Available online at www.sciencedirect.com
SciVerse ScienceDirect
Procedia Computer Science 19 (2013) 992 – 997
Procedia Computer Science

The 4th International Symposium on Frontiers in Ambient and Mobile Systems (FAMS)

Automatic Adaptation of Multimedia Documents

Alti Adel[a], Sébastien Laborie[b], Philippe Roose[b]

[a]*Université de Sétif –Fcaulté des Sciences – Département d'Informatique, Cité ElBaz, 19000 Sétif, Algeria*
[b]*Université de Pau et des Pays de l'Adour – LIUPPA – T2I, 2 Allée du Parc Montaury 64600 Anglet, France*

Abstract

Currently, multimedia documents can be displayed on multiple platforms (laptops, smartphones, tablets, etc.), that resulting in a birth of new information system called pervasive. The various execution contexts of a multimedia presentation introduce different constraints for the presentation itself. In this paper, we propose a specific ontology for on-the-fly (runtime) adaptation of multimedia documents. More precisely, we propose semantic rules allowing the automatic generation of dynamic and quality composition of heterogeneous components. Our proposed ontology has the great advantage to offer to users a flexible infrastructure in order to easily govern the response time and the quality assembly of their own applications at runtime.

Selection and peer-review under responsibility of Elhadi M. Shakshuki

Keywords: Context; QoS; multimedia application, multimedia document, on-the-fly adaptation, dynamic composition;

1. Introduction

The mobile technology has been widely accepted by end-users and is still evolving very fast. Actually, mobile phones are no longer simple text or voice communication devices, nor are no longer planning and organization gadgets. Those handheld devices are no longer isolated from the Internet. The development and the fusion of multiple functionalities in Smartphones yield to information systems called *"pervasive"*, i.e., to make information accessible with a wide variety of devices that can connect each other's. In this context, devices have heterogeneous hardware capabilities and characteristics (*e.g., screen size, battery power*) and software (*e.g., players, codecs*) ones. It mobile situations, each user has various preferences and handles media from various types (*video, sound, image, text*). These problems require real time (i.e., on-the-fly/at run-time) adaptation of multimedia documents.

In this article, we propose a generic ontology that handles semantic rules allowing the automatic generation of a dynamic and a quality composition of heterogeneous adaptation services. This ontology provides a semantic description of adaptation services (*e.g., name, location, category, role*) and describes semantic relationships between adaptation services, such as the dependency, the substitution (*i.e., a service has the same role as another one*) and the equivalence. We have specified an adaptation architecture that exploits our ontology in order to compute adapted multimedia documents. This

1877-0509
Selection and peer-review under responsibility of Elhadi M. Shakshuki
doi:10.1016/j.procs.2013.06.138

architecture uses a semantic inference engine that is responsible of planning and optimizing the selection, the deployment and the execution of adaptation processes based on a customizable quality of service.

A novel hierarchical service ontology is proposed where semantic descriptions of adaptation services, semantic services relationships combined with context-constraint, is used to better guide the adaptation process and to better discover and compose adaptation services, specifically to provide the "best" service composition adaptation according to semantic properties based upon common ontology concepts.

Our focus on the use of the equivalent relationship to dynamic adaptation of selection services for better flexibility, adaptation and customization of dynamic user quality preferences.

The paper is structured as follows: Section 2 presents an overview of our dynamic semantic-based adaptation architecture and compares it with current adaptation frameworks.Section 3 details our ontology and Section 4 presents the adaptation services search algorithm. Finally, Section 5 concludes the paper.

2. Adaptation multimedia document based on service semantic information

In the literature, a fair amount of research has been conducted on document adaptation [2, 3, 4, 5, 6]. Usually, the quality of service of an adaptation framework is not customizable, in other words the quality of the adaptation process is usually predefined with a fixed set of properties. In [1], a variety of heterogeneous service platforms manage the services composition and the quality of the results. This complexity is clearly noticeable when a given service is provided by two or more neighbors' terminals, within the same area of the mobile clients; a decision should be made to select the most appropriate services based on contextual description with the best QoS.

