CONTENT TRANSCODING MIDDLEWARE FOR PERVERSIVE GEOSPATIAL INTELLIGENCE ACCESS

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ABSTRACT

In this paper, we describe a novel content transcoding middleware for accessing military geospatial intelligence information in real-time. Intelligence information, including maps and location, category and properties of object targets, is adapted for various pervasive devices such as laptop, personal digital assistance (PDA), cellular phone, etc. The middleware is deployed as proxies on the Web using the IBM Websphere Transcoding Publisher (WTP) platform, which facilitates the middleware management. We developed several Java-based plug-ins and Extensible Stylesheet Language (XSL) stylesheets for content transcoding. A prototype has been established and real experiments have demonstrated the effectiveness of this novel middleware.

1. INTRODUCTION

Accessing versatile types of information from pervasive devices is a challenging goal to many applications. Many previous researches address the need of a content-based transcoding middleware and proposed some solutions [1-4]. Using metadata in the XML format is widely considered as a promising solution for adaptation. Standards such as MPEG-7 and MPEG-21 have been used to address this need in transcoding multimedia content [6]. For some other specific domain data such as graphics, image and text, W3C suggested an XML-based standard, Scalable Vector Graphics (SVG), which can provide much richer interactivity than general images. It can also provide some forms of metadata for transcoding. In addition to the metadata standards, another hurdle in deploying a transcoding middleware is an infrastructure which allows developers to add novel transcoding plug-ins and has the capability to scale and easy to administrate. Websphere Transcoding Publisher (WTP) is an IBM product which can be served as an infrastructure for various kinds of transcoders.

We propose a novel content transcoding middleware for accessing military geospatial intelligence information. We utilize the Web Common Operating Picture (WebCOP), which is a development system that allows network users to retrieve geospatial intelligence information (such as map, image, target objects, property of objects, etc.) through regular desktop/laptop web browsers, as the information source of our middleware. We developed and implemented a prototype to provide content access capability to a wide variety of devices with different personalization, device constraint and network constraint requirements. Also, a main challenge this prototype system has to deal with is the scalability and abundant administrative functionalities required for practical system deployments.

The tangible benefits of our approach include:

- **Reduce WebCOP server workload**: The adaptation of the WebCOP content for pervasive devices is performed by the WTP, while the WebCOP server is only responsible for generating intermediate formats that are device neutral and individual profile independent.
- **Enable quick content adaptation**: The transcoding of the WebCOP content for the device is done at the edge of the network, and can thus provide device-dependent and individual profile dependent content adaptation.
- **Demonstrate federated WebCOP services for Scalability**: The proposed prototype is a demonstration of federating WebSphere Transcoding Publisher, which can be viewed as an intelligent cache, deployed within the network and at the edge of the network that federate with WebCOP servers and provide much better scalability.

The scope of the project is to (1) enable universal access of WebCOP by pervasive devices based on Device and communication characteristics Personal preference/role, and (2) enable client-side and server-side rasterization of graphics based on SVG (including maps).

Figure 1 shows the overall structure of the transcoding middleware. It includes an Enterprise Information System (EIS) which stores the geographic maps and object information – types, location, time, etc. A WebCOP server is used to fetch these information and then convert it to Web format, such as HTML and Images. WTP works as a proxy for the devices that stand in

![Architecture of the overall system](image-url)

**Figure 1**: Architecture of the overall system.
between the devices and the WebCOP server.

This paper is organized into the following sections. Section 2 describes the middleware infrastructure and the major components of the middleware – SVG and WTP. In Section 3, we describe the details of individual transcoders and their properties. Some example of the usage environment is demonstrated in Section 4. Section 5 gives a conclusion.

2. MIDDLEWARE INFRASTRUCTURE

Figure 2 shows the proposed architecture for pervasive access of WebCOP that includes:

- **WebCOP server**: which is a J2EE Application Server, in which two plug-ins are added. These plug-ins convert maps and objects from proprietary WebCOP formats to SVGs and generate property sheet of intelligence information using HTML format.

- **Content adaptation plug-in**: we focus on using SVG as an intermediate format to facilitate role and device specific transcoding. In the right-hand boxes of this middleware, the top areas represent the format of the intelligence property sheets and the bottom ones show that of the map and object images.

- **Content adaptation engine**: we use Websphere Transcoding Publisher with the addition of new modules that can leverage the annotations or transcoding hints inside the SVG. A brief introduction of the two important infrastructures: SVG and WTP are shown in the following subsections.

2.1 Scalable Vector Graphics

Scalable Vector Graphics (SVG) is a language for describing two-dimensional graphics in XML 1.0, developed by the World Wide Web Consortium (W3C) as the Web standard for presentation of vector graphics images. Most graphics on the web today are in raster (bitmap) formats (e.g. JPEG, GIF, and PNG), containing information about every pixel. Vector graphics, on the other hand, describe an image in terms of shapes, lines and text. Raster graphics files tend to be large and the image quality deteriorates quickly when enlarged or shrunk. SVG vector files are compact and the images can be viewed at any scale without loss of clarity. Texts can be scaled independently from the images. This is an important advantage such that the text information on the transcoded SVGs for the pervasive devices can keep clear and readable.

SVG allows for three types of graphic objects: vector graphic shapes, images and text. Graphical objects can be grouped, styled, transformed and composited. The feature set includes nested transformations, clipping paths, alpha masks, and filter effects. SVG allows hyperlinks. Some of its profiles can incorporate Javascripts to provide enhanced features. An SVG can be considered as an HTML page with enhancements on graphics, text, and images. Other benefits of using SVG are:

- Screen images are always crisp and can be scaled without loss of detail.
- SVG files are, on average, smaller than other Web image formats and therefore are quick to download. Background images can be embedded inside an SVG file. Thus, an SVG can be stored as a single self-contained file, which reduces the Internet traffic between proxy and the intelligence WebCOP server.

Some free SVG rendering software is available on laptop/desktop PCs, e.g., Adobe SVG viewer plug-in for Internet Explorer. For Pocket PC devices, CSIRO developed an SVG toolkit with a free trial version of stand-alone Pocket SVG Viewer application.

**Figure 2**: Transcoding Proxy for Accessing Web Common Operating Picture (WebCOP) on pervasive devices
2.2 Websphere Transcoding Publisher

IBM Websphere Transcoding Publisher (WTP) transforms content based on what the requesting device can handle, and on the capacity of the network being used. Web content can be transformed differently for different devices and networks. WTP can be deployed as a network proxy, as a reverse proxy, as a filter, as a plugin in edge server, or as JavaBean components in customer’s own application. WTP transforms data by intercepting and transforming requests and responses to deliver a targeted response to a user. It tailors HTTP requests, generates responses, and transforms and filters the responses. When WTP works as a proxy, it supports existing Internet applications and data without requiring programmers to redesign corporate systems for different devices. WTP supports common types of Web data.

WTP uses four types of resources to process documents: (1) Preference profiles: WTP uses preference profiles to represent the characteristics of devices, networks, and users, as well as organizational policies. Each profile tells WTP how to treat documents that will be delivered. (2) Transcoders: A transcoder is a program that modifies the content of a document/image. Transcoders are selected based on the preference profiles with conditions specified when the transcoder is created. (3) XML stylesheets: WTP can use Extensible Stylesheet Language (XSL) stylesheets to convert XML documents to any markup language. Each stylesheet is represented by a stylesheet selector, which contains conditions for the selection of the stylesheet for use by WTP. (4) Annotators: An annotator typically is applied to a group of Web pages with similar tagging. Each annotator is based on knowledge of the structure of document. WTP provides tool to allow manual or automatic metadata annotation to documents.

The Administration Console is a graphical interface for many of administrative tasks. It provides a tree view of resources (preference profiles, annotators transcoders, and stylesheets), the ability to edit individual resources, a menu structure to provide access to other tasks, and help for each panel, as well as a list of other help topics. Figure 3 shows the architecture of WTP.

3. TRANSCODERS

Table 1 is a list of the capability of the devices that we used in our testing environment. We can see that these devices have highly variant capabilities. Laptop PCs can display all kinds of information: SVGs, HTMLs, Images, etc. On the other hand, Nokia Mobile phone can only display a specific subset of HTML tags, GIF images, without mouse-click interactivity capabilities.

We developed an SVG template for WebCOP server and several transcoding plug-ins for WTP:

- **WebCOP to SVG transcoder**: We developed an SVG template which is composed of three nested sets: object templates, background image, and foreground objects. Object templates are used to define specific types of objects and their shapes. Foreground objects use a group of global parameters of translation and scaling, that can be changed while the SVGs are cropped or scaled. Individual object has its translations and scaling parameters relative to a group origin point. This template is used by NG to develop a WebCOP to SVG transcoder.

- **SVG to SVG’ transcoder**: Based on the client device profile, WTP transcodes an SVG based on the viewbox, global shift of the foreground objects and cropping/scaling of the background image in SVG. Also, we embed the manipulated background image into the SVG to reduce the work and transmission load for proxy load.

- **SVG to Mobile SVG transcoder**: Mobile SVG includes two profiles – SVG Basic and SVG Tiny. These are subsets of the SVG profiles that are designed for mobile devices. We develop this transcoder for converting general SVGs into the format that is compliant to the SVG profiles used by the Pocket SVG Viewer. Some transcoding is needed such as the font style of text and strict requirements of DTDs in the SVG headers.

- **SVG to Image transcoder**: Batik is a Java-based toolkit for applications or applets that want to use images in the SVG format for various purposes. Batik provides building blocks that developers can assemble in various ways in their Java technology applications or applets to generate, parse, view or convert SVG contents. Batik can convert SVG content into other formats such as JPEG, PNG or TIFF or other formats (transcoder API). We use Batik to generate a plug-in which converts the original WebCOP PNG images to either JPEG or GIF.

- **SVG to HTML transcoder**: This transcoder is based on an XSLT stylesheet. For a non-SVG rendering device, general browsers that reads HTMLs can be used to displayed a transcoded SVG files that have been converted to HTML and an image. The hyperlink properties of the original SVGs are utilized by the image maps inside the HTML.

<table>
<thead>
<tr>
<th>Device capabilities</th>
<th>SVG Support</th>
<th>HTML Support</th>
<th>SVG/HTML Interactivity</th>
<th>JavaScri pt Support</th>
<th>Screen Size (Display area)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WebCOP function</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Desktop + IE browser + SVG plug-in</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>1400x1200 or 1024x768</td>
</tr>
<tr>
<td>HP iPAQ + Pocket IE</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>240 x 320 (220 x 280)</td>
</tr>
<tr>
<td>HP iPAQ + SVG Viewer</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>240 x 320 (220 x 280)</td>
</tr>
</tbody>
</table>
Table 1: The device capability

<table>
<thead>
<tr>
<th>Device</th>
<th>Capability</th>
<th>Resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sharp Zaurus + Opera browser</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Nokia Mobile Phone + Browser</td>
<td>No</td>
<td>Partial (GIF only)</td>
</tr>
</tbody>
</table>

4. EXPERIMENTS

We deployed a prototype transcoding middleware as a proxy at the Internet. Any browser of pervasive devices can set the URL of the middleware as its HTTP proxy. We have tested the system on desktops, laptops, HP Pocket PC (WinCE device), Sharp Zaurus (Linus-OS device), and Nokia Mobile Phone Browser in a wireless LAN 802.11b environment in Washington, DC with the proxy in New York. Figure 4 shows an example of the WebCOP content triggered by different transcoding profile. A proxy administrator can set the cropping factor, scaling factor and the zooming factor via the WTP administration console. Figure 5 shows the transcoded content using the PocketIE browser on a PocketPC device. It also shows the intelligence information associated with the objects on the map. All figures and property sheets are transcoded to HTML and JPEG images. In Figure 6, we can see the transcoded result on the Nokia Mobile phones.

An advantage of the proposed system was observed. After our presentation at the debut demo, an audience challenged whether this system can let his Sony Clie, a Palm-OS device which was not originally supported, access the WebCOP content. Within 10 minutes, our proxy administrator added this device to the WTP profiles, helped the device accessing the wireless LAN, and set the HTTP proxy. Afterwards, it could access the customized WebCOP content right away. This example showed the flexibility and usability of the proposed middleware.

5. CONCLUSION

We presented a prototype of content transcoding middleware for accessing military geospatial intelligence information. The ease of maintenance is a major advantage of this system. The transcoding middlewares can be very scalable and run on multiple proxies. This system deployment distributes the computational requirements from the WebCOP server to the numerous transcoding middleware. In the future, we will further investigate on the personalized information access and interactivity capability to the middleware.

6. REFERENCES