Course Assignment in Asian-Mind Learning Broadcast Channel

Meng-Huang Lee, Li-Hua Huang and He-Rong Zhong

Shih-Chien University, Taipei, Taiwan

*e-mail:meng@mail.usc.edu.tw

Abstract

Based on our previous distributed E-learning platform, Asian-Mind, this paper presents the course assignment in Asian-Mind’s learning broadcast channel for the distance learning courses of Shih-Chien University, Taipei Campus. The popular courses are allocated to the broadcast channel with more broadcast time. The others are still remained the uni- cast on-demand service. The broadcast channel can serve the student’s accesses at university campus or at their homes with the university ADSL pay service. And from the workload analysis, this approach can get the merit of bandwidth sharing for the most popular courses.

1. Introduction

Recently, there are many web-based E-learning platforms proposed [7]. Although there are many improvements in the network bandwidth and storage capacity, but for a successful E-learning system (it should provide a lot of learning courses and allow a lot of learners accessing the system), system resource (storage capacity and network bandwidth) is still a major problem.

In our previous work, Asian-Mind [7], we implemented a system resource management mechanism (content caching to the local site nearby the learners and admission control for learner accesses) in the distributed web-based E-Learning platform to explore the tradeoff the storage cost and network bandwidth cost [1,2,3]. For good quality of content accessing, the continuous media course contents are distributed to the course content servers which are closer to the learners according to the course content access popularity. And for guaranteeing the learning quality, learning accesses are admitted by the admission control mechanism in Asian-Mind. Asian-Mind is successfully used as the network learning platform in the two campuses (Taipei campus and KaoHSiung campus) of Shih-Chien University, Fu-Jen University, and HiNet (the largest Internet provider in Taiwan). Twenty-four E-learning courses are available.

But as the number of students enrolled in the distance learning system increases, the network and server loading are increasing with traditional uni-cast course-on-demand service. Therefore, in Asian-Mind, we provide broadcast channel scheme for the distance learning courses of Shih-Chien University, Taipei Campus, and assign the course contents to the channel according to their popularities.

One of the major advantages of broadcast scheme is that it can deliver course content in a fixed and predefined schedule and consumes constant bandwidth regardless of hundreds or thousands of learners for the course content, especially for the “hot” course content [6]. If the system workload is heavy, we can get more bandwidth sharing merit from the broadcast scheme [5,6]. Therefore, in Section 2, we will analyze the workload of the Asian-Mind, and show that we can get the bandwidth sharing merit by the broadcast scheme. For a learning system, it should not only provide the learning service at anytime, but also at any-place. In Section 3, we will describe the deploy architecture of the broadcast channel that meet the any-place criteria. The next issue for the broadcast scheme is how the courses are assigned to the channel. The basic concept of our assignment algorithm is if a course is popular, then more broadcast time should be allocated to this course content. In Section 4, we will present our assignment algorithm. Finally, conclusions and discussions are given in Section 5.

2. The workload analysis of Asian-Mind

In the semester of Spring 2003, Shih-Chien University, Taipei Campus, provides 4 distance learning courses. They are “knowledge-based economics”, “recreation, sports and life”, “interactive multimedia network”, and “multimedia system”. The number of enrollment of these four courses is listed in Table 1. And the access log of the 4 courses is listed in Table 2. The average course duration is about one and a half hours. The video quality is about 100 kbps (bits per second). We define a broadcast time slice in the broadcast channel is the duration of playing one course content unit. The value in the system is one and a half hours.

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Take the access workload of March 2003 for example (in Table 2). If the system adopts uni-cast course-on-demand service, the average number of access request will be 5.56 in a broadcast time slice (there are 20 week days in March 2003 and 16 broadcast time slices in a week day). That is, in average, there are 5.56 access requests concurrently, and the system requires 556kbps bandwidth. But if we deploy 2 broadcast channels (200kbps in all) for the most popular course contents, and other course contents are still remained as uni-cast on-demand service. As the example analyzed in Section 4, these 2 broadcast channels can accommodate about 93% of access requests. Then, in average, one more access request bandwidth can enough accommodate all the other’s uni-cast on-demand service. This shows that the system can get the bandwidth sharing merit by the broadcast scheme.

