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Time Scheduling in a Peer-to-Peer Remote Access Laboratory for STEM Education

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***Abstract*—Remote Access Laboratories (RAL) are online environments that allow users to access instruments through the Internet. Such environments enable users to control equipment and collect data without being present in the laboratory. This also means that users work in a disjoint manner and cannot co-ordinate equipment usage directly with each other, as they would do in regular on-site laboratories. Remote laboratory management systems deal with scheduling users, as most instruments cannot process multiple users' requests at the same time. Two scheduling strategies are predominantly used in RALs: time slotting and the queuing. This is straightforward in centralised, service-oriented environments, in particular, when instruments are available continuously throughout the day. In this paper, time scheduling in the context of a Distributed Peer-to-peer Remote laboratory featuring quest-based learning, is discussed. Here interaction with the entire system is organised around a set of learning activities or *quests*. This includes the experiments designed by users and the sharing of experiments by users. The providers of the experiments have the flexibility to put their systems online as per their capabilities. As such, the experiments availability become scarcer and must be judiciously assigned to the users who need them most.**

Keywords— remote laboratory; scheduling; peer-to-peer network; e-learning systems; learning management system

I. INTRODUCTION

Remote Access Laboratories (RAL) [1] are online environments that allow users to access instruments over the Internet. Such environments enable users to control equipment and collect data from it without the need to be present in the laboratory or classroom. This means that users work in a disjoint manner, unable to co-ordinate the usage of the experiment manually with other participants as it often occurs in a regular on-site laboratory. Generally, the remote laboratory management system (RLMS) handles scheduling and user access, as multiple users typically cannot control experimental instruments simultaneously.

A Distributed Remote Access Laboratory (DRAL) employs a distributed RLMS that can support peer-to-peer collaboration [2-3]. The main reason to take a distributed approach is to allow users to design rigs on their own and share them with other users. Fig. 1 shows the basic architecture of a P2P RAL. There are two types of users in the system:

- *Users* or *clients*, who operate the experiment for learning purposes (also known as the *players*); and
- *providers*, who host and operate experimental setups.

Quest-based learning [4] is a special instance of game-based learning where the players are given a set of targets or goals to achieve. These target objectives relate to particular learning objectives. The RALfie [5] project introduces quest-based learning to DRAL environment to allow school students to design and build their own experiments [6] and then run each other's experiments. Each experiment is part of a quest which in turn is part of a large hierarchy of the quests that are related to different fields of study. Completing one such quest means the player has gained the knowledge about a particular Science, Technology, Engineering and Mathematics (STEM) topic. The use of quest-based learning adds new varieties of motivating factors and user requirements to achieve certain goals in the entre RAL based game and thus affect the scheduling.

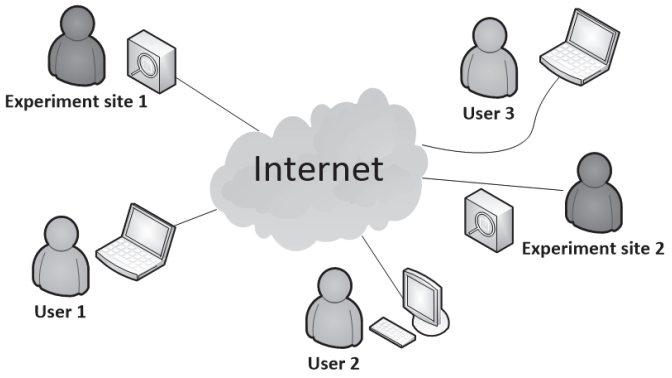

Fig. 1. The distributed P2P RAL system.

Time scheduling, i.e. making sure that each user can access experiment effectively, has been addressed in the context of traditional RALs, e.g. [7]. Scheduling users in a distributed environment that features a gaming approach poses new challenges: Firstly, experiments will usually not be online all the time, but be limited to specific time periods. This is in contrast to regular RAL where the equipment is typically available '24×7'. Secondly, due to the nature of quest-based learning, there are a number of prescribed sequences in which experiment have to be completed, i.e. users will have varying requirements while selecting experiments. In technical terms, both identify additional constraints for the user-scheduling problem.

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This paper proposes and evaluates a novel scheduling scheme based on time-slotting that is suitable for DRAL. The decision to allocate a particular experiment to a particular user is based on the users' preference for that experiment which will in practice be determined by the learning quest. To solve the scheduling problem it is formulated as a *terminal assignment problem* with a known solution [8]. The aim is to find suitable pairings between users and providers such that the highest number of experiment sessions can be completed in a given time period while user preferences about sequencing are taken into account. While motivation and context of the problem formulation are specific, the solution is applicable to other learning environments as well.

