Asian Journal of Information Technology 5(5) : 480-484, 2006

A Soft Real Time on Line Examination System

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Abstract: Any agency chosen to perform the task of selecting candidates for admission to any professional education has to administer a common entrance examination, evaluate the responses and allot seat according to the merit of the examinees. This task has three parts viz, conduct of examination, evaluation and allotment of seat for admission. In this study a soft real time on line examination system has been designed and software developed for implementation. To set questions of the same standard varying degrees such as toughness, easiness and mediocre factors have been introduced in each question in the question bank. An algorithm has been developed to set question papers of more or less the same standard to be dispensed and examinations conducted at different points of time. All the physical and application of mind activities of the examinees are monitored through software agents and communicated to a central location.

Key words: Real time, on line, toughness factor, smart card, hall ticket, virtual private network

INTRODUCTION

Admission to any professional education in India is opened to a prospective candidate by conducting a national or state level entrance examination for all aspirants desirous of joining any professional course. Tamil Nadu, a State in India has organized and conducted such examinations in many chosen centers with in the state. On an average 95% of the candidates who compete in this entrance examination is from the State of Tamil Nadu. During the year 2004, the number of candidates who appeared for the entrance examination was 1,49,343. This examination of each three hours duration conducted in several centers in three sessions spread over two days. This system requires issue of hall ticket for personal identification. Based on experience, it takes two to three minutes for the preparation of the hall ticket and dispensation. However, a candidate may have to be present around the centre anywhere from 45 minutes to about three hours due to lengthy queue, occasional hardware failure and so on. A statistical model has been developed[1], to schedule online registration, with an objective to minimize congestion in operation on any day. Each candidate has to fill up an application form, key in personal data, verify the entered data, pose for a photograph get a register number assigned, print the hall ticket and collect it.

Further, during each session of the examination the bonafides of the candidate have to be verified. Absentees are noted for tallying the registered and appeared. The manual tally of absentees and straightening the records takes three weeks, involving lot of man hours. Only one third of the candidates appeared for the examination, qualify to file an application for admission. A mathematical model has been developed for optimal allocation of candidates to counseling for admission[2-4]. The manual process of receiving the application along with the basic qualifying examination marks and the community, consumes lot of man hours. Still ambiguous cases arise. Hence, it is proposed to introduce the smart card for entrance examination with biometric identifiers such as thumb impression, eye ball etc., to enhance the identity and to reduce the time and effort for manual verification. Instead of hall ticket, smart card containing register number and the pedigree information of the candidate is issued.

It is also proposed to conduct the examinations online real time at various centers. Since number of candidates taking this examination is of the order of 1.5 lakhs, the online examination for a particular subject has to be conducted in batches spread over a period of few days, according to the availability of personal computers in a particular centre. This necessitates to dispense sets of question paper which have to be of the same standard. A candidate can register for the examinations and collect the smart card. A statistical model has been developed to schedule the real time on line examination with an objective to minimize the congestion in any centre on any day.

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Table 1: Statistical parameters for the dates of birth distribution

Sr#	Parameter	Daywise	Monthwise
1	Mean	4,560.55	11,781.42
2	Variance	5,82,456.65	2,32,18,782.58
3	Standard deviation	763.19	4,818.59
4	Co-efficient of variance	0.167	0.409

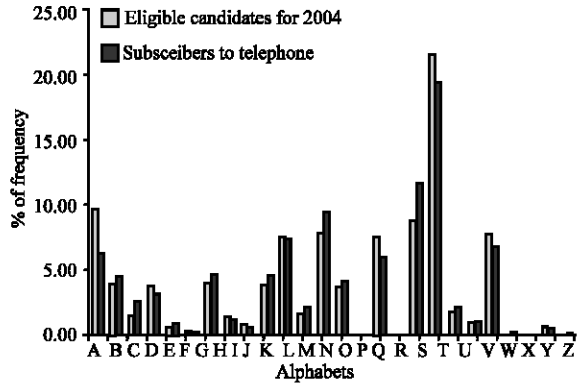

Fig. 1: Distribution of names according to alphabetical order of eligible candidates for 2004 and subscribers to telephone

