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INSTITUT NATIONAL DE RECHERCHE EN INFORMATIQUE ET EN AUTOMATIQUE

Project-Team WAM

Web, Adaptation and Multimedia

Rhône-Alpes

THEME SYM C

Table of contents

1. Team **1**
2. Overall Objectives **1**
2.1. A Web of Diversity 1
2.2. Need for Adaptation 2
2.3. XML Transformations 2
3. Scientific Foundations **2**
3.1. Transformations 2
3.2. Adaptation 3
3.2.1. Device Independent Formats 3
3.2.2. Profile and Negotiation 3
3.2.3. Transcoding and Transformation 4
3.3. Multimedia Documents Authoring 5
3.4. Multimedia Documents Description 5
4. Software **6**
4.1. Amaya 6
4.2. LimSee2 6
5. New Results **7**
5.1. Transformations 7
5.1.1. Containment in XPath Expressions 7
5.1.2. XPath Formal Semantics 7
5.1.3. Logic-Based XPath Optimization 7
5.1.4. Stream-Based Processing 7
5.2. Adaptation 7
5.3. Multimedia Authoring 8
6. Contracts and Grants with Industry **8**
6.1. RIAM Satin Project 8
6.2. Microsoft Research Grant 9
6.3. Collaboration with IBM Research 9
7. Other Grants and Activities **9**
7.1. National Actions 9
7.2. International Actions 9
8. Dissemination **9**
8.1. Leadership within Scientific Community 9
8.2. Conferences, Meetings and Tutorial Organization 9
8.3. Teaching 10
8.4. Conference and Workshop Committees, Invited Conferences 10
9. Bibliography **10**

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2. Overall Objectives

The WAM project (Web, Adaptation and Multimedia) was created in January 2003 to explore the field of adaptative multimedia on the Web, with a special focus on structured documents transformation and adaptation.

2.1. A Web of Diversity

Diversity on the Web increases steadily, be it the diversity of information or the diversity of access devices and communication networks. Diversity of information comes from the multimedia Web. Information shared on the Web consists of text for a significant part but also of pictures, drawings, video, animations, music, voice, etc. These media can just stand independently from each other, such as a movie or a song, but they can also interact with each other in genuine multimedia documents that tightly integrate pieces of information in different media.

Devices are also multiple. The workstation or personal computer that was typically used in the early days of the Web is no longer the dominant access device. In Japan, for instance, there are now more cell phones than PCs used to access the Web. TV sets are also following this trend. Recent developments in the TV industry clearly show the convergence between television and the Web. Web users can watch at TV programs on their desktops while TV sets can be used to access Web sites. The digital television technology is borrowing more and more techniques from the Web, such as XML, for instance. The automotive industry is also developing embedded devices that provide access to the Web. The Web is ubiquitous and all sorts of devices with very different capabilities are involved in Web access.

Simultaneously, these devices are using new kinds of networks, ranging from personal networks such as Bluetooth to the global Internet. In the broad range of communication technologies, wireless and mobile networks (UMTS, WiFi) are taking an increasing part. Their original features make a big change from the traditional wired Internet and have a strong impact on the way information is exchanged over the Web.

2.2. Need for Adaptation

The increasing diversity of information, devices and networks makes the original scheme of the Web inefficient. The usual model of a single Web page targeted at a large color screen accessed through a high speed network does not work any more. Some information providers face this problem by developing their contents into different versions, each one suited to a specific class of devices. Another approach is to create the information in a single, universal format and to adapt it automatically to the environment where it is delivered.

The WAM project works along the second approach. It aims at developing models, methods, architectures, protocols, formats, languages that allow content to be adapted "on the fly" to the context in which it is actually used. In this approach, no restriction is put on the type of the information that has to be adapted; multimedia information is considered with the broad diversity of media that are now commonplace on the Web.