The remainder of the paper is organised as follows: Characteristics of scheduling mechanisms used for traditional RALs are discussed in Section II. Followed by an analysis of which of these is suitable in the context of DRAL and quest-based education. Requirements and assumptions regarding the new scheduling strategy are presented in Section IV. The *terminal assignment problem* and its application in this context are discussed in Section 5. Section 6 presents simulation results on the proposed scheduling method.

II. Related Work

Time scheduling in remote laboratories has been investigated in the past [7, 9-10]. Time scheduling in RAL is essentially solving a problem of resource allocation within a given set of equipment (resources) that can perform various operations. The solution will vary depending on the nature of rig operation e.g. time taken, amount of data etc. The goal is to maximize both the efficiency of the instruments' use as well as the quality of users learning.

There are two major methods of scheduling users: time slotting and queueing. Combinations of these methods have also been proposed [9-10]. Time scheduling is directly related to the nature of the experiment in terms of how much time it takes to complete one experimental activity event before the users have to provide further input. Some experiments are dynamic and 'live', requiring constant vigilance on the part of the user, whilst other activities may take a considerable amount of time to operate after the user has provided a set of inputs. This section discusses the existing scheduling methods and why they are not directly suitable for the DRAL.

A. Time Slotting

Time slotting or *time reservation* divides a given period of time into discrete slots according to the experiment nature. Each slot is then allotted to a user during which the user has full control over the equipment. Characteristics of the time slotting mode include that the user gets the full access and gives inputs at will. The user input gathering and processing does not have to be at periodic interval. The inputs may be given at random time within the time slot. This allows the users to apply a wait and see approach where they can take time and analyse their current position in the experiment and then move forward.

This feature is most suitable for experiments that are fast experiments involving a variable environment and the users making multiple decisions to get the required result. By allotting a time slot to individual users the utilization of the resources drops. A poorly designed time slot length can cause the users to finish the experiments too early. Also, the users may not use the equipment much with the time slots and spend more time on the decision-making component leading to internal slot fragmentation. Since the times at which the users may start the experiment are discrete, they are allotted the slots in a *First-Come-First-Serve* basis. This may result in multiple time slots being unassigned if none of the target users can use it at that time leading to external slot fragmentation. The number of slots limits the total number of users that can be served.

B. Queuing

Queuing is the converse of time-booking. It creates a list of users requests and processes one request at a time. The user gives a set of inputs for an experiment and each of these requests (with a set of inputs) are put in a *queue* by the experiment controller or the RLMS. The requests are then executed in order i.e. FIFO manner. The characteristics of the queuing mode include that users get full access but are unable to provide inputs at will. The users' inputs are bundled as one closed packet of information that is processed as whole at discrete intervals of time. The inputs may be given at any time but the response will depend upon the number of requests in the queue before that. This denies the users an interactive session and there is no scope for changing inputs once experiment processing starts.

This feature of reduced accessibility is most suitable for experiments that are slow and can be done with automated instruments that perform experiments with user inputs. The environment variables can be set only once and the users have only one chance to get the required result. Obviously he RLMS allow the users to post another modified request in future, so the users can always get accurate results under the desired environment variables. By forcing each instruction set in a queue and executing them successively, the utilization of the resources is optimal. The instruments are never idle. There is no scope of internal of external fragmentation of time. But it is inapplicable for experiments that are fast and interactive.

C. Other Methods

Several attempts have been made to combine the two methods to exploit the advantages of each and overcome the disadvantages. In [10] a mechanism that is adaptive and can be used to optimize the usage of instruments depending upon the number of users to be supported and the nature of and time taken for the experiment is presented. By setting the parameters of timeslot length and number of users in it, this method can be used for almost all kinds of experiment.

The viability of RAL to support laboratory related experiences in Massively Open Online Courses (MOOCs) have been discussed in [11]. The parameters for determining scalability were: student numbers, laboratory activity duration, average laboratory sessions per student and the usage window of an experiment in a day. While these parameters are relevant for MOOC based laboratory systems, they do not provide a solution to the operational management of distributed P2P laboratories based on the students immediate learning requirements or interests.

In a DRAL, users are typically unable to start an experiment session at any random time, as the the limited capabilities, time and resouce constraints of the providers must also be taken into account. The server side flexibility and unpredictable availibility results in scarcer experiment availibility where management of assigning experiments to users must be further optimized.

III. Suitable Time Scheduling for STEM RAL

Recently there have been attempts to integrate RAL in *Science, Technology, Engineering and Maths (STEM)* education [12-13]. This section discusses specific characteristics of RAL experiment that are used in the contect of STEM education and suitable scheduling strategies.