3. The deploy architecture of the learning broadcast channel

For a learning system, it should not only provide the learning service at anytime, but also any-place. The students may access the system when they are at university campus or when they are at home. Providing the broadcast channel at university campus is possible but how to provide the service to the student’s homes is a major problem. Most broadband network services for the home users are the ADSL or cable modem provided by telecom company or cable system company. Shih-Chien University (Taipei Campus) is in cooperation with Chungwa Telecom company and provides the ADSL pay service for the student’s home users. Students can apply the service. The architecture of the network service is as in Figure 1. From Figure 1, Shih-Chien University (Taipei Campus) plays the role of a small ISP (Internet service provider), and integrates the campus network and student’s home network as a whole network. There are about 7,000 students in Shih-Chien University, Taipei Campus. The university dormitory can accommodate 1,000 students, and the maximum number of ADSL pay service provided by the university is 5,000. And the campus computer rooms are opened from 8:00 A.M. to 10:00 P.M. Therefore, the learning broadcast channel not only can provide the service for the student’s accesses at university campus, but also at their homes.

4. The course content assignment in the learning broadcast channel

The most important issue to provide the learning broadcast channel is how the courses are allocated to the channel. As described in the previous sections, popular courses are allocated more broadcast time. From our one year’ access log study, we find that, for the course contents, the access behavior is highly historical access frequency and highly predictable. The characteristics of course contents are highly dependent on each other. For example, for accessing chapter 3 content, the students, for the most part, had accessed chapter 2 content. And in a short period of time, they are predicted to access chapter 4 content. Take the access log of course “interactive multimedia network” (in Figure 2) for example. As the week-time progress, the peak population of course content is from one course content to the other then to another in sequence (this result is mainly up to the instructor’s homework assignment every week). Therefore, the access population of course contents is highly historical and predictable, and is not as the studies by the traditional video-on-demand researches which the video programs are basically individually independent [1,2,3]. In their studies, the “hot” contents are defined by the most accessed population and most system resources are allocated by the traditional way.

But in Asian-Mind, the historical and predictable characteristics of course content are considered. From Figure 2 observations, for a course C with M contents, C1, C2, ……CM. If this week’s most top peak population course content is C(n), then in next week, by the course progress predictable characteristics, the peak population course content will be C(n+1), the second peak population will be C(n) for some brushup review accesses), the third will be C(n+2) (for some students may take the leading in learning progress), the fourth will be C(n+3), etc. Then the course content population sequence from top to least in the next week will be

C(n+1), C(n), C(n+2), C(n+3), ………

Many researches adopt Zipf’s law distribution to characterize the content population [4]. Zipf’s law states that the probability of the n th most popular of M movies is

\[ C/n \]

\[ C = 1/(1+1/2+1/3+……….+1/M) \]

For example, using this distribution, the 5 th most popular movie is requested the fifth as often as the most popular movie.

But from our experience in Figure 2, the distribution is so centralized that it can not be characterized by Zipf’s law which population distribution characteristics is much more even. Therefore, we adopt the distribution function proposed in [3].

\[ P(k) = \frac{(1-\alpha)}{a^k / \alpha(1-a^N)} , k=1,2……..M \]

\[ P(k) = aP(k-1) , 0<\alpha<1 \]

According to system access log, we can adjust \( \alpha \) to characterize the system population distribution. If \( \alpha \) is smaller, the distribution is more centralized. In our system, we choose 0.3 as the value.

