System Model for t-learning Application Based on Home Servers (PDR)

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1. Introduction

Although there has been considerable development in e-learning through the Internet, digital TV also presents an opportunity for learning in the home. With the introduction of interactive digital TV and the TV-Anytime application, the opportunities for learning in the home will grow. As the number of learning materials is growing exponentially, there will be a need to:

- facilitate searches, selection, acquisition, and use of educational contents gotten through the Internet or traditional TV broadcasting
- facilitate the sharing and exchange of educational resources
- enable educational content and learner information to be shared
- ensure that educational content can be reused.

Thus, we should have educational metadata and define a potential scenario by which educational material can be targeted to groups of users based on aggregated profile data at the head-end and/or content can be broadcast and intelligent profiling agents at the (PDR) level capture and store content of specific interest to individual users.

The term "t-learning" has been taken as meaning TV-based interactive learning [1]. In other words, t-learning is an interactive digital TV means for increasing learning opportunities in the home. Although the phrase "e-learning" is used for learning via the Internet using a personal computer, with the convergence of the Internet and traditional broadcasting in the form of home server technology, t-learning will be a subset of e-learning and we can consider that t-learning refers to the offering of e-learning services using digital TV technologies. Moreover, t-learning's objective is to create digital TV metadata for educational purposes.

2. Educational metadata for TV

Educational metadata are specifications that are designed to facilitate the description, packaging, and delivery of educational content. Their purpose is to facilitate searches, evaluation, acquisition, and use of educational resources, for instance by learners or instructors or even by automated software processes.

Some learning metadata specifications have been created for e-learning to assist with description and discovery of educational resources, such as IEEE LOM, Dublin Core, and SCORM. Figure 1 shows the relative scope of these specifications.

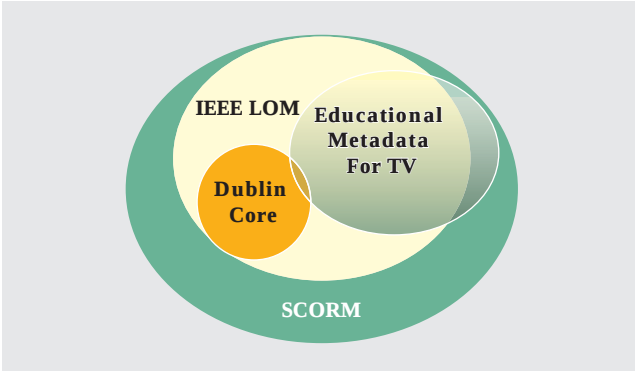

Figure 1: Schematic diagram showing the relative scope of some learning metadata specifications

Broadcasters/content providers need to customize existing specifications to their needs in using digital TV technologies.

Educational metadata for TV is descriptive information about any kind of audiovisual educational resource for the purpose of finding, managing, and using such resources more effectively.

The IEEE Learning Object Metadata (LOM) is the standard for learning object metadata approved by the IEEE Standards Board. This standard specifies a conceptual data schema that defines the structure of a metadata instance for a learning object. For this standard, a learning object is defined as any entity -digital or non-digital- that may be used for learning, education or training [2].

Dublin Core Metadata is used in the development of education-specific elements, education qualifiers, and value qualifiers to be used to describe educational materials for the purpose of enhancing resource discovery. The Dublin Core is a metadata specification for the content of digital libraries, museums, etc. [3].

SCORM (Sharable Content Object Reference Model) is a reference model, and it is designed to support interoperability for learning metadata technology. SCORM has consolidated the work of all the different standards organizations into a common and usable reference model. SCORM is a unified set of core specifications and standards

for e-Learning content, technologies, and services. Today, these various specifications and standards bodies are collaborating on SCORM, both in its current and future forms [4].

SCORM will be the future standard for learning (e-, m-, or t-learning), because its specifications have been taken from the major standards organizations and have been widely implemented and it is designed to support interoperability for learning metadata technology.

3. System model for t-learning application based on home servers (PDR)

In our t-learning model, we assume that the broadcasting system is a unidirectional network and educational metadata is created and pushed to the PDR. In the home, the user submits his/her education category, the level or classification, educational type (movie, simulation, exam...), language, age, occupation, and other information. The PDR creates an XML schema according to the user profile and preferences. When the PDR receives educational metadata from the broadcaster or content provider, it matches the data with the user profile and selects the proper content.

4. Filtering and retrieval system

The abundance of educational content precipitates a need for "filters" to help users obtain programs that they really want to watch. Filtering is designed to assist the PDR by adapting to the users' personal preferences. For the purpose of interoperability, educational metadata and the user profile are both represented in XML.

To ensure that there is a proper filtering and retrieval system, we can use an adaptive algorithm to get content according to the user profile. In this manner, within the user's profile, there will be terms that indicate his or her interests. The terms have individual weights and orders.