To overcome these limitations, we aim at representing conflicts, multimedia contents and services qualities semantically thanks to Semantic Web languages. Hence, we propose the Adaptation Service Quality (*ASQ*) ontology. Based on this ontology, we have specified an algorithm for the automatic generation and selection of quality adaptation paths following user's preferences. User can give semantic constraints that are instances of ASQ classes at runtime. By representing service semantic information in *ASQ* (*name, location, role, category, QoS*), the reasoner can easily generate the adaptation path.

Fig.1 presents our dynamic semantic-based adaptation architecture. A user can request a multimedia resource with its quality preferences semantically tothe media server, the adaptation system computes automatically quality adaptation path and then send an adapted document to the user. Our proposal has several advantages, such as: semantic determination facilities to better guide the adaptation process, flexibility and shorter computation time for quality assembly of heterogeneous multimedia services.

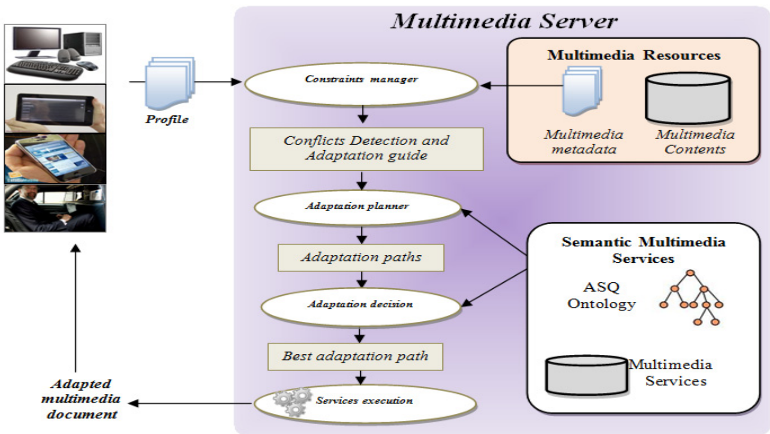

Fig. 1. Our proposed architecture for multimedia documents adaptation.

3. The proposed ontology

The ASQ (*Adaptation Semantic Quality*) ontology (see Fig.2) defines common concepts as well as relationships among those concepts to represent multimedia data, service parameters (*compression ratio, resolution, color number, etc.),* semantic service information (*service role, media type, action parameters, resources needs, QoS parameters, semantics of input/output, location and time*) and context constraints.

Bulleted lists may be included and should look like this:

- *Service* has a name, a version and unique ID (URI).
- *Service_Role* = {*Transmoding, Transcoding, resize, compression, etc.*}.
- *Service_Location*: the location which the service facilities are located.
- *Service_Time*: time when the service is executed.
- *Step: Start*, *Current*, *Passed*, *Finish*.
- *Service_Semantic_Relation:* The semantic relations are used to guide the automatic assembly in heterogeneous applications. When the service configuration is not possible, the adaptation can be done by replacing one or more assembly services by replacing it by another one (*or another set of services*) offering the same functionalities with the best quality of service.We distinguish the following types:
  - *Service dependency relation:* is a semantic relation between two adaptation services which means that the successor is linked to its predecessor.
  - *Service equivalence relation:* is a semantic relation between two services that play the same role within the same location and the same category.
  - *Service substitution relation:* is a semantic relation permitting for example dynamic changes affecting QoS properties while service is running.
- *Adaptation Service:* allows the transformation of a multimedia object into another multimedia object satisfying a given profile. Two types of adaptations can be distinguished :
  - *Technical adaptation:* This adaptation is related to the capacity of mobile devices (*memory, display, etc.*). It can be: *transmoding:* conversion of formats (*e.g., JPEG to PNG), transcoding:* conversion of types (*e.g., Text to Sound).*
  - *The semantic adaptation:* This adaptation is related to the constraints of the data types handled by mobile devices. It allows the content change without changing the media type and format e.g*.: text summarization, language translation*, etc).
- *Context:* dynamic selection of adaptation services must take user preferences and limitations of mobile device into account with respect to the service.