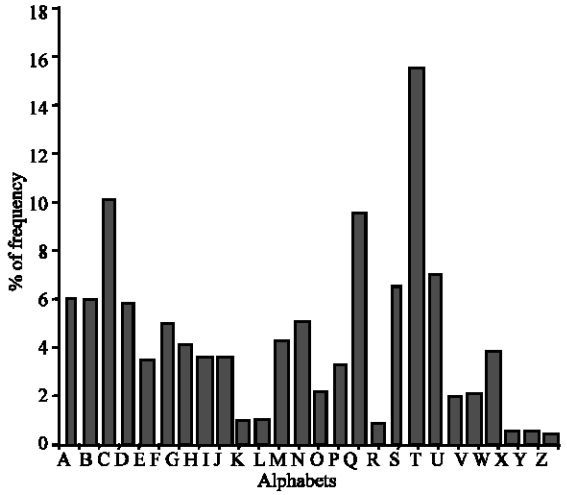

Fig. 2: Distribution of words in English language according to leading alphabets

MODEL FOR REAL TIME ON LINE CONDUCT OF EXAMINATION

Those candidates who wish to take the examination are allotted to the nearest examination center by another distance optimized model. There will be at least two examination centres in each district headquarters. Each centre is having a database server and at least 100 personal computers are hooked to a central server through VPN. Yesteryear's data were analyzed and a statistical model has been chosen to avoid congestion on any day and in any centre. In other words a load balancing on the system has been adopted for implementation.

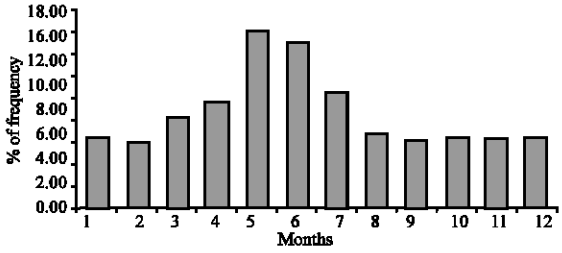

Fig. 3: Distribution of dates of birth of candidates of the year 2004 according to months in a year

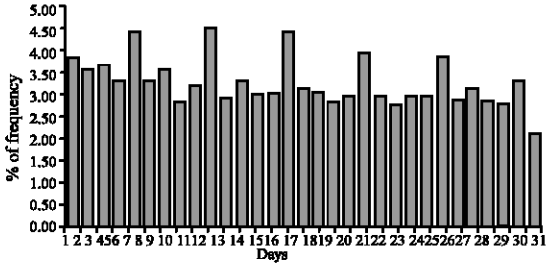

Fig. 4: Distribution of dates of birth of candidates of the year 2004 according to days in a month

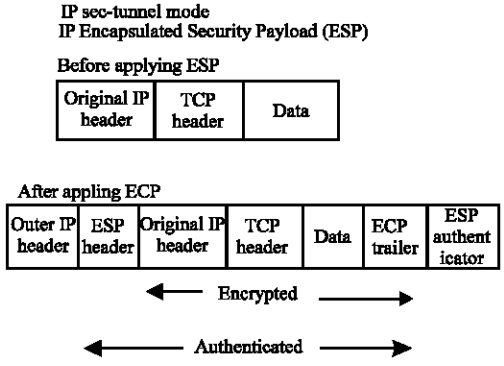

Fig. 5: Encapsulated security payload

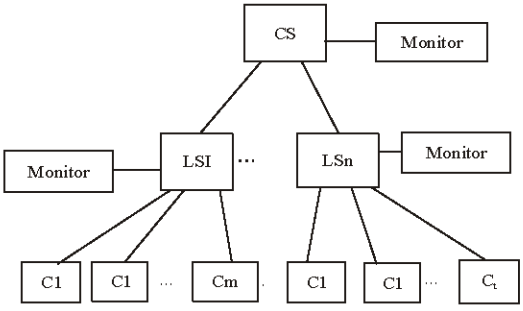

Fig. 6: Architecture of database servers

Candidates hailing from each district were identified and their names sorted alphabetically[1,5]. There is a wide variation in names starting with the leading alphabets A

to Z. For instance names starting with the letter 'S' is the peak in the distribution and very few names start with the alphabets O,Q,W,X,Y,Z. There is a gross non uniformity in the distribution. The distribution of dates of birth of candidates appeared for the year 2004, according to months in a year and days in a month are also analysed.

In order to justify the non uniformity in the distribution of names according to leading alphabets one or two similar problem was also analysed and found to behave more or less in the same manner. The problems analysed are:

- Distribution of names according to leading alphabetical order of subscribers to telephones.
- Distribution of words in English language starting with leading letters A to Z.
- The months of birth of children born over a span of one calendar year.

Charts 1, 2 and 3 reveal there is wide non uniformity in all the distributions. Chart 4, day wise birth rate distribution model has an edge over the other three distributions and hence this has been chosen for implementation[6,7].

The day wise birth rate in a month is more consistent with Coefficient of Variance (COV) of 0.167 than the month wise distribution with a COV of 0.409.

Based on the statistics, a schedule has been drawn on candidates' day wise dates of birth in a month. For example, candidates whose dates of birth fall on 1st, 2nd, 3rd day of any month are summoned to the nearest center to take examination (one subject) on the first day of the schedule. Those whose dates of birth fall on 4th, 5th and 6th day are summoned on second day and so on.

GENERATION OF OPTIMIZED NUMBER OF QUESTION SET

The examinations are conducted in various centers on different dates and the layout of the computer center may vary from center to center. The number of sets of question paper to be set also varies. The number of different sets of questions required for a particular session will depend on the physical layout of the PCs in that centre. Given a layout of the computer centre and by marking the neighbors for a particular PC, the number of sets is estimated, so as to avoid visibility of a monitor assigned to one candidate by another to avoid malpractice in the examination. The neighbors are marked based on the physical distance between them.

The malpractice problem is rooted out by not dispensing the same set of questions to neighbors. Since the question bank is large enough, the probability of a question repeating in a set of papers dispensed to a neighboring cluster is remote .

The number of sets of questions required for a centre = max { (number of neighbors to i^{th} machine), i=1 to n } + 1 where n is the maximum number of PCs available for examination.

GENERATION OF QUESTIONS

Since the examination has to be conducted in batches and each batch has many sets of question papers, it is required that all the sets must be of the same standard ie., if a candidate takes n different sets of questions, he/she should score more or less the same score with a reasonable statistical tolerance . Each question in the question bank is associated with a toughness factor (five point scale, 5-very tough, 4-tough, 3-moderate, 2-easy and 1-very easy), which is used to generate question papers of same standards. For example, a set with average 3.5 toughness factor is to be generated, all the sets should have 3.5 toughness factor, distributing the questions from different chapters depending on the number questions from each chapter.

For a set, each question has equal probability of being selected. For example, if the number of questions in each chapter is fixed and total toughness factor is fixed, we can find the number of questions required with each of the toughness factor. If x_k is the number of questions required with toughness factor k ($1 <= k <= 5$), by solving the following equations.

$$\sum_{K=1}^{5} x_k = n \text{ (n Is the number of questions in each set) and} \quad (1)$$

$$\left(\sum_{K=1}^{5} kx_k\right) / \left(\sum_{K=1}^{5} x_k\right) = T, \text{(the required toughness factor)} \quad (2)$$

we can find x_k's . For picking up the question, random numbers are generated separately for fixing the chapter number and then the question number, within the chapter selected, so as to get the chosen average toughness factor. Given the number of chapters for a particular subject, the number of questions to be picked up from a chapter, and the number of questions for a set, a set of question paper with the prescribed number of questions is generated.

The toughness factor for the set (T) =

$$\sum_{i,j} \{t_{ij}\} / n$$

where t_{ij} is the toughness factor of i th chapters j th question, which has been selected for the set,

$1 <= i <= n_c$
$1 <= j <= n_i$
n-the number of questions in a set.
n_c-number of chapters
n_i-number of questions from the i^{th} chapter.

Algorithm:
Given n, n_i and x_k
Set m=0, m_i=0 ($1 <= i <= n_c$), y_k = 0 ($1 <= k <= 5$)
Repeat the steps while $m < n$

Step 1: Generate random number (i), {the number falls within the given range for chapters}
If $m_i >= n_i$ go to step 1.

