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Load Handling Ability of
COMPUTER BASED TEST SYSTEM
used for
WEB BASED ONLINE TEST
or
INTRANET BASED TEST IN CLASS OR LAB
or
ONLINE FEEDBACK AND SURVEYS

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A NOTE OF LOAD HANDLING ABILITY

1. Introduction

Computer Based Test System is a Browser based software, working on a Server-client structure. It can be used for conducting test with following setups:

a) **Web Based Online Test:** where the candidate attempts the test in internet browser on a windows computer at his home or Cyber café.

b) **Intranet Based Test in Lab/Class:** where candidate attempts test in internet browser on a computer in the institute Lab connected to the server in the Lab through local intranet.

c) **Offline Computer Based Test using Android Device or Desktop interface:** where the candidate temporarily connects his Computer/ Tab/ Smartphone at his home or Cyber café or Lab, to the Lab-server or internet-server, downloads the test on his device, solves the test offline, and later connects again through internet to upload.

2. Factors that affect the performance

Broadly, an Online Test or Institute management solution can be divided into two major components, Software and Server Environment. But it is not just a Software or a Server in isolation...the solution depends on an optimal mixture of several parameters.

Software capability and Environment capability are 2 different things. The same Online Test Software can handle 10 or 10000 candidates if it is supported by a suitably capable Application Server having proportionate resources, appropriate Data Transfer Bandwidth at Server and good internet bandwidth at user end.

Besides buying the same software, the type of need determines the server infrastructure. If you have a low-end requirement with minimum budget, like a coaching center distributing free tests, so accordingly cloud deployment with basic bandwidth that support 0-10 concurrent users should be opted. Increasing bandwidth to keep provision for entertaining higher number of simultaneous 25-50 users will be a wastage of resources in anticipation of maximum load. It is better to plan workload by time sharing.

However, if your tests are of critical importance even for 25 students, you must buy surplus bandwidth at the server level and ensure candidates appear in a Lab, or have a broadband connection at home or 3G/4G connection in smart device.

If you plan to conduct tests of more number of candidates like 50-100, then you should opt for an in-house server in the lab, eliminating all dependency on internet and bandwidth. Because if server is on cloud and users in lab, that lab must have consistent internet with high bandwidth is the range of 10+ MBPS. If the server is on cloud and the users are distributed in their homes, cyber café or using their smart devices with mobile internet, they will have different experiences depending on their internet.

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3. Glossary of Terms (User/ Login/ Test/ Attempt/ Token/ Load)

a) **A User** is a member registered in the online test system who is given access to login. He may or may not login and may or may not attempt tests. So number of users is not directly related to load on the system.

b) **A Test** is a question paper which is some static data. It is different from a "test attempt" that involves real-time data transfer and bandwidth consumption. There might be several question papers created but no users to attempt them. Then this is only dead data but no transaction load on the system. So number of tests is also not directly related to load on the system.

c) **A Test Attempt** is the actual use of the system when there is real-time data transaction with the server when one user is solving one test. This is when the load is exerted on system resources. So test attempts are chargeable.

   *Max test attempts can be No. of Tests **X** No. of Users.*

   But actual attempts are very less because all users do not attempt all tests.

d) **A Login** is an instance when the user is actually accessing and using the software. A login is not counted as a test attempt if the user simply accesses the software but does not start a test. One user may login but not do anything, so it is not counted as a test attempt or charged as a test token. One user may login several times during a test, if he gets disconnected. Logging-in multiple times in a single test is also not counted as multiple test attempts.

e) **A Test Token** is the price for a test attempt. One test attempt may be worth one or more test tokens. Same test with provisions for more bandwidth for more users to attempt simultaneously might be costlier and be worth more no. of test tokens. ***The concept of Token is not valid in the new cloud hosting charging system in effect from 01-Sep-2016.***

4. Understand the term "Load" in context of the Online Test System

The load on an Online Test System is very different from the data contained by the system. It is not the number of registered students. It is also not the number of questionnaires uploaded.

Till the time there is no use of system to solve the test by a candidate, there is no load. It is just a dead database which is occupying disk space. But since there is no transaction and use of data bandwidth, thus we call this situation as a no-load condition.

There can be 100 or 10000 registered candidates and there might be 1 or 250 question papers ready uploaded in your system BUT still there will be no load if no candidate is solving any question paper at this point of time. The actual usage of the system begins when a user starts attempting a question paper.

When a candidate solves a question paper the database of the online test system is repeatedly hit several times in a minute to retrieve and store the latest responses or changes made by the candidate. It is only then that the bandwidth and other capabilities of the database server are put to use.

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5. Concurrent User Logins

Suppose a test is active for 3 days and total 10000 candidates will take part in it during these 3 days. The server is running 24 hours and the candidates might login at their convenient time during the active period of the test. Since the duration of the test is also fixed, so all these candidates will not remain logged-in and will be able to use the online test system for all 3 days. Any candidate will login and solve the test with one or more logins attempts and will have to leave the system as soon as the total running time of the online test reaches the defined test duration.

In this way, some candidates will log-off in some time and other new candidates will log-in. So the candidates solving the test in these 3 days will be uniformly spread over 3 days and at any point of time there may be about 50-60 candidates logged-in and solving the test. Even if one question paper or several question papers solved by various candidates, the concurrent load on the system is the number of candidates logged-in at one particular instant.

In simple language, the server requires more RAM to be able to run multiple instances of the database server to support multiple logins. Some versions of Operating Systems and Database Server also have limits of maximum RAM that they can use and this puts a check on the maximum concurrent logins it can smoothly sustain. In either case the better the server infrastructure the better concurrent login load can be sustained.

Here it is important to understand that if at any one point of time the number of candidates currently solving the test is not exceeding more than 50 then the server that can handle 50 simultaneous logins of database instances is perfectly Ok to conduct a test of 10000 candidates.

6. Server Environment factors that affect the performance

Server environment includes Processor Cores, RAM and Storage type (affecting processing ability), Operating System, Database Server and Data transfer bandwidth suitable enough to meet required work load.

a) **Server Computing Resources:** Server's hardware resources like Processors/Cores, RAM, the free space on the server storage media that in-turn affects the size of cache files and paging files that can be created on the drive, and the efficiency of the storage media, all have a major impact on the server performance in serving the tests to a group of candidates.

If there are more processes running on the server, it is always suggested to keep surplus resources to make available minimal resources for test process at any point of time.

b) **Operating System:** The other major factor that is considered a component of the server resources is the version of OS installed. There are maximum RAM usage limitations for Operating Systems. So even if you have multiple Processor Cores and high RAM on your system and higher version of SQL, still if the OS has a limitation, it will form a bottleneck.

Version	Limit on X86	Limit on X64
Windows Server 2008 Standard	4 GB	32 GB
Windows Web Server	4 GB	32 GB
Windows Server 2008 R2 Standard	-	32 GB
Windows Web Server R2	-	32 GB
Windows Server 2008 Enterprise	-	2 TB
Windows Server 2012 Standard	-	4 TB

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c) **Database Server:** Similarly, various versions of SQL have their respective limitations on the maximum amount of memory that they can use. So even if you have deployed a server with 64 GB RAM, but it is installed with SQL Express edition, the SQL shall not be using memory more than 4GB, and this would form the bottle neck in serving more than 10-20 users. So it is suggested to install SQL standard or Web edition with minimum 32 GBs to meet a workload of upto 50 concurrent users.

7. Suggested Server configuration as per expected load

ITEMS	UPTO 25 Concurrent Users	UPTO 50 Concurrent Users	UPTO 100 Concurrent Users	UPTO 200 Concurrent Users	UPTO 500 Concurrent Users
CORES	4+	4+	8+	16+	32+
RAM	16 GB+	32 GB+	64 GB+	64 GB+	200 GB+
HDD / SSD	100 GB+	100 GB+	200 GB+	200 GB+	500 GB+
OS	7 Pro 64 bit +	2008 R2 Std / 2012 Std 64 bit +	2008 R2 Ent / 2012 Std 64 bit +	2012 Std 64 bit +	2012 Std 64 bit +
SQL	2008 R2 Express +	2008 R2 Web + per core	2008 R2 Web / 2012 Web + per core	2012 Std + per core	2012 Std + per core

+ indicates this is minimum parameter. The component should be higher than this for better result.