A. Suitabile method for DRAL for STEM

STEM-based distributed RAL focuses on the experiments that are completed in the K12 education sector in the fields of science and technology. STEM experiments have a number of unique characteristics compared to typical RALs used by tertiary undergraduate students.

Experiments are typically composed of actuators and sensors that have visible locomotion as opposed to any integrated measurement system. The STEM RAL aims to develop the students' basic concepts of science and technology by relating or representing them to real-world objects i.e. visible or audible phenomenon. The RAL for undergraduate experiments on the other hand may rely on raw measurement data (in text form) from a setup that does not change over the experiment duration.

The time reservation mode is most suitable for the STEM based laboratory because most STEM based experiments are highly interactive. Students require acute understanding of the experiment running by viewing or hearing the events in real time. Thus sufficient time must be allocated to each session.

Although there are experiments that are suite a queuing approach these are outside the scope of this paper.

B. The basic principle

The regular time scheduling scheme followed by a centralised mechanism cannot be directly applied in the P2P RAL as the user are not expected to provide 24x7 service. A basic solution to the problem can be obtained by simply extending the time scheduling to two sets of users. This approach requires the following steps:

1. Hosts creates time block suitable for them during which the experiments will be available.
2. Each time block is then divided into slots depending upon the estimated average time for completion of the experiment.
3. The users book the slots within this time slots as suitable to them.

This approach suffers from the following deficiencies:

- The time for which the experiments will be turn online has to be minimized. But with no information on when or how many users will be using the experiment, the providers may have to keep their equipment for long periods of time or short intermittent period without anyone actually using them.
- While some users may get their best choice of experiments, others may get only the experiments that are not allotted to others although they want something else. This may result in irregular learning pattern.

It reduces the time for which the experiments are available to the users. If users do not turn up in their allotted slot it creates a lag in time for all users.

IV. The RAL Experiments and Users

The use of quest-based learning [4] in the context of RAL has an impact on scheduling strategies. Different types of incentives [4] in the quest based learning approach provides for a variable user requirements and interest in experiments available. Generally quests, related to the users' field of interest or courses, will be used to guide them through the relevant experiments within a short time period of a few days in order to gain experience points and badges within the quest game system. Therefore experiment clusters relating to quests are important to a particular user for that period of time.

The overall satisfaction score (W) of users in the system can be defined as the average of all users' satisfaction relating to what experiment they can perform in the duration of the next time period. This is based on the importance of the quest/experiment the user performs in a particular period of time with respect to their immediate goal (e.g. to obtain a badge) in the game.

A. Why are experiments only available for a limited time?

The distributed nature of DRAL enables users to become providers of resources. But individual providers cannot guarantee or be obliged to serve each and every users request. The providers of experiment may wish to provide the experiments online periodically only as:

- Experiments are heavily dependent on video feedback for the entire duration of the experiments session. This video feedback, despite the best compression mechanisms, will consume a large amount of internet data. Apart from that the rigs themselves may consume large amount of data. Periodic availability will ensure lower or uniform consumption of data over constant period of time compared to 24/7 availability.
- Experiment may require vigilance during operation as these are prepared by individuals and could fail during operation.

Thus a limited exposure of the experimental rig will ensure lower cost and higher longevity of the rigs. The assumptions with regards to user-provider time scheduling in this paper are:

- The users will be available for any actual duration in real time for which the experiments are online. This will be done through negotiations between the user and the provider.
- The provider is able to keep their rigs online according to the user demands at all reasonable time periods but would like to limit the actual time due to reasons specified earlier.

B. Input Parameters

Following are the inputs required by the system in order to perform the assignment of time slots to the users:

1. *Total Time Period*: In the RAL system providers will keep their rigs online for a particular period of time within a larger window of time. For example, 2 hours every week, where a week is the time period (T) and 2 hours is the value for d_e.
2. *The total number of experiments available* (n): This is the total of different experiments that are available in the next time period. Each experiment will have a duration for which the experiment will be available online d_e in T as fixed by the user.
3. *User Preference*: To increase the efficiency of the assignments between the users and providers, the users are asked about the preferred experiments. Each user rates n number of experiments according to preference that they would time to do in the next T. Each user is however allowed to do only one among these experiments. The total number of users is U.