Step 2: Generate random number (j) {the number falls within the range for question in the chapter i}
If q_{ij} is selected already go to step 2
If $y_k >= x_k$ for $k = t_{ij}$ go to step 2

Step 3:
Select q_{ij},
compute $m_i=m_i+1$, m=m+1, $y_k = y_k + 1$ for $k = t_{ij}$
go to step 1

where x_k number of questions required with toughness factor k
y_k number of questions selected with toughness factor k
m_i number of questions selected from chapter i ($1 <= i <= n_c$)
n_c number of chapters
n_i number of questions required from chapter i
m is number of questions selected, $m = \sum m_i$, ($1 <= i <= n_c$)
n is total number of questions required,

$$n = \sum_i n_i, (1 <= i <= n_c)$$

q_{ij} is j th question in i th chapter
t_{ij} is the toughness factor of j th question in i th chapter

SECURED NETWORK

The central database where the question bank is created and stored may be linked to all other centers through a Virtual Private Network(VPN) using IPSec- tunnel mode. The required sets of question papers for a particular center are generated at the central place and distributed to the local centres. The local examination center's database in turn supply the individual candidates questions, evaluate the answer and print the mark sheet. Once the session is over, every details are transmitted to the central database.

The central database server is securely connected to the other centres over internet using an encrypted and authenticated IPsec tunnel. IP packets from a host on the local subnet to a host on the remote subnet are forwarded to the local Security Gateway (SG) which in turn tunnels the IP packet to the SG on the remote end of IP Sec tunnel where they are delivered to the destination host.

Since the IP addresses of any two hosts located in the geographically separated subnets are hidden by the encrypted encapsulation, an attacker's eavesdropping on the internet tunnel cannot gain access to any information about the internal tunnel structure of the sub networks. Detailed traffic analysis based on host and port addresses which can be applied to IP sec transport mode connection fails in the presence of an IP sec tunnel where only the two security gateways and the IP sec traffic exchanged between them are visible.

MONITORING SYSTEM

The physical and application of mind exercise of the candidates, from the time one logs on to the system and logs out are patrolled through software agents. The database updation and insertion are monitored. IP addresses of machine initiating activities are monitored. Since the IP address of the source and destination are captured, whenever a candidate tries to surf the net is watched by the agent, the unwanted destination addresses (other than the database server) are screened and an alarm is raised in the local monitoring system and the candidates information is send to the central monitoring system for further action.

The authorized list of IP addresses are available in the local database server and the transactions from those authorized machines are allowed to interact with the database server. This prohibits the use of unauthorized machines for the examination and also avoids impersonation.

SOFTWARE IMPLEMENTATION

The Central database Server(CS) with Oracle as back end is serving question sets to different local database servers(LS1,LS2…LSn) , based on the request. When a candidate desires to take an examination, based on the schedule prepared[5], come with smart card and is being authenticated by thumb impression already available in smart card. The candidate can take the examination for the prescribed time limit. The local database server which maintains the addresses of local machine, monitors the IP addresses of the source and destination, does not allow any other machine whose IP address is not available. The screens are designed to display the questions and get the answers. Whenever the candidate selects an answer, it is updated in the local server. When the candidate clicks

"Evaluate" button, the answers are evaluated and mark sheet is printed and the smart card also updated.

A memory resident java program monitors the activities of all the client machines, like IP addresses of destination, insert, update activities of Oracle operations. Whenever the destination IP address is different from that of the local server, it sends message to the monitoring system available at that center and to the central monitoring machine. The monitoring system's screen at local center is divided into slots depends on the number of machines available in that center, warning signals are displayed and the details are available in the database . Apart from this monitoring software agents, video cameras are fixed and continuous recording of the proceedings is done for further review, if needed.

CONCLUSION

Based on the yesteryear's data, a statistical model has been developed to summon candidates hailing from various destinations to register for the entrance examinations. An algorithm has been developed to select question papers of same standard for dispensation on different days. A relational model has been developed and an integrated system is available for implementation, which may be implemented through VPN, IP Sec –tunnel mode. Using smart cards, the authenticity of the candidate is ascertained at any stage. Software agent has been developed to monitor the activities of the candidates.

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