Assume there are S time slices in the learning broadcasting system, Let A(k) be the number of broadcast time slices
allocated to the \( k \)th most popular course content. Then the number of broadcast time slices allocation procedure is as follows:

Initially, \( k=0; \)

While( \( S \geq 0 \) ) {
    \( A(k) = \text{INTEGER}(S \times P(k)) \);
    \( S=S-A(k); \)
    \( k++; \)
}

For the course contents that are not assigned into the broadcast channel by the above procedure, they are all remained the traditional uni-cast on-demand service.

In Asian-Mind, we provide 2 learning broadcast channels (each is 100kbps) for the four distance learning courses of Shih-Chien University, Taipei Campus. We choose one and a half hours as the course unit duration (that is the same duration of a broadcast time slice). For the 3 hour credit courses, the learning progress per week is 2 course units. As for the 2 hour credit courses, the course unit duration is about one and a half hours, and the learning progress per week is 1 course unit. Therefore, the learning broadcast channel is divided by the time slice of one and a half hours period. Then, in each weekday, there are 16 broadcast time slices per channel, and 32 broadcast times slices in the two channels. According to the assignment procedure described above, take the course of week 3 of the semester Spring 2003 for example, in a weekday’s broadcast service, 23 broadcast time slices are allocated to the course units of week 3 of the four courses, 7 broadcast time slices to the course units of previous week (week 2), and 2 broadcast time slices to the course units of next week (week 4). The others are remained the uni-cast on-demand service.

5. Conclusions and Discussions

This paper presents the course assignment in Asian-Mind’s learning broadcast channel. The popular courses are allocated to the broadcast channel with more broadcast time. The others are still remained the uni-cast on-demand service. The broadcast channel can serve the student’s accesses at university campus or at their homes by the university ADSL pay service. And from the workload analysis, this approach can get the merit of bandwidth sharing for the most popular course contents.

According to our experiences, the access workload distribution is highly dependent on instructor’s requisition. For all these four courses, home-works are given every week, and the access log will be as the reference of class participation. Therefore, the access distribution is most centralized.

The most interesting observation is that the historical and predictable characteristics of the course contents. The most popular course content can be highly predictable by the learning progress, especially the learning progress is time-tabled and requisitioned by instructors. This characteristic gives more information in advance for the system resource allocation design.

References


Figure 1. The network architecture of Shih-Chien University, Taipei Campus and its ADSL pay service

<table>
<thead>
<tr>
<th>Course name</th>
<th>Knowledge-based Economics (3 credit hour course)</th>
<th>Recreation, sports, and life (2 credit hour course)</th>
<th>Multimedia System (3 credit hour course)</th>
<th>Interactive multimedia network (3 credit hour course)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of enrolled students</td>
<td>67</td>
<td>50</td>
<td>68</td>
<td>59</td>
</tr>
</tbody>
</table>

Table 1. Number of enrolled students of the four Shih-Chien University(Taipei Campus) distance learning courses of Asian-Mind
<table>
<thead>
<tr>
<th>Course name</th>
<th>Knowledge-based Economics</th>
<th>Recreation, sports, and life</th>
<th>Multimedia system</th>
<th>Interactive multimedia network</th>
</tr>
</thead>
<tbody>
<tr>
<td>March 2003</td>
<td>586</td>
<td>171</td>
<td>521</td>
<td>503</td>
</tr>
<tr>
<td>April 2003</td>
<td>571</td>
<td>196</td>
<td>502</td>
<td>518</td>
</tr>
</tbody>
</table>

Table 2. Log of number of access requests of the four Shih-Chien University (Taipei Campus) distance learning courses of Asian-Mind

Note: We choose one and a half hours as the course unit duration (that is the same duration of a broadcast time slice). For the 3 hour credit courses, the learning progress per week is 2 course units. As for the 2 hour credit courses, the learning progress per week is 1 course unit.

![Access workload of course "Interactive Multimedia Network"

Figure 2. Access workload of course “Interactive Multimedia Network"