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A Proposed Software Architecture for Graphical Data Manipulation in the Context of a Mobile GIS for the Tourism Industry in Mauritius

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ABSTRACT
By definition tourists are mobile, that is they travel from one place to another, in their quest for experiences. Therefore, based on the fact that they are mobile and searching for information, it can be deduce that mobile assistance can greatly improve their quest. The initial stage of this research is an attempt to provide a true mobile GIS; one which is reachable by Java enabled cellular mobile phones with colour display and network capabilities. The objective is to provide reliable anytime, anywhere access to geographical information about Mauritius. A proposed software architecture for the presentation of graphical maps over mobile phones is being investigated and developed.

INTRODUCTION
Mauritius is a tropical island situated between Latitudes 19°50 and 20°32 South and Longitudes 57°18 and 57°46 East in the Indian Ocean. The Tourism sector is a very significant contributor to the Mauritian economy. It is also defined as the country's third economic pillar. In the past two decades tourist arrivals have increased at an average annual rate of 9 % with a corresponding increase of about 21% in tourism receipts.[1]

Information and Communication Technologies (ICT) have also contributed in the promotion of Mauritius as a high standard tourist destination. But these are mainly restricted to simple web presence whereby information about the island and all related tourism attractions, products and services are available. Once on the island, ICT is not much help to the tourists in their daily activities. Mauritius is a volcanic island with craters and mountain ranges, surrounded by the sea and small islands that are near the shore. These constitute the main tourists attractions and in such areas, the traditional technological means of accessing information are inappropriate. Often, only a simple paper based map is available. In this context, there is much scope for a more dynamic and reliable service for tourists, which can be accessed via a mobile phone, irrespective of time and location to act as a tourist guide. This shall form the main objective of this study.

THE APPROACH
Numerous technologies are being merged together including the Geographical Mark-Up Language (GML), Scalable Vector Graphics (SVG), eXtensible Mark-Up Language (XML), Java 2 Micro Edition (J2ME), and Java 2 Enterprise Edition (J2EE), to come up with a complete ubiquitous GIS. One of the most important factor that was carefully considered before tackling the design of the application was the availability of geographical information of Mauritius. The most complete set of spatial data is available in the form of digital maps. It covers the whole island in scale ranging from 1:100000 to 1:2500. These maps are available in AutoCAD format (.dwf). The strategy adopted for this research project is firstly to divide each district of the island into smaller areas and, thereafter, use of a 1:70000 scale to represent each area. Spatial data are removed from those small areas and converted in GML 3.0, which is an XML-based language used to encode geographic information. GML encoded information can be easily transported over the internet [8]. Moreover, similar to XML, GML is only a data content language, which requires a presentation language to be associated with it.

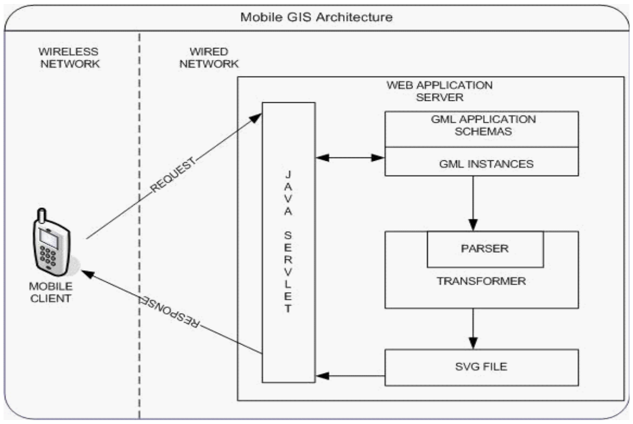
SVG has been the selected presentation language. It is suitable for mobile devices and can also be associated with GML. Two sub-profiles SVGB (Basic) and SVGT (Tiny) have been defined by the W3C [2]. This study mainly addresses SVGT as it is suitable for highly restricted mobile devices. For a mobile phone to access SVGT files, a browser has been designed, based on the open source TinyLine SVGT viewer [3]. This mobile SVGT browser provides functionalities such as zooming, pan-zooming, vertical and horizontal scrolling. Horizontal scrolling is one issue which has not yet been solved with raster graphics on mobile phones. However, this is possible with the vector graphics.

J2ME (Java 2 Micro Edition) brings the cross-platform functionality of the java language to the smaller devices, allowing mobile wireless devices to share applications. Today, almost all mobile cellular phones are java enabled, which surpasses the "static" nature of such type of devices [4]. Mobile phone users can browse the web and download J2ME applications. These applications range from personal data management software to games. J2ME enabled mobile phones have opened the door to a new era in mobile computing.

The model devised for the development of a mobile GIS is based on a client server approach over the existing wireless and wired network. The clients are J2ME enabled mobile phones, equipped with colour display and network capabilities. The perfect client would be a smart phone, which is now considered as a new class of computing device and is indeed a mobile phone equipped with removable memory cards, full-colour quarter VGA display or better and support for 3G networks. On the server side a J2EE web application server handles the client requests and provides the appropriate responses. The software architecture over the existing networks is shown in Figure 1.

The client makes a request for a geographic map from a mobile phone via the wireless network. This request is generated by the J2ME midlet and is directed to the application server. The server processes the request by creating or using an existing instance of a GML file. The GML instance contains all the geographic features about the particular area required. The GML file is parsed and transformed into a vector graphics file (SVGT). The client then accesses the map through its SVGT browser. To convert GML to SVGT, a java parser and transformer has been written. The J2EE platform provides access to JAXP (Java API for XML Processing). With JAXP 1.3 incorporated into the servlet, GML files can be parsed and transformed for presentation. This is performed with the use of XSLT - eXtensible Stylesheet Language Transformation -

Figure 1. Mobile GIS Architecture



which is an elegant and powerful mechanism for modifying the format, content and organisation of XML documents. An XSL stylesheet has been written and templates have been defined to convert GML tags into SVGT tags.

Since mobile phones are limited devices with low processing power, care should be taken not to overload the device. In this line, A.Piras et al[5] proposed a compact GML for merging mobile computing with mobile cartography, which delegates more processing to the client. Since such strategies can increase the response time, client server architecture has been adopted, whereby most of the processing is laid upon the server. The clients only deal with forming requests and interpreting responses. For the time being all the maps are generated and stored on the server. The client uses the browser to view and make requests on the generated maps.

Once the realisation of the software architecture is proven as feasible, it is expected that the service will be delivered through a website. Tourists connect to the website with their Java enabled mobile phone, download and install the client application. Once the application is launched the users only need to specify their queries using the menus that will be provided, and all the processing behind each action or query remains transparent. The user is guided with pop-up messages generated by the application. For example, each time a connection to the wireless network is required, the system generates a small message. In this case, the user is always aware that the operation requires network connection, hence involving a fee. This cost of network usage is a very important issue for the popularity of this mobile GIS. GPRS is the technology that provides an 'always on' connection and such a facility is available in Mauritius. The mobile GIS is be based on GPRS, and in this context, all data send over the network is optimised. All queries and responses is of the minimum size possible and the design focuses on reducing the number of requests that a client might need to make. These inevitably reduce the cost of network usage.

There are still many problems that need to be tackled, e.g. whether to store geographical information about Mauritius only in GML files, or will the need of a database arise. In this perspective, the work of J.Zhang et al[6] and L.Harry et al[7] are being investigated. Another problem lies in the fact that a tool might be needed to either convert proprietary AutoCAD files into GML or extract the geographical data. The client interface design is another important issue since mobile phones are relatively small devices compared to desktop computers. The user interface design again requires careful attention. There are other means for delivering the client application which can be more attractive to the user point of view. A 24/7 broadcast at specific areas of the airport of Mauritius is possible and the interested users only need to activate the Bluetooth connection of their mobile and download the application free of charge. The feasibility of this solution needs more investigation. International users who will use access the mobile GIS through expensive international mobile phone services is another issue and this can be a major impediment. Such barriers can only be broken so as to make the GIS service affordable.

CONCLUSION

Several technologies have been combined in an attempt to create a software architecture model to display digital maps over mobile phones. The architecture is now being validated with the implementation of a prototype. The first prototype is expected to create an environment which provides unrestricted access to geographical information, compared to the limited access inherent in the traditional means. The main outcome of the project is to allow the tourists to explore Mauritius with more assurance and more access information, irrespective of their geographical location within the island. It is also expected that the once implemented, this shall also benefit the domestic tourists or the local people.

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