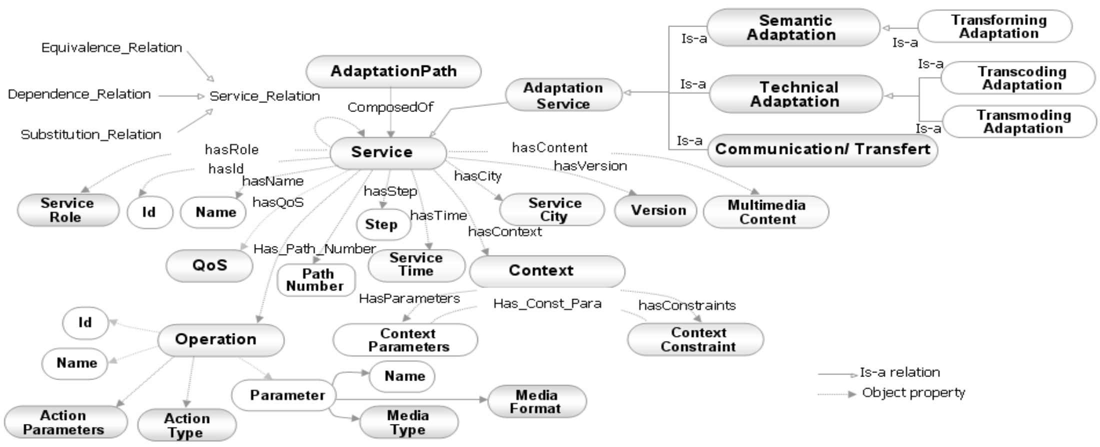

Fig. 2. The description of multimedia adaptation services ontology.

Due to the costs and benefits, the static QoS management is achieved by a process of selecting between several services, while the dynamic QoS management is provided by the dynamic adaptation process control that handles the adaptation as parameters changes (*compression ratio, image resolution, image size, etc.*) to provide adequate quality that satisfy context execution

The service quality level can contain several QoS matches with user several objectives (Fig. 3.a):

- *Cost:* we distinguish two criteria's: AT (Adaptation Time), average time needed to deliver service adaptation and TT (Transfert Time), average time to transfer the adaptation document
- *Benefit:* AQ (Quality of Adaptation) degree of output quality compared to input quality.

The semantic adaptation process is composed of semantic adaptation services. It defined by *adaptation services* and *adaptation paths* subclasses (Fig. 3.b):

- *Adaptation services:* is a dynamic set of adaptation services matching user preferences and its context usage.
- *Adaptation paths:* is described by various adaptation services composition, while the output service matches another service input (*e.g., semantic output parameters of a given service share the semantic input parameters of another service*).

Our adaptation decision process uses a *QoS* function in order to select a quality adaptation path. From Eq. (1), we can observe that *QoS metric* is a ratio of weighted sum of benefits to that of costs of adaptation services. The QoS function is calculated for each adaptation service in the adaptation path and for each adaptation path. The comparison of score adaptation paths allows us to select the best path. In this case the values of a quality formula are used for classifying the relevant adaptation paths that have potential benefit. The evaluation of the adaptation paths having the same mark of benefit that maximize users' qualities (expressed as preferences). That will only modify the mark of the adaptive criterion (e*.g. execution time, transfert time*). So, reasoning is specified by analyzing finite sets of adaptation paths having the same mark of benefit metric and differs only by their adaptability cost to the context.

$$QoS(path) = \frac{W_{benefit} * \sum_{s \in path} Benefit(s)}{W_{\cos t} * \sum_{s \in path} Cost(s)} \qquad (1)$$

Where $W_{benefit}$ and W_{cost} are weights associated respectively to the mark of benefit and cost. These weights cannot be set directly by the user. A user may specify in advance that the execution time is not a constraint and that he prefers a hi-quality video, and these weights are then computed automatically during the profile creation. All these weights are set between *[0, 1]*. The higher the weight value is important, the more it is an important criteria. The quality function is customizable and parametrizable according to different needs of users and context parameters. Cost is parametrizable according to context parameters like CPU load, energy saving, low bandwidth, etc. Moreover, the benefit is parametrizable for specific media parameters like compression ratio, frame rate, resolution, etc.

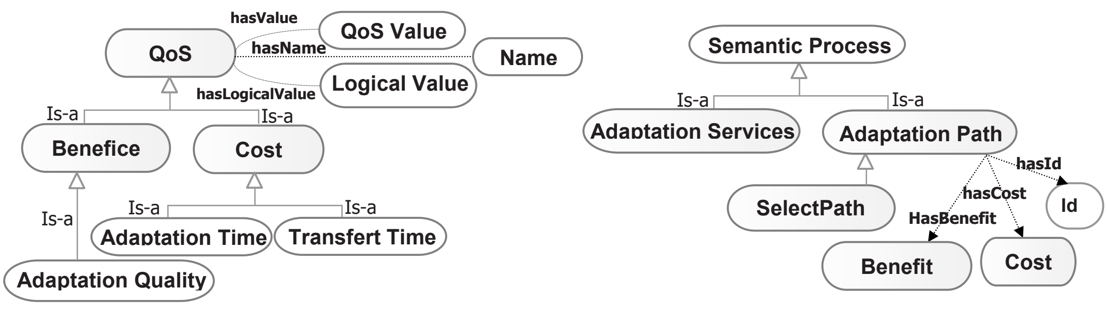

Fig. 3. (a) Modelling the quality of service of the adaptation process; (b) Modelling the semantic adapatation process.

4. A dynamically semantic-based assembling of adaptation services

4.1. Algorithm for dynamic semantic-based assembly of adaptation services

From a set of multimedia document and profile properties, we have specified a procedure that retrieves and combines relevant adaptation services. The main steps of this procedure are presented as following:

Step.1: *Identification of adaptation roles from semantic conflicts*

The semantic matching is done between the profile and resource parameters. Two descriptions are semantically equivalent if all the matching values between parameters are exact. Several conflicts may be identified when a device needs to play a multimedia document. The potential conflicts that may identified among them in terms of type and format of data encoding, a list of multiple parameter values, such as screen size, user language and battery power. If there are no differences between profile and resource properties go to END else go to Step2.

Step.2: *Finding relevant adaptation services from the adaptation guide*

The *inference engine component* is responsible to communicate with the constraint manager in order to initiate the relevant service identification. This is made thanks to a semantic-based matching process, which exploits the categorization of the ontology hierarchy to find suitable matches. The adaptation guide enables the *inference engine component* to find appropriate services. For that purpose, it matches its functional and non-functional properties (*service_role*, *service_location*, *multimedia_content, QoS_parameters, service_time, media_type, media_format, etc.*).

Step.3: *Assembly dynamically adaptation services*

Depending on the resources availability of the device, the environment context and the service provider context, the function of the adaptation planner is to generate adaptation paths and to adapt a service from the primary list identified in the previous step within the equivalent functionalities.

Step.3.1: Find dynamically relevant adaptation services : In case of context changes (*e.g., less available memory, user location, less bandwidth*), the *inference engine component* will be notified by a set of contexts metadata in order to dynamically filter adaptation services which match the context usage with maximum potential benefit from the list of candidate services.

Step.3.2: Semantic relationships between Adaptation Services and Inference Rules: This step consists in constructing all possible combination between adaptation services based on the list of adaptation services of Step 3.1. This is based on semantic relationships between adaptation services; those are used to implement rules based on their semantics. This step returns a list of adaptation paths.

Step.4: *Selection of quality adaptation path*

At first, we calculate the *cost* and *benefit* of each path. Once all possible compositions have been calculated, we select the optimal path in *terms of cost with the best quality of service*. The user is able to customize the quality parameters in order to fulfill his/her needs (one user may want a fast adaptation with quality outputs, while another one may want an energy saving adaptation with an average media).

