Adaptable Architecture for Mobile Learning

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Abstract: With advent of mobile technology and its huge popularity, mobile devices can serve as ideal tools for learning. Also the fact that they are easier to carry as compared to laptops have made mobiles a popular medium. Nevertheless the need to adapt the already existing e-learning architecture to this changing paradigm of mobile learning is challenging considering limited resources of mobile devices. This paper proposes architecture for mobile learning where context discovery, adaptation and synchronization services have to be introduced for seamless delivery of content to mobile devices in changing communication environment of the user.

Keywords: - m-learning, mobile architecture, content adaptation, e-learning, context discovery

1 Introduction

Aim of mobile learning is to access knowledge anytime anywhere offering flexibility to users or learners in terms of time and location. Mobile learning generally referred to laptop computers originally. But with increasing popularity of mobile devices like PDA, smart phones has added a new dimension to the mode of e-learning. The probability of a user carrying a mobile phone with him is more than that of a laptop, which makes mobile phone a ideal way “to be in touch”.[6]

Issues in mobile learning environment are:

- Users are dispersed geographically.
- Constant mobility between users. The environment in which these users work keeps on changing constantly.
- Mobile device have constraints such as limited battery life, small display screen, cumbersome navigation interface, limited memory, network quality functionality constraints etc.[8]
- A user will be motivated to learn only when the access to information is fast and he is not put off by difficult navigation. Also the number of transactions to achieve a particular task must be minimal.

2 Aspects of M-learning

The wireless technologies of the mobile revolution have seen the worldwide proliferation of wireless communication devices. The idea behind m-learning is that it allows on-the-go professionals to connect to training courses anytime and anywhere. M-learning can include anything from job aids and courseware downloaded on personal digital assistant to Net-based, instructor facilitated training via laptops and mobile phones[1].

The following are major aspects in the paradigm shift from e-learning to m-learning which help us to identify the requirements for designing the architecture:

1 Knowledge dissemination change:-
- From mainly text based and graphic based of e-learning to highly graphical, voice and animated instructional style.
- From static classroom learning with internet to on- the - move learning environment.

2 Communication:-
- From asynchronous, time delayed notification through emails and web site updates to instant notification via sms.
• From passive to active communication where response is generally interactive and spontaneous.
• From face-to-face communication to flexible communication with respect to time.
• From Email to email to anytime communication. Wired to wireless connectivity hence no geographical restriction.
• From being dedicated to certain timings to flexible 24/7 timings.
• From inhibited learning due to group consciousness to inhibition free learning.

3 Feed back to students:
• From mass based standardization to customized feedback.
• Bench mark Based grading to performance and improvement based grading.
• Standard to individualized test.
• Delayed feedback to instantaneous feedback.

3 Architecture for m-learning

3.1 Learning objects database:
Here the actual content is kept in this layer. This layer can house the entire learning objects or these objects can be distributed at different locations. In such cases issues like replication, consistency have to be addressed.

3.2 E-layer services
This contains various services pertaining to e-learning such as library service, fees service, administration service, content service. The users of these services are mainly students. The service layer serves as the interaction point between the student and instructor where the student is connected to a wired network via a desktop or laptop with more resources like memory, processing power and battery life.

3.3 The mobile layer or M-layer:
The limitations of mobile devices pose constraints when it comes to disseminating content. Most web pages are designed for computer screens with 800 x 600 resolutions. This makes the content delivery on small devices illegible and not easily navigable. Hence it is necessary to have a context aware layer that will format the content depending on the device parameters. Transcoding techniques where transformation from one presentation language to another is done, but interaction is difficult to achieve. This layer takes care of hiding different details of different physical methods of context detection. Here context means identification of user, spatial, temporal information, environmental sources (noise), availability of resources such as battery, display, network, bandwidth etc. [2][3][5]

3.3.1 Content Management and adaptation.
The content adaptation service includes the adaptation of structure, adaptation of media (audio, video, data) format, quality of service of the content to be delivered. Once the user is logged to the system the content presented to him must be of good quality. The content can be broken down into semantically related blocks. The granularity of the block can depend on the student’s level where smaller content can be delivered in a block. For an advanced learner of a particular course a semantically advanced block can be delivered. This can be achieved by placing the content blocks as nodes of a tree and performing tree pruning in order to deliver optimally related content at a time. Therefore there is a need to keep user profile and the user preferences. The user on the mobile device must be able to clip whatever information he does.

