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**E- LEARNING TOOLS PERFORMANCE MANAGEMENT**

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**Abstract:** *E- Learning techniques have emerged as powerful tools for distance learning applications used by learning institutions like universities that offer distance learning solutions to the public. For e-learning tools to work efficiently, it is of major importance to have the possibility to measure in a real time all the performances of the information and communication technology systems involved (servers, databases, connections etc). Such an approach makes solving potential problems much easier, by diagnosing and treating the causes in a short time so that the users of the system are minimally affected. Among the parameters of modern e- learning systems that have to be continuously monitored are the content usage, database usage, disk usage, communication bandwidth occupied, web host latency, web page hit number per month, CPU utilization per application server, total number of users etc.*

*The purpose of this paper is to present a case study of e- learning systems monitoring by taking as an example the Black Board learning platform used by a university with a considerable number of students. By analyzing the above mentioned parameters for the given learning platform, system administrators can solve problems efficiently and can even anticipate future issues by taking into account the current parameters. For example, by observing an increase in the disk space usage for the past period of time, the disk space can be better dimensioned to avoid future problems. The presented case study e- learning platform offers the possibility to visually interpret the parameters that are monitored, over a longer time frame, being an advantage over other parameter monitoring methods.*

**Key words:** *e- learning monitoring, e- learning parameters, learning platform*

## I. INTRODUCTION

Modern distance learning applications used by learning institutions like universities are becoming more and more popular, but their parameters have to be monitored constantly if we want to obtain good performances and avoid down times. For this reason, if we want e-learning tools to work efficiently, it is of major importance to have the possibility to measure in a real time all the performances of the information and communication technology systems involved (servers, databases, connections etc). Such an approach makes solving potential problems much easier, by diagnosing and treating the causes in a short time so that the users of the system are minimally affected.

In the present paper the intention is to present a case study of an e- learning system monitoring, more precisely, the Black Board learning platform used by a university with a considerable number of students. By analyzing certain parameters for the given learning platform, the system administrators can anticipate and solve problems efficiently based on the current state of the system.

There will be presented the state of the system in two different time frames, one year apart: January 2011 and January 2012. The following parameters of the e-learning system from the two time frames will be compared:

- Storage usage statistics;
- Course/ user statistics;
- Content usage;

- Database usage;
- Bandwidth usage;
- Latency;
- Page hit numbers.

### 1.1. Storage, course and user statistics

Knowing the statistics regarding the storage status, the number of available courses and the number of users that are enrolled is the starting point for a good management of a modern distance learning platform. Carefully monitoring of these parameters is the job of system administrators of every e- learning platform, because its correct sizing must take them into consideration.

Following is a comparison between the status of these parameters for the Blackboard learning platform, corresponding to two distinct time frames, each one month long, and one year apart (January 2011 respectively January 2012).

**Table 1. Production Average Storage Usage for Period**

File System	Size (GB) – January 2011	Size (GB) – January 2012
Content	88.32 GB	186.95 GB
Database	661.15 GB	565.80 GB
Total	749.47 GB	752.75 GB

As it can be seen, from the table above, even though the size of the content that is loaded on to the learning platform has doubled, from 88.32 GB to 186.95 GB, the database size has been reduced with almost 100 GB, and, as a result, the total difference is not so great.

All this variations cannot be correctly interpreted without a perspective on other indicators such as the number of users of the e- learning platform.

**Table 2. Course/User Statistics**

Active Users	140494	71847
Enabled Users	152802	186643
Total Courses and Organizations	2841	5330
Enrollments	287490	651458

From Table 2 there can be observed that while the number of enabled users increased with about 22% (from 152802 to 186643), the number of active users decreased dramatically with about 50%. Also from the table below there can be observed that the total number of courses almost doubled (from 2841 to 5330) and the number of user enrollments to courses increased with 126%. However, the reduction in the number of active users concomitant with the increase of enabled users can mean a lack of interest of the users to the e-learning system, meaning that users are not enough motivated.

## II. CONTENT AND DATABASE USAGE

The Black Board learning platform also allows the system administrators to view the content usage and the database usage graphically. This facility is important when the system's evolution in time must be monitored, making it easier to avoid problems such as exceeding tablespace dimensions.