4.2. Evaluation scenarios and evaluation results

Several scenarios have been experimented. A first simple one is made of single re-sizing service that resolves resolution conflicts using *a colored picture*. A second scenario is when there is not enough available battery to continue displaying such *a colored picture.* The inference engine will skip to the next available equivalent service offering the same image decreasing the number of colors to grey, and requiring less battery (*a black and white picture).* The third one is made of total at least three atomic adaptation services (*sound extraction, transmoding sound to text and transmoding text to image*) that resolves format conflicts. Table 1 shows the evaluation results. The adaptation path 3 turns out to be the best. Differences can be seen in the adaptation cost of this adaptation path and other adaptation paths, which is due to the low adaptation cost compared to other paths under environment evolution (i.e. *CPU load, low bandwidth*).

Table 1. Adaptation paths evaluation results (*weight for benefit is more important than cost* $W_{benefit}= 0.7: W_{cost}= 0.4$)

Adaptable services	Benefit (ms)	Cost (%)
MP4toWAV, WAVtoTXT, TXT2PDF	320	0.156
MP4toMP3, MP3toWAV, WAV2BMP, BMP2PDF	**200**	**0.164**
MP4toMP3, MP3toWAV, WAV2TXT, TXT2PDF	470	0.151

In order to validate the feasibility of our algorithm, we have evaluated the computation cost of the inferred adaptations paths adaptation path on Android OS 2.1 smartphone LG540. Some results are illustrated in Fig. 4. We have considered almost 30 adaptation services. Naturally, when the adaptation service repository size rate increases quickly, the match of services will increase also increase, and thus increasing in consequence the computation cost of adaptation paths. Our approach improves the efficiency and accuracy in comparison with the similar composition approach [1]. That is, it has a good performance in composing potential adaptation using service-context and semantic service relationships.

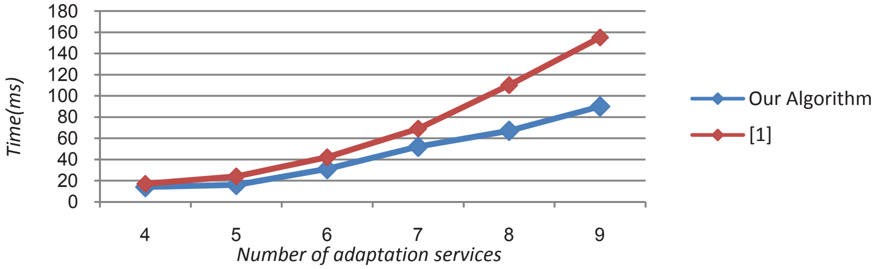

Fig. 4. Response time under various adaptation services.

5. Conclusion

The contribution of this work deals with dynamic and semantic composition of heterogeneous services to the changing environment of the service provided by multiple heterogeneous platforms. Our proposal is a fruitful idea for using service semantic information. It enhances dynamicity and agility of the services composition. The ontology is used to select and compose dynamically potential adaptation services to the client context changes. Investigations towards using semantic web and cloud computing are in progress.

References

[1] Hai Q.P, Laborie S, and Roose P. On-the-fly Multimedia Document Adaptation Architecture, International Workshop on Service Discovery and Composition in Ubiquitous and Pervasive Environments (SUPE), 2012; 10 :1188-1193.

[2] Moissinac J.C. Automatic discovery and composition of multimedia adaptation services. 4th International Conferences on Advances in Multimedia (MMEDIA), 2012.

[3] Jannach D, and Leopold K. Knowledge-based multimedia adaptation for ubiquitous multimedia consumption, *Journal of Network and Computer Applications* 2007; 30(3) :958-982.

[4] Laborie S, Euzenat J, Layaïda N. Semantic adaptation of multimedia documents. *Multimedia Tools and Applications* 2011; 55(3):379 - 398.

[5] Adzic V, Kalva H, Furht B, A survey of multimedia content adaptation for mobile devices. *Multimedia Tools and Applications* 2011; 51(1):379-396.

[6] Derdour M, Roose P, Dalmau M, and Ghoualmi Zine N. An adaptation platform for multimedia applications - CSC (Component, Service, Connector). *Journal of Systems and Information Technology*, 2012; 14(1): :379-396.