C. Cost and Choice values of User-Experiment relation

Once the users select the experiment there are $U \times n$ number of relations formed between each user and the experiments. Whilst calculating the assignments using the TAP solution the cost values *c(u, e)* for user *u* and experiment *e* is used and while calculating the satisfaction score (W), the original choice or priority values as considered. A *choice* or *priority* value, *i(u, e)*, for an experiment *e* is the users' entry to the system when they choose the priority of the experiments in order 1, 2, 3 ... n where a lower number indicates higher preference. The *cost c(u, e)* is then based upon the priority, depending upon the users' condition in the system compared to others. The user-experiment relationship may be valued as follows:

1. Polynomial: The costs may be assigned in quadratic or following a polynomial function for e.g.

$$c(u, e_i) = f(i(u, e)) \quad \ldots(1)$$

where *i(u, e)* is the priority value of the choice value that ultimately determines the value of the cost *c(u, e)*. *i(u, e)* is a subset of the natural numbers 1, 2, 3, ..., n.

This gives different levels of priority to user-experiment relations and makes important experiments more important than the others compared to the linear approach. These may be related to other factors relating to assignments in the previous rounds. For e.g. if some user is unassigned in the previous round due to unavailability, others' costs may be increased compared to them, so that while minimizing this particular user gets a better chance of getting the satisfactory allocation. These will lead to *polynomial* type relations.

2. Linear: The relationships are *priced* linearly i.e.

$$c(u, e) = i(u, e) \quad \ldots(2)$$

In a linear case no consideration is given to the users' condition in the prior assignments and the cost values for assignment is equal to the current priority of the experiment for the user.

The user-experiment relationship represents the importance of the experiment to the user with respect to the users' goal in the game based learning system. This relationship may not necessarily be determined by the students themselves but could account for other factors as well.

V. MATCHING OF USER AND PROVIDERS

This section discusses how the scheduling problem in DRAL can be expressed in form of the *Terminal Assignment Problem*, its solution and ways to use it with the DRAL.

A. Formulating the TAP

The scheduling problem can be described as a Terminal assignment problem as follows:

1. There are users (or *terminals*) that are to be assigned to the experiment sessions.
2. Each user has the equal weight (q_u) of 1 that is the number of experiment they can perform in the next time period.
3. Each experiment has an average usage time t_e associated with it. The number of time the experiment can be done in the next time period T is obtained by using the providers available time d_e for an experiment as

$$a_e = \frac{d_e}{t_e} \quad \ldots(3)$$

Thus there are a_e copies of the experiment *e* that are to be assigned.

4. The total number of experiments sessions (E) comprising all experiments' sessions s, that can be performed in the next time period T is

$$E = \sum_{e=1}^{n} \frac{d_e}{t_e}$$

The total number of users that may be accommodated

$$U \leq E$$

5. The experiments (or *contractor*) are the other set of nodes to which the users are assigned to. The capacity of each experiment session (a_e) is variable.
6. The cost *c (u, e)* between each user *u* and an experiment *e* is the based on Eq1 or Eq2 which represents the preference values of the experiments for the users.

Figure 2 shows as example of the scenario with 7 users and 3 active experiments, where a_e is the number of experiment session that may be run in the next time available period. In a sample analysis, for experiment 1, let this value be 3, and for experiment 2 the value is 1 and for experiment 3 it is 5. The users u_1 to u_7 have all requested the 3 experiments with their preferred choices. Users u_1 and u_2 have chosen experiment 1 as their first choice, u_3 and u_4 have chosen experiment 3 as their first choice while users u_5, u_6 and u_7 has chosen experiment 2 as first choice. Clearly, not all of them can be assigned to their first choice experiments in the next time period T.

Solving this terminal assignment problem will assign the user with the lowest edge values i.e. the highest preference or lowest possible choice values for each users such that the

$$P = \left(min \sum_{u \in U,\ s \in E} c(u, s) \right)$$

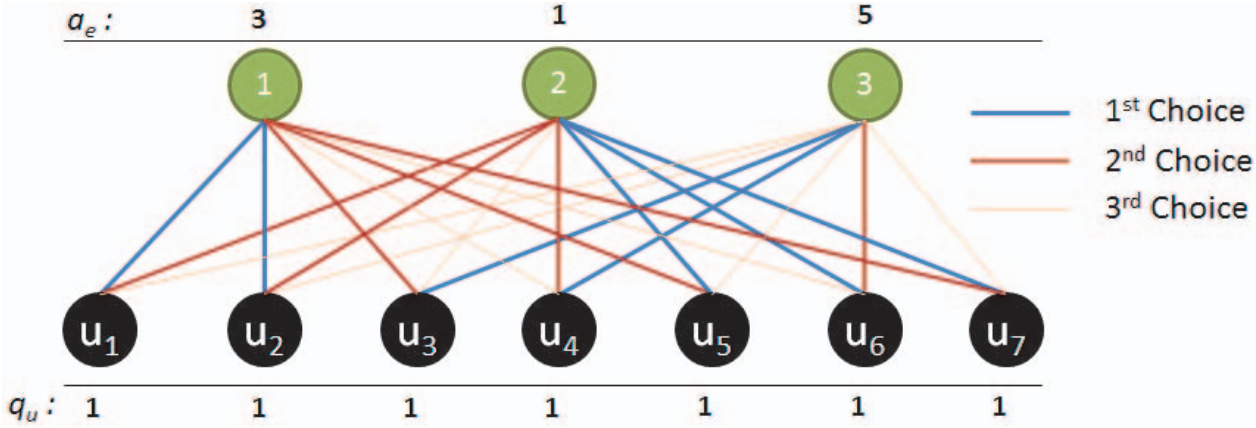

Fig. 2. An Example Scenario.