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8. Network and Connectivity factors that affect the performance

a) **Server Data Transfer Bandwidth:**

In our standard package, we provide a bandwidth that supports 25 simultaneous users for one account and charge accordingly. The price is exponentially high if 50 or 100 simultaneous users have to be allowed. So instead of paying high cost for an accentuated workload which is rarely required, even clients prefer a minimum balanced price and adjust the workload by time sharing. 25 logins is standard because based on data usage pattern over the years we observed that this is the most commonly exploited limit and very rarely it exceeds this concurrency needs.

b) **User Internet Connection Bandwidth**: Server Data transfer bandwidth and User Internet bandwidth again are 2 different things....the lowest one forms the bottle neck. If there are different users connected to the same server giving the same online test, but having internet connections of different bandwidth, then their experience will be different. The user whose bandwidth will be low, his response time will be more. Server receives requests, sends data, but if student bandwidth is low, he will take time to see.

Suppose even if we provide a very high end server with high bandwidth, still the final experience will be as of limiting bandwidth at user level.

c) **Consistent Connectivity:** Besides the speed, quality of connectivity is important. A high band and fast internet connection, which a user claims he is able to surf websites properly, might not be suitable for Online Test or Online Application. Because most websites involve download of static data in packets so in between connectivity for a fraction of a second does not affect. But in case of online test, in order to save the answers given by user, the software contacts the data server in every few seconds. If the internet connectivity is intermittent at this instant, it might lead to malfunction or even logouts. So the type and quality of internet connection is also important not just the MBPS label from the service provider. A 1 MBPS connection with consistent connectivity may perform better than a 2 MBPS connection with intermittent connectivity in rainy season.

Type of User	Minimum Internet Requirement	Optimal Internet Requirement
Single User on Browser	Normal dial-up is sufficient to work but, screen loading time will be slow, might be subject to disconnections and timeouts	The more speed the better. Faster speeds will facilitate faster downloads.
Single User on App	2G connection is OK to download but it will take time to download. No issues while working because it works locally on device, without internet connectivity but slow speed at time of uploading can be risky. Also devices with poor processors, smaller screens might perform slow and face limitations.	3G connection is good, though it is required only for a limited period to download and upload the test at the start and end of the process, but even if this is smooth and fast, it will create a better user experience.
Multiple User in Test Lab	Bandwidth requirement depends on number of users. 50 users will need in range of 8 MBPS, 100 users might need 10+MBPS.	For this high concurrency, it is suggested to conduct test only in Lab with local server to avoid all dependency on internet bandwidth.

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9. Planned Solution for Large Scale Online Exams

Some of the organizations that are planning to conduct tests with high expected participation, have in mind that these examinations might be needing some exceptionally superior softwares. This concept is not fully correct.

When such a large scale examinations like CAT, IBPS are conducted pan India, they are not conducted with the help of just one single license software loaded on one single dedicated server hosted at some datacenter. Such large scale examination event involves a completely planned solution wherein many servers using multiple software licenses hosted locally in each exam centre or at several datacenters are used and later the data is collated after exam for result processing.

One of the major reason for such a distributed network arrangement is to distribute workload on various servers and also to have backup of the process in case any server fails to deliver. Later when the exam execution is over, the data from all servers is collated to process results.

Thus the software might be same as that is used by a small scale institution, but the total solution is formed by parallel implementation of multiple threads to meet the high workload requirements.

10. Suggested approach to optimize the use of resources for Self-owned Servers

With the above understanding about impact of server capabilities in delivering the test to a number of candidates, it is always suggested to initiate a metered start of the test process on any new server. If the implementation is on a single server with limited resources, then in case of online candidates accessing the system over cloud, it is suggested to schedule the tests for sufficient period so that all candidates are not forced to login within a narrow window of time. Thus at any one point of time, the number of users logged into system will automatically reduced. Also since there is more time window, the max number of candidates logging into the system can be limited by the system administrator. In this manner the accentuated load on the server can be dissolved by increasing the time window for system use.

If the tests are to be attempted by a group on several computers connected to a server in a lab, it is suggested to distribute the candidates in small size groups. So that the users can attempt over a period of time to enable optimal use of resources on time sharing basis. In this manner, more number of users can be handled with limited resources of the server.

It is assumed that the user implementing this Computer Based Test/Feedback System has understood the above approach and shall implement the system with awareness to above approach.