A Standard XML Based Protocol for Spatial Data Exchange

- Its Capabilities and Real Applications -

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Abstract. The G-XML project was a joint project organized by universities, governments and companies in Japan from July 1999 through March 2000 for establishing a standard XML based protocol for spatial data exchange, that is, the *G-XML protocol*, between any GIS (Geographic Information Systems) including ubiquitous GIS. Some prototype systems based on the G-XML protocol have been already developed as software components, and their source codes will become open in May 2000. Some companies had already used the alpha version of open source codes and developed some experimental applications based on the G-XML protocol. This paper introduces the capabilities of the G-XML protocol and its real applications.

1 Introduction

Geographic Information Systems (GIS) are not open for various reasons. One reason is that application domains of GIS are governments and companies, which are generally not open organizations. However, the culture of the Web is changing everything related to information systems including GIS. Furthermore, the eXtensible Markup Language (XML) [10] became an Internet Standard of W3C [11] in February 1998 as an important new technology of the universal format for structured documents and data on the Web. Most communities of various information systems tend to adopt XML for new data formats for interoperability on the Internet as well as their Intranet. GIS community can also adopt new XML based formats for spatial data exchange in the near future. However, there were almost no practical standard of XML based spatial data formats and no license-free software components for them at the beginning of 1999. We had a perspective that both new XML based spatial data formats and license-free software components based on them can have an impact on GIS industry as well

as IT industry to spread GIS over Japan as daily tools for ordinary people. We focused on consumers rather than experts as major users of GIS, because a big consumer-oriented GIS market based on the Web and mobile phones is about to appear in Japan.

About sixty million people have portable phones now in Japan. The number of the portable phones exceeded the number of ordinary wired phones. About ten million portable phones have the capability to use the Web on the Internet. The biggest Internet service provider of Japan is NTT DoCoMo Inc. [6] that provides the Internet service for only portable phone users. It is usual that ordinary users access the Web outdoors. It is possible that the majority of Internet users may shift to the portable phone's environment from usual PCs. Also, some portable phones with GPS will be available this summer. In the near future, ordinary users of portable phones will browse some information related to their place from the Web, and create and exchange real-time data describing their activities with their locations. Thus, the location information will be significant to exchange any types of data on the Internet. The coming portable phones will have basic functions of GIS. Also, portable phones including GIS functions will become cheap or free. It is possible that GIS on portable phones will have enough functions that cover most uses of GIS for consumers. Thus, consumer-oriented GIS may overcome conventional expert-oriented GIS. The GIS paradigm shifting from expert GIS to low-cost consumer GIS may be similar to the computer paradigm shifting from main frames and workstations to PCs. At any rate, the low-cost consumer GIS may change the style of conventional GIS.

2 G-XML Project

G-XML Project [4] was organized in order to develop a standard XML based protocol, called *G-XML Protocol*, for spatial data exchange on Networks from July 1999 through March 2000. The project members consisted of experts from universities, companies and governments. In addition to establishing the protocol, the project developed some prototype systems, called *G-XML prototypes*, using the protocol at the same time so as to check if the protocol is simple enough or not to develop real spatial applications. One characteristic of the standardization activity is that license-free software components will be open at the same time when the specification of the protocol, called G-XML version 1.0, becomes open in May 2000. The development of alpha version of both the protocol specification and software components was finished in November 1999. Then, more than 10 selected companies had developed experimental spatial applications using the alpha version of software components. The developed experimental G-XML applications were exhibited in the open symposium of G-XML project held in Tokyo on February 10, 2000.