In Figure 1 is presented a graph of the content usage over the past two years, covering the two time frames that are analyzed in the present paper. The first time frame, January 2011, is somewhere at the beginning of the steep increase of the usage, while the second timeframe, January 2012, is situated in the extreme right of the graph.

The steep increases in the content usage graph can be observed during the exam periods in January-February and June. There is also a steep decrease of the content usage somewhere in July-August 2011, possibly caused by the fact that there is situated the summer vacation.

Content Usage graph

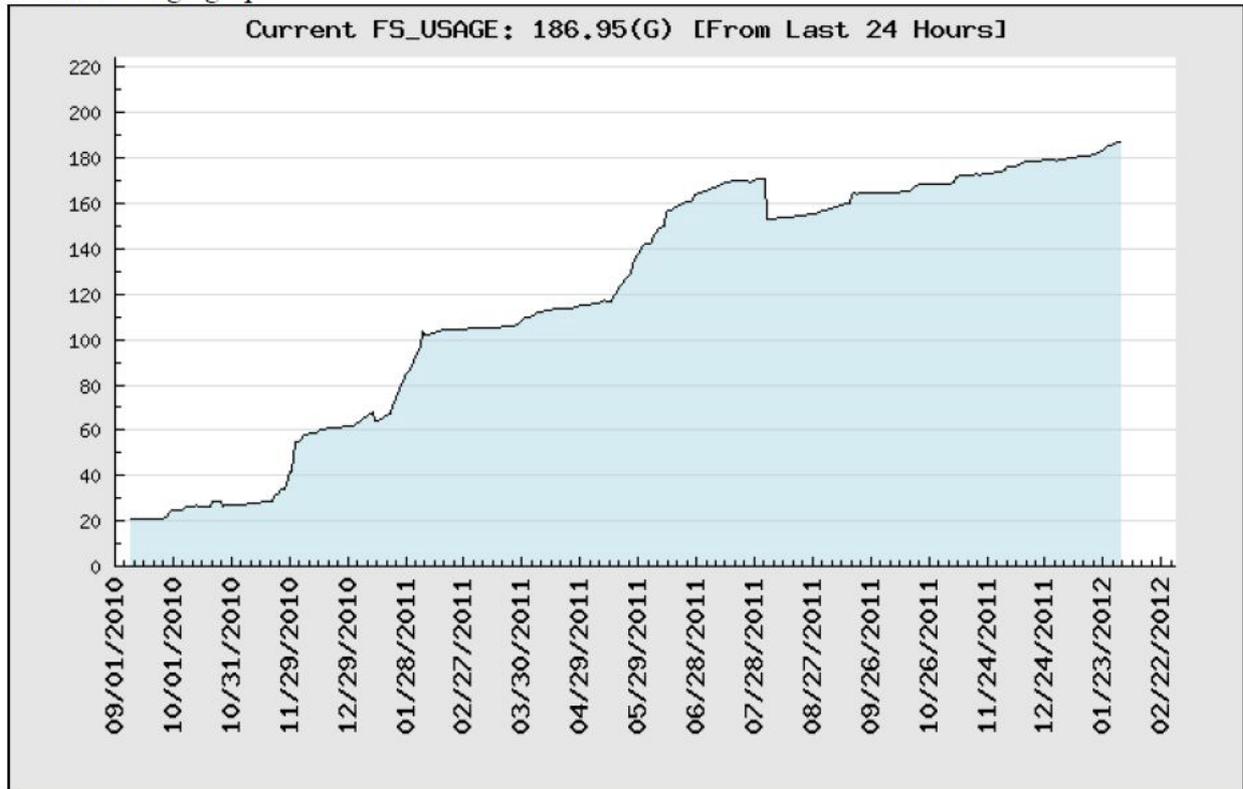


Figure 1. Content usage graph for the past two years

Database usage graph

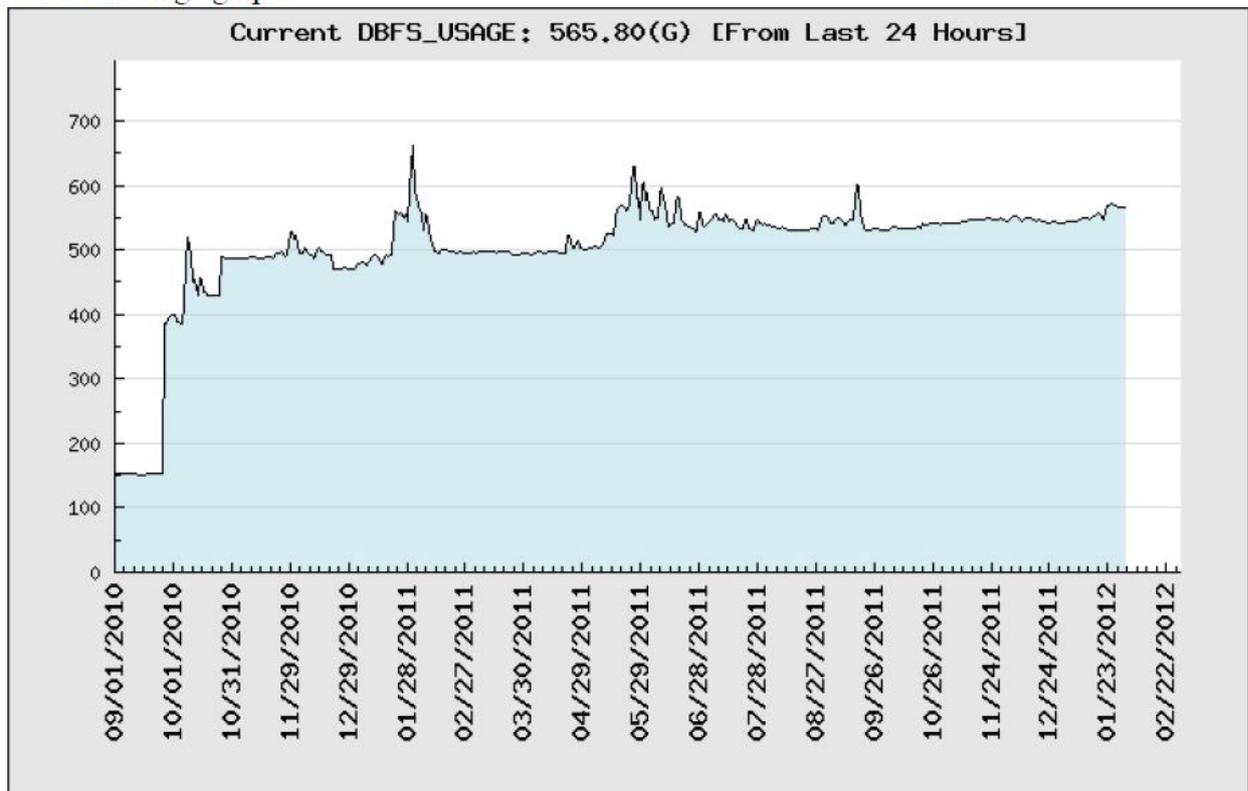


Figure 2. Database usage graph for the past two years

While Figure 1 shows the variation of the content size during the last two years, Figure 2 shows the variation of the database size during the same period of time, covering the both timeframes that are analyzed in more detail.

The most important fact that can be observed on the database usage graph is that there is a slightly increasing trend from October 2010 to present. This trend is interrupted by some spikes that usually occur during the exams (January – February 2011, June 2011 and September 2011). As an exception can be noticed that we cannot find such an increase in January 2012, partly because the data displayed covers the time until 23<sup>rd</sup> of January, about the same date that exams start.

The graph from Figure 2 shows more than the data analyzed in the previous chapter. While there the data showed a slight decrease in the database size, by studying the graph it is now clear that the sample in January 2011 was taken during a local spike, while in reality the trend is slightly increasing. This demonstrates how important for e-learning platform system administrators is to have the proper tools to correctly monitor all the performance characteristics. By analyzing the available data it is possible to size the database accordingly.

### III. BANDWIDTH USAGE

Besides the total size of data that is stored by a distance learning platform like Blackboard, bandwidth is another key factor, directly influencing the number of users that can access content concomitantly. This is due to the fact that usually distance learning content is located on servers and it can be accessed by users over the internet from all over the world. Bandwidth for a distance learning server must be dimensioned according to the maximum number of users anticipated to connect in the same time. For distance learning platforms that offer the possibility to evaluate students by online tests, usually the time with the most connections is during the exam hours. For this reason it is important to have tools to monitor the bandwidth and the total number of connections.

#### Bandwidth usage:

Report for Throughput on All-Objects

Jan 01 2011 00:00 GMT+02:00 - Feb 01 2011 00:00 GMT+02:00

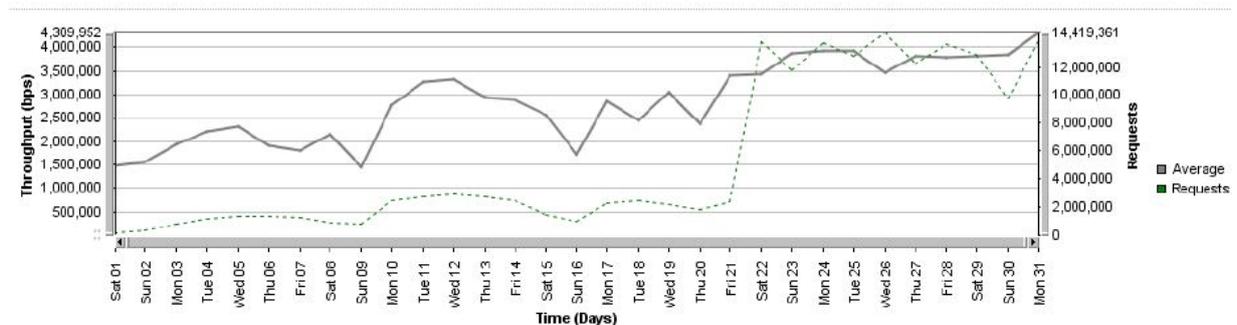


Figure 3. Bandwidth throughput related to requests – January 2011

In the above figure it is presented graphically the bandwidth throughput measured in bps during January 2011, correlated with the number of requests that are made by users. It can be observed that the throughput is relatively small in the beginning of the month (starting from 1.5Mbps), increasing after 20<sup>th</sup> of January when the exams begin (to over 4.3Mbps). The requests, shown with dotted line, increase dramatically only after 21<sup>st</sup> of January when the exams begin (from 2 million to more than 12 million individual user requests).

Figure 4, presented above, shows the same parameters for January 2012. The difference between the two time frames is that in January 2012 the bandwidth throughput seems to be better adapted to the number of user requests, and slightly higher (from 2 to 5.5 Mbps), while the number of requests is significantly lower, at around 4 million.

## Bandwidth usage:

### Report for Throughput on All-Objects

Jan 01 2012 00:00 GMT+02:00 - Feb 01 2012 00:00 GMT+02:00

[Browse Data](#) [Export Data](#)

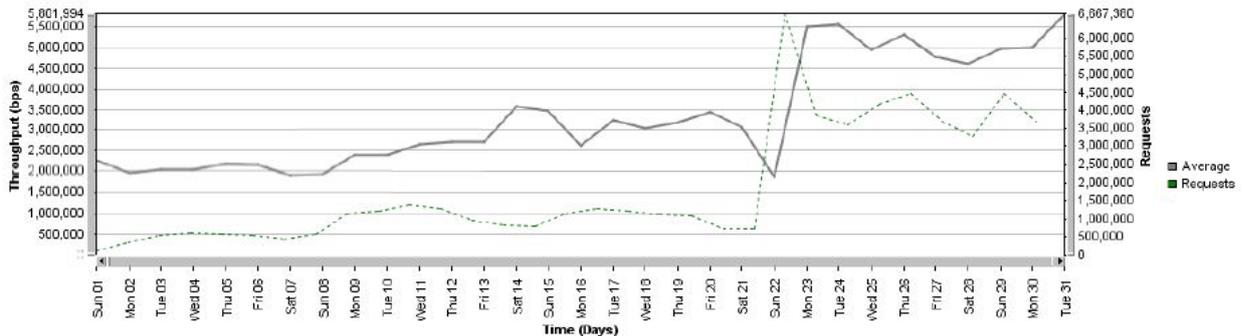


Figure 4. Bandwidth throughput related to requests – January 2012

## IV. LATENCY AND PAGE HIT NUMBERS

The latency is related to the number of requests (page hit numbers) and the available bandwidth and is perceived by the distance learning platform users as a delay in loading the content they want to access (tests, courses etc.).

The Blackboard learning platform offers the system administrators the possibility to visualize the latency related to the number of requests.

## Host Latency:

### Report for Host Latency on All-Objects

Jan 01 2011 00:00 GMT+02:00 - Feb 01 2011 00:00 GMT+02:00

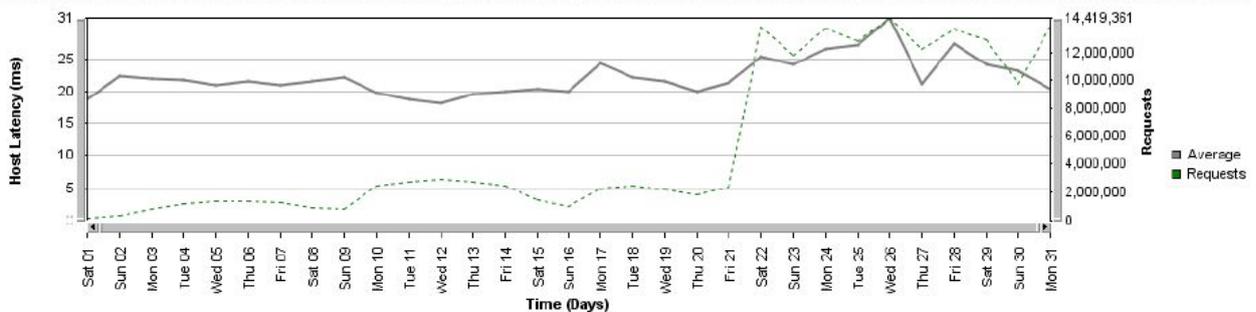


Figure 5. Host latency related to the number of requests – January 2011

As it can be seen from Figure 5, the host latency of the learning platform server does not exceed 31 ms in the busiest days at the end of January 2011. The number of page hits is figured with dotted line to show the busiest time.

In Figure 6, the host latency is plotted for the second timeframe, January 2012. As it can be observed the latency is constant at the beginning of the month, but after the number of requests increases, it goes from about 25 ms to more than 110 ms. 110 ms is about one tenth of a second, not a perceivable delay, but its causes should be investigated, indicating potential future issues. This should be taken into consideration as the number of requests is much smaller than in the same period of 2011.

## Host Latency:

### Report for Host Latency on All-Objects

Jan 01 2012 00:00 GMT+02:00 - Feb 01 2012 00:00 GMT+02:00

[Browse Data](#) [Export Data](#)

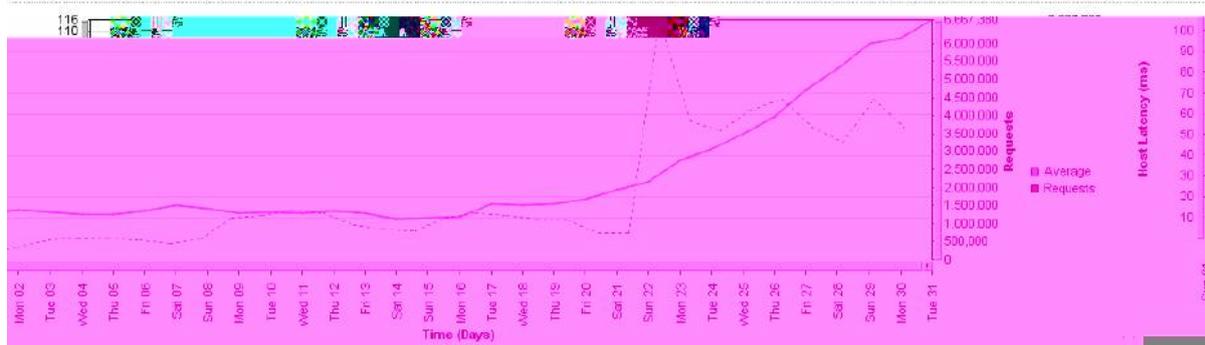


Figure 6. Host latency related to the number of requests – January 2012

## V. CONCLUSIONS

By continually monitoring the parameters of distance learning platforms such as Blackboard (content usage, database usage, disk usage, communication bandwidth occupied, web host latency, web page hit number per month etc), it is possible to predict and solve problems efficiently, before they cause major disfunctionalities.

By analyzing these parameters over a longer time, system administrators will become accustomed with the behavior of the system. From the presented case study it can be concluded that e-learning platforms that offer visual tools to monitor parameters such as those mentioned above have an important advantage, making spotting and solving problems easier, resulting in a lower down time and lower maintenance costs.

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