif | 4 | 4 | 0 |
| ice_qcif_15fps | 1 | 1 | 0 |
| intros_422_qcif | 6 | 6 | 0 |
| mad900_qcif | 4 | 3 | 1 |
| miss_am_qcif | 3 | 3 | 0 |
| mobile_calendar_422_qcif | 2 | 2 | 0 |
| mother_daughter_qcif | 5 | 5 | 0 |
| bridge_close_qcif | 4 | 4 | 0 |
| mthr_dotr_qcif | 3 | 3 | 0 |
| news_qcif | 3 | 3 | 0 |
| pamphlet_qcif | 4 | 4 | 0 |
| paris_qcif | 2 | 2 | 0 |
| salesman_qcif | 5 | 5 | 0 |
| sign_irene_qcif | 4 | 4 | 0 |
| silent_qcif | 2 | 1 | 1 |
| soccer_qcif_15fps | 3 | 3 | 0 |
| students_qcif | 2 | 2 | 0 |
| suzie_qcif | 1 | 1 | 0 |
| bridge_far_qcif | 6 | 6 | 0 |
| trevor_qcif | 1 | 0 | 1 |
| vtc1nw_422_qcif | 5 | 5 | 0 |
| washdc_422_qcif | 5 | 4 | 1 |
| carphone_qcif | 2 | 2 | 0 |
| city_qcif_15fps | 5 | 5 | 0 |
| claire_qcif | 1 | 1 | 0 |
| coastguard_qcif | 3 | 3 | 0 |
| **TOTAL** | **125** | **120** | **5** |

Fig 4 shows the level of demand of video files by the viewers. Out of the 39 distinct files demanded by the viewers on network, intros_422 and bridge_far take the highest value followed by akiyo, mother_daughter, salesman, vtc1nw_422, and city. In all the demand for these 6 files, none was rejected as well.

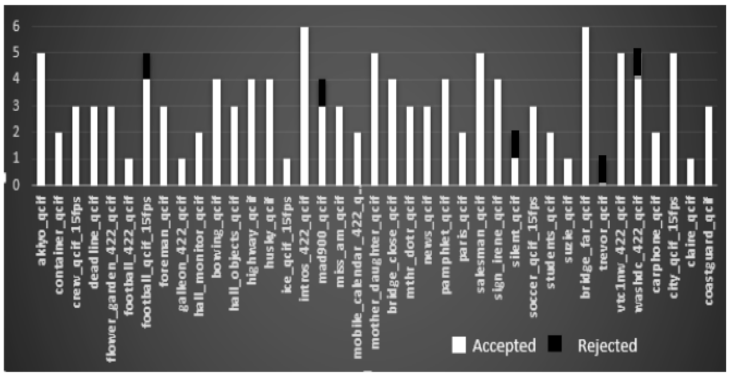


Fig 4 Demanded video files on network.

## 6. Conclusion

An admission control mechanism has been developed for multimedia server on the incoming requests from the viewers. This method is used in order to guarantee the continuous delivery of a video stream based on the design concept of capacity reservation and reduce the loss rate during streaming. The research has shown admissibility of video file request by relating it to a dichotomous data which can be modelled using logistic regression technique because of its flexibility and interpretability. The technique was used on the processors' busy values and the desired outcome shows whether the request is admissible or not.

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