# Authoring design patterns for user & device dependant adaptive data presentation

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Abstract

In 2000 the iSign project started as a virtual web-based laboratory for students of study program electrical engineering. Continuous development in the last years led to a heterogeneous learning environment offering learning material, adaptive user settings and access to a simulation tool. Access is available via web and wireless devices such as PCs, Laptops, PDAs, smartphones and mobile phones.

Our attempt to adapt the content to the user's needs and the currently used device led us to a XML based data structure. This report shows our research results about content adaptation based on XML data. The two main aspects for that process are: the device capabilities and the adaptation methods using XML data.

## Introduction

The accelerating evolution in the mobile device market has shown that it is more and more impossible to distinguish mobile devices on a rough and general classification such as PDA, smartphone or mobile phone [6]. One main result of the in-depth study was that this categorising is not a proper decision for solving the problem of capabilities dependant content delivery. As a conclusion we use a combination of all important capabilities to define the classification of the device (Chapter 2). During the recent years XML has been proven to be the adequate and powerful technology to store content in a presentation independent manner. We define an additional attribute inside the XML tags to manifest classifications (Chapter 3). At the same time this will help the authors to generate learning material for different devices in an efficient and structured way (Chapter 4).

To provide proper solutions to the problem of platform-dependant web content delivery and the storage of data in XML format, early attempts discussed providing two different presentations for desktop and mobile platforms [4]. Later, different studies concentrated on providing several presentations for different models [5] or categories [6] of mobile devices.

## Device Classification

The new concept of device classification is based on isolating the important capabilities, described by classification parameters. These parameters can be combined to a vector which spreads out a parameter space. Finally the parameter space is transformed into a low-dimensional space which is then divided into the targeted number of classes. Figure 1, models an example space for an application, which is designed to offer 7 different presentations depending on the visual and connection capabilities of the devices. Note that the first presentation (class 1) is omitted as it is reserved by default to desktop devices (PCs and laptops). This new concept has the advantage of flexibility in the selection of the classification parameters, and the number of classes. However, the more parameters are taken into consideration the more complicated the system gets.

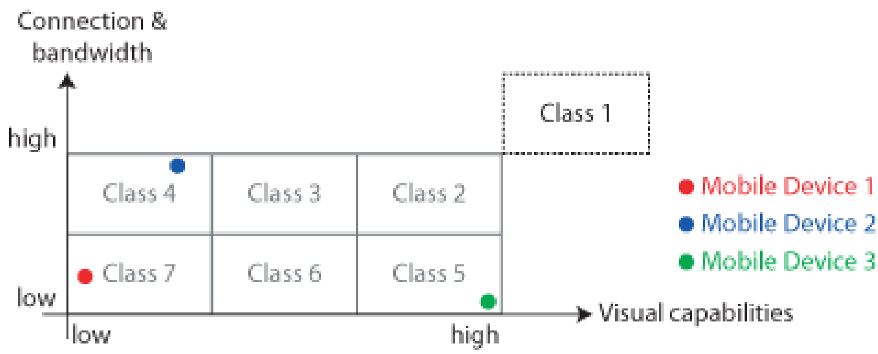


Figure 1: An example of 2 dimensional space divided into 7 classes

Devices classification factors

During the investigation the following general categories of classification factors were found:

**Visual factors:**

Currently, there is a huge variance in the visual capabilities of the available mobile devices in the world wide market. While there are a lot of visual limitations on an application which is running on a mobile phone with a small screen and limited number of colours, other more visual oriented mobile devices provide means for applications with advanced visual capabilities. Here comes the importance of enabling the same application to use the maximum visual abilities of the used device. The main factors that were found to vary from one device to another are: the display size, the screen resolution, the screen size in characters, the number of colours and the orientation of the device.

**Media factors:**

The available mobile devices were found also to have a wide range of media presentation capabilities (i.e. acceptable MIME media types). While one mobile device may be able to present a media type with a certain file format, another may not be able to present the same media type or may have the ability to present it but needs another file format. These media types are text, images, audio and video.

**Connectivity factors:**

These are the connection speed and the Internet access method, which specifies whether the device is connected to the Internet via a Wireless LAN or a mobile network service provider.

Other factors that may vary from one device to another are: the supported languages, the memory size, the operating system and its version.