and the satisfaction score (W) is then obtained as dividing the sum of all assignments choice values (P) by the number of users (|U|),

$$W = P / |U| \quad \ldots (4)$$

The solution to the TAP will make sure that every user gets their most preferred choice as possible maintaining an optimized satisfaction level. One optimal solution to the example in fig 2 is $\{u_1, u_2, u_5\} \rightarrow e_1$, $\{u_3, u_4, u_6\} \rightarrow e_3$ *and* $\{u_7\} \rightarrow e_2$. The lesser choices for u_5 and u_6 is because, they along with u_7 opted for e_3 which is available for only one time slot during the next T.

The TAP in general terms for variable requirements weights of the *terminals* and the variable capacities of *concentrators* are *NP-Hard* problems. However, for TAP with equal weights (q_u) for all *terminals* as in this case the augmenting path algorithm can solve the problem in polynomial time an provide a correct solution [8, 14]. The TAP solution implemented is based on the algorithm described in [14]. It splits the concentrators or each experiments session into individual nodes with capacity equal to 1. The detailed discussions on the *alternating chain* algorithm are out of the scope of this paper.

B. Using the Predictor Model in DRAL

In DRAL, the global management server or the distributed P2P RLMS is responsible for executing the assignment algorithm. The duration of a time period T is taken as a week or 7 consecutive days. The scheduling is done in the follow the steps:

1. The provider enters the d_e for the experiment in the DRAL system
2. Using equation 3, the value for a_e may be obtained as per t providers wishes and the value for t_e of their experiment.
3. The provider also inputs certain lengths of time for the availability of the experiment in the week.
4. If a provider does not wish to keep their experiment online at all, then the value d_e is marked 0. The list of experiments provided to users is the experiments with non-zero d_e values.
5. The users then assign the priority or choice values *i(u, e)* from 1, 2, 3, ... n, for the available experiments.
6. After this the DRAL system does the assignment procedure and informs the user about the experiment that has been assigned.
7. The users then book a time slot from the providers list.

A specific function for determining the actual cost of each user-experiment relation $c(u, e)_t$ for a given time period t is deployed for an implementation to balance the users satisfaction (see Eq. 5). This function however may vary from system to system depending upon how the users are related to their experiment. Very important user-experiment relations, for e.g. an experiment that must be done by a user in the next Time period, may be pre-scheduled before starting to assign the experiments.

VI. Implementation and Simulation

A. Test Settings

Assuming that a rig may be created by a group of up to 5 students, let us consider there are 20 experiments. The 20 experiments are to be kept online at different rates a_e depending upon the availability and feasibility of the hosting sites. The a_e is generated as a random number between 2 and 5. The number of users is considered equal to the total number of experiment sessions ($U = E$) available. As discussed earlier, providers of an experiment are not obliged to accommodate every user that may be in the system. But, if providers are aware of the number of users in the system, they will keep the values of *de* accordingly so that $U \leq E$ always. The worst case scenario of $U = E$ is considered here.

It may be assumed that these students belong to a certain cohort, say 10th standard students from 3 schools. Each of these users are also part of a small group of peers that creates at least one of the 20 rigs and hosts it. Each student will run all the 20 experiments personally as part of their quests in the game during a year. The RAL system now must assign the users (or students) with the experiment of their best choice. Choices for any experiment for any user will be depended on their requirements regarding the *class work* or their motivation in selecting quests related to their field of interest, all of which are variable with time.