Content adaptation is not something that comes into play at the last moment, when information has to be delivered to the client. To allow efficient adaptation at that time, it is important that the original information presents some features that make adaptation easier or even possible at all. This means that the production methods should also be involved in the whole process of content adaptation. The WAM project is especially interested in authoring tools for the Web, with the perspective of creating multimedia documents that ease adaptation and improve device independence. Two editors are currently under development. LimSee2 is dedicated to the production of multimedia documents in the SMIL 2.0 format, while Amaya targets multi-namespaces XML documents containing text, mathematics, and animated graphics and using CSS style sheets.

2.3. XML Transformations

It is clear that a major means to adapt documents is to transform them according to the actual context where they are used. The project focuses on structured multimedia documents represented as XML structures. Regarding transformations, the objective is first to characterize the theoretical and practical tools needed for efficiently transforming XML structures, and then to develop models, formalisms and algorithms that are necessary for transformation languages.

A strong motivation for this research on transformations is adaptive multimedia, but transformation of XML documents and data has actually a broader range of applications. Transformations are ubiquitous in the processing of structured information on the Web, ranging from formatting to repurposing and life-cycle management. Actually, XML transformations are considered as a key paradigm for document processing.

3. Scientific Foundations

3.1. Transformations

Keywords: *XML structures transformation, XPath, document models, document transformation, path expressions, transformation languages*.

Participants: Pierre Genevès, Nabil Layaïda, Vincent Quint, Jean-Yves Vion-Dury.

Structure transformation is a specific domain that can be approached following different abstraction levels with respect to programming specifications. The lowest level is based on general purpose languages, such as Python or Java, associated with dedicated libraries and toolkits that implement a standard structure manipulation API, typically the DOM. On the opposite, there are dedicated languages, such as XSLT, which abstract over data and control complexity through a tree-based data model and a powerful execution model. Some properties are expected from specialized languages in order to help solving the most common problems: expressiveness, verifiability, efficiency, modularity, reusability, scalability, simplicity, clarity, etc.

These problems are studied using the fundamental connection between Monadic-Second-Order (MSO) logic and automata on trees. Most of our theoretical work follows this approach.

For XML structure transformations, some more properties are of particular importance:

- *Type checking*: Few languages are able to use typing information related to the input document, and even fewer are able to perform type checking with respect to the output document (XDuce, CDuce, Circus, XQuery). Here, we understand types as the structural constraints over documents as expressed in a DTD or a schema.
  A challenge is to address "late type checking": the ability to ensure the final type soundness of a chain of transformation steps, while allowing some steps to temporarily violate the typing constraints.
- *Efficiency:* Transformation languages need powerful static analysis and deep optimizations in order to reach high efficiency. Such techniques take advantage of clear and powerful formal semantics to help optimization.
- *Stream-based processing*: Many transformation languages assume that the whole structure to be transformed is available when the transformation process is run. In streaming applications however, documents may be very large or even infinite and the transformation has to be performed on the fly, with resources that are bounded to some extent.

3.2. Adaptation

Keywords: *World Wide Web*, *adaptation*, *adaptive multimedia*, *authoring*, *device independence*, *document format*, *multimedia*.

Participants: Sébastien Laborie, Nabil Layaïda, Tayeb Lemlouma.

The purpose of multimedia document adaptation on the Web is to take advantage of the numerous devices and networks that are now constituting the Web, and to get rid of the traditional model of a PC accessing servers through the wired Internet. In other words, the Web infrastructure is changing gradually to a device-independent architecture, where information resources can be efficiently accessed through many kinds of devices and networks.

To reach this goal, the WAM project is following two complementary approaches, a comprehensive, global approach that could require significant changes to various aspects of the current Web infrastructure, and a restricted, pragmatic approach that avoids such changes by using the current infrastructure and adapting existent contents.

There is no general solution to the problem of device independence today. Most efforts are rather dedicated to the development of good practices. To make progress towards a solution, three aspects are considered in the project: device-independent formats, profile negotiation and transcoding.

3.2.1. Device Independent Formats

Ideally, content would be created or generated in a single universal format that could be delivered "as is" to any conceivable device. In practice this seems impossible, so the real techniques seek to minimize the number of variants needed, each variant being targeted at as wide a range of devices as possible. The problem becomes more complex when taking into account the various pieces of information that are needed to satisfy a user request for a Web resource. These include various types of media that constitute the content of a Web page as well as all supporting material such as style sheets that determine how the content is rendered.

The creation of such material is called authoring. Typically the authoring process must adapt material for delivery to devices. The construction of the adaptation processes themselves may also be regarded as a form of authoring, though more usefully regarded as a form of programming. Authoring of raw material, style sheets, layouts and adaptation processes may be performed by different individuals with different skills. The challenge is to facilitate this separation of concerns.

3.2.2. Profile and Negotiation

Several variants of the same Web resource are available or can be generated on a server. The next problem is to decide which one has to be delivered in response to a user request.

This problem is addressed through profiles and negotiation. A profile is a formal representation of the context in which content is used: user abilities and preferences, device capabilities and limitations, network

characteristics, etc. These descriptions must be both static and dynamic as the context may change over the time a Web resource is accessed and used. Although some proposals are already available to describe profiles, such as UAProf or CC/PP, more research is needed to precisely and comprehensively describe a context.

Profiles are used in a negotiation in order to find the best suited form of the information to be delivered in a given context. Negotiation may be complex as it may require various pieces of profiles stored in different repositories. Device manufacturers and access providers may have their own profile repositories, while the user profile will reside somewhere else. The negotiation then becomes a distributed application involving multiple information bases.

The goal of the negotiation process is to establish where the adaptation must occur between three interacting entities: user agent, proxy and server. A successful negotiation allows adaptive content to be delivered while optimizing the performance of the overall system in terms of latency, bandwidth, and computing power.

Negotiation is closely related to the request for the information resource. The HTTP 1.1 transport protocol, for instance, carries some negotiation information such as language preference in the same message as the request itself. For more sophisticated negotiations, transport protocols have clearly to be extended. An alternative is to develop new negotiation protocols that interact with transport protocols.

3.2.3. Transcoding and Transformation

Negotiation allows a server to select the right form of information to be delivered. The next problem is to generate this form. It could be prepared in advance or transformed on the fly according to the outcome of the negotiation process, and based on an adaptable format.

To transform multimedia documents, one can rely on their semantics. The semantics considered here do not deal with the document content, but with the composition that is made explicit in a Web document:

- temporal semantics: in what order and when should each piece of information be presented to the user,
- spatial semantics: what are the relative positions of the document components on the display space,
- navigational semantics: how are pieces of information related in the hypertext network.

This approach allows the definition of adaptation in very general semantic terms, independently from the multimedia objects. The temporal dimension is of particular importance in multimedia documents and is probably the most challenging one.

Another way to transform Web documents is offered by Web formats. Most of these formats are modular and are defined as profiles that assemble different sets of modules. XHTML, SMIL and SVG, for instance, have Basic profiles for mobile devices. SVG, the vector graphics format for the Web, has also a Tiny profile for low-end mobile devices. With such profiles, adaptation may be achieved by transforming a document from one profile to another, better suited to the device involved.

Finally, adaptation is also performed to cope with the quality of service (QoS) offered at any moment. This low-level adaptation is done by transcoding:

- Content can be annotated to allow the sender to pick alternative fragments of information in different encodings, or to change encoding or resolution, depending on the QoS.
- The choice of the encoding has to take into account the capabilities of the receiver as expressed in the negotiation.
- Hierarchical coding techniques can be used, as in scalable formats like JPEG 2000.

3.3. Multimedia Documents Authoring

Keywords: *authoring environment, constraints, editing, multimedia, structured editing, timeline*.

Participants: Romain Deltour, Stéphane Gully, Peter Hewat, Nabil Layaïda, Vincent Quint, Irène Vatton, Daniel Weck.

Before a structured multimedia document can be transformed or adapted, it has to be created. The WAM project works on interactive authoring environments. Developing such environments is a challenging issue: structured multimedia documents are complex objects and the process of creating and updating them is complex too. Well-established paradigms for office documents or static technical documents do not work. The WYSIWYG approach does not apply in a context where the final form of the document (What You Get) is multiple and unknown at creation time. Writing a description of a document in some formatting language is extremely difficult given the various levels of description that are involved: content, logical structure, layout, style, synchronization, hypertext structure, dynamic behaviours, etc. New approaches are needed.

On the Web, multimedia documents are based on XML. They are considered through several types of structures: layout, time, hypertext, animations. Following this approach, we develop techniques that allow users to manipulate all these structures in homogeneous environments. The key idea is to present simultaneously several views of the document, each view showing a particular structure and allowing the user to manipulate it directly. In addition, these views are "synchronized" to show the consequences of every change in all other views. The XML markup, although it can be accessed at any time, is handled by the tools, and the author does not have to worry about it.

Three editing tools based on this concept are under development, Amaya, LimSee2, and Satin. In Amaya the emphasis is put on the integration of several XML vocabularies and associated technologies, and on direct interaction with the Web: the user can edit remote documents in exactly the same way as local files. LimSee2 is dedicated to a single XML language, SMIL, and the focus is on the time dimension of multimedia documents and their dynamic contents. In Satin time and synchronization are also in the focus, as well as user interaction, but the target is interactive digital TV, while LimSee2 is Web-oriented.

We are also investigating the integration of natural language processing services in authoring environments. This is done in cooperation with the CLIPS laboratory from Grenoble University. The goal is to develop translation systems which interact with the user during translation in order to disambiguate the text. The result of this step is a tree of disambiguation information that is considered as a valuable complement to the source document. The idea is to integrate this disambiguation phase in the authoring process with a two-fold objective: creating enriched, self-explanatory documents and helping authors to learn how to create less ambiguous text. We are working on the definition of a document model that encompasses all required structures and on the associated authoring and visualization services.

3.4. Multimedia Documents Description

Keywords: *digital library, document description, document query, metadata, multimedia*.

Participants: Marc Caillet, Cécile Roisin, Joseph Roumier.

Even if recently significant standardization efforts have been spent on producing description languages for multimedia documents, the problem is not solved yet. Many application domains cannot cope with available description languages. The WAM project is working on this topic in two complementary directions:

- Uniform access to heterogeneous document bases with multiple entry points (metadata attached to documents, terminology and ontology bases). The goal of J. Roumier’s Ph.D. thesis is to model the various components of an architecture that comprises document servers, access points, and interfaces to provide integrated document query and annotation services. The target application is a technical document management system for maintenance.

- Description structures for audio-visual documents, focusing on formal consistency to make descriptions usable in very large bases, such as archives of audio-visual documents. This is the topic of M. Caillet's Ph.D. thesis in cooperation with INA, the French archive of broadcast radio and television. Typical applications of this work are the production of a thematic audio-visual offer from archives or producing the same interactive application on various media (CD-ROM, DVD, Web).

4. Software

4.1. Amaya

Participants: Stéphane Gully, Vincent Quint, Irène Vatton.

Amaya is an open source Web editor, i.e. a tool used to create and update documents directly on the Web. Browsing features are seamlessly integrated with editing features in a uniform environment that allows users to save files locally and on remote servers as well. This follows the original vision of the Web as a space for collaboration and not just a one-way publishing medium.

Work on Amaya is a joint effort with W3C that started to showcase Web technologies in a fully-featured Web client. The main motivation for developing Amaya was originally to provide a framework that can integrate many W3C technologies during their development with the goal of demonstrating these technologies in action while taking advantage of their combination in a single, consistent environment.

Amaya started in 1996 as an HTML editor. Support for the creation and debugging of CSS style sheets was soon added. It was then extended to support XML and an increasing number of XML applications such as the XHTML family, MathML (for mathematical expressions), and SVG (for vector graphics). It now allows all those vocabularies to be edited simultaneously in compound documents. Amaya includes a collaborative annotation application based on the Resource Description Framework (RDF), XLink, and XPointer.

Now that a number of technologies are implemented in the editor, developments focus on usability. The latest extensions are oriented towards robustness and ease of use. An important redesign phase was carried out in 2004 for improving the user interface on several platforms: Linux, MS Windows, and Mac OS-X.

Four public releases were made in 2004, on 5 March, 27 April, 9 July, and 21 October.

4.2. LimSee2

Participants: Romain Deltour, Nabil Layaïda, Daniel Weck.

LimSee2 is an open source authoring tool for multimedia documents using the SMIL 1.0 and 2.0 formats. It features a powerful graphical user interface designed to ease the manipulation of time-based scenarios in SMIL multimedia presentations. SMIL (Synchronized Multimedia Integration Language) is an XML language, so LimSee2 is an application that constantly deals with common XML issues: parsing, validation, namespaces, DTD-driven editing, encoding, etc.

The aim of LimSee2 is to keep most of the XML aspects hidden from the user, so that there is no need to manipulate raw data: everything can be done graphically. The main specificity of the SMIL language is that it clearly separates the two main areas of a multimedia presentation:

- Spatial layout specifies where and how multimedia objects should be displayed in a 2D space.
- Media synchronization specifies how multimedia objects should be synchronized over time.

The development of LimSee2 started in October 2002. The first public release was made on 13 June 2003. Version 1.0 was released on 30 September 2004.

5. New Results

5.1. Transformations

5.1.1. Containment in XPath Expressions

Work on containment in XPath expressions was continued in 2004. The containment relation between two XPath expressions p_1 and p_2 (denoted $p_1 \leq p_2$) holds true when, for any XML tree t and any context node x, the set of nodes selected by p_1 is included in the set selected by p_2, starting from x in t. It is worth noting that the equivalence relation between two expressions (denoted $p_1 \equiv p_2$) can be expressed using two containment relations. (i.e. $p_1 \leq p_2$ and $p_2 \leq p_1$), and given a suitable algorithm, equivalence is reducible to containment.

Some problems reduce directly to containment or equivalence, such as expression optimization and key inference [7]. Containment is also important for static analysis of XSLT transformations. Indeed, type-checking XSLT transformations can be split in two parts. First, the content generation part of the stylesheet needs to be validated against an output schema. The second part consists in testing the containment of the XPath expressions of the transformation with path expressions extracted from the output type. Moreover, it can reveal two aspects of the expressions valuable for transformation designers and query programmers: consistency and performance. In practice, complex XPath expressions turn out to be difficult to interpret, so that errors can be easily introduced. The consistency of an expression can be verified by checking if it is contained in the empty path.

The containment and equivalence of XPath expressions have been studied using an inference system combined with a rewriting system. The inference system allows us to assert and prove properties on a class of expressions. In contrast with model-based approaches, the inference and rewriting systems are applied to the XPath language directly. We believe this will help understanding the underlying issues of deciding containment on the language itself.

5.1.2. XPath Formal Semantics

[10] has introduced an interpretation of XPath in First-Order Logic, and describes a framework for formal study of XPath. The framework relies on the Coq proof management system, and aims at tackling combinatorial complexity of proofs caused by XPath structure. A formal proof of the equivalence of XPath denotational semantics and its logical interpretation has been provided.

5.1.3. Logic-Based XPath Optimization

New results [9] [11] have been achieved for optimizing XPath expressions by taking advantage of the containment relation over an XPath fragment. Static analysis and transformations of XPath expressions have been described in order to eliminate redundancies and to detect contradictions at compile-time. Practical experiments have been carried out to illustrate the performance gain using major XPath engines.

5.1.4. Stream-Based Processing

A method for refactoring XPath 1.0 expressions for stream-based evaluation purposes has been proposed [8]. This extends the normalization of XPath expressions into the Core language (as described by the W3C formal semantics draft) for the case of data-flow XML processing.

5.2. Adaptation

Adaptation methods transform the content from its original state into another state in order to meet the constraints of the target environment. In [2], information description formats were studied. The outcome of this study permitted the development of several techniques for content adaptation in different presentation contexts. Information exchanges used in this context were based on a declarative approach where the content structure is separated from its presentation. A complete context-aware adaptation infrastructure has been presented in detail in [13]. The adaptation considers the context of the client and also the environment of every client request but with an incremental context build-up. A device-independent model was also defined in order to

obtain a completely automatic adaptation system. This system uses a context description model together with a client repository and offers device context management and querying functions.

In order to assess the effectiveness of the approach, the platform has been developed and tested with two network infrastructures: an IEEE 802.11 wireless LAN and a wired network. From this platform, we showed that querying and exchanging context fragments increases significantly the performance of the system. Some experiments on the performance of the platform for mobile accessible multimedia content have been presented in [13].

The adaptation platform uses NAC as its core architecture. NAC [12] defines a content negotiation and adaptation architecture based on a set of components such as ANM (Adaptation and Negotiation Module) and UCM (User Context Module). The context description and management are based on a new metadata model called UPS (Universal Profiling Schema). UPS was defined using CC/PP and RDF. During an adaptation session, profile analysis is performed using repository services and a new negotiation protocol. NAC has been tested with several adaptation schemes such as static adaptation, dynamic adaptation, media and structural adaptation. The results of this work have been contributed to the W3C and helped in the definition of some standards such as CC/PP and Device Independence. In addition, NAC has been used to define best practices and guidelines [16] that Web content authors and solution providers should employ for creating adaptive content.

5.3. Multimedia Authoring

Techniques for editing structured multimedia documents constitute the background of the editors Amaya and LimSee2. Recent work carried out by the team in this area was published in 2004.

A particular emphasis was put on the innovative features of XML that make it different from usual structured documents, as inherited from SGML. This includes in particular namespaces, well-formedness, style sheets, and non-textual vocabularies. These new XML features have a strong impact on editing techniques and require new methods, such as handling multi-DTD DOM trees (namespaces), constraint-free structure manipulation (well-formedness), style sheet debugging, and high-level interfaces for non-textual vocabularies [15]. A consequence of supporting multiple namespaces is is the ability to edit compound documents [14].

Even if multimedia contents are widely used and standard formats exist both for media items and presentation structures, there is still a gap between user requirements and existing tools. A comprehensive study [6] was carried out to analyze user needs for specification, management and editing of multimedia documents with a special focus on the SMIL language and its players and authoring tools.

6. Contracts and Grants with Industry

6.1. RIAM Satin Project

Participants: Peter Hewat, Nabil Layaïda, Vincent Quint, Cécile Roisin.

Satin (Synchronized applications for interactive digital television) is a joint project with the HTTV company, funded by the French ministry of industry through the RIAM network.

Most interactive television services broadcasted today are completely independent from the audio and video streams, as if the two worlds of television and interactive applications were only sharing the same broadcast channel. The main goal of Satin is to introduce some synchronization between the two kinds of contents. To achieve this goal, a comprehensive environment is being designed and implemented for creating, producing, broadcasting and presenting interactive digital television applications that are synchronized with audio-visual contents. This project is based on both the Web standards and formats created by W3C and the digital television standards from the MPEG group. It is a contribution to the next generation of the PrimeTV product from HTTV.

The main contributions of WAM concern formats (based on XML and SMIL), the editing environment, and the simulation component, which allows the author to immediately get feedback on user experience.

6.2. Microsoft Research Grant

Participant: Nabil Layaïda.

Projet WAM and project Sardes received jointly a Microsoft Research Innovation Excellence Awards for Embedded Systems to work on dynamic adaptation of embedded multimedia applications on Microsoft Windows CE .Net.

Multimedia applications are increasingly deployed and run on mobile terminals, characterized by limited capacities in terms of network bandwidth, CPU, memory or display size. Therefore, managing Quality of Service for multimedia applications executed on mobile terminals is a crucial issue. Recently we experimented with component-based dynamic adaptations on a proxy node for adapting multimedia streams according to the requirements of the terminals. A perspective to this work is to enable such adaptations on the terminal, which would allow new QoS management strategies. We exploit Windows CE .Net and compact .Net technologies to implement dynamic adaptation of embedded multimedia applications.

6.3. Collaboration with IBM Research

Participant: Pierre Genevès.

During a 3-month visit at IBM T.J. Watson research center, Pierre Genevès worked on static optimization of XPath expressions for evaluation upon streaming XML data. Pierre received an IBM Invention Achievement Award for results that aim at supporting queries which include context-state references or backward navigation [8] in a stream-based architecture.

7. Other Grants and Activities

7.1. National Actions

Ministry Grant: Satin is a RIAM project carried out with the HTTV company.

INRIA Software Development Grant: the development of LimSee2 was supported until September 2004 by a grant (ODL) from INRIA.

The WAM project is a member of Working group 3.3 Multimedia Documents of GdR-PRC I3.

WAM participates in CNRS network RTP 33, Documents and content.

Collaboration with INA on description languages for multimedia documents.

7.2. International Actions

The WAM project cooperates with NRCD (National Rehabilitation Center for Persons with Disabilities, Japan) on accessibility features in the LimSee2 editor.

The Amaya Web editor is developed jointly with W3C. The software is distributed by W3C.

8. Dissemination

8.1. Leadership within Scientific Community

Nabil Layaïda is a member of the W3C Synchronized Multimedia working group. Tayeb Lemlouma is a member of the W3C Device Independence working group. Vincent Quint is a member of the W3C Advisory Committee.

Vincent Quint is a member of the steering committee of CNRS RTP 33: Documents and content; Cécile Roisin is a member of AS95: Time in digital documents.

8.2. Conferences, Meetings and Tutorial Organization

Vincent Quint is a member of the steering committee of the conference on mobile multimedia, Mcube.

Cécile Roisin is a member of the steering committee of the ACM Symposium on Document Engineering.

Jean-Yves Vion-Dury was a co-organizer of the Workshop on High Performance XML Processing, New York, NY, USA, May 2004.

8.3. Teaching

Nabil Layaïda and Cécile Roisin give lectures on Structured Multimedia Documents in the joint Master of UJF and INPG, University of Grenoble.

Nabil Layaïda also teaches on XML Technologies at the third year of ENSIMAG, Grenoble.

Cécile Roisin also teaches on XML Technologies at the third year of INSA, Department of Telecommunication, Lyon.

Cécile Roisin gave a lecture in the INRIA school Publishing on the Internet, Aix-les-bains, September 2004.

8.4. Conference and Workshop Committees, Invited Conferences

Cécile Roisin is a member of the editorial board of the journal Document numérique. She was the editor of the special issue on Time and documents.

Jean-Yves Vion-Dury was program committee chair of the ACM Symposium on Document Engineering, DocEng2004.

Tayeb Lemlouma was invited speaker at MIPS 2004, Second International Workshop on Multimedia Interactive Protocols and Systems.

Members of the WAM project were on the following program committees: W3C Mobile Web Initiative Workshop, ACM Symposium on Document Engineering DocEng2004, Workshop on High Performance XML Processing, workshop on Handheld Computing ISICT 2004, International Workshop on Managing Context Information in Mobile and Pervasive Environments MCMP-05, 20th ACM Symposium on Applied Computing SAC 2005, 8th World Multi-Conference on Systemics, Cybernetics and Informatics SCI 2004, 3rd International Symposium on Information and Communication Technologies ISICT 2004, ACM Multimedia Systems Journal, Revue I3.

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