Towards a Dynamic Adaptation of Documents within Pervasive Information Systems

Karim Djemal[1], Chantal Soule-Dupuy[2] and Nathalie Valles-Parlangeau[2]
[1]*BSC France, Tour Montparnasse, 33 Avenue du Maine, 75755 Paris, France*
[2]*IRIT/ University of Toulouse, 118 Route de Narbonne, F-31062 Toulouse Cedex 9, France*

Keywords: Pervasive Computing, Document Adaptation, Dynamic Adaptation, Multistructurality, Contextual View, Adaptation Process.

Abstract: Nowadays, Pervasive Information Systems has increasingly become a focus of communication technologies development. In this paper, we focus on document adaptation within Pervasive Systems. Such adaptation is reached using document multistructurality. In fact, each document structure may represent a different document view which is adapted to a particular context. Thus, we introduce the MVDM model which ensures on the one hand, the multistructured document management, and on the other hand, the generation of new contextual views that are suited to different uses. In order to illustrate the feasibility of our approach, we provide a process of document adaptation based on the MVDM model.

1 INTRODUCTION

With the advent of new information and communication technologies, new needs have emerged mainly requirements dealing with exploitation of document that represents the biggest information source. In fact, the rapid development of mobile computing (mobile phone, laptop, PDA and so on...) induces new applications and new challenges. This development has promoted the notion of Pervasive Computing. To be in such context requires the design and the development of the reliable and powerful methods and tools that exploit the document information. These methods and tools must make the information accessible at anytime and anywhere, regardless of the devices used.

The main goal of our work is to propose a solution to dynamically manage and create adapted document representations from the integration of all available document information in function of contextual situation. Thus, we present a solution for the document adaptation in response to a user request in a given context. The capacity offered by a model of multistructured documents include the consideration of different views attached to a document, but also offer the option to add other views linked to that document. These views can generate different contextual representations of a document adapted to context.

After presenting the general context of our work, we present some related works which deal with adaptation. In this paper we focus on the document adaptation and therefore we detail the various issues involved. We propose a solution based on the document multistructurality. Thus, we formalize a methodology for modeling these documents. This methodology is based on a fragmentation technique: the document is divided into structural nodes connected by relations. This fragmentation allows to link each piece to one or more views. From these views, we propose to generate contextual representations of the document. To illustrate our proposal, we treat the example of a medical file that must be adapted to the context of its use. Through this example, we present some instantiations of our model. Finally, we propose a process of dynamic adaptation of documents. This process describes the various possible cases of adaptation.

2 PROBLEM AND AIMS

Ubiquitous systems are designed to make information available at anytime and anywhere. These systems must be used in different contexts according to user's profile, location, application and devices (see Figure 1).

 Djemal K., Soule-Dupuy C. and Valles-Parlangeau N..
Towards a Dynamic Adaptation of Documents within Pervasive Information Systems.
DOI: 10.5220/0004002001760182
In *Proceedings of the 14th International Conference on Enterprise Information Systems* (ICEIS-2012), pages 176-182
ISBN: 978-989-8565-11-2

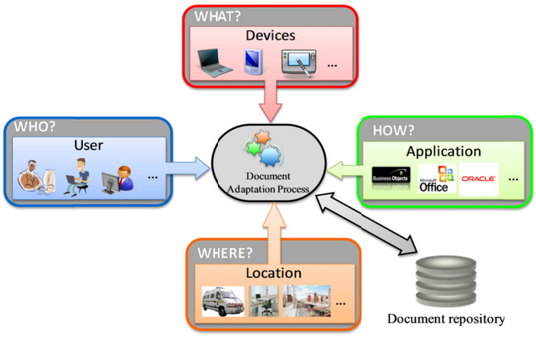

Figure 1: Components of a ubiquitous pervasive environment.