A simple example of the user profile metadata is shown below:

```
<?xml version="1.0" encoding="UTF-8"?>
<UserEducationalPreference>
    <Name>John</Name>
    <Age>11</Age>
    <Language>English</Language>
    <Occupation>Student</Occupation>
    <Category>English language</Category>
    <Level>Elementary</Level>
    <EducationType>Lecture</EducationType>
    <AppropriateFormat>Video
    </AppropriateFormat>
</UserEducationalPreference>
```

We define each term as a 2-tuple (term, weight). The weights and orders describe the relative importance of the terms in the profile; e.g., for the previous example, we have:
(Category, 4.2), (Language, 3.7),(Level, 3.1),
(EducationalType, 2.8), (Occupation, 2.3),
(AppropateFormat, 1.6), (Age, 1.2).

The user's profile can be represented as a vector:
$p = (w_1, w_2, w_3, ...w_n)$

The profile example can be represented as

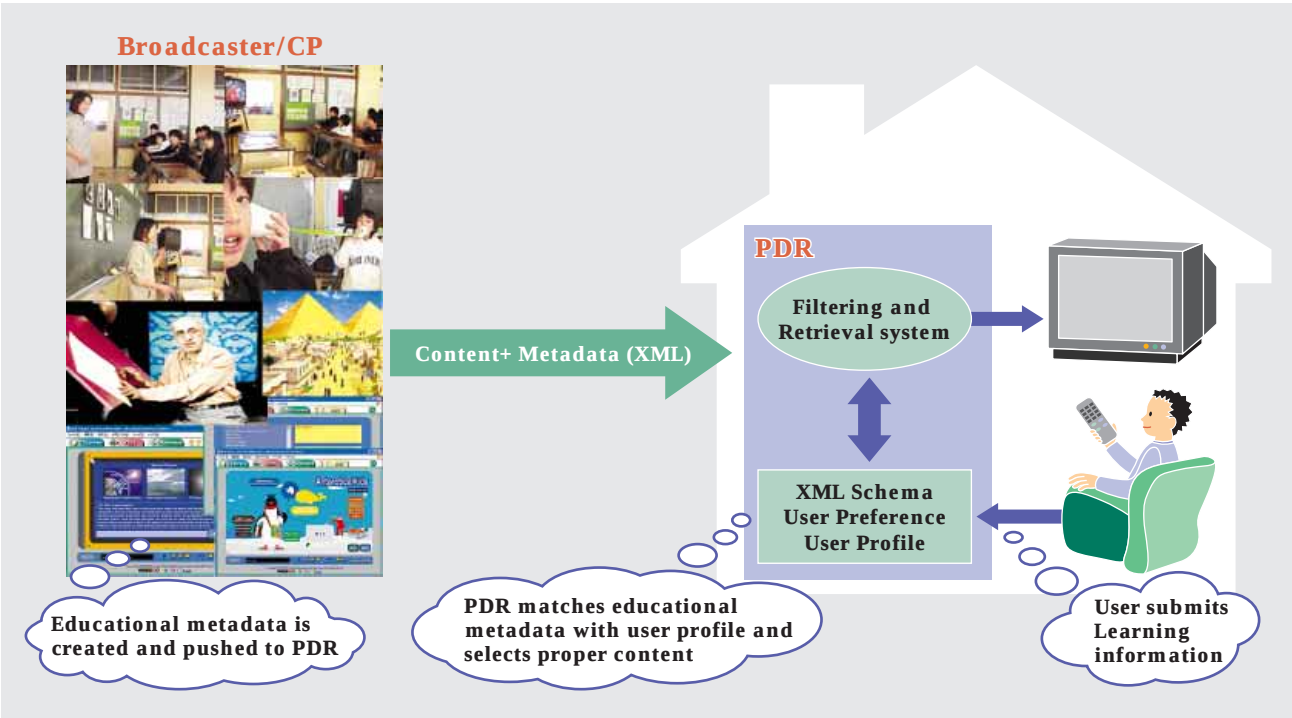

Figure 2: System model for t-learning application based on home servers (PDR)

P= (4.2, 3.7, 3.1, 2.8, 2.3, 1.6, 1.2). Similarly, content can be also represented as a vector, with C= (c_1, c_2, c_3, ...c_n). The interpretation of the content vector is as follows: c_i =1 indicates that the t_i's in the profile metadata and in the educational metadata field are the same and c_i =0 indicates that the t_i's in the profile metadata and in the educational metadata field aren't the same.

