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An Adaptation Technique for Multimedia Applications Based On the User Context to Manage the Service Quality

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Abstract-Currently, the adaptation of multimedia applications is necessary, because documents can be accessed at anytime and anywhere with a wide variety of devices, such as PDAs, laptops and tablets. Unfortunately, in most applications dedicated to this type of problem, are essentially based on the heterogeneity of the data (image, sound, text, video and encoding format for each type), related to a user context, the context of terminal and network receiver and transmitter. In this paper. We propose an architecture on-the-fly adaptation of multimedia documents. More precisely, we propose a procedure that selects the relevant adaptation policies to build a document adapted to ensure quality of service and to consider the limits users (physical handicap, preferences of users).

***Keywords*:** Quality of Service, Adaptation, selection algorithm, Multimedia document, User Context.

1. Introduction

Computer systems today are increasingly pervasive, built over heterogeneous components and offer features with complex interactions (Derdour M. ,2010). The implementation of multimedia applications is frequently made on the basis of components and services to multimedia documents to adapt to changing conditions (users, equipment). Two types of adaptation are generally considered: adaptation of multimedia objects individually and adaptation of the document structure or composition (Laborie S. et al. ,2011). Unfortunately, most of these adaptations are essentially based on the hardware and the user context do not take into account the preferences of the user. Multimedia documents must be run on many platforms (mobile phones, PDAs, ...). This mix of uses and media requires the adaptation of documents to their execution context, unpredictable at the time of design document (Laborie S.,2008). In addition, users are not all interested in the same information and do not have the same expectations, knowledge, skills or interests. They are able to understand or accept the services and documents in the organization, content, modes of interaction and presentation are tailored to their needs and profiles.

Currently, we can access to multimedia documents wherever they are with a wide variety of devices that can connect to the Web. The use of heterogeneous mobile devices let us face a large amount of new problems. One of them is the compatibility of multimedia contents with context restrictions. Actually, users' mobility and preferences, device capabilities and network connections must be considered before playing a multimedia document. The real-time on demand (i.e., on-the-fly) adaptation of multimedia documents is an interesting solution to solve the problem. Indeed, it allows transforming multimedia resources according to constraints which are related to players, codecs, resources, user languages, hardware, etc (Pham Hai Q et al.,2012).

According to (Amous I.et al.,2005) , a fair amount of adaptation architectures have been proposed and usually grouped into three main categories: (1) server-side adaptation, (2) proxy-based adaptation and (3) client-side adaptation.

The development of multimedia applications for pervasive computing presents a number of challenges for software engineering, including in particular, the adaptation of context-aware applications: adapting to the environment (location, time, condition, etc..), connectivity (flow, protocol, etc..), the limits of the device (screen, sound, etc..) and even users (physical disability, personal choice, etc..).

Taking into account all of these contextual factors is a complex task for the programmer (Lemlouma T.,2004) .

The content used in an adaptive system can be very heterogeneous. Content servers can transmit a variety of formats and feature-rich documents. Complex content can be requested by a device which has limitations of processing, display, etc. To ensure a good quality of service, the system shall be capable of transmitting and transforming this complex content to be compatible with the capabilities and preferences of the end user.

The design of an architecture that adapts multimedia content to any user of the heterogeneous web environment is a challenge. The currently proposed solutions do not address the problem of adaptation with complete architectures; they try to provide means to very specific needs such as adapting images for mobile, video transcoding, etc. These solutions are often based on how pure programming, following closed approaches and little flexible. It therefore seems important to study how to make the adjustment more open and flexible and thus cover several types within a single architecture (Lemlouma T. ,2004).

These solutions are specific and limited to some aspects of the environment (the size of the screen for resizing images, network throughput for transcoding video, etc...), It is because there is no model that takes into account all aspects of the context; represents a model for the description of terminal characteristics and user preferences to guide content adaptation process (Lemlouma T. ,2004). Consideration of the context is partial and does not take into account all the entities that can influence the process of transmission of relevant content, which is why we follow an approach to the identification of all elements of the adaptation and their characteristics, starting with the client itself and the content it may request.

A model describing the characteristics of the environment is necessary, but not sufficient to respond to requests from client applications. Indeed, the model description must be accompanied by a technique to establish a correspondence between the different dimensions of context. This technique should be as complete as possible, considering all possible adaptations. The difficulty of the problem is that there are no single source constraints. Indeed, each component of the network (client, network, server, etc...) can pose its own constraints and is the manager of the quality of service to find a compromise between these constraints.