A context reflects a combination of various parameters related to a particular situation. Thus, several definitions have been proposed. Among these definitions, the most significant according to the concern of this work are the following ones:

- according to (Dey et al., 2001), “the context includes all information that can be used to characterize the situation of an entity. An entity is a person, place, or object that may be relevant to the interaction between the user and application, including user and application”;
- (Chaari et al., 2007) define the context as “all of outside parameters of the application that might influence its behavior by defining new views on its data and functionality. These parameters can be dynamic and can change during use of the application”.

Contextual adaptation is one of the central mechanisms in the implementation of pervasive information systems. The heterogeneity of devices, of connection means, of users and of information exchanged involves two adaptation categories: the system adaptation and the information adaptation.

In the first category, there is a system which fits to a particular context. (Aksit & Choukair, 2003) propose the development of adaptable applications. In this case, the adjustment affects the architecture design, implementation and deployment of applications.

In the approaches of the second category, two types of information adaptation have been proposed:

- The adaptation of presentation: in this case, the adjustment applies to user interfaces. Thus, the transformations are performed at the display;
- The adaptation of content: consists in transforming the information to be provided according to data types or formats in accordance with specific context. The nature diversity of the data (text, image, etc.) requires special treatment for their adaptation.

These different types of adaptation have introduced three different approaches of implementation within pervasive information system architecture (Lei et al., 2001):

- Client-side Adaptation: the adaptation mechanisms are running at the level of the receiver (terminal). Two types of adaptations are adopted: the adaptation of content by transformation or by selecting the best representation received. We discern (Lei et al., 2001) that offer solutions for the media adaptation, (Marriott et al., 2002) aimed at adapting a particular graphic format “SVG” and (Fisher et al., 1997) that address the web page adaptation. This approach provides a distributed solution for management of the client heterogeneity. The best knowledge of the terminal characteristics allows an effective adaptation to the context. However, the terminal generally has a low storage and processing capacity. Thus, it is not able in some cases to execute the adaptation mechanisms.
- Proxy-side Adaptation: Proxy is an intermediary node between the client and the server. It ensures the information adaptation according to contextual constraints (Chaari et al., 2007) (Berhe et al., 2004) (Singh et al., 2004) (Wee et al., 2003). (Chaari et al., 2007) use web services to achieve the adaptation mechanisms. (Berhe et al., 2004) include specific Proxies that are responsible for establishing the interface between web services and the local Proxies. (Singh et al., 2004) suggest using the Proxies to localize a version of adapted data. If no version adapted to the context is found, the proxy sees to transcode the data to create one. Transcription mechanisms of image “JPEG” were defined in (Wee et al., 2003). The main advantage of this approach is that it does not depend on specific proxy (any proxy can be chosen). This allows one the hand to choose the proper machine to ensure optimum adaptation, and secondly to ensure the continuity of process in case of failure. But, the main drawback of this approach concerns the security. In fact, any proxy can access to any information.
- Server-side Adaptation: the functionality of the traditional server is extended by adaptation mechanisms. (Margaritidis et al., 2001) offer techniques for adapting multimedia documents on the Internet. (Hori et al., 2000) annotate the HTML/XML to guide their adaptation. They are based on XML to ensure the link between the various annotations and elements of the original

document. (Mogul, 2001) focuses on the transcript image for the web. The advantage of these works is the centralization of adaptation mechanisms. Thus, the entity adaptation for a particular context is applied only once on the server. Conversely, poor knowledge of the client's characteristics may be source of erroneous information and therefore a source of a bad adaptation. Moreover, despite their ability of processing, the servers may be congested due to many requests and may not be able to satisfy some clients. To resolve this problem, (Luo et al., 2004) have proposed an adaptation by rewriting queries. This solution allows to secure data exchanged through the creation of virtual views.

In this paper we focus on the dynamic adaptation of document content on the server side. The question that arises is how to deliver the adapted document for a suitable context. Should we define in advance the contextual situations and jointly document descriptions arising? Or must we generate dynamically an adapted document according to a suitable context?

