Versioning of Information Goods and the Commercial Marketing of Geographic Information Services

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ABSTRACT

Although there is much enthusiasm about the commercial potential of geographic information (GI) services as the middleware between the provider and requestor of geographic information and geoprocessing resources within spatial data infrastructures, economically viable marketing practices remain a rare case. This paper outlines the relevance of versioning (also referred to as vertical differentiation) for the marketing of the aforementioned resources. In this context, particular attention is paid to the modelling and marketing of price-quality differentiated GI service versions.

KEYWORDS: GI service marketing, versioning (vertical differentiation), quality of service

INTRODUCTION

The usefulness of geographic information and geoprocessing resources is undoubted. With these resources in hand we are able to answer such questions like 'Where is this?', 'What is there?' or 'How do we get from here to there?' We are used to consult cartographic maps and navigation systems when we are engaged in sightseeing tours, vehicle routing, or any other kind of human way finding. Consequently, geographic information and geoprocessing resources can be claimed to have economic value.

In the international geographic information community one of the contemporary challenges is to develop and deploy distributed technology solutions that provide means for accessing, exploring, and utilizing distributed geographic information and geoprocessing resources over a communication network like the Internet; anywhere, anytime, and with any device. Today, the scientific research and industry development put special emphasis on interoperable geographic information services; henceforth referred to as GI services. The proceeding diffusion of GI services – most notably of geographic model / information management services and geoprocessing services as defined in the GI services taxonomy of ISO 19119 (ISO/TC 211 2002) – is likely to turn geographic information and geoprocessing from a formerly scarce and expensive resource into a ubiquity.

The GI service architecture defined in ISO 19119 and the OpenGIS Reference Model (OGC 2003) inspired researchers, engineers, and practitioners alike to embark the research on commercial marketing of geographic information and geoprocessing resources by means of GI services. The development of the Web Pricing and Ordering Service (WPOS) and the XML Configuration and Pricing Format (XCPF) for charging users' access to GI services is just one example for these efforts

(Wagner 2003, OGC 2002). Such work is likely to gain more prominence because of the directive of the European Parliament and of the Council on the re-use of public sector information (European Parliament and Council 2003). This legal act aims at facilitating the re-use and the exploitation of the economic potential of (geographic) information acquired and maintained by public entities.

With regard to the marketing mix concept (Kotler 1997), particularly the establishment of sound price models for digital information is anything but simple (Shapiro and Varian 1999). