Toward a dynamic system for the adaptation multimedia fluxes in the P2P architectures

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Abstract

This article proposes an architecture that adapts multimedia flows context of the participants in communication in peer-to-peer systems. This architecture allows a pair to play several roles (pair adaptation, Proxy or communicating), the adaptation peer researches adapters, compose them, if it is necessary to have interfaces to adapt, to realize the complex adaptation operations and send them to peer communicating. The peer Proxy supports the execution of the interface if the communicating peers are not able to execute it. This architecture allows recomposing dynamically the adaptive interfaces, so; this facilitates changes in the user's environment and in the adapters.

The construction of the adaptation interfaces is dynamic; it applies the Choquet integral on a set of cœfficients in order to have a compatible interface to the needs of the communicating. A complete chain of adaptation is implemented using the Java language for creating interface adaptations, the Web service for description and communication profiles such as RDF and HTTP, and we propose a model that describes adaptation profiles based on the standard CC/PP (Composite Capabilities / Preferences Profile) of W3C.

Keywords: multimedia flows, adaptive management, adaptation graph, Wrapper, choquet integral

1. Introduction

The community of internauts in multimedia communication and exchange flows multimedia such as videos is increasingly broad. These communications are often done through systems peer to peer. Internauts will receive multimedia flows from terminals with varied characteristics and through heterogeneous access networks. These internauts also want that their preferences should be taken into account in all the services they use. Therefore, the multimedia flows must be adapted to the context and to the preferences of the users.

Many architectures supply and adaptation of multimedia content have been proposed, some as ISIS [20], following the approach client / server, while others, such qu'UMA [22], ADMITS [23] , WAM [21] and APPAT [4] are based on the model client / intermediate (s) / server. An intermediary is a node inserted between the client and server and dedicated, for example, to the discovery of services or adaptation flows (eg transcoding image or video). The intermediation avoids charging the client and the server of specialized tasks, which are independent of the final offered service and which are resource's consumer.

The adaptation can be complex, several methods are sometimes necessary; each method is dedicated to one or several adaptation functions. Such functions can be offered by service providers and compound the request. Taking into account the users environment for P2P systems, we are considering in this work, the adaptation methods to be provided by pairs participating in P2P network. The construction of the interface is dynamic and in real time to the requested adaptation. The model client/intermediate/server is thus extended to P2P model, but in this time, the pairs will cooperate in the construction of the adaptation interfaces and for execution if necessary.

In this work, we take into consideration the physical handicap users, that is, the terminal's profiles and the user's profiles. To illustrate the proposed approach, we take as example two pairs. First, we find a blind user who speaks French in front of a multimedia application. Second, deaf person speaks English language. To ensuring the communication between these two pairs we require the construction of the two interfaces of adaptation. In this case, we have the translation of the text to sounds and sounds to text. The interfaces are built by

the cooperation between the adaptation peers. After the construction of the interfaces, the communicating peers will see if they have the ability to execute the interfaces at home. Otherwise, we look after a Proxy pair that supports the execution of the interfaces. The proposed system must provide a means to seek resources for adaptation and compose them in order to realize complex operations of adaptation.
The rest of this article is organized as follows, in the first part; we present similar works. Then we try to give a definition for the adaptation, and its different types. Next, we introduce our architecture by presenting the design of our system and the description of the media and profiles. A chain of construction of the adaptation interfaces is then presented. Finally, the article concludes with conclusions and perspectives.

2. Related works and positioning of the contribution

Several recent research projects offer multimedia adaptation architectures such as architecture based Wrapper proposed by Metso [3], MAPS [6], M21 [5], APPAT [4], NAC [2] and PAAM [8] , Based on a P2P model improved, being thus similar to our approach.
MAPS (Media Accelerating Peer Services) extend the existing infrastructure P2P with some modules that allow personalizing the functions of research and delivery of documents. MAPS contain a module that allows the access to adapted content to the characteristics of a terminal client, to its storage capacity and to the constraints bandwidth of its access network. However, MAPS does only that applications for streaming video, and the other media are not considered and the composition of several elementary media is not assured. The application of the shares files are not considered also.
APPAT (Adaptation Proxy Platform) is an architecture based Proxy. It is not constructed according to the P2P model, but it distributes adaptation over several host called adaptations Proxy, which also represents an evolution in relation to architecture client/intermediate/server. APPAT is specially designed for collaborative applications where several participants simultaneously accessing the same data. This platform deals only with non composed media such as videos and images and is not intended to be widely used.
Rong and al. propose M21 architecture that facilitates the dynamic adaptation of resources in a P2P environment. The standard MPEG-21 [7] [9] describes the information in the descriptors DIA (Digital Item Adaptation) such as descriptions of the used environment. The dynamic is taken into account and a wide spectrum of multimedia content including composed documents is considered. However, this architecture has no composed mechanism of distributed adapters.
The principle of NAC is to interpose a proxy between the client and server. This Proxy supports the most of the negotiation and the adaptation. NAC has defined an independent module called management system of profiles, which ensures the analysis and the management of the context descriptions (a description of the terminal, content, methods of adaptation, and so on.) in profit of the content adaptation. The filtering applied by this architecture-level XSLT style sheets, is not effective because the content of the page XML remains the same. Also, the profile manager neither takes into account the disabilities of the client, nor the goal of transferring power to manage the choice of interface adaptation. The document transfer between the server and the Proxy can cause an overload in the network especially in the case of several connections at once.
PAAM proposes a generalization of architecture client / intermediate / server architecture based on a P2P model, particularly design and realize a system that takes into account the context of a user and which adapts a composed multimedia documents following adaptation policies, thanks to a generic motor decision-making for adaptation, and in an environment where adapters are provided by peers. However, this architecture does not take into consideration the case of pairs capable of handling the adaptation interface and which allows a real P2P environment and the use of an adaptation policy based on condition / action, which can neither manage complex adaptations nor behavioural adaptation. Also, we note the absence of a management optimization of graph adaptation.
The system ASPMA (Adaptation System for P2P Multimedia Applications) that we propose aims to overcome the limitations of the projects previously described. We propose, in particular, the mechanisms to integrate new adapters and to accommodate the request of complex adaptive interface starting with the existing adapters in the host's adapter. ASPMA allows the dynamic construction of the optimal adaptation interfaces of multimedia documents, and the management of the changing contexts of the users, of the terminals and of the media. Thereafter, we call "flow multimedia" a document sent by a pair in which several elementary media (eg video, image, text, audio) are synchronized in time and/or spatially organized. It should be noted that our platform support "streaming" only for a few types of adaptation (Ex: audio text). Otherwise, the user receives the multimedia document composed and adapted only if all the adaptations are completed.

3. Multimedia documents adaptation

Adaptation is any action that can satisfy a need for a client, software or a device without changing the purpose and the context of multimedia message, thus the use of

this document. The adaptation can be classified according to several classifications, the all depend on the field and on the context. For example a classification depending on the environment will give us two types of adaptation, adaptation to the user and adaptation to the task. A classified according to the content will create three types of adaptation: structural, media and semantics.

Structural Transformation: This category of technical concerns the transformations applied to the global organization (spatial or temporal) or to the tree logic of the document. Some examples of such transformations [10] [11] [18] are the transformation of the HTML documents towards the XHTML documents Basic for the terminal mobiles, the filtering of the HTML documents, the transformation of a textual content written in XML to a graphical representation SVG, the temporal transformation [16] [17], and so on.

Media transformation (content): In this category, we find the methods of transformation concerning the adaptation and the encoding media. For example, the adaptation of the images and the video using a reduction of colour or greyscale, a downsizing or a conversion of encoding format. This category of transformation take place at the bottom of the encoding of media resources and requires thorough knowledge of encoding source and target. Much works have developed techniques and applications for the adaptation of media resources, such as adapting images for mobile terminals [12], the adaptation of the video in mobile environments [13], and so on.

Semantic adaptation: In many situations, and to ensure an adaptation that produces a coherent content, the techniques of adaptation of the technology must take into account the semantic aspect of source content. The semantics of content exceeds the encoding or the structural organization of content by associating a meaning to the different parts of the content and to the relationships that may exist between these parties and the objects used in the content. A good knowledge of the semantic content allows the definition of a more advanced technical adaptation. In the literature of the semantics adaptation, we find many efforts that have been made in this field, as [14] which aims at defining a framework for the conception and use of the profiles applications, or a part of the work presented in [15], which defines an approach to a semantic adapting focusing on the temporal dimension of multimedia documents.

4. Adaptation approach

According to Jean-Marc Pierson [1], there are four approaches to adaptation, in which architecture of adaptation must be based.

- Based server: the content server provides adaptation (static and / or dynamic)
- Based client: the terminal client provides processing or selecting the best representation
- Based proxy: an intermediary between the server and the client ensures the adaptation.
- Based service (distributed): proxy provides the adaptation services

Our approach (Fig. 01) is based on a hybrid approaches: based customer, based service, and based Proxy. The adaptation interface is made from a blend adaptation services; available on the network or provided by peer adaptation. The execution of these interfaces is provided by a proxy pair or by communicating pairs themselves, according to the capacity of the communicating terminals. To provide adequate adaptation interfaces, we used the standard CC / PP (Composite Capabilities / Preferences Profile) W3C. This standard is of great flexibility, allowing us in the future to define our context integrating physical disabilities of the users and the specific needs of each application.

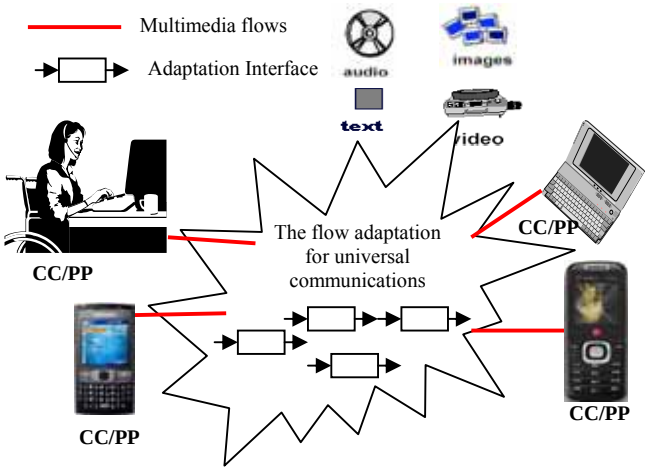
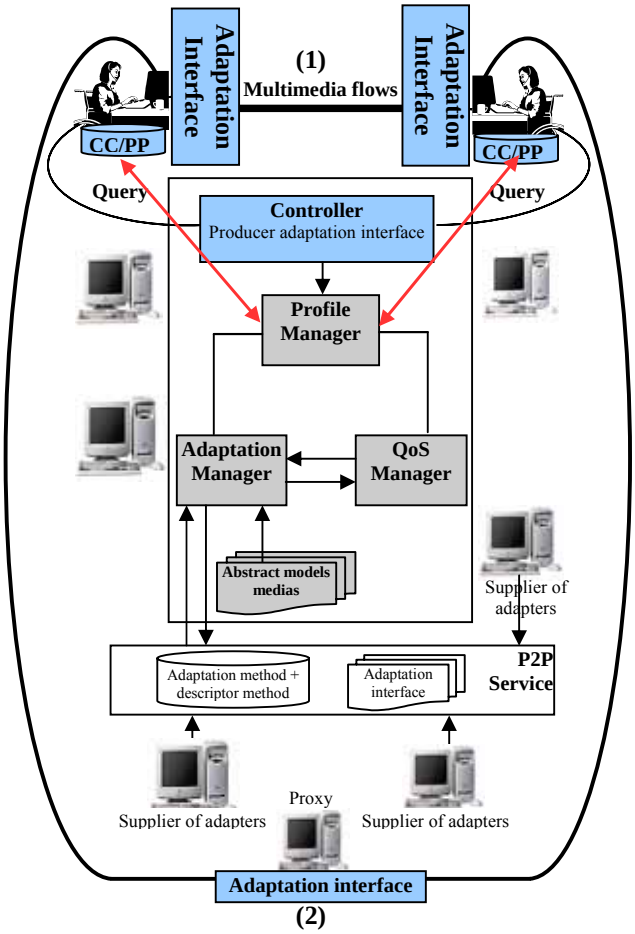


Figure 01: Overview on ASPMA

5. Architecture functional ASPMA

In Figure 02, the multimedia flows passes through a loop adaptation initiated by a peer that sends a request to the controller, this one sends back to the manager profiles (**MP**) links to the profiles of user (CC/PP). Thereafter, the profiles are processed by the MP and sent to the adaptation manager (**AdM**), that, guided by the abstract models of media, decide whether an adjustment is necessary, in this case the AdM determines adaptation operations required (specification of the adaptation interface). Once this decision is taken, **AdM** seeks to adapt the interface among them which have already occurred. Otherwise, a graph of adaptation is constructed by **AdM** from a available adapting methods; at the service level peer-to-peer or suppliers adaptation. A graph of adaptation is a collection of adaptation methods

composed in sequence or in parallel. The search for suitable adapters in the P2P network is facilitated by the presence of descriptors provided with each method of adaptation. After its construction, the adaptation interface must be validated by the manager of quality (**MQoS**) based on specified criteria in the context.



(1)- Execution of the adaptation interface by the concerned hosts
(2)- Execution of the adaptation interface by the proxy

Figure 02: Architecture of adaptation multimedia flows

In next section, we give more details about the used descriptors, P2P platform used as support, managers which make up the ASPMA platform, and the process of construction of the interface adaptation.

5.1. Descriptors

Our architecture is based on three types of descriptors: the descriptor of the user, the descriptor of the media and the descriptor of the adapter.

●The user's descriptor is represented by a profile that contains the capacities of its terminal, the preferences and physical characteristics of the user and the context of the multimedia communication (objective).

The researchers in the field of sensitivity to the context have proposed several languages of the context description. For example, APPAT based on CC/PP to describe the context; while M21 is based on the MPEG-21 formats relating to the description of the context.

CC/PP uses RDF, one of the key specifications of the Semantic Web. CC/PP is the first recommendation that is based on RDF. The use of RDF for CC/PP has many advantages: scalable vocabularies, decentralized vocabularies, and simple integration of the interface from different sources.

To describe the description of our users, we used the CC/PP with an extension to take on consideration the physical characteristics of the user and the objectives of transferring multimedia flows. The descriptor is presented as follows:

[User_Profile]
|
+--*ccpp*:component-->[Terminal]
| |
| +--*rdf*:type----> [Plateforme_Materiel]
| +--display_Width--> "....."
| +--display_Height--> "....."
| +--display_color--> "0/1"
| +--capacity memory--> "....."
| +--CPU speed--> "....MH"
| +--Connexion_supported--> [Types]
| |
| +--*rdf*:Wap----->"0/1"
| +--*rdf*:GPS----->"0/1"
| +--Media_Accepted--> [Types]
| |
| +--Audio----->"0/1"
| +--Vidéo----->"0/1"
| +--Text----->"0/1"
| +--Image----->"0/1"
|
+--*ccpp*:component-->[Logiciel_Used]
+--*ccpp*:component-->[Navigateur_Used]
+--*ccpp*:component-->[physical_Used]
|
+--*rdf*: handicap_dumb----> "1/0"
+--*rdf*: handicap_blind----> "1/0"
+--*rdf*: handicap_silent----> "1/0"
+--*rdf*: .....
+--*ccpp*:component-->[Need_Media]
|
+--*rdf*: use----> "Treat / View/ Analyze"
+--*rdf*: quality----> "High / average/ bad"

The definition of physical handicap of the user allows taking into consideration his need, during the specification of adaptation. And therefore the use of the concept the need media allows the management quality of the provided interfaces, in order to avoid the provision of the adaptive interfaces that make the adapted flow unnecessary.

● the diversity of the media and its characters and their various uses suggest that what is needed more than before is to define an abstract description to represent the different types of the media. The descriptor media contains information relating to each type of media, such

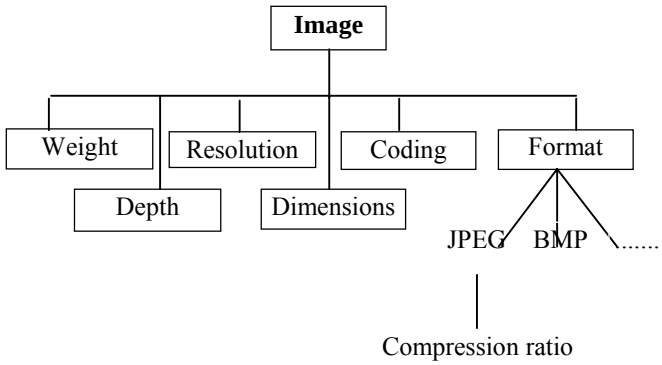
as available format, the possible passage between the format and the types of the possible adaptation. The table below presents a summary of the media and the possible adaptation:

Table 01: Type of media and technical adaptation content

Category	Text	Image
Transcoding	-format conversion -font size reduction - change of police, color ...etc.	-data size reduction -dimension reduction -color depth reduction -color to grayscale -format conversion
Transmoding	-text-to-audio transformation	Image to text
Summarization	-text summarization	- Extraction components
Translation	-Translation of the text	-Translate color image

Category	Video	Audio
Transcoding	-frame rate reduction -spatial resolution reduction -temporal resolution reduction -color depth reduction -format conversion	- change sampling - format conversion
Transmoding	-video to image transformation -video to text transformation -video to audio transformation	-audio to text transformation
Summarization	- Extraction key frames	-audio highlight
Translation	-language translation - establishment of subtitle	-language translation

An example of image descriptor is as follows:



● Adapters descriptors inform on the input and the output of the adapter, so the specification of the adaptations achieved. To not fall on the problem of redundancy adaptation methods, we used the Wrapper; each type of media is represented by a wrapper that includes all methods of adapting dedicated to this type media and the link between these methods, allowing efficient management of functional dependencies between services of adaptations. The Wrapper is extensible through the links between adaptation services. To describe Wrappers we used XML.

<Adaptation>
<Wrapper>
<Wrapper_image>
< Transcoding>
<service name ="BMP2JPEG", input="JPEG", output="BMP", description = "this function assures a passage of the BMP format to the JPEG format" **>**
<parameter name="compression"**>** to specify the percentage of compression **</parameter>**
<parameter name="resolution"**>** to specify the number of point by Pixel **</parameter>**
<parameter>.....
..... **</parameter>**
</service>
<Transcoding>
< Transmoding>
.....
</ Transmoding>
< **Summarization >**
.....
</ **Summarization >**
< Translation >
.....
</Translation>
</Wrapper_image>
<Wrapper_video> … </Wrapper_video>
<Wrapper_Text> …</Wrapper_Text>
<Wrapper_Audio> … </Wrapper_Audio>
<Wrapper>
--This section contains the description of the interfaces already produced
<Interface_PAk>
<Interface name=" deaf-blind", **description** = "this interface is destined to make the adaptation audio-text and the inverse **">**
<Parameter name ="Param_source"> if it is about a communication **</Parameter>**
<Parameter name ="Param_destination"></Parameter>
<Parameter name ="Param_ network", **type_connexion="WAP">** if the interface of adaptation takes in consideration the parameters network **</Parameter>**
</Interface>
<Interface name="Translation"> **</Interface>**
</Interface_PAK>
</Adaptation>

Today, there are unfortunately no dedicated tools to the description of adaptation services. Some languages service description such as WSDL (Web Service Description Language) may be used. One of our future contributions will be the improvement of the language service description to describe more specifically a resource adaptation and to facilitate its research.

5.2. The P2P services

As shown in Figure 2, ASPMA is based on a P2P platform services that could be KaZaa [25] or Gnutella [24], this type of application allows the exchange of files

of all kinds. We expect from P2P system to provide functions to declare shareable resources and adaptation to research them, to oversee peer participants and to obtain notifications on the status of other peers if necessary.

5.3. The adaptation services

Our architecture includes three managers: profiles manager (**PM**), adaptation manager (**AdM**), and a quality manager of interfaces adaptations (**MQoS**).

● Profiles manager: The manager collects the profiles of the communicating peers, which are located at bases CC/PP, put them update, analyse them before he generates the overall context encompassing the needs of the user or the application, the capacity of the terminal and the requirements of the network. This context is then sent to **AdM**.

● Adaptation manager: The **AdM** analyzes the context sent by the **PM** to find a functional specification for the needed adaptation. Once this specification is made, an application is sent to P2P service to get back all the adaptation methods suitable to the specification. The interface adaptation is generated according to the methods provided and the available interfaces. After, this interface will be validated by the **MQoS** and send to the communicating peers or to the proxy adaptation.

6. Construction process of the adaptation interface

After receiving the adaptation methods, the generation of the adaptation interface goes through several stages:

- *Construction of adaptation interface*

The graph adaptation is made from the descriptions associated with the adaptation methods of coping that will pinpoint the task, will the inputs and outputs of each method.

In our experience, we have not worked on parallel adaptation (eg video aggregate in two audio files and image sequence, and the treatment of audio and images that can be done in parallel).

Each knot in the graph represents a method of adaptation, the arch to express the relationship between the methods, the arch are labeled by factor provided by the manager of quality of service depending on the context. Knots E and S represent respectively the input multimedia flow and the output flow multimedia.

- Graph optimization

To request an adaptation, several roads satisfactory the desired interface adaptation can be found. However, there are criteria alloying the choice of the most appropriate interface.

This phase can eliminate the isolated knots from the graph of adaptation; an isolated knot is a summit which does not belong to any path between E and S.

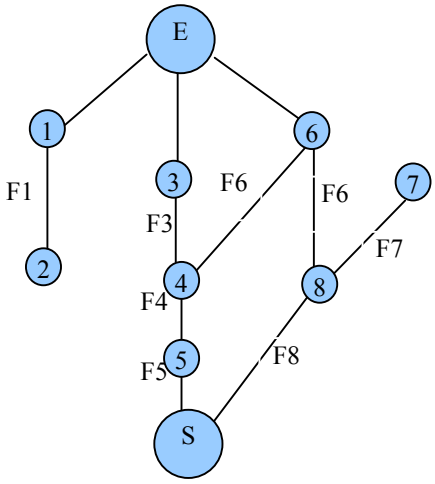


Figure 03: Graph of existing adaptations

- The calculation of the weight graph arch

This phase is provided by the **MQoS**, the latter calculates the weight of the arch from a set of criteria such as output quality, the compression ratio, the time of performance, reliability, flexibility, ...etc.

To calculate the weight of each arch, we need a multi-criteria calculating method. Generally the used method is the weighted sum. But in our case the criteria are not equally important. Thus, we need a more effective method, which takes into account the importance of the criterion by providing the context of adaptation. Michel GRABISCH [19] has demonstrated the inadequacy of the sum weigh in helping the multi-criteria decision, and he proved that the Choquet integral is more effective.

MQoS defines an order of the criteria of the quality of the service; this order depends on the context of adaptation. The **MQoS** applies thereafter the Choquet integral on the values of criteria with the definite order.

- Finding of the optimal path

To calculate the most appropriate path, AdM applied a multi-criteria aggregation under Choquet integral. The application of Choquet integral provides a balanced way in terms of quality, compared to all arch.

In the table below, we have applied two methods of calculation: the weighted sum and the Choquet integral, and we have noticed that the results obtained by The Complete Choquet are more effective.

The weighted sum: In this example, the operator of a weighted sum shows interface 1 as the best, although it is bad compared to the arch 3. While the interface 3 is relatively good compared to all arch.

$$w_1 x_1 + \ldots + w_m x_m = \sum_{j=1}^{m} w_j x_j.$$

The Choquet integral: Before applying the Choquet integral by AdM he ordered the arch by providing the context preferences, in descending method then he uses the following formula:

$$\sum_{1 \le k \le p} (y_{ij}^{k} - y_{ij}^{k+1}) \mu(E_k) = C_\mu(y_{ij}^{1}, \ldots\ldots, y_{ij}^{p})$$

Path (i)	Bow1	Bow 2	Bow 3	Aggregation Choquet integral	Aggregation weighted sum
Interface 1	0,18	0,16	0,10	0,139	0,152
Interface 2	0,10	0,12	0,18	0,136	0,127
Interface 3	0,14	0,15	0,15	0,149	0,146

● Construction of interface and the integration methods
After defining the path and the methods of adaptation, we still have to integrate these methods to construct the adaptation interface. This stage is very important because it is not obvious that the methods are compatible or adaptable.

7. Conclusions & perspective

In this article we have proposed ASPMA, an architecture that provides adaptive interfaces for the multimedia communication depending on the context of the participants inspired of P2P architectures. The adapters are made available by freely distributed systems over the network.
The modularity of our architecture allows considering many improvements to ASPMA, such as the facility of integration and adaptation, thus the evolution in terms of descriptors and the provided interfaces. We are currently developing descriptor media and adapters to enable the construction and the provision of appropriate interfaces. Another perspective is to manage the streaming of voluminous flow multimedia.
In this presentation of architecture ASPMA and its main features, it is clear that few points on which this architecture makes a contribution. The first point is without doubt a comprehensive approach to the problem of adaptation, which takes into account all the characteristics of the heterogeneous environments and the diversity of the user, with all its constraints. This approach includes document formats and media objects, models and description languages context, methods of transformation of structures and contents. Moreover, it defines a completed process, open, flexible and efficient to produce complex adaptive interfaces.

We found that the adaptation of multimedia flows in a heterogeneous environment provided by P2P appliances and mobile networks is a huge problem with many faces. Several techniques are converging to its resolution, which will go from formats document independent to terminals to transforming structures and content, through description languages context and content.

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