

Barriers for the implementation of GI standards and interoperability

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Abstract. In this contribution we will present a study of barriers in the implementation of GI standards and interoperability. In contrast to other approaches, we are focusing on two aspects, the availability of software products, and the competence profile of existing personnel. For the study we have made several surveys, which will be summarized. A discussion shows the main results as well as the necessary actions.

Keywords: interoperability, standards, education, competence, software products.

Introduction

Working for the ETeMII project¹, we tried to identify barriers in implementing GI standards and to identify possible solutions. Our basic assumption was that there are barriers, and that it is important to solve them. The existence of barriers has been proven by the slow progress at early stages of Open GIS Consortium (OGC)², one of the first initiatives to promote GI interoperability, and by the increasing interest in studies or projects dealing with promotion or improving the implementation process (in Europe for example GIPSIE³, preANVIL⁴, and ETeMII itself). The importance to solve them is demonstrated by numerous use cases and business requests in interoperable GI services.

In contrast to other approaches, we are focusing on two aspects, the availability of software products implementing GI standards, and the competence profile of existing personnel in GI interoperability. The hypothesis is that (some) barriers are in the lack of availability of a critical mass of software products, as well as in the lack of skilled personnel. This hypothesis is proved by several surveys we have made, and which will be summarized in this study. Recommended actions coming out in the conclusions concern partly software providers – which turn out to be uncritical –, and partly universities. The results concerning the latter group are of special interest for AGILE.

The ETeMII project is a EU-FP5 funded initiative, aiming to enable better access to geographic information. The project will finalize its operations by the end of year 2001. The objective of this paper is to report on the findings that have been made in this context within the ETeMII project.

The study is structured as follows. In Section 2 we discuss the problem and our approach. Section 3 investigates the availability of software products, and Section 4 investigates the competence of available personnel. In the latter section three surveys are presented, concerning industries' requirements, educational material, and university courses in interoperability. We conclude with a summary of the results.

Identifying the barriers

It is realized that there is a lack of experiences of implementing interoperability GI standards. This means that reviewing and analysing experiences is not a fruitful method for identifying implementation barriers. Instead, other approaches than collecting experiences have to be used.

Strategies for implementing or refining information systems have been well investigated during the past decades. When implementing GI standards and interoperability, a similar methodology may be used. An implementation process involves a number of steps. Such procedures are described in various textbooks, for instance by Bernhardsen 1999 or Aronoff 1989. Some steps are equal to common system implementation/refinement, while specific interoperability questions are introduced in the others.

Examples of the latter kind are the creation / modification of a business model. This model should explain why an information system needs to be established or improved. Will it be more effective, provide better products,

¹ <http://www.ec-gis.org/etemii/>

² <http://www.opengis.org/>

³ <http://gipsie.uni-muenster.de/>

⁴ <http://www.anvil.eu.com/>

new business opportunities, better basis for decisions etc? These benefits must be both identified as well as quantified. Several attempts have already been made, in order to identify such benefits. The Open GIS Consortium (OGC) has for instance established the Web Mapping Testbed, which among other things aims to show the potential of interoperable systems. The preANVIL project has formulated a set of showcases, which shows potential application of interoperable systems. There are also several other attempts, all more or less aiming at identifying different benefits. But to create a business model, the benefits must also be quantified. This process is unique for each organisation and the results are usually also confidential.

The preliminary system design is during the implementation process used to estimate the costs of implementing a system. What products are available, which customisations are required? Will the user requirements be met? Will the objectives as expressed in the business model be met? To perform this task, software products must be available and the organisation needs skilled persons, able to perform such analysis. The software vendors are continuously providing more and more products, although their marketing might not always focus on GI standards and interoperability. But also the competence problem within an organisation may be a barrier. This problem has so far received limited attention in the general debate, although it remains a problem in several steps in the implementation process.

In the cost / benefit analysis, several important decisions are taken, for instance whether to assign external software consultants for customisation or to use in-house personnel. To make such decision and the corresponding cost estimates, deep knowledge of the underlying technologies are required.

When creating strategies for data supply, the needs of external data, the adoption of GI standards and network-based resources are analysed. It might be necessary to achieve improved supply of external data, for instance in quality, delivery time, reduced need of reformatting etc. To create such a strategy, the standards have to be adopted by a variety of data suppliers and data users. A critical mass of service providers and data suppliers is here required.

There are also several other steps involved in the implementation of an information system, such as the procurement of equipment, customisation / software development, data acquisition, pilot projects / system test, organisational issues, training and financing. It is however here assumed that implementing systems using GI standards and interoperable components are in these aspects not very different than other types of information systems.

As a result, the barriers here being identified are the creation of business models, the availability of software products, the competence profile of in-house personnel and the availability of external data based on international GI standards. An additional barrier not analysed here is the awareness issue. If organizations are not aware of the potential GI standards and interoperability provides, the process of improving the current system(s) do not start at all (van der Vlugt and Winter 2001).

The remaining part of this study will focus its work on the availability of software products and competence raising actions within the organisations. The reasons for leaving the other barriers out are as follows.

- Some work has already been carried out, for instance by OGC and the preANVIL project, in order to identify components (benefits) in a business model (why do we need GI standards and interoperability). To quantify these components in terms of benefits is a matter for each organisation. As a result, the identification of components in business models will not be studied further in this specific study.
- Problems and barriers related to the availability of external data are studied within several other studies, both within the ETemII project as within other projects. This means that there are less reasons for this study to address this specific issue. As a result, this study is concentrating its efforts on the potential barriers that so far received less recognition, namely the availability of software products, and the competence profile of existing personnel.

Availability of software products

Existing software products that conforms to the OpenGIS interface standards are listed at the OGC web server (OGC, 2001a) together with products claimed to have implemented the same specifications (OGC, 2001b). More detailed surveys of existing products and their reports may be found product surveys, for instance GEOWorld (2001). The surveys provides more detailed information about the software, such as price, client support, server support, spatial data formats and support of basic GI functionality

OGC have defined rules for conformance testing. As today (October 2001), 19 products have passed the OGC conformance testing. In addition, 93 products are claimed to have implemented these specifications. No conformance testing of the latter products have however yet been performed.

Table 1. Number of software products being registered to be in conformance with the OGC interface specifications. Products from European vendors are in parenthesis.

Time period	Number of products successfully tested for OGC conformance	Number of products with OGC implementations
- 1999	8 (2)	5 (5)
2000	3 (0)	37 (20)
2001 (until October)	8 (3)	51 (38)
Sum	19 (5)	92 (63)

It should be mentioned right away that the number of products is not a good measure of the impact on the market. A better measure is net income of products, but such figures for OGC compliant products have not yet been found.

Although Table 1 has its limitations, two observations can easily be made, namely

- The number of new products is continuously increasing. It seems that we are entering a stage where the supply of software products based on interoperability standards is not a major barrier any more
- The European vendors are active in providing product based on the OGC specifications. Currently about 61% of the products are European. But as pointed out earlier, this does not mean the Europe has the corresponding part of the market.

The price differences between the products are significant. OGC Web Mapping Service software ranges for instance in price between 3000 US\$ and 25 000 US\$ (GEOWorld, 2001). This indicates that there are differences in performance and functionality between the products, although they claim to fulfil the same OGC specification.

Competence of the personnel

To adapt the competence of the personnel to changing demands, two alternative strategies may be applied. One strategy implies that the existing personnel may receive additional training and education in order to improve their own competence and skills. The other strategy means that new personnel categories are hired, complementing the competence profile of the existing personnel. In practice, both strategies are often applied at the same time.

When improving the competence of the personnel, several strategic questions have to be answered, such as

- What type of competence is lacking? What competence profile is required in order to implement GI standards and on interoperable systems?
- If existing personnel needs to upgrade their competence, what resources are available? Where can I learn more about GI standards and interoperability?
- If the organisation needs additional employees with other skills and competence, where are they educated? Are our universities providing sufficient education within this field?