Time period (T) is considered to be a week. Hence, at least 20 weeks will be required for all students to complete each of the experiment, if all users choose unique experiments each week as their first choice. For each user, a random priority values is generated for each week in the simulation. The experiments that have already been done are not expected to be done again. Thus, these experiments have no priority at all. The priority (or choice *i(u, e)*) of each user always starts with the value of 1and then vary according to the number of experiments that has been completed. The user's cost for any experiment *e* in for the time period T is given by,

$$c(u,e)_t = (i(u,e))^{1+y} \quad \ldots (5)$$

for,

$$y = CompletedExperiments(u)_t - \min_{x \in (U - D_t)} \{CompletedExperiments(x)_t\}$$

where, *i(u, e)* is the priority of the experiment assigned to the user *u* in week *j*. *CompletedExperiment(u)*$_t$ is the number of experiments that have been completed by user *u* by week *t*. D_t is a set of users who have completed all experiments by week *t*. Note that, from Eq. 1 and Eq. 4, the choice or priority *i(u, e)* must be minimized and the lower the value of choice, the higher the actual priority of the experiment for the user.

This ensures that if a user is unassigned for a week, then all other users' costs are increased to give the unassigned user a fair chance in the next week. The costs associated with the user-experiment relationship is thus dependent on the satisfaction score (*W*) in previous rounds of experiments assignments. The user array is randomly changed in the system to simulate the different orders the users may come in to the system.

The simulation measures the satisfaction score for each week which must be low to ensure god assignments and the time taken for completing experiments. While calculating W, if an user is unassigned in week *j*, the $i(u)_j$ is assumed to be equal to n (=20) to indicate total dissatisfaction. Thus the satisfaction score for assigned users in week *t* is

$$W_A^t = \left(\sum_{a \in A} i(a)_t\right) \Big/ |A| \quad \ldots (6)$$

where $i(u)_t$ is the choice value of the experiment assigned to user u for week *t* and *A* is a set of active users who have been assigned to an experiment in week *t*, and Thus the satisfaction score for all incomplete users *(S = U - D_t)* in week *t* is

$$W_S^t = \left(\sum_{a \in S} i(a)_t\right) \Big/ |S| \quad \ldots (7)$$

For calculating W, the original choice number $i(u)_t$ is used instead of the modified cost of user-experiments relationship c(u).

B. Results

Fig 3-6 shows the results where $U = E = 74$. Fig 3 shows the a_e assigned to each of the 20 experiments. Note that the 3 experiments with $a_e = 2$ have to be done for at least 37 weeks because with the current system only two users can use them in a week.

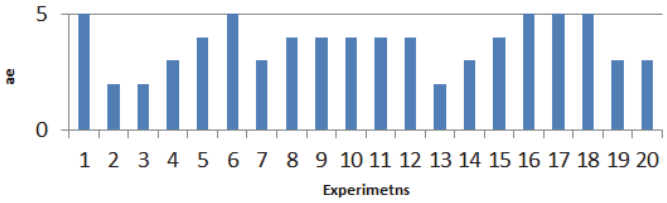

Fig. 3. The a_e set for each experiment.

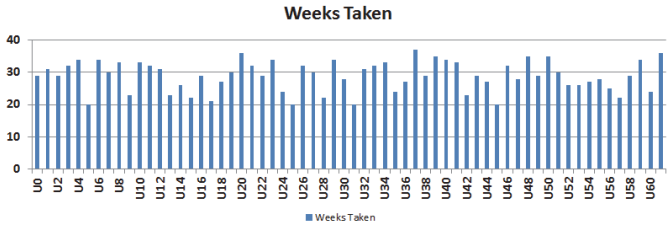

Fig. 4. The completion time of all users.

The allocation of experiments is done based on the user choices. For all users, the number of weeks taken for completing 20 experiments is between 20 to 37 weeks (as shown in Fig 4) with a mean of 26.7 weeks and a standard deviation of 5.7 weeks.

Fig 5 and 6 shows the simulated performance of the scheduling scheme. The observations can be summarised as follows:

- The number of active users i.e. the users which have been assigned to at least one experiment in the next week starts with 74 and remains so for the first few weeks after which they start to fall as experiments that are available for more slots are already done by the users and the scarcer experiments resources are now assigned as much as possible.
- Likewise the Satisfaction score (W_A for active users) is very low (< 2) for all weeks which indicates good assignments. The W_S, considering all users left ($U - D_t$) with D_t number of users having completed all the experiments, is similar to W_A for the first few weeks after which, it increases. As experiments start becoming scarcer, the algorithm makes compromises for every assignment in the smallest amount so that no one is disadvantaged. As there are more clashes of choices between the users after the initial periods, many users are unassigned for the following weeks largely increasing the values of W_S.
- The number of users completing all experiments by any given week increases since week 20.
- After week 15, the availability of required or active experiments drops drastically as shown in Fig 6. The users who still need to do experiments declines after week 20, but the number of active experiments drops earlier causing a large number of users remaining unassigned for the later weeks (> 15). The number of unassigned users again drops when experiments become more available compared to the number of users left.

- No user is assigned the same experiment more than once.