The G-XML project was funded by the Ministry of International Trade and Industry in Japan. The project consisted of a head committee and two subcommittees. The chair of the head committee is Professor Masao Iri of Chuo University. One of the two sub-committees was organized for developing the G-

XML protocol for spatial data exchange. The other was for developing G-XML prototypes based on the protocol. The authors were the chairs of the two sub-committees. There was another related committee for investigating activities of international spatial data standardization in order to harmonize the Japanese standardization with the international one. The chair is Professor Hiroshi Imai of University of Tokyo. The secretariat of the project [4] was organized in the Database Promotion Center, Japan [2]. The project also organized a potential user group of G-XML. The user group has now about 220 members from about 180 companies in April 2000. The G-XML project finished the development of both the specification of G-XML protocol version 1.0 and G-XML prototypes version 1.0 in March 2000, and concluded in the same month. The secretariat of the project is now preparing introductory documents about the G-XML protocol and prototypes for developers and users. All specifications, software components, and documents will be freely open in May 2000. All documents are written in only Japanese. However, there is a plan to prepare English documents about G-XML this year.

3 G-XML Protocol

The goal of G-XML protocol is to make GIS truly popular for ordinary people. We could learn many things from the history of the Internet. From a technological view, the Web technology has played the most important role for popularizing the Internet. Before the advent of the Web, the Internet was used only in universities and research organizations. Then, the Web appeared in 1991 and the Internet has been spreading over the world. HTML 1.0 was a description language of hypertexts on networks. At that time, the hypertexts on networks were not popular for ordinary people. HTML 1.0 was not powerful enough to create fine artistic contents compared with contents created by commercial DTP software, but it was simple enough to understand and create rough contents easily by hands. It means that the software for creating hypertexts were all free. HTML 1.0 was far from an ideal document description language such as SGML in terms of the elegance and the powerfulness for creating structured documents, but it was simple enough to develop various Web applications easily. Let us imagine that SGML or XML was used as the first standard hypertext language on the Internet instead of HTML 1.0. It might have been too bulky for most users to understand its usefulness at that time. Furthermore, the Internet might not have become popular and have disappeared now, because Microsoft networks might have defeated the Internet without HTML 1.0. Thus, HTML 4.0, XML and SGML were too early as standard hypertext languages to be used at that time before the Web becomes popular. After many people understood the usefulness and real applications of the Internet and the Web, more functional and elegant languages such as XML can be adopted in the society. Thus, any standardization cannot be independent of popularization, trends and backgrounds. We believe that standards should evolve time after time. In this sense, HTML 1.0 must have been actually the ideal hypertext description language at the beginning when the

Web appeared. GIS was not popular for ordinary people in 1999. The situation is still the same now in 2000. We need some *simple* standard protocols for spatial data exchange because the current phase is the time before GIS becomes popular. After GIS becomes popular, elegant protocols should be proposed.

The G-XML project began to develop a new protocol, that is *G-XML protocol*, for spatial data exchange from July 1999. The G-XML protocol is only a set of DTD (Document Type Definition). G-XML protocol should be simple enough for developers and users to understand. The target application domain of G-XML is wider than the domain covered by conventional GIS. We considered that there are four typical application patterns for the coming GIS domain. G-XML protocol was designed for the four typical application patterns. The fist sub-protocol, called *Real World G-XML* or *RW-GXML*, covers the conventional GIS domain. The second sub-protocol, called *Point & Direction Based G-XML* or *PD-GXML*, is based on *point of interest* for ordinary people to easily generate spatial data outdoors using portable phones and mobile computers. The third sub-protocol, called *Semantic G-XML* or *S-GXML*, covers map data without geometric data. It can be applied to support easy-understanding sketch maps or voice/text navigation. The fourth sub-protocol, called *Graphics Based G-XML* or *G-GXML*, provides a geocoding framework for SVG (Scalable Vector Graphics) [9] which is promised as a next standard Internet graphics format. Thus, the G-XML protocol is composed of these four sub-protocols: RW-GXML, PD-GXML, S-GXML and G-GXML. Although making only one big protocol covering all four application patterns may be possible, we were afraid that it might be confused for developers and users. Thus, we intentionally chose separating four sub-protocols for the four typical application patterns. The first original point of G-XML is that we made good use of XML technology earlier than other standardization activities for developing a simple protocol. The second original point is that we found four typical application patterns for covering various domains related to present and future GIS.