Figure 2: Proposed architecture.
The limited memory and screen size of a mobile device are major constraints in readability of content on mobile devices such as PDA and smart phones.
not need. This necessitates the need for editing and authoring tools. The learning objects will be delivered accordingly. This scheme is useful when the user goes into a disconnected mode or has limited battery power. Content adaptation can be content-to-content correlated, for example content for particular concept is requested then other content based on same concept can be recommended. The author of the content can tag and recommend certain contents.

3.3.2 Synchronization service.
This service takes care of keeping the content and user preferences coherent and synchronized whenever the user was offline. This is necessary feedback which helps to understand user preferences and plan delivery of next chunk of content bloc in an optimal way.

3.3.3 Context discovery service
Different user use different devices and are mobile, hence the user environment changes with respect to time and location as well as network. The user can be connected to network or disconnected and again reconnected. Hence there is a need to incorporate these changing parameters of the mobile environment in order to ensure that a user can use the services without many problems. The context discovery layer discovers the context of the user and determines the adaptation level of content delivery.

For example if a user connected in his office via wired internet leaves his office for home, the system will switch to GPRS and the content will be formatted accordingly and vice versa when he reaches home wherein he will be connected to wired internet. This entire handover will be transparent to the user.

Also if the user is situated in a crowded place such as bus, railway station the context service will gauge the parameters accordingly which will be notified to the content adaptation layer and appropriate action will be taken while delivering the content such as high animation and video quality with low audio signals. The learner or user can now visualize content rather than depending more on audio.

Also if the power parameter is below a certain threshold, then the either audio or video quality of content delivery can be compromised.

The context discovery has following components:-
- Event service.
- Message service
- Direction service.
- Location service.

The context service layer is composed of basic utility services such as logging, error cases, initializing parameters. Apache axis, which is a proven service oriented platform to develop java web services can be used. These are services that the context layer should include but not limited to:

Event service provides support for
- authenticating user, and
- keeping user profiles and preferences

Message service provides for
- Notifications consisting of device properties like memory, battery information, and communication bandwidth etc.
- Any time based notification.

The direction service will redirect the user to different servers via the e-layer to where learning objects are stored.

Location services will determine the location of the user and respond to any queries that concerns his geographic location.

When the user requests for a particular content, the HTTP request from the user will go through the M-Layer which will determine the type and make of the device. This will be stored as metadata which further will perform content adaptation and integration and will be sent back to the user via HTTP response.

The mathematical approach:-

Let X be the content, denoted by X= (V, A, T) where V is video, A is audio, T is text.

Let D1…..Dn be all types of possible devices. Let Di = (s,d,f) represent each mobile device where s is screen size, d is display and f is format of the device.

Let T be the transformation function that will receive input from the content and mobile device D and will deliver appropriate adapted content C to the device.

\[ T(X, D1) \rightarrow (C) \]

4 Challenges
The content adaptation is mostly server based (XML/XSLT, COOCOON AxKIT), proxy based (Palm Web Clipping, AvantGo) and client based (XHTML/CSS). But most of these architectures consider online access to content. Here the challenge is to enable the user to learn related blocs of content thus giving the user a feel of completeness under minimal resource circumstances. Use of heuristic algorithms can determine which content chunks can be cached into the mobile device when the user could go offline as determined by the parameters in the context discovery service and also user preferences which could predict what content he might need next. Also user navigation should not be complex so that the user is put off by it. An easy and neat GUI must be designed, which would complete the task with minimum keystrokes etc.

Security is one aspect which has to be addressed with due importance since it involves payment of fees, test grades. The developers of the design must consider this aspect during its development life cycle.

The design of the proposed architecture is under implementation. Optimizing the design will be an on going effort. A Java based Web application on .NET Framework for a target device such as PDA or Iphone which are rich in multimedia support will be developed.

5 Conclusion

This paper suggests the need for an optimized architecture, where the aim of learning knowledge irrespective of time and space constraints has to be achieved. Enabling people of different ages and classes must be able to access knowledge at any point of time seamlessly. The design should help in enriching the user experience. Here, a layer to adapt to mobile environment is introduced which will adapt to the changing environment of the users. This layer will customize the content delivered to the mobile device depending on the certain device and user parameters.

References:


