The Development and Customization of GIS-Based Applications and Web-Based GIS Applications with the CASE Tool AIGLE

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ABSTRACT
In this paper, we propose a visual CASE Tool named Aigle with multiple abstraction levels including a visual language (oriented end-user) and a technical visual language context (oriented designer) for Geographic Information Systems. This CASE Tool addresses the problem of the customizations of GIS applications on several marketed GIS platforms. The use of visual language is suitable for the readability of high level diagrams by non-expert end-users. AIGLE generates automatic customized GIS-Based Applications and Web-Based GIS Applications thanks to a user-friendly interface. Thus the designers can save 95% of the time spent on developing. More over a visual object oriented method is proposed to facilitate the design of spatial applications

Keywords
CASE tools, Conceptual Modeling, Spatial Database, Geographic Information Systems (GIS), Web-Based GIS, GIS-Based Applications, Visual Languages.

1. INTRODUCTION
A growing number of GIS-based applications for the web have been developed and marketed last decade (traffic monitoring, site location and remote geographic databases access, ...). The development and the customization of these applications is mostly a heavy task and time consuming. Therefore, tools are needed to facilitate the automatic production of such GIS-based applications. Thus a CASE tool named AIGLE has been designed and developed for the modeling and the customization of GIS-based applications. This CASE tool has been marketed by the company CIRIL since July 98; it implements an object-oriented method named OMEGA. AIGLE was recently extended to support the customization of web-based applications. This article provides an overview of the CASE tool AIGLE, as well as the description of its Web extension. The main advantages of such solution are: (i) the portability regarding marketed GIS, (ii) automatic generation of code in MapBasic and a standard Java web applications, (iii) a visual formalism in a specific OO method for GIS.

2. PRESENTATION OF OMEGA METHOD
Many works about Visual Language (VL) and visual programming have been carried out during the last decade. The proposed approach in this paper consists in developing a visual language for query and design in Geographic Information System (GIS) applications [4].

This language will cover design stages and end-user query language for spatial data which have a very high expressive power. A visual object oriented formalism based on Object Modeling for End-user Geographic Application (OMEGA) formalism is proposed. A dynamic visual representation of object state transitions is introduced in order to evaluate the design of an application before the encoding stage. The design of a GEUA (Geographical End-User Application) [16] is made by using a special formalism based on the OOA [2], MODUL-R [1], CONGOO [6] and the unified method UML methods. The OMEGA method [4] leads to an operational description of the GEUA organization and architecture. It covers all the aspects of design by considering four general views and giving an abstract level of a designer's point of view:

1) **An organizational view** including requirements, collection of specific objects having semantic aspect for the end-user (use case) taking into account a possible existing alphanumerical system, organization of costs, planning and staff structuring;

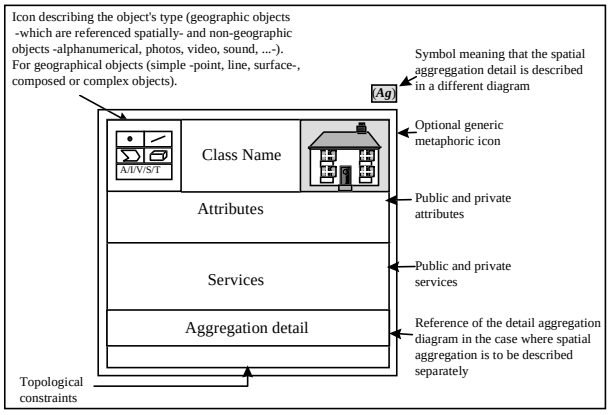

Figure 1. Graphic description of spatial meta-class with OMEGA

2) **A static view** for describing objects and classes of objects with specific graphical representation (Figure 1.). It is important to mention that for the pictogram representing geographic objects, one must consider the scale of the representation of the object (e.g. a road may be considered as a line or surface in function of scale's point of view). A meta-class is represented by a double

frame with an iconic pictogram describing the object's type and a generic symbol giving a visual information of thematic data. Each object class could have an end-user representation (metaphoric icon) and technical representation (graphical representation with, in addition of the metaphoric icon, an iconic symbol for spatial data, the class name, attribute, and services). Each object meta-class has a multiple abstract representation depending of the designer requirements. Static view is associated to a class diagram model. Class diagram model is composed of user class diagram in which objects are represented by icon metaphors and technical class diagram in which objects are represented by their technical representation (Figure 2). The user class diagram is more "readable" for a non-expert end-user; thus it will facilitate the validation of diagrams with end-users.

3) **A dynamic view** including the description of object reactions to different events. If the objects have a « reasonable » number of transition states, each object state is associated with a dynamic metaphoric icon. This last point helps for testing (in different dynamic scenarios) and gives a semantic dimension for static scenarios.