Study on requirements on competence for implementing GI standards and interoperable systems

One objective of this study is to investigate which skills and knowledge are requested by the industry to work with interoperability. To investigate this, a survey was carried out among the OGC community. The result from the survey is a competence profile of skills and knowledge that reflects the current educational needs. The work consisted of the following steps

- to identify skills and knowledge that may be of interest for the industry
- to send a questionnaire to the OGC community and to collect the answers
- to compile a report of the results of the questionnaire

The questionnaire was distributed in May and August 2001. In total, 21 responses were received, which corresponds to a response rate of 10%. This low response rate means that the survey cannot be used in a quantitative analysis. The results have to be interpreted as indications and be treated very conservatively.

To summarize the results, the most requested skills are from an industrial point of view the following:

- Web technologies and programming
- Project management

- Programming
- Object oriented modeling
- Client-server architectures

The skills mentioned above are mainly of a technical nature. The reason for this may be either the nature of business of the responders (OGC community) or that we in general are short of persons with such skills.

Study on educational materials available to the public

A survey of educational materials of GI interoperability that are available to the public have been carried out. The goal here was a list of educational material available to the public, that anyone can access or purchase in order to improve his/her knowledge. Publicly available educational materials may here be textbooks, web-based resources, multimedia tool, etc.

Based on a conceptual map of interoperability concepts, search engines have been used to search the WWW. This procedure is further described in Meyer et.al, 2002. A metadatabase have been built with descriptions of resources. The intention is that this metadatabase will be made public at the JRC website.

The final compilation of resources, after filtering and quality control phases, contains 298 records. The frequency of resources has been analysed according to different concepts.

Table 2 details the number of resources classified by the resource type. It is worth mentioning that the resource type "Tutorial" is the most numerous which usually can be downloaded from the Web. It can be observed that the resources are more likely to be self-educated than educational. This is for example shown by the small number of "courses" in comparison with the number of "tutorials" and similar resources.

Table 2. Frequency of the different resource types.

Resource Type	Count	Resource Type	Count
Tutorial	44	White Paper	7
Specifications	37	Contribution Paper	7
Presentation	36	Report	7
Article	35	Project Document	6
Linkpage	33	Manual	5
Book	22	Glossary	3
Implementation Examples	17	BeginnerPage	3
Project Page	14	FAQ	1
Guide	10	Dissertation	1
Course	9	Code Library	1

Study in university courses in GI interoperability

The final study to be presented here concerns the education within the field of GI interoperability as carried out by the universities. This study is carried out as a survey restricted to AGILE members only. The survey is based on the list of skills and knowledge required for implementing interoperable GI standards, provided by the survey among the OGC membership. This list defines the knowledge domain this subtask shall investigate.

The result of this investigation may be summarized as:

- The response rate is 22%, indicating that GI interoperability is a topic in European curricula.
- The skills most requested by industry are taught at most places. The weakest teaching is in client-server architectures and communication skills (taught at 69% of the places), followed by programming (!) and distributed services (taught at 77% of the places).

The survey compared GI education in Europe with the needs of industry involved in GI interoperability. The motivation for this survey was the identification of barriers on GI interoperability in the university education on GI. It came out that the willingness to teach interoperability issues is high but the issues are considered to be very special such that they are placed at the latest stages in the curricula, or are expected to be self-taught. However, the weaker response in programming leaves open how far the essential skills are existent at the later stages (in geography curricula). Thus, education is still a critical point for the diffusion of GI interoperability. The survey shows that institutions are willing to adopt their curricula to what they accept as future trends.

Conclusions

The major conclusions of this study can be summarised as follows

- The number of new products based on GI interoperability is continuously increasing. It seems that we are entering a stage where the supply of software products based on interoperability standards is not a major barrier any more.
- The European vendors are active in providing product based on the OGC specifications.
- The university-based education seems to be fairly well adapted to the business needs, in general.
- The companies indicate problems in finding graduates with the required skills for their openings. This is somewhat in contradiction with the previous statement. The reason for this contradiction has not been investigated.
- The European universities show a willingness to teach interoperability issues. But the courses are placed at the latest stages in the curricula, or are expected to be self-taught.
- The weaker response in programming (in geography curricula) leaves open how far the essential skills are existent at the later stages. Thus, education is still a critical point for the diffusion of GI interoperability.

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