4 G-XML Prototypes

The G-XML project developed pieces of software, that is, *G-XML prototypes* for using the G-XML protocol. Only Java was used as a programming language and a set of basic software components for developing all software. Advent of killer software products based on a standard is significant to make the standard popular. In the case of HTML 1.0, Mosaic was the killer software product based on it and was free. It is important that some killer software products based on the G-XML protocol appear for making the G-XML protocol popular. We are not sure if one of our developed prototypes become a killer software product or not. We have a vision that license-free fundamental software components for using the G-XML protocol will be useful and will make it easy for developers and users to create new fascinating software products which may become killer ones. All our developed source codes of the G-XML prototypes will be open for developers and users so that they can use partially and extend the source codes.

Also, some of the prototypes as they are can be used as G-XML tools for viewing, editing and converting G-XML instances which are spatial data compliant to the G-XML protocol.

There are seven G-XML prototypes as follows.

1. G-XML Viewer
2. G-XML Editor
3. G-XML Mailer
4. G-XML Mobile Communicator
5. G-XML Converter for Shape File
6. G-XML Wrapper for Oracle
7. G-XML Wrapper for SVG

The G-XML Viewer is a Java2 standard edition applet to view RW-GXML, PD-GXML and S-GXML instances on Web browsers. The G-XML Editor is a Java2 standard edition application to read, write and edit RW-GXML, PD-GXML and S-GXML instances. The G-XML Mailer is a Java2 standard application to exchange email messages including maps which are formatted in the forms of RW-GXML, PD-GXML and S-GXML instances. The G-XML Mobile Communicator is a Java2 micro edition application to create points of interest as PD-GXML instances and to view G-GXML instances on mobile communicators. The G-XML Converter for Shape File is a Java2 standard application to convert between Shape data and RW-GXML instances. The reason of selecting the Shape which are spatial data format of ArcView GIS software, ESRI [3], is only why ArcView is one of the most popular GIS software. We never intend to support ESRI. We just want to make and test a real conversion tool between real GIS data and RW-GXML instances. The G-XML Wrapper for Oracle is a Java2 enterprise edition servlet to retrieve RW-GXML, PD-GXML and S-GXML instances from a relational database and to submit RW-GXML, PD-GXML and S-GXML instances to it. We selected Oracle database systems only because they have been most sold in the present market of commercial relational database management systems. The G-XML Wrapper for SVG is a Java2 enterprise edition servlet to convert RW-GXML, PD-GXML and S-GXML instances to G-GXML instances on the fly for transferring spatial data to SVG and G-GXML compliant IT machines. Fig. 1, 2 and 3 show some examples of our developed real applications using the G-XML prototypes.

5 Concluding Remarks

The G-XML project developed the G-XML protocol and the G-XML prototypes in less than one year; from July 1999 through February 2000. All specifications, software source codes and documents will be freely open on the web site of G-XML [4] in May 2000. The G-XML project finished in March 2000. A new project will be planned for promoting G-XML activities. Main aims of the new project may be to upgrade the G-XML protocol and to develop it as an international standard as well as a Japanese standard.

Most users of current GIS can be considered passive because they only use spatial data provided by governments and map companies. The G-XML was designed for realizing the coming spatial information society for everyone to easily retrieve, create and exchange spatial data everywhere at any time using any IT machines. We believe that the coming consumer-oriented GIS will be able to provide ordinary people with a new life environment which may be different from the present framework of GIS. The new style GIS is called *Human GIS* for nurturing human's daily creativity with new spatial thinking tools and spatial data infrastructure.

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8. Oracle Co.: http://www.oracle.com/
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10. Extensible Markup Language (XML): http://www.w3.org/XML/
11. The World Wide Web Consortium (W3C): http://www.w3.org/

Fig. 1. A web page of showing Shinjuku area around Tokyo Metropolitan buildings and some location information of taking photos with G-XML Viewer

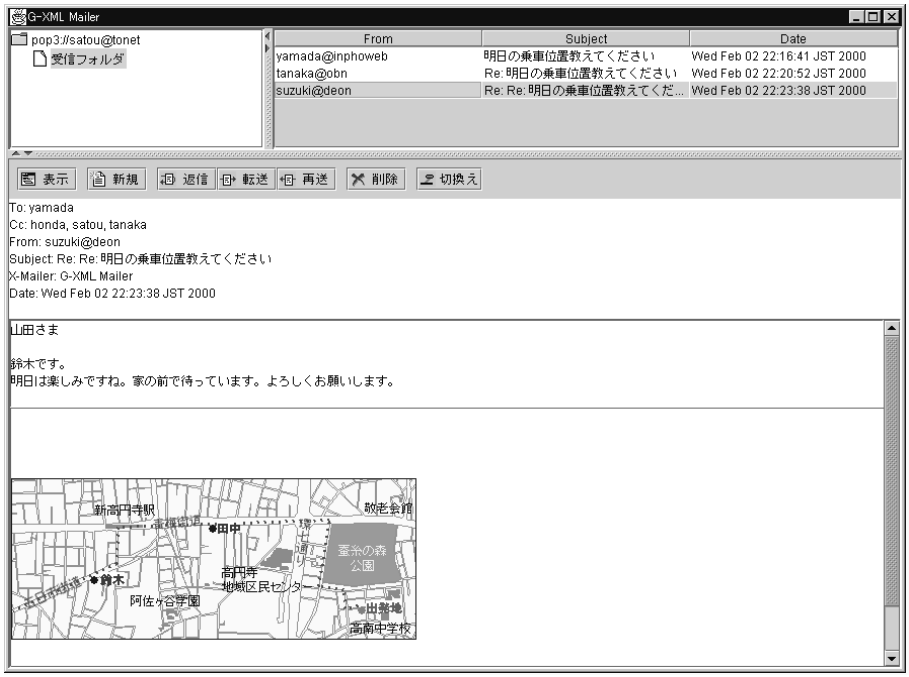

Fig. 2. G-XML Mailer for exchanging messages with editable maps

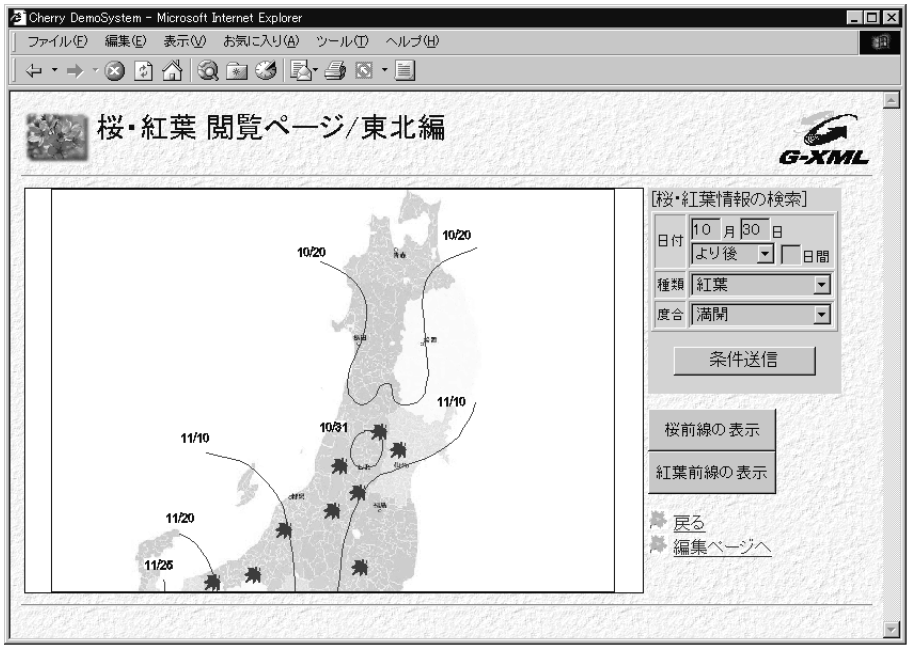

Fig. 3. A web page of showing a contour map about dates of coloring maple leaves on a Japan map using G-XML Wrapper for Oracle. All spatial data about coloring maple leaves can be submitted through web pages to a relational database in the form of PD-GXML instances, and can be retrieved from the relational database through web pages