4) **A functional view** including different services description and the main scenario description.

3. PRESENTATION OF THE CASE TOOL AIGLE

AIGLE [4] is a CASE tool which is dedicated to automatic generation of geographical software application. This tool is to be used by users with little knowledge in computing and in GIS. It helps the users to work with customized marketed GIS software without having to understand and to go deeper into the GIS software complexity. AIGLE generates rapid prototypes on a marketed GIS (ArcInfo, MapInfo™, JAVA, etc.) and "Oracle". Thanks to specific GIS driver, AIGLE has the possibility to automatically generate geographical applications on several GIS. The portability is guaranteed thanks to an intermediate language based on SQL3 MM [3] and specific GIS drivers. Currently Two specific drivers have been developed for MapInfo™ and for Java Thus, AIGLE is the only industrial tool to generate GIS code (Java, MapBasic, …) from a to z and to compile, link and run an executable GIS-Based customized software. AIGLE is also a **GRAD tool** (Geographical Rapid Application Development) helping **designers** to build a GIS application that **meets user's requirements** and is **delivered in few hours** since the analysis stage has been performed (for example it helps the MapInfo™ customization to go 20 times faster than on usual manual coding). By using AIGLE, the designers will then have more time to spend on analysis than on development. AIGLE is a **GIS wizard** for **final users** who have just to worry about what they're expecting with GIS and not about how a GIS works. By using AIGLE, the final users will build their own customized applications through a user-friendly interface.

4. AUTOMATIC CODE GENERATION OF GEOGRAPHICAL APPLICATIONS

In order to validate our approach and to facilitate the customization of GIS applications for end-users with a low knowledge in computing we have developed a new CASE tool named AIGLE which supports OMEGA method and offers a GIS wizard. This product generates in several target GIS specific applications regarding end-users needs (Figure 3). AIGLE has been developed and tested with an automatic generation of several geographical applications on MapInfo ™ and Java. AIGLE has been marketed since July 1998 by CIRIL. Automatic code is generated thanks to a user-friendly interface. Thus, a same application is generated in different languages such as MapBasic (MapInfo) or other marketed GIS for local execution and Java for Web environment. In order to produce Geo Web-based applications in Java a specific architecture for customizable Web-Based Applications has been introduced.

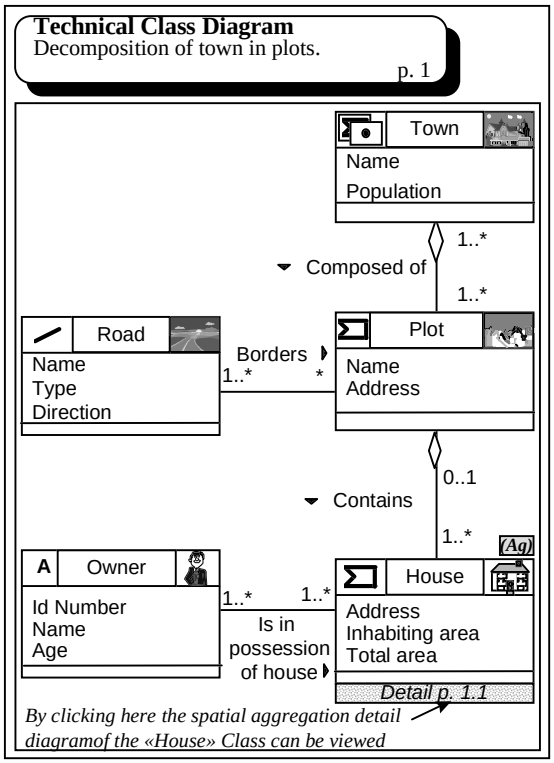

Figure 2. An example of Technical Class Diagram with OMEGA formalism. Metaphoric icons are replaced by a technical representation of objects.

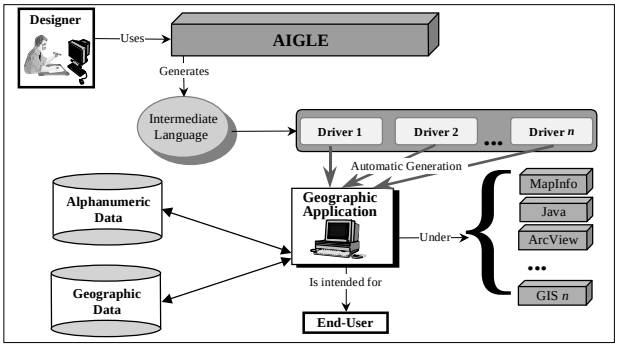

Figure 3. AIGLE Internal Architecture

5. CUSTOMIZABLE WEB-BASED APPLICATIONS

The popularity of GIS-based applications for the Web constantly increases. Indeed, Internet simplifies remote access to geographic data via a common user interface. Dozens of GIS-based systems

can be found on Internet. Their areas of application concerns route planning, town visualization, … As regards our products, we propose a Web-based application adaptable to a wide variety of fields. Using AIGLE and spatial libraries written in Java, we have recently developed a generic Java applet providing functionality to manage geographic data. Once downloaded from a Web server, this applet is executed in a Web browser by the client (figure 4). This applet gives the capability to: download maps from a remote database, display geographic layers, configure display of geographic information, zoom in and zoom out on maps, select and edit geographic objects, display thematic mapping. This customized applet is automatically generated by AIGLE on the server side. In the proposed architecture; both geographic and alphanumeric data are stored in a relational database on the server side. The applet directly communicates with the RDBMS (Remote Database Management System) via the JDBC (Java DataBase Connectivity) interface. Based on the two-tier architecture paradigm, our application performs all "geoprocessing" tasks on the client-side in order to provide to the end-user a real-time execution. Figure 4 presents this architecture. Part of the Java Development Kit, JDBC is a Java API (Application Programming Interface) for executing SQL commands. JDBC includes a driver manager which allows an application to access several different RDBMS through several different drivers.

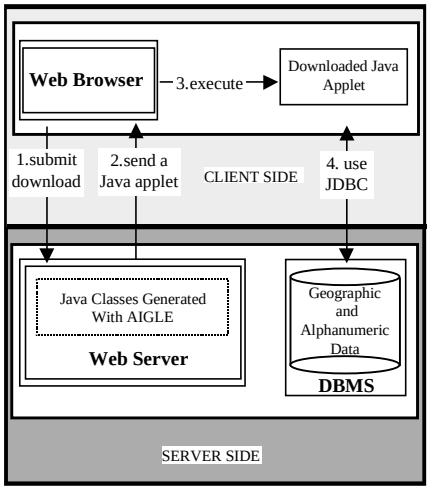

Figure 4. Two-Tier Applications-Based Architecture of Applications generated with AIGLE

To use JDBC with a particular RDMBS, the Web browser needs to download the specific driver from the server to mediate between the Java applet and database. We currently use a JDBC-ODBC bridge driver that implements JDBC operations by translating them into Microsoft's ODBC (Open DataBase Connectivity) services. The Bridge implements JDBC for any database for which an ODBC driver is available. A specific tool was developed so that geographic data of MapInfo, ArcView or AutoDesk document could automatically be imported into diverse databases via ODBC interface.

6. CONCLUSION

We have shortly presented a CASE tool named AIGLE which supports a visual method OMEGA with a multi-level abstraction visual language helping the designers to produce readable and useful class diagrams. Such a tool generates automatic code on several target GIS platforms.

The main advantages of AIGLE are (1) the independence of target GIS, (2) automatic code generation, (3) an incremental system design, and (4) integration in a CASE tool. The independence of target GIS is fundamental to guarantee the portability of the applications. The benefits of the automatic code generation is that the developers no longer have to worry about implementation details. Such a tool offers an incremental system design. The integration in a CASE tool guarantees the management of the application from design to implementation and maintenance. The CASE tool AIGLE has been marketed since July 1998 in France. Several customized geographical applications have been automatically generated under MapInfo™/Oracle, Java and marketed (urban real estate management, cemetery management, election management, assignment of children into schools, harbours management, school bus itinerary, etc.). With AIGLE end-users as well as designers can save 95% of times spent on developing customized GIS-Based Applications. AIGLE enables high level specifications to be converted into applications running on several GIS such as MapInfo or in a Web environment. AIGLE also offers a GIS Wizard dedicated to the fast customization of geographic software applications.

7. REFERENCES

[1] Caron C. & al., International Journal of GIS and Spatial Analyis, Vol. 3 N°3/1993, pp.283-306.

[2] Coad P.&al., Object-Oriented Analysis, Prentice Hall 1991.

[3] ISO/IEC SC21/WG3 N1680, ISO Working Draft SQL Multimedia and Application Packages (SQL/MM)-Par 3: Spatial, Mars 1994.

[4] Lbath A., "AIGLE : A Visual Environment for the Design and automaic Generation of Geographic Applications", Phd Thesis, INSA, Lyon, France, November 1997.

[5] Laurini R. &al., 1992, Fundamentals of Spatial Information Systems, The APIC series, Academic Press.

[6] Pantazis D.N. Methodological analysis for design and development of GIS., Phd Thesis, Université de Liège, 556 p, 14 décembre 1994.