C. Future Work

This paper proposes basics extension to the single user service oriented time-reservation scheduling widely sued in RAL to a dynamic dual user version suitable for DRAL. Following are some of the ways it can be enhanced:

1. The actual time frames at which the users will access the experiments are not taken into account in the current context. It will be helpful if users could be matched with experiments keeping in view whether they can be present for the experiments provided providers and users can connect only for a fixed period of time within T.
2. The importance of the user-experiment relation is given for their own preference and any subsequent compromise in assignment that is made by assigning lower value experiment to some users. In a quest based or dynamic DRAL that employs hierarchical relations between experiments the costs of user-experiment relation could vary. For e.g., an experiment may have a series of pre-requisite experiments, which has to be completed before it. In such a case, the users have larger importance in completing a task that is a must for proceeding further experiments, making it possible to predict the number of users interested in a given experiment.

CONCLUSIONS

The paper discussed the scheduling problem in the remote access laboratory with a P2P approach where the providers have limited capabilities for hosting remote experiments. The RAL experiments are set up as a quest-based hierarchy where users interests could widely affect the experiments they would like to perform. With limited resources in a P2P setup the users must be judiciously assigned to the most required experiments. Using the proposed scheme based on the solution to *terminal assignment problem*, users are accommodated as best as possible to the experiments depending upon the user-experiment relationships.

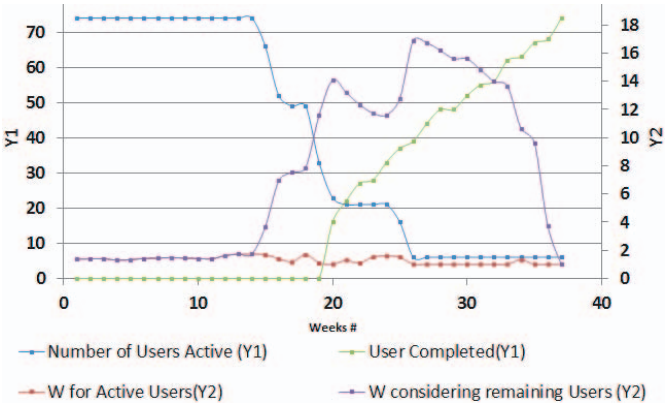

Fig. 5. The average Satisfaction Score (W) of all users in every week.

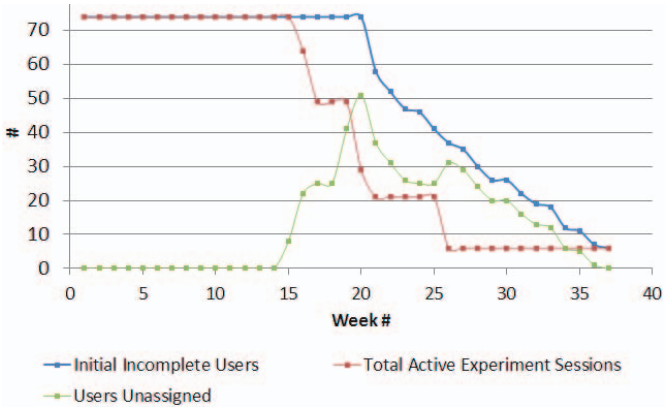

Fig. 6. The average Satisfaction Score (W) of all users in every week.

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TALE 2014 – Notification of Acceptance

From: **TALE 2014 Conference Secretariat** (tale-conference@conftool.net)
Sent: 22 October 2014 14:57PM
To: anandamaiti@live.com
Cc: anandamaiti@live.com; kist@ieee.org; andrew.maxwell@usq.edu.au

Dear Ananda Maiti,

Thank you very much once again for submitting a paper to the 2014 IEEE International Conference on Teaching, Assessment and Learning for Engineering (TALE). On behalf of the TALE 2014 Program Committee, we are pleased to inform you that your submission has been accepted for presentation at the conference, subject to the reviewers' feedback being satisfactorily addressed. The review results are appended at the end of this email.

Please begin making revisions to your paper in light of the reviewers' feedback. The final version of your paper must be uploaded to the conftool system (https://www.conftool.net/tale-conference/) no later than October 31, 23:59 NZST (UTC+12, displayed here: https://www.conftool.net/tale-conference/). At least one author must also register for the conference on or before this date in order for the paper to be included in the conference program and published in the conference proceedings and in IEEE Xplore.

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3. The abstract must be no longer than 100 words.
4. Page headers and footers must not include any information whatsoever (no page numbers, etc). They must be completely EMPTY.
5. Page margins must be set to the following dimensions: Top = 1.9 cm, Bottom: 4.29 cm, Left: 1.29 cm, Right: 1.29 cm.
6. Paper size must be A4, not Letter or anything else
7. You are required to upload both MS-Word and PDF versions of your final paper to the conftool system. To reiterate, the Word template available on the conference website must be used; the PDF version of your paper should be generated from the Word version. "Reverse engineering" of the Word version from the PDF version is not acceptable.
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Congratulations on the acceptance of your paper! Should you have any additional questions, please feel free to contact us. We look forward to seeing you in New Zealand in December.

Yours sincerely,

Henry Chan
Ford Lumban Gaol
TALE 2014 Technical Program Co-Chairs

Dale Carnegie
TALE 2014 General Chair

Craig Watterson
TALE 2014 General Co-Chair

Russ Meier
Steering Committee Chair

CONTRIBUTION DETAILS

ID: 54
Title: Time Scheduling in a Peer-to-Peer Remote Access Laboratory for STEM Education

REVIEW RESULT OF THE PROGRAM COMMITTEE:
This contribution has been accepted.

OVERVIEW OF REVIEWS

Review 1
========

Contribution of the submission

The paper describes a new and sophisticated scheduling method for granting students access to limited online resouces for practicing/performing experiments in virtual labs.In contrast to simple and widely used approaches the needs of the students are taken into account leading to better results compared to simple time slot booking or queueing.

Evaluation of the contribution

Quality of Content (10%): 8
Significance (10%): 10
Originality (10%): 8
Thematic Relevance (10%): 10
Presentation (10%): 8
Overall Recommendation (50%): 9
Total points (out of 10) : 8.9

Comments for the authors

The presented approach allows to efficiently use the available resources, can cope with varying an unpredictable amounts of resources and keeps the student motivation high by considering their needs. Besides the application for remote virtual labs I could imagine to extend the ideas to other situations e.g. outside of education.

-=-=-=-=-=-=-=-=-=-=-

Review 2
========

Contribution of the submission

A new algorithm for organizing access to a virtual lab.

Evaluation of the contribution

Quality of Content (10%): 2
Significance (10%): 4
Originality (10%): 6
Thematic Relevance (10%): 0
Presentation (10%): 8
Overall Recommendation (50%): 2
Total points (out of 10) : 3

Comments for the authors

Improved access to a virtual lab does not involve the improvement of teaching or learning, only solves an organizational problem in particular cases.

-=-=-=-=-=-=-=-=-=-=-

Review 3
========

Contribution of the submission

This paper describes and evaluates a scheduling scheme based on time-slotting suitable for Distributed Remote Access Laboratories,. which is very interesting since it tackles with the idea of suitably addressing learning to its learner.
The idea seems quite new and is very well described. The simulated results presented are very promising.

Evaluation of the contribution

Quality of Content (10%): 10
Significance (10%): 8
Originality (10%): 6
Thematic Relevance (10%): 10
Presentation (10%): 10
Overall Recommendation (50%): 9
Total points (out of 10) : 8.9

Comments for the authors

The paper is very clear and well written. The work described is of major interest for this conference.

-=-=-=-=-=-=-=-=-=-=-

Review 4
========

Contribution of the submission

This contribution describes the scheduling problem in the remote access laboratory with a P2P approach where the providers have limited capabilities for hosting remote experiments. the main contribution is the proposal of a method based on the solution to terminal assignment problem. In this method the users allocation is performed considering the user-experiment relationships.

Evaluation of the contribution

Quality of Content (10%): 6
Significance (10%): 8
Originality (10%): 6
Thematic Relevance (10%): 8
Presentation (10%): 8
Overall Recommendation (50%): 8
Total points (out of 10) : 7.6

Comments for the authors

The quality of this contribution is good and I recommend its acceptance. The contribution would be excellent if it included results on real cases of use and not just simulated.
Just a suggestion to change; the STEM acronym for first time on page 1 (Section I), but its meaning is explained on page 3 (Section III).

-=-=-=-=-=-=-=-=-=-=-

Review 5
========

Contribution of the submission

The contribution addresses the scheduling problem in remote access labs by means of flexible shared experiments between users. In comparison to other methodologies, such as time slotting, the proposed queuing allows users with P2P limited resources to perform the experiments in an optimal way.

Evaluation of the contribution

Quality of Content (10%): 8
Significance (10%): 8
Originality (10%): 6
Thematic Relevance (10%): 6
Presentation (10%): 6
Overall Recommendation (50%): 8
Total points (out of 10) : 7.4

Comments for the authors

This paper is a proper contribution to this congress. However, it has been written in such a way so I encountered many problems in understanding. From the beginning, the objectives are quite clear, which is nice, but the authors keep repeating the pros and cons of each approach in every subtitle, which makes the reading a bit tedious.

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