Consider a simple example of educational metadata attached to content as follows:

```
<?xml version="1.0" encoding="UTF-8"?>
<EducationalMetadata
xmlns:xsi="http://www.w3.org/2001/XMLSchema-
instance" >
    <GeneralInformation>
        <Title>English skill with reading</Title>
        <Description>English skill with reading
          will help students learn and apply the
          basic principles of effective
          composition</Description>
        <Category>English language
          learning</Category>
        <Language>English</Language>
        <Version>Fifth edition</Version>
        <Duration>45 minutes</Duration>
        <AgeRange>15-20 years
          old</AgeRange>
        <Keywords>English, language, reading
          skills </Keywords>
        <Level>Collogue level </Level>
    </GeneralInformation>
    <TechnicalInformation>
        <Format>Video, audio, text</Format>
        <IntendedCourse>students- special
          learner</IntendedCourse>
        <EducationalType>Lecture,
          exercise</EducationalType>
        <Classification>Level 3
          intermediate</Classification>
        <AggregationLevel>lesson
        </AggregationLevel>
        <Prerequisite>Intermediate
          graduated</Prerequisite>
          <Relation>English lessons,
            grammar</Relation>
    </TechnicalInformation>
</EducationalMetadata>
```

Here, the C vector according to the profile and this content is C=(*1,1,0,1,1,1,0*). We can measure the similarity between P and C by using the equation:

$$Similarity\ (P,C) = \frac{\sum_{i=1}^{n} w_i c_i}{\sum_{i=1}^{n} w_i}$$

For computational reasons, we can take the weights of the n highest weighted terms to represent the user's preferences. For the previous example, n=7 , so the *similarity* is calculated as:

Similarly = 0.7725

Personalization can be achieved through two processes:

Explicit: the user directly defines numerical values reflecting his interest in the data elements.

Implicit: the user profile is automatically updated based on the selection of items made by the user. The user can rely on the automatic selection of stories based on his current profile, or change this selection, for example, to add materials corresponding to new topics of interest.

Thus, it becomes possible to define a process for calculating the weights of terms in a user profile. For example, the ratio of user's actual watching time to the content's total duration is significant.

5. Instance educational metadata for TV

Educational metadata is created to describe of any kind of audiovisual educational content gotten through the Internet or traditional TV broadcasting. In this manner, we define two kinds of data related to educational content:

General Information describes the educational content as a whole. This information consists of:

- Title: A name given to the educational content.
- Description: A textual description of the educational content.
- Category: A group of educational and pedagogic characteristics.
- Language: The language of the content.
- Version: The edition of the educational program.
- Duration: The time for continuous education content to be displayed.
- AgeRange: The age of the typical intended user, e.g. 5-9, 15-20, adults.
- Keywords: Keywords or phrases describing the topic of the educational program.
- Level: A general standard of education.

Technical Information that describes requirements and technical characteristics of the educational content. This information consists of:

- Format: identifies educational content such as video, audio, application, and text.
- Requirement: The technical capabilities needed for using the educational content.
- IntendedUser: The principal users of the educational content, i.e., students, teachers, managers, special learners, and so on.
- EducationalType: The specific type of content: exercise, simulation, exam, narrative text, experiment, self assessment, lecture, etc.
- Classification: classifies the educational content as to where it falls within a special classification system.
- Aggregation Level: The functional granularity of the educational content such as: raw media data, lesson, course and set of course.
- Prerequisite: Education that is necessary before using

the educational content.

- Relation: describes the relationship between the educational content with other educational materials
- Right: describes the intellectual property rights and conditions of the educational content that should be defined for determining cost, copyright, and other restrictions.
- Properties: People or organizations who create, publish, edit, and design content, e.g., authors, publishers, editors, graphic designers, etc.

6. Conclusions

-We can increase the opportunities for learning in the home by using a t-learning application based on home server technology and a Personal Digital Recorder (PDR).
- It's possible to access audiovisual educational contents through the Internet and traditional broadcasting networks by using XML for educational metadata and t-learning.
- One has to define specifications for educational materials through the digital interactive television.
- Educational content and metadata can be pushed to the PDR and targeted to groups of users based on profile data.
- To ensure a proper filtering and retrieval system, we can use an adaptive algorithm to get the content according to the user's profile.

Acknowledgments

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I began my research at NHK STRL in the Recording Technology and Mechanical Engineering department last September under the "NHK Science & Technical Research Award for ABU Engineers". This research will be of help for broadcasters to define and use the educational metadata for their needs in using digital TV. This research consists of a proposal on educational metadata for TV learning materials and describes a system model for a t-learning application based on home servers (PDR). In this model, the broadcasting system is a unidirectional network and educational metadata is created and pushed to the PDR. Moreover, this research introduced a filtering and retrieval system to assist the PDR to get the proper content according to the user's profile by adapting the metadata attached to the content with the personal preferences. This experience has helped me to develop my knowledge and it has led to an opportunity for me to participate in the TV-Anytime Forum 25th meeting in Kobe.

It has been very enjoyable to work in NHK STRL and I am impressed with the kindness of the Japanese people who made my family homestay in Japan so pleasant. I am very thankful to all my colleagues for their help and support.