The definition and storage of different document versions according to any contextual situation ensure adequate adaptation because there are as many document versions as possible contextual combinations. However, this solution generates a complexity, redundant storage and a lack of flexibility due to the difficulty of taking account of a not predefined contextual situation.

The ad hoc generation of contextual representations of the document provides a dynamic adaptation. This generation may be done by a direct matching between the original structure of the document and the structure defined by the context. In this case, the problem is the reliability of results given the heterogeneity that might exist between the two structures to compare.

3 FROM MULTISTRUCTURALITY TO ADAPTATION

Documents, complex or not, can be defined and described through different structures that are linked to the nature of documents or related to the uses that may be done. These structures may be more or less independent. They might contain their own fragments or use those of one or many structures while adding additional information. Therefore, a same document may be represented through several structures having a same nature according to the context for using this document. The use of these structures seems to be an appropriate solution to generate a contextual representation of the document. In fact, each structure has a particular document organization. It allows to identify unambiguously the information fragments that compose the document, and their emplacement.

Thus, to be able to adapt the description of document to any content, it is necessary to fragment this document in structural nodes that are connected through various kinds of relations. A relation connects two nodes according to a particular view. Each view represents a sub-structure of the overall structure of a document. It is then composed of a set of nodes included in the set of nodes extracted from this document. The view notion is used to define the several types of structures (Djemal et al., 2008).

Taking into account the different views related of a same document seems to be an appropriate solution to find the adequate document representation according to a particular context. Each view represents a particular context. For example, we can get an "expert" view and a "framework" view, etc.

Thus, we defined two types of views:

- Structural views: to identify the different types of structures.
- Contextual views: to take into account the various contextual representations of a document.

To describe these structural and contextual views, we propose the model MVDM presented in what following, as well as adaptation capabilities it offers.

3.1 MVDM Model

The model MVDM "Multi View Document Model" is designed to manage multistructured documents. It includes both levels generic one and specific one (Djemal et al., 2008).

Generic Level. The generic level provides a meta representation of documents. In this level, the views are described of a generic way regardless of the document specifications.

The notion of generic structure (GS) allows to group documents in classes. Each document class is considered as an homogenous and coherent document set of a structural point of view.

Specific Level. The specific level characterizes the special document features. Therefore, it identifies the different fragments of this document and their organizations.

Each specific structure (SS) is attached to a GS. The GS embodies a global structure which covers the all of sub-structures. These sub-structures are represented by generic views (GV). Thus, each GV refers to a class of specific views (SV). This allows us, on the one hand, to establish analysis and queries on document collections by combining the exploitation parameters on multiple views, and on the other hand, to define several representations of a document. In fact, each view serves as a grammar or schema for a different structural description of a document.

Compliance Link. The relationship between the two levels (specific and generic) is ensured by a special link that we define as "*compliance link*". UML does not have this type of link; therefore, we opted for a new stereotype: "≙"

Interest of the Compliance Link. The relationship between the specific and the generic level can be described as an inheritance because the specific classes are on one hand, fully consistent with the generic classes, and on the other hand, they can be enriched by specific information. But, in this case, these classes are subclasses; and not instances of the mother class.

Characteristics of the Compliance Link. The compliance link such as we have defined should have, in addition to the generalization/specialization aspect, the following characteristics:

- A child meta class is an instance of the mother meta class. This instance has all the characteristics of the derived meta class,
- The homomorphism: This link provides the homomorphism between the specific and generic level. Indeed, this relationship ensures that every specific fragment needs to be attached to a generic fragment,
- Classification: each generic fragment includes a set of specific fragments. This allows to create fragment classes that facilitate the access to a specific fragment.

3.2 Static and Dynamic Adaptation

The originality of the MVDM model rests on the possibility of adopting both types of document adaptation: static adaptation and dynamic adaptation.

The static adaptation is performed by storage of the different SV of the document. These views such as we have designed allow to share of nodes. This overlapping between the views eliminates the storage duplication. Thus, the document contents are stored once in specific nodes. The different views are based on these nodes to form the different contextual representations of a document.

The generic level of the MVDM model ensures the dynamic adaptation. In fact, the matching between a GV and the SS of the document allows to generate a new SV sharing the document contents and whose a structural description is an "instance" of a GV used.

The compliance link allows to manage classes of structures. According to the MVDM model, each GS is a class of structures. A GS can be composed of one or more GVs. Suppose we have a SS "SS_1" attached to a GS "GS_1" (see Figure 2) "SS_1" has only one SV "SV_{11}" that represents the structure of the original document. The intersection between this SS and each of the GV already defined can provide further SV. In the example (Figure 2), the intersection of "SS_1" with "GV_{13}" allows to generate the SV "SV_{13}". Thus, the compliance link ensures full coverage of the organization of the SV created and the original GV.

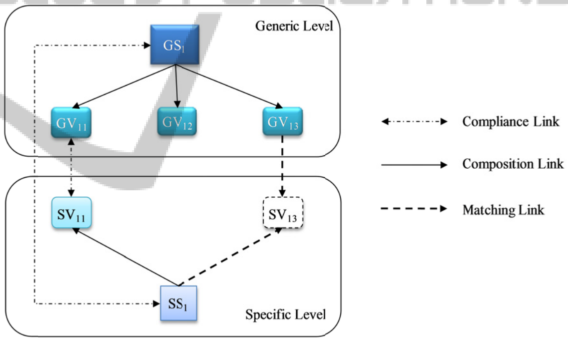

Figure 2: Generation principle of specific views.

3.3 Example

To illustrate our proposals, we consider the example of a medical file of a patient within a hospital. Figure 4 (APPENDIX) shows the GS of this document. This structure represents a global structure to all contextual views already defined. For clarity, we have not presented a non hierarchical links that might exist in a GS.

Each medical file can be consulted by different users according to several contexts. It can be used by a secretary to edit the personal data ("PersonalData") of a patient, it may be requested by an ambulance service that asked urgency information to do the first aid to a patient, or it is consulted by a doctor. These three contextual situations are represented by the MVDM model through three GVs attached to the same GS "MedicalFile" (see Figure 3).

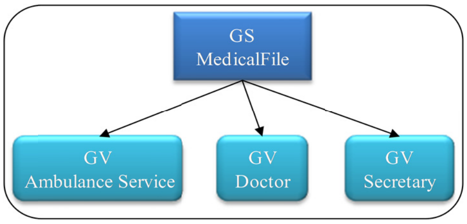

Figure 3: Generic representation of medical file.

4 PROCESS OF DOCUMENT ADAPTATION

In our approach, the documents are represented according to the MVDM model within a document repository located in server-side. To provide the appropriate document for each contextual situation, we propose a process of document adaptation. This process is composed of eight phases.

4.1 Adaptation Phases

Phase 1. Detection of Context Parameters. This phase is activated to identify new characteristics that define the context parameters. On the same axis, these characteristics may be identical for different parameters. For example, two different terminals (PDA and Smart Phone) may have the same display characteristics. In earlier works (Chevalier et al., 2005), our team modeled these features as a resource profile. Relationships and matching between these characteristics are based on a standard or on a specific naming space (rdfs,...). This is done to detect the features to be used and in our case for matching of views.

Phase 2. Structure Extraction. This phase requires the combination of detected context parameters. These parameters can be combined using, for example, the first order logic which can ensure the intersection of different criteria extracts from the context. From the contextual situation, the system must determine the contextual view of the document to provide.

Phase 3. GV Selection. The system must select one of the GVs stored in the database, the view corresponding to that representative of the context. Algorithms of comparisons structures must be developed to achieve this phase. To ensure a correct and secure adaptation, the distance between the structures to compare must be equal to zero. The system must find the identical view as representative of the context. Thus, two cases that arise: if no GV has been selected then the system generates a new GV (phase 4), otherwise it selects the corresponding SV (phase 5).

Phase 4. Generation of VG. Where the system cannot find a GV that is identical to the contextual view of the document to provide, it proceeds creation one. It will be attached to a GS selected while taking into account the nature of the document requested.

Phase 5. Selection of the VS. During this phase, the system try to select the SV that matches the selected GV and the document requested. If this view does not exist, the system must generate a new SV (phase 6). Otherwise, the system will generate the document (phase7).

Phase 6. Generation of VS. In this case, it is about to create a new specific view. This view is the result of the matching of the GV selected in phase 3 or the GV generated in phase 4, with a SS that represents the document. The GV provides information about the structure of the new SV, and the SS determines the specific content of this SV.

Phase 7. Document Generation. The SV reflects the structural organization of a document. It allows to present a document as a set of nested and ordered nodes. The leave nodes refer the document contents. Thus, it is entirely possible to generate a contextual representation of document from its SV.

Phase 8. Document Sending. The sending of the generated document is the latest phase in our process. In this phase, the document is sent to the appropriate terminal.

4.2 Example of Adaptation

To illustrate some phases of our adaptation process, we take up the example of GS “MedicalFile” (see Figure 4 in APPENDIX). This GS consists of three views according to three different contexts: “Doctor”, “AmbulanceService” and “Secretary”. We consider now a nurse wants to access to patient information. In this case, a new contextual situation is defined (phase 2). Before adding a new GV, the system compares this new view with GVs already defined. After the running of structure comparison algorithms (phase 3), it appears that no GVs already defined represent the new contextual situation. Thus, the system must generate a new view GV “nurse” (phase 4).

When the new GV is generated, the system proceeds to the creation of the corresponding SV (phase 6). Figure 5 (APPENDIX) shows the generating process of a SV. Indeed, the system combines the specific nodes related to the SS “MedicalFile” with a view generic “Nurse” (see

Figure 5 in APPENDIX).

5 CONCLUSIONS

This paper proposes a solution for the document adaptation within pervasive information systems. This solution is based on the management of document representations through contextual views. The representation and the coordination of these views are established according to MVDM Model. In fact, this model manages two kinds of views: structural views and contextual views. Through these views, it is possible to define several structures for a same document. From these structures, context adapted documents are generated.

To achieve these goals, we propose an adaptation process based on the MVDM Model. This process ensures:

- the document adaptation to a contextual predefined situation. This kind of adaptation is guaranteed by the matching between the SS of the original document and the GV representing the contextual situation,
- the document adaptation to a undefined contextual situation. This done through the generation of new GVs adapted to new contexts.

There are two approaches to manage the multistructurality: one based on models (Bruno et al., 2006) (Chatti et al., 2007) (Le Maitre, 2006) and another based on syntax (Huitfeldt, 1993) (Sperberg-McQueen et al., 2004). The MVDM model is part of the first category of approaches. The breakdown of multistructurality related works is presented in (Djemal et al., 2008). The use of approaches has shown the need of further treatment to exploit these documents. In fact, the syntactic approaches require a specific parser to the proposed solution, while the approaches based on models require specific language (for example some extensions of XQuery languages).

The originality of the MVDM model lies on the definition of the generic level. This level has two particular meta classes: “GenStr” and “GenView”. The “GensStr” serves as a grammar or schema for a multistructured document. “GenView” represents one of the structural descriptions of this document. Thus, each GV allows to define clearly the structural organization of a SV which is used to generate the adapted version of a document.

Our proposals have been validated through a tool entitled MDOCREP (Multimedia Document Repository), which integrates and analyzes the multistructured documents and especially multimedia documents. We have shown the ability of this tool to manage the incorporation of multiple views of a document. Therefore, it can generate the adapted documents according to these views.

The evaluation of our system within dynamic context is a major concern, which we will consider in our future work. Concretely, we will try to define interchange mechanisms and protocols in order to transfer contextual parameters and adapted documents. These must be done within an architecture specific to our proposals.

REFERENCES

Aksit, M., Choukair, Z., 2003. Dynamic, adaptive and reconfigurable systems overview and prospective vision. *In: Proceedings of 23rd International Conference on Distributed Computing Systems Workshops*, pp. 84-89.

Berhe, G., Brunie, L., Pierson, J. M., 2004. Modeling service-based multimedia content adaptation in pervasive computing. *In: Proceedings of the 1st conference on Computing frontiers*, pp. 60-69. ACM New York, NY, USA.

Bruno, E., Murisasco, E., 2006. MSXD: A Model and a Schema for Concurrent Structures Defined over the Same Textual Data. *In LECTURE NOTES IN COMPUTER SCIENCE* 4080, pp. 172-181. (2006)

Chaari, T., Ejigu, D., Laforest, F., Scuturici, V. M., 2007. A comprehensive approach to model and use context for adapting applications in pervasive environments. *In: The Journal of Systems & Software*, pp. 1973-1992.

Chatti, N., Calabretto, S., Pinon, J. M., Kaouk, S., 2007. MultiX, an XML-based formalism to encode multi-structured documents. *In: Proceedings of Extreme Markup Languages* 2007.

Chevalier, M., Soulé-Dupuy, C., Tchienehom, P., 2005. Profiles Semantics and Matchings Flexibility for Ressources Access. *In: IEEE international Conference on Signal Image Technology and Internet based Systems*, pp. 224–231.

Dey, A. K., Abowd, G. D., Salber, D., 2001. A conceptual framework and a toolkit for supporting the rapid prototyping of context-aware applications. *In Human-Computer Interaction* 16, 2-4, pp. 97-166.

Djemal, K., Soule-Dupuy, C., Valles-Parlangeau, N., 2008. Formal modeling of multistructured documents. *In: Proceeding of Second International Conference on Research Challenges in Information Science*, RCIS 2008, pp. 227-236. IEEE.

Fisher, B., Agelidis, M., Dill, J., A, P. T., B, G. C., C, C. J., 1997. CZWeb, Fish-Eye Views for Visualizing the World-Wide Web. *In: Proc. of the 7th Int. Conf. on Human-Computer Interaction (HCI International '97)*, pp. 719-722, Elsevier.

Hori, M., Kondoh, G., Ono, K., Hirose, S., Singhal, S., 2000. Annotation-based web content transcoding. *Computer Networks* 33, 1-6, pp. 197-211.

Huitfeldt, C., 1993. MECS-A Multi-Element Code System. *ACH-ALLC*, pp. 16-19.

Le Maitre, J., 2006. Describing multistructured XML documents by means of delay nodes. *In: Proceedings of the 2006 ACM symposium on Document engineering*, pp. 155-164. ACM New York, NY, USA.

Lei, Z., Georganas, N. D., 2001. Context-based media adaptation in pervasive computing. *In: Electrical and Computer Engineering*.

Luo, B., Lee, D., Lee, W. C., Liu, P., 2004. QFilter: fine-grained run-time XML access control via NFA-based query rewriting. *In: Proceedings of the thirteenth ACM international conference on Information and knowledge management*, pp. 543-552.ACM New York, NY, USA.

Margaritidis, M., Polyzos, G. C. 2001. Adaptation techniques for ubiquitous internet multimedia. *In Wireless communications and mobile computing* 1, 2. pp. 141-163.

Marriott, K., Meyer, B., Tardif, L., 2002. Fast and efficient client-side adaptivity for SVG. *In: Proceedings of the 11th international conference on World Wide Web*, pp. 496-507. ACM New York, NY, USA.

Mogul, J. C., 2001. Server-directed transcoding. *Computer Communications* 24, 2, pp.155-162.

Singh, A., Trivedi, A., Ramamritham, K., Shenoy, P., 2004. PTC: Proxies that transcode and cache in heterogeneous Web client environments. *In: World Wide Web Journal* 7, 1, pp. 7-28.

Sperberg-McQueen, C. M. Huitfeldt, C., 2004. GODDAG: A Data Structure for Overlapping Hierarchies. *In: LECTURE NOTES IN COMPUTER SCIENCE*, pp. 139-160.

Wee, S., Apostolopoulos, J., 2003. Secure scalable streaming and secure transcoding with JPEG-2000. *In: IEEE, International Conference on Image Processing*

APPENDIX

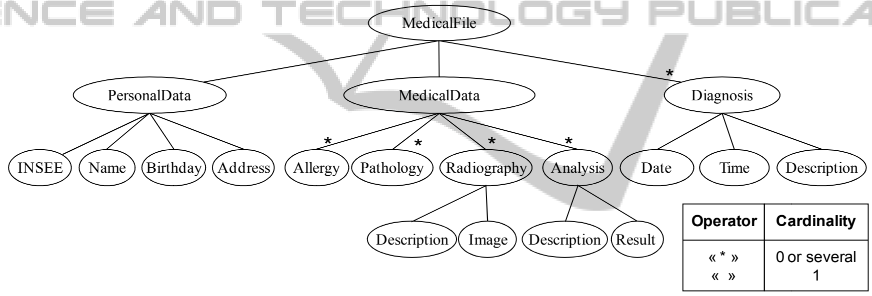

Figure 4: Generic structure of Medical File.

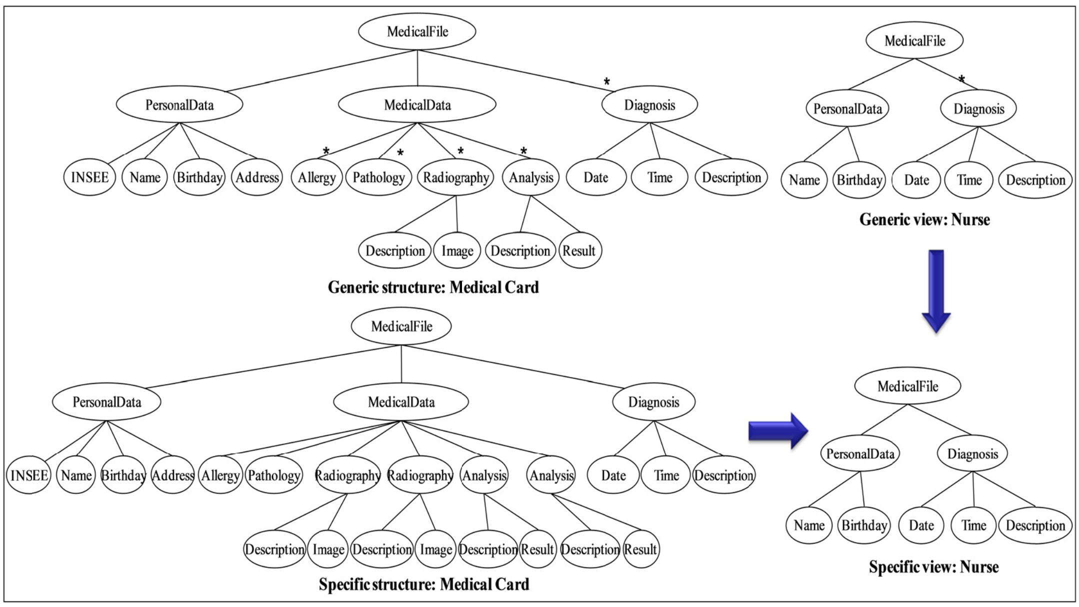

Figure 5: Generating of specific view.