## Factors Determination Methods

The following are the main approaches used by mobile web developers to evaluate actual values for necessary factors:

**HTTP Request Headers:**

Using HTTP request headers such as the user-agent header and the accept headers is the easiest approach to be implemented and the fastest from the performance point of view, but it has some drawbacks. One problem is that it provides a very limited set of information about the user's browser like the accepted MIME types, preferred character set and accepted language set. Another problem is that browsers may not provide full or correct information. However, this approach can be effectively used to distinguish microbrowsers from normal ones, in other words, mobile devices from desktop devices (PCs and laptops).

**CC/PP framework, UAProf:**

The CC/PP (Composite Capabilities/Preferences Profile) framework is recommended by the W3C (World Wide Web Consortium) [2] as a standard for delivering information about the used mobile device. This standard defines the structure of the device profile based on the RDF (Resource Description Framework) [2], but it does neither provide any recommendation about the content of such profiles nor the way they are delivered and by whom. For this purpose, the UAProf (User Agent Profile) [3] standard is used which is defined by the OMA (Open Mobile Alliance) and followed by most of the mobile device manufacturers. This approach provides clearer, more precise and more variant information about the user's mobile device. It provides information about the connectivity capabilities of the device but this is still not enough for providing information about the connection bandwidth and the method of payment; whether the user is concerned about the connection time or the amount of delivered data.

In some cases, a simple software code could be applied in order to have a more precise value for some of these factors such as the connection speed.

But, for some of the factors there is currently no other way than asking the user to provide the factor, such as the Internet access method.

Module implementation

The implementation is realised as shown in Figure 2. The class evaluation module is integrated into the presentation tier of the system. It detects the device's capabilities and determines its class according the above described factors when the user connects to the system. However, the importances of such a single factor can vary dependant on the content (e.g. Text versus video). The Data Collection & Arrangement unit is only concerned about the resulting class in addition to the identifier of the requested page in order to perform its task.

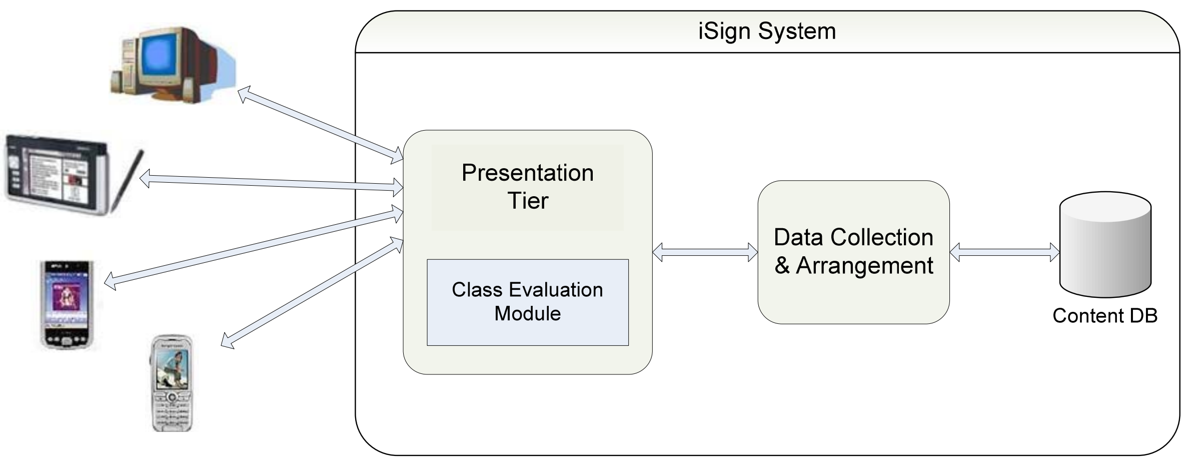


Figure 2: The iSign theory delivery subsystem

A combination of the determination methods which are mentioned before was used in the implementation of this module. The flowchart in Figure 3 models the whole process. First, it is detected whether the user is connecting to the system via a mobile device or a desktop device by analysing the user-agent header. Then, the visual factors are detected using the UAProf XML file which is downloaded from the manufacturer's server. The last step depends on the internet access method which must be delivered by the user.

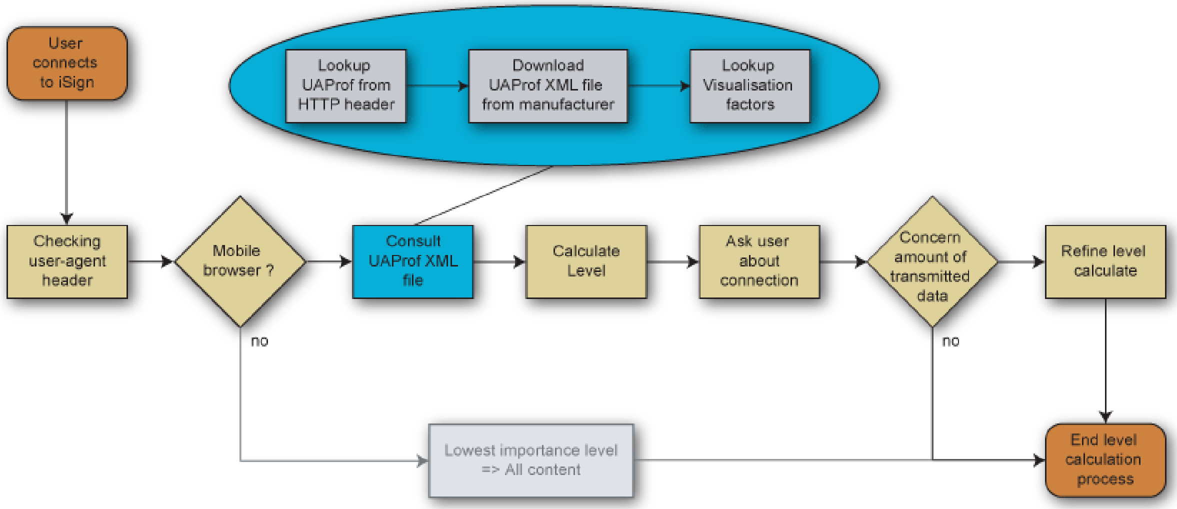


Figure 3: Class evaluation flowchart

XML data adaptation methods

The analysis of actual mobile device market studies has shown that all microbrowsers of the currently delivered mobile devices by the world wide market leaders fully support the WAP2.0 standard [8]. This implies the full support of XHTML MP (XHTML Mobile Profile), a subset of the XHTML markup language.

Our intention is, that all content is available as XML data (source data). The actually requested information can be selected individually depending of the request details. It forms a result set for the requesting user.

Only those content parts within the source data will be selected and provided as a result set which correspond to a predefined ***content class***. That is, according to the request details an appropriate class will be selected and consequently only those content parts, which belong to this class, will be inserted into the result set. Technically there has been carried out a mapping between request (details) and corresponding class.

The content class information has been realised by an additional attribute within all XML tags which are used as information source. It indicates to which class the content of the respective tag belongs. This ***class attribute*** is used when the content of the XML data is processed to dynamically form the result set (Figure 4).

The processing of the source data and transformation into two different result set formats (XHTML and PDF) is realised by the iSign system. Java code uses the instructions given by XSL file and processes the content of the source data accordingly. For each class there exist two XSL transformation files, one for XHTML and one for PDF output, respectively. The XSL transformation file that is used for the dynamic generation of PDF result sets contains instructions corresponding to XSL-FO. The XSL transformation file used for the generation of XHTML result sets contains pure XSLT instructions.

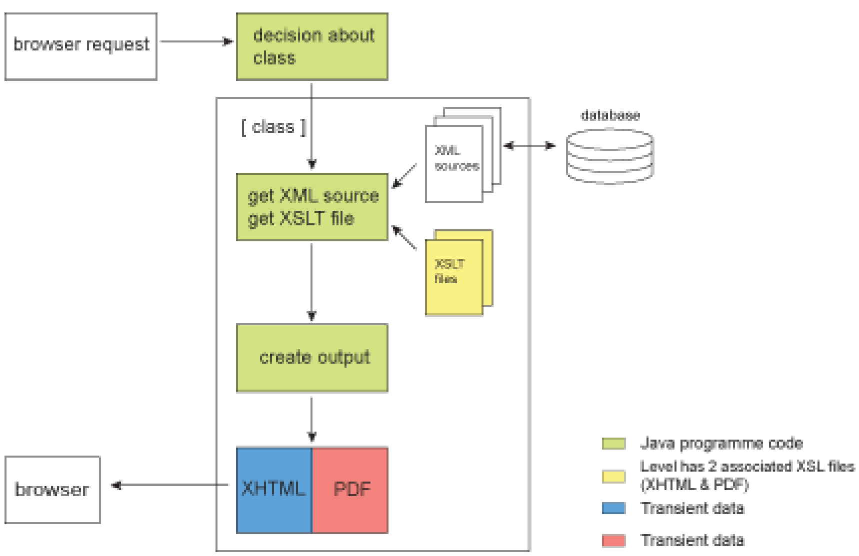


Figure 4: Dynamic creation of XHTML and PDF result sets

The benefits for the authoring process are:

- Use of XML format guarantees flexibility and portability of information.
- Only one additional attribute within XML tags - the class attribute – is necessary.
- The author is able to arrange the content in a hierarchical manner. Essential information is included in all the result sets, i.e. tagged with the content class that is always included in the result set. All supplementary information can be added incrementally using the other content classes until finally the content class is used that is only included for desktop systems which provides best conditions for displaying all information.

## Design Patterns

The XML based data storage allows the authors to classify their content according to the importance of the content. Usually authors tend to generate their learning materials and later on strip it down to adjust the content to lower end devices. As result content can get incomprehensible and difficult to read and understand. Furthermore when cutting down content important relationships within the content might get lost and thereby also the information that is intended to be transmitted will be lost.

In this system contents which are less important can be omitted on lower end devices without loosing the learning contents. As a result of the studies and the development of this system it was found out that authors have to start with the ***essential*** learning content (Figure 5). This information has to be presented on all devices, whether the device is a mobile phone or a high end personal computer.

In the next steps the authors can add additional learning content. Every new added information has to be tagged and classified, whether the added information is ***important***,

***relevant*** or ***optional***. In this way the authors ensure that the learning content on low end devices is still understandable because the ***essential*** content is transmitted. In order to avoid storage of the same content multiple times, a less important class contains always the information of all more important classes (e.g. Class relevant includes additionally content of important and essential).

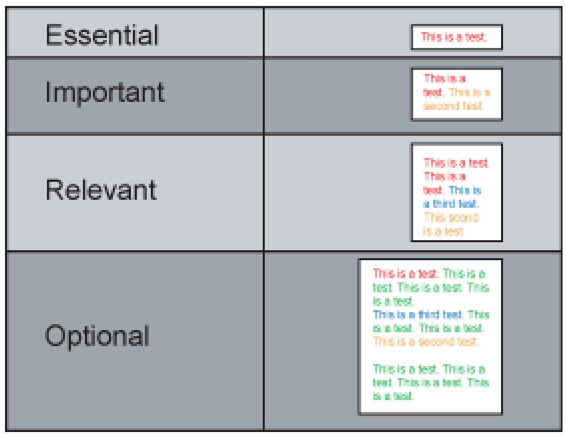


Figure 5: Content classes

The system decides which device fits best to an existing class and transfers the corresponding content. But the system does not automatically divide the content into different classes. This will and has to remain an author's task.

To categorise text into different classes is not a problematic task but it is time consuming. A problem can occur with other media formats like images, sounds and videos. It can not be guaranteed that all devices can present this media formats. As result this formats should be used with care especially if the importance of the learning content is high (as example ***essential*** content).

The best media solutions for images are media formats which are vector based and can be scaled without quality loss. Unfortunately such media formats are in most cases **not** supported by low end devices. In order to display such a media format on a low end device a media format conversion has to be performed at the server side. The output of such a conversion has to be a media format which is supported by the corresponding device (e.g. JPEG). Although a conversion has to be performed in order to present vector based media formats on most of the devices these formats are preferable. The reason is that these formats are scalable to fit optimal on the device screen without loss of quality.

In contrast to vector based formats, the pixel based can not be scaled without loss of quality. However scaling happens often on end devices in order to adjust the media to the screen. But scaling such materials can have dangerous side effects. For example small lines can disappear in a scaled down image. To avoid an unpredictable on device scaling, the format should be adequate “pre-scaled” by the system.

## Conclusion and Future Work

The introduction of multiple XML based content classes and a corresponding classification of a connected device has increased the flexibility and adjustability of the system. However the authors effort to classify content in the actual state of the system requires a lot of technical knowledge and is time consuming. Further work will focus on simplifying the content creation and classification. Additionally, new developments will be studied and included in the existing system if of benefit. As example the W3C is currently working on a new markup language called DIAL (Device Independant Authoring Language) [7]. DIAL is based on XHTML, CSS and other W3C recommendations, but it also offers extra features which are aimed to make it easy to present content on a wide variety of mobile devices.

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