This paper is organized as follows: section 2 presents some related work and some architecture for adapting multimedia documents. From a service scenario of adapting multimedia document, we present some concepts in Section 3. Section 4 illustrates this technique by a scenario in which our proposal is applied. Finally, Section 5 draws the concluding remarks.

2. Some Related Works

The development of multimedia applications for pervasive computing presents a number of challenges for software engineering, including in particular, the adaptation of context-aware applications: adapting to the environment (location, time, condition, etc..), connectivity (flow, protocol, etc..), the limits of the device (screen, sound, etc..) and even users (physical disability, personal choice, etc...). Taking into account all of these contextual factors is a complex task for the programmer (Derdour M. ,2010).

Several architectures have been proposed for the adaptation of multimedia applications such as architecture Kalimucho proposed in (Louberry C.,2010), where the choice fell on the dynamic adaptation to the context as a tool for managing quality of service. The author proposed a platform for the reconfiguration and the contextual deployment of application in context constrained environment. For this reason, the architecture is based on a classification of context to take into account the different properties of pervasive applications, devices, mobility, the environment and the requirements of the application itself, however, no management of user preferences is proposed.

Other architectures address the adaptation of multimedia streams with adaptation techniques for the description of format and content (Kazi-Aoul Z., et al..,2003), (Derdour M.et al,2010). Some focus on the adaptation of the logic service to the growing number of users of the web characterized by different contexts and wishing to exchange multimedia content through applications Peer-to-Peer (P2P) (Layaïda N.et al,2005) (Kazi_Aoul Z.et al,2006).

Table. 1. Comparative table of some architecture

	Adaptation	Negotiation	Server-side	Proxy-side	Client-side	QoS(User Preferences)	XML /SMIL
NAC(Layaïda N.et al,2005)	✓	✓	✗	✓		✗	✓
KALIMUCHO(Louberry C.,2010)	✓	✗	✓	✗	✗	✗	✓
PAAM(Kazi_Aoul Z.et al,2006)	✓	✓	✓	✗	✓	✗	✓
DCAF (El-Khatib k,2004)	✓	✗	✓	✗	✗	✗	✓
APPAT(Lapayre J.C. ,2005)	✓	✗	✗	✓	✗	✗	✓
MARCH(Ardon S. ,2003)	✓	✗	✗	✓		✗	

A user context is characterized by the preferences of the user's terminal capabilities and characteristics of the access network. Some of these contextual elements can be dynamic and change according to the time or place. Unfortunately, most architectures (Bouix E.,2007), (Derdour M.,2009) focus on the heterogeneity of the data (size and type) and do not take into account the choices and preferences of the user to manage the quality of service (QoS).

Our architecture will improve the adaptation of multimedia documents by taking into account user preferences.

3. Formal Presentations of Concepts of Adaptation Technical of Multimedia Document

The components of our architecture work together such that the quality of service is maximized. Since quality of service is closely related to maintaining the semantics of the original content, a content delivery system should use adaptation methods that preserve the content semantics.

A multimedia document may be composed of different types of contents, such as videos, audios, texts and images (Laborie S. et al. ,2011).A multimedia document is an entity that combines pieces of information which come from various media types named multimedia objects (as known as media items) (Pham Hai Q et al.,2012). Typical examples are Web page including synchronized video, audio, image or texts. Figure 1 represents a multimedia document example played on a PDA.

Based on the work of (Pham Hai Q et al.,2012), a concept for the management of service quality by the user is added.

3. 1. Concept 1 (Media)

The multimedia document is composed to a set of media m_i ($1\leq i \leq n$, where n is the total number of media contents), a multimedia document is always described as an assembly by a specified scenario, called static traditional media (text, image), as well as continuous media (audio and video). For instance, a multimedia document may contain three image, video, two text, and sound $M= \{i_1, i_2, i_3, v_1, t_1, t_2, a_1\}$.

3. 2. Concept 2 (User Preferences)

We offer to the user of document preference scale u_j (between 1 and 4) it uses to assign a priority to each media size. The user puts zero for non-priority formats (the user gives zero for formats which not want on the document and it does not want to make adjustments on it). For instance, user want to see the document in Figure 1 on here laptop and print, so it gives $u_1 = 3$ for the image, $u_2 = 4$ for text and u_3, u_4 put 0 for the video and sound. $UP = \{(i_1, u_1), (i_2, u_1), (i_3, u_1), (v_1, u_3), (t_1, u_2), (t_2, u_2), (a_1, u_4)\}$. Our technique needs to find the best of adaptation multimedia document, optimized in terms of either service time or service cost, which can deliver requests from users.

3. 3. Concept 3 (Media Properties)

A media may refer to a set of properties pi ($1\leq i \leq n$, where n is the total number of media properties) (Pham Hai Q et al.,2012), such as the media formats, sizes, languages. For instance, a multimedia document may contain an images (i_1,i_2,i_3) with the following characteristics: format = BMP. Text characterizes by: language = fr. Next to the video characterizes by: format=avi, language=fr. finally sound characterizes by: format=mp3, language =fr.

3. 4. Concept 4 (User Context)

which consists of three profiles: The user profile that is composed of static characteristics (name, etc.), evolutionary characteristics that are defined by the environment (location, language, time, etc.) .The terminal profile which has, firstly, the context of the material (type of the device, the screen size, etc.), and on the other hand, the context of the software (operating system, formats, etc.), the network profile that exposes information about the network type, characteristics, etc. a set of constraints c_k ($0\leq k \leq q$ where q is the total number of constraints) that has to be satisfied in order to correctly execute a multimedia document (Pham Hai Q et al.,2012).

For instance, the context of the user in Figure 2 may specify that c1= (type-device=laptop), c2= (media resolution < device resolution), c3= (video-format=mov), c4 = (media language = arabe), c5=(image-format=JPEG),c6=(sound-format=no).

Consequently, in order to correctly execute a multimedia document on a specific device and to satisfied the user preferences (quality of service for the user), each user preference of media u_i has greater than zero, and media property p_i has to comply with all constraints c_k specified in the concept user context, a document property p_i does not satisfy a constraint c_k it means that a conflict has been detected.

3. 5. Concept 5 (Conflict Media Property)

A conflict x is composed of the following elements < p, m, c >, where p is a property related to a media element m (or the whole document), such that the value of p does not comply with the constraint c.(Pham Hai Q et al.,2012), but we only created the conflict for the media in a higher user priority value to zero (u_i> 0).

For instance, considering the examples given in Concept. 1,2 ,3 and 4 three conflicts can be detected between the media properties and the user context: x1 = < format = BMP, i, image_format=JPEG > for the tree image in document, x2 = <language=fr, t1, language=ar> and x3 = <resolution=highRes, i, deviceRes>for the three image. To resolve these conflicts, there are adaptation policy that are able to transform the initial document has an adapted document to user preferences.

3. 6. Concept 6 (Adaptation Service)

It keeps given by (Pham Hai Q et al.,2012) definition, we enriche service adaptation by the Estate permetre cost to calculate the cost of adaptation to choose the conflict adaptersi there is a choice between conflict.

- id: a service identifier (e.g, a URI).
- input Parameters: the content characteristics that will be treated by the service.
- outputParameters: the adapted content characteristics that will be computed by the service.
- actionProperty: the document property that the service is modifying.
- actionType: an adaptation service manages three types of actions:
    - o Transcoding: it modifies the format of a media content into another one, while preserving the media type. For example, a JPEG image modified to a PNG image.
    - o Transmoding: it modifies the type of a media content into another one. For example, a textual content modified to an audio content.
    - o Transformation: it modifies the media content, while preserving the format and the type of the media. For example, the modification of a PNG image resolution.
- weight: it corresponds to the current availability of the service.
- QosProperty: demonstrate the quality of adaptive media service.

- Cost: the cost of this adaptation service.
- Time: the time of this adaptation service.

You can resolve a conflict by one adaptation service or you can use a sequence of service and you can calculated on the same time the cost and time to adaptation.

Table 2. ADPs, Input Parameters & Output Parameters.

Adaptation service	Action Property	Input Parameters	Output Parameters	QosProperty	
				Cost	Time
ADP1	Format	BMP	JPEG	2	128
ADP2	Language	FR	AR	4	64
ADP3	Resolution	JPEG	JPEG	3	250
ADP4	Format	AVI	MP4	8	300
ADP5	Type	MP4	MOV	5	125

3. 7. Concept 7(Conflict Adaptation Service)

If there is a conflict between the adaptation services, we will use our political: max user preference, min cost or time depending on user choice designate in user preference.

Cps=max(UserPreferences),min(QosProperty)

3. 8. Concept 8(Services Dependency)

Two adaptation services ADP4 and ADP5 may have a dependency (i.e., ADP4→ ADP5) if the output parameters of ADP4 correspond to the input parameters of ADP5. From these service dependencies, a graph representation can be used in order to represent all possible combinations between adaptation services.

Therefore, the paths in the graph are created by matching the input and output parameters of ADPs until the output parameters are equal to the adapted content. In Scenario where we have a total number of five ADPs, we assume that input and output parameters for each ADP are as in Table 2. Service cost is in $ and service time in Mbit/sec.

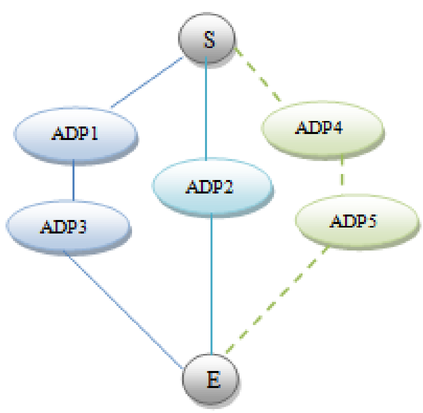

Fig. 3. Adaptation Graph for the Scenario.

Thus, depending on their input and output parameters, adaptation services may be chained in order to solve a specific conflict by finding a path in the graph representation of the service dependencies. The Adaptation Graph for the Scenario is similar to Figure 3 which contains three different paths.

3. 9. Concept 9(Adaptation Path)

An adaptation path is a chain of adaptation services that solves a conflict. This chain must satisfy the following criterion:

- The Start Node represents the original media content.
- The End Node represents the adapted media requested by the user.
- The first path must contain max User Preferences of media.
- The first element of the path must be able to treat the original media.
- The path must contain an adaptation service that solves the conflict.
- The last element of the path does not have to introduce new conflicts.
- The total value of QosProperty must be inferior of the value given by the user.

For each conflict, several adaptation paths may be computed. Of course, different strategies may be determined in order to select the best solutions (e.g, shortest path, minimum value QosProperty, preserving the original media types). However, we won't detail these strategies in this paper.

Obviously, when all conflicts have been solved, it means that the device is able to correctly execute the adapted multimedia document. In the next section, we illustrate of the technique by the scenario that determines relevant adaptation services that solve some detected conflicts.

Table 3. Result of adaptation using our technique and the technique of (Shahidi M. et al., 2010).

	Conflict Media Property	Adaptation service	Cost	Time	Our technique		(Shahidi M. et al.,2010)	
					Cost	Time	Cost	Time
Path1	X1	ADP1,ADP3	5	378	9	442	22	867
Path2	X2,X3	ADP2	4	64				
Path3		ADP5,ADP6	13	425				

4. Illustration of the Technique by the Scenario

We have implemented our technique in NetBeans platform. Through the interfaces presented below, we aim to give an overview of our prototype, designed for the adaptation purpose of multimedia document, from the QoS parameters preferred by the user. Our prototype allows to specify the type of document, its format and media priority (Best, Good, Average, Low and Media Ignore).

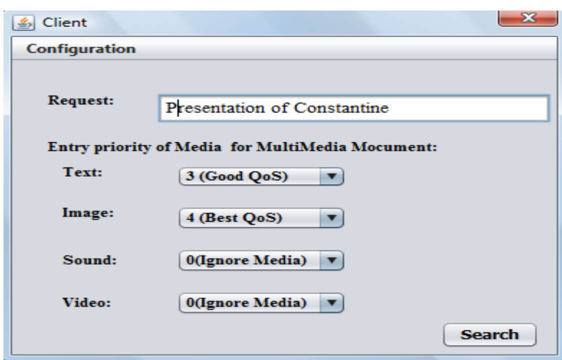

Fig. 4. A view of user's interface.

To better understand our technique, we consider the following scenario: Ali wants to see a multimedia document that presents Constantine, on his Laptop. With our interface to access services, Ali asks multimedia available document and selects the priority of the media (see Fig. 4.). If Ali decided to get a modified document that offers him only images and text with Best Qos, Ali validates this choice through the user interface and selects the proposal corresponding to the desired multimedia document. To manage the quality of service, he puts the preference values (image = 3, text = 4, sound=0, video=0) and puts zero for other formats of lesser importance. The query was sent to the multimedia document manager to find the requested document.

For Scenario, considering service cost, our technique selects two paths which consist of ADP1, ADP3 and ADP2. Therefore, this service can be provided to the user with the cost of 9 (see Table 3).As discussed, we have used the Adaptation Graph method to justify the concept of choosing the best set of ADP.

5. Conclusion

In this work, we presented a technique that allows dynamic adaptation of multimedia documents. The main feature of our proposed technique is primarily at the level of the control aspects of adaptation and the quality of service by the user preference.

Already proposed solutions do not address the problem of complete adaptation architectures, but rather try to provide solutions to specific needs such as adapting images for mobile or transcoding of video. Our objective is to overcome the shortcomings of incomplete proposals. The work carried's goal is to manage the quality of service of multimedia documents distributed by proposed the selection adaptations algorithm based on user preferences.

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