A DIGITAL TELETEXT SERVICE

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ABSTRACT

Digital Teletext is one of the most important interactive services of emerging digital television. As an enhanced version of existing analogue Teletext service, it's a resident application of the set-top box. Its information will be stored in a data carousel and transmitted via broadcasting network. The new service can display smooth graphics and images, have page links and a menu driven navigation method. However, there is no standard specification available for the content format. This paper presents a content format based on Extensible Markup Language (XML). A prototype of digital Teletext system is implemented using the Java programming language.

Keywords: digital Teletext, XML, content format, Java, user interface.

1 INTRODUCTION

The analogue TV teletext service is popular in many countries. It is a well-established method of delivering textual information to the home users. Teletext uses the vertical blanking interval (VBI) between lines of video to transmit data packets and displays text pages on television screen [Weitzel99]. The Teletext decoder memory stores part of page data [ETS97]. Viewers access information using a remote control to select three-digit number on the screen. The Teletext information is comprised of standard text combined with limited amounts of simple color graphics.

The technology of analogue Teletext does not exist in digital television. There are no vertical blanking intervals. Instead, the text information is stored in data carousels and transmitted cyclically as transport streams together with other streams of content elements [EN97]. Digital television will have more bandwidth. This makes it possible for digital Teletext service to have navigation menus, full-color graphics, formatted text, and even images [Gerard99].

Some service providers, such as BBC digital Teletext service, use MHEG-5 language for coding digital Teletext service [Gerard99]. MHEG-5 works well for writing content with hyperlinks or hotspots. However, only set-top boxes with a MHEG-5 virtual machine can process and format the service [NorDig00].

Our work is based on the previous work described in the paper [Vuorimaa00]. The earlier results show that XML can be used in digital Teletext service.

XML as a text-based markup language is a W3C standard since 1998. It's a method of putting structured data in a text file. It's a set of rules (via Document Type Definition) for designing text formats for data so that XML files generated areeasy to read and parse, unambiguous, extensible, interoperable, and platform-independent.

XML is a powerful tool to model digital Teletext content format, specify text font styles, store large volume of digital Teletext information in database, and edit XML documents. XML parser is a set of Java class libraries. Thus, it can be embedded together with digital Teletext application bytecodes, since all the Multimedia Home Platform (MHP) compatible set-top boxes will have a Java virtual machine in the future [DVB00].

Besides, XML can be used in a Java platform as an interface for storing, retrieving,

processing generic hierarchical object structure, and developing user interface of digital Teletext service.

In this paper, we present a Digital Teletext system developed in the Future TV project. The application uses more advanced DTD to define content format, such as tables, graphics, separate page, font style, broadcasting service, etc. The application organizes large volume of information using XML and uses Java as programming language. Compared to the previous version, new functionality has been added to the system, e.g. http access to archives, caching XML pages, displaying tables and graphics based on the definition, animation (newsflash), and page links.

2 XML & JAVA TECHNOLOGY

XML documents have hierarchical structure. Unlike HTML, which is used for formatting and displaying data, XML represents the contextual meaning of the data. The designer is free to use any XML tags to mark up information that make sense for a given application using Document Type Definition (DTD).

The DTD is a part of XML standard. It's the grammar for XML file that is defined by the designer. A DTD specifies the rules for syntactic correctness.

The DTD associated with an XML document is defined by the document type declaration, which appears at the top of the XML file. For example,

<?xml version="1.0" encoding="ASCII" ?>
<!DOCTYPE texttv SYSTEM texttv.dtd">

The document type declaration may contain either an inline copy of the document type definition or a reference to that document as system file name [W3C98]. We use the latter method.

After the structure of XML data has been defined using a DTD, one has to write the Java code to associate each element with a Java class. We used the DOM (Document Object Model) API instead of the SAX (Simple API for XML) API as an XML parser in our system. The DOM API allows programmer to represent XML document as a tree of nodes in Java program.

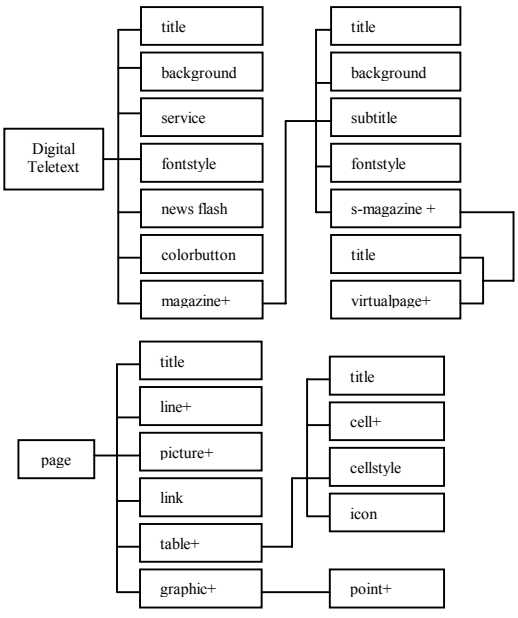
The DOM describes a set of language-neutral interfaces capable of representing any well-formed XML. The DOM parser reads an XML file and then returns a representation of the file as a tree of objects (cf. Figure 5). This gives immense power in manipulating structured documents in Java. All the functions (e.g., display, read XML data, etc.) can be processed in Java classes.

In addition, the GUI (Graphics User Interface) API [DVB00], which is defined in DVB-MHP (Digital Video Broadcasting-Multimedia Home Platform) Java platform, includes functionality to draw graphics/widgets on television screen and to input events from a remote control. It is based on Java Abstract Window Toolkit (AWT) with additional TV extensions. This GUI API is quite suitable for coding the user interface of digital Teletext service [Peng00a].

3 MODELING DIGITAL TELETEXT SERVICE CONTENT

Figure 1 depicts the content format defined in the DTD file and used in our digital Teletext system. It forms a tree of XML document. Each element node corresponds to a tag in a XML file. Table 1 lists the DTD file structure.

In Figure 1, the root node *Digital Teletext* has seven child element nodes. *Title* node contains the title text of digital Teletext service. *Background* node has *Title* and *Image* attributes. They are used to carry the title of *Magazines* and the file name of background image. *Service* node has attributes that can carry channel information of current broadcasting, such as *Logo*, *Channel Name, Program Type, Program Title, Program Duration, Clock,* and *Date.* The purpose of adding service node is that viewer can still view current television program, while using the digital Teletext service (cf. Figure 2).



Content Format of Digital Teletext
Figure 1

```
<!-- DTD file format for Digital Teletext    Peng
Chengyuan    2000.05.25 -->

<!-- This DTD document is used to define the data
structure of Digital Teletext Service Content-->

<!ELEMENT      DIGITALTELETEXT  (TITLE,
      BACKGROUND, SERVICE, FONTSTYLE?,
      NEWSFLASH?, COLORBUTTON+,
      MAGAZINE+ )>

<!ELEMENT      TITLE (#PCDATA)>

<!ELEMENT      BACKGROUND (#PCDATA)>
<!ATTLIST        BACKGROUND
         Title CDATA #REQUIRED
         Image CDATA #IMPLIED>

<!ELEMENT      SERVICE   (#PCDATA)>
<!ATTLIST         SERVICE
         Logo CDATA #REQUIRED
         ChannelName CDATA #REQUIRED
         ProgramTitle CDATA #REQUIRED
         ProgramName CDATA #REQUIRED
         Duration CDATA #REQUIRED
         Date    CDATA #IMPLIED
         Time    CDATA #IMPLIED
         Id      CDATA #IMPLIED>

<!ELEMENT      FONTSTYLE (#PCDATA)>
<!ATTLIST        FONTSTYLE
         Type CDATA #IMPLIED
         Style CDATA #IMPLIED
         Size CDATA #REQUIRED
         Color CDATA #REQUIRED>

<!ELEMENT      NEWSFLASH (#PCDATA)>

<!ELEMENT      COLORBUTTON (#PCDATA)>
<!ATTLIST        COLORBUTTON
         Label CDATA #REQUIRED
         Color CDATA #REQUIRED
         FocusColor CDATA #REQUIRED>

<!ELEMENT      MAGAZINE  (TITLE,
           BACKGROUND?, SUBTITLE,
           FONTSTYLE? (PAGEHEADER+)?)>

<!ELEMENT      SUBTITLE (#PCDATA)>

<!ELEMENT      PAGEHEADER (TITLE,
            VIRTUALPAGE+)>

<!ELEMENT      VIRTUALPAGE (TITLE?,
           (LINE+)?, (PICTURE+)?, (LINK+)?,
           (FORM+)?, (GRAPHICS+)?)>

<!ELEMENT      LINE (#PCDATA)>

<!ATTLIST         PICTURE
         Width CDATA #REQUIRED
         Height CDATA #REQUIRED
         Link CDATA #REQUIRED
         Caption CDATA #REQUIRED>

<!ELEMENT   LINK(#PCDATA)>

<!ELEMENT      FORM (TITLE, CELL+,
          CELLSTYLE?, ICON?)>

<!ELEMENT      CELL (#PCDATA)>
<!ATTLIST CELL
         Width CDATA #REQUIRED
         Height CDATA #REQUIRED
         Left CDATA #REQUIRED
         Right CDATA #REQUIRED
         Down CDATA #REQUIRED>

<!ELEMENT      CELLSTYLE (#PCDATA)>
<!ATTLIST         CELLSTYLE
         Type CDATA #REQUIRED
         Size   CDATA #REQUIRED
         Style  CDATA #REQUIRED
          FColor CDATA #IMPLIED
          BColor CDATA #IMPLIED>

<!ELEMENT     ICON (#PCDATA)>

<!ELEMENT      GRAPHICS (POINT+)>

<!ELEMENT      POINT (#PCDATA)>
```

The Document Type Definition of Content
Table 1

FontStyle node has attributes *FontType*, *FontStyle*, *FontSize*, and *TextColor*, which are used to define font styles of the main page of digital Teletext service. *Newsflash* node carries text of headline news. It shows the most important news headlines to the viewers, while they are viewing the digital Teletext pages. *ColorButton* includes attributes *Label*, *Color*, and *FocusColor* to indicate the label, color, and focus color of the four color buttons (i.e., red, green, yellow, and blue) labeled in the remote control [Peng00b] [NorDig00].

Most of the information is underneath the *Magazine* node, since the text information is organized as magazines. The symbol "+" in Figure 1 denotes multiple nodes. Each magazine has its own magazine *Title, Background, Subtitle,* and *Font Style* attributes. Each magazine also includes *s-magazine* nodes. Each sub-magazine has its own title and pages. *VirtualPage* node includes attributes *File* and *Number*. *File* is an XML file name. Digital Teletext service will contains huge volume of information, and thus it is impossible to cache each page in set-top box memory. Therefore,

a separate page format definition is needed. Each page is still numbered.

A separate *Page* node is comprised of six child element nodes (i.e., *Title, Line*, *Picture, Link, Table,* or *Graphic*). Node *Title* represents page title. *Line* is a plain text node. *Picture* node has *Width*, *Height*, *Link*, and *Caption* attributes. *Link* node includes a pointer to another page. This is an easy way of implementing page links.

Table node consists of *Title*, *cell*, *Cellstyle,* and *Icon* nodes. *Cell* includes attributes *Left*, *Right*, *Down*, *Width,* and *Height.* These attributes are used to indicate the relative position of current cell to previous cell. *CellStyle* comprises some useful attributes to draw cells of the table. These attributes are *Font Type*, *Font Size*, *Font Style*, *Foreground Color*, and *Background Color.* *Icon* node carries the file name of icon (cf. Figure 4).

The main page of digital Teletext service
Figure 2

Graphic node has attributes *Type* (draw line or spline), *Fill* (filled color), and *color* (line frame color). *Point* node is its child node. The text value of *Point* is its x-y coordinate value.

A page from News magazine
Figure 3

Figure 2 shows a screenshot of the main page of digital Teletext service. The upper part is channel logo, digital Teletext service title, date and timer. The newsflash and four color buttons are at the bottom of Figure 2. Left panel shows the main index of magazines. The video and channel information is displayed on the right side.

A Page from Transportation magazine
Figure 4

Figure 3 shows a page from News magazine. This page includes lines of text and images. Figure 4 is an example of tables displayed.

4 JAVA IMPLEMENTATION

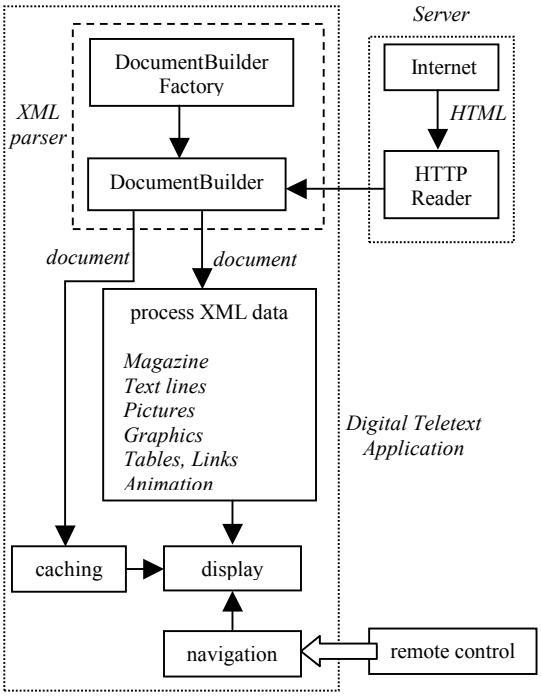
The test system was implemented using JDK 1.3 as programming platform and JAXP 1.0.1 (Java API for XML Parsing) as an XML parser. JMF2.1 was used to present streaming media (i.e., video).

Figure 5 illustrates the system architecture of the digital Teletext service. One of the new functions added to the system is http access to archives. The server is used to simulate a data carousel for transmitting data to the client (set-top box). The data information including XML and image files is obtained from the Internet via *HTTP Reader* using HTTP protocol. The *HTTP Reader* is responsible for converting needed information in HTML files from the Internet into XML files when data pages are requested by the viewer. It is a very complicated part in the system because the data information from the Internet changes quite often. Also some symbols like &, >, and <, etc., which are reserved by XML language, have to be filtered and processed specially.

When pressing *Text* button on a remote control [NorDig00], the digital Teletext service is activated. The application part reads XML data from the *Server*. The data is then parsed via the XML parser. In XML parser module, a *DocumentBuilder* instance is generated by

DocumentBuilder factory. Some documents with object trees are output from *DocumentBuilder*. The application then processes the documents.

The application consists of four processes except XML parser, i.e., Process XML data, caching, display, and navigation The *Process XML data* includes functions for processing *Magazine, Text lines, Links, Pictures, Graphics, Tables, Newsflash,* etc. Each function corresponds to a Java class, which is associated with an element node in the DTD file (cf. Figure 1). Each Java class includes relevant processing, e.g., traversing and reading XML data needed for each process and displaying them on a Java GUI panel. Special processes for display are needed in *Tables*, *Graphics*, *links*, and *Animation* (newsflash) modules.



System Architecture of Digital Teletext Service
Figure 5

Based on the definition of a table (i.e., each cell of the table is relative to the previous cell) the program draws each cell using only relative coordinates. This is an easiest way to display tables using XML.

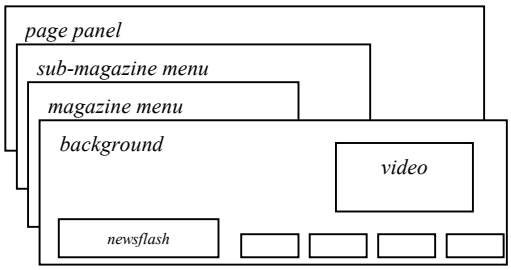
In *Graphics* module, a new graphical type -spline was added as well as line-frame graphics. The spline is 2–degree composite spline curve. The curve passes all its control *points,* which are carried in XML files.

Page links are a very important feature in digital Teletext service. Each page corresponds to an element node in XML. It is numbered by tree-digit number *ABC*. *A* denotes which magazine the page locates. *B* is sub-magazine number of the page. *C* is page number. The XML document is a tree structure as mentioned in section 2. Therefore, a tree-traversing algorithm is suitable for searching a special page using the tree-digit number.

The future digital Teletext service can also have animations [Vuorimaa00]. Newsflash is actually an animation by using Java thread feature. It was executed concurrently with the service.

The purpose of caching digital Teletext pages was to enable fast access to most frequently searched pages. Each page is an XML file defined in the DTD file (cf. Figure 1).

Java GUI API is an ideal tool to program the user interface of digital Teletext service. The user interface of the system consists of several panels (cf. Figure 6). The panels are overlapped. The panels that are not activated are set invisible. When more than two panels are visible, the new panel added is covered by other panels.



Layout of Layered Panels
Figure 6

A remote control can be modeled using Java Event model. A detailed description of remote control buttons and model can be found in [Peng00b] [NorDig00].

5 CONCLUSIONS

This paper presented a working prototype of digital Teletext service programmed using DVB-MHP Java platform with XML data representation. In particular, the definition of basic content format was described in detail. These basic element nodes are necessary to document large volume of data information. In real system, more nodes has to be defined and added. We think that our work is valuable and useful to both researchers and practitioners.

The future set-top box can have only a subset of all available Java classes. Thus, the limited resources of set-top box make develoment

of digital Teletext different than Web development. The advantage of digital Teletext service based on Java and XML is that full XML browser is not needed. Also, Extensible Stylesheet Language (XSL) is not required. XSL is good for designing stylesheets, but it has too much overhead to be used in digital Teletext service. Also, it is unlikely that XML browser will be embedded in set-top boxes in the near future [Vuorimaa00] [DVB00].

We plan to port this application together with other multimedia services into a set-top box environment using the system developed in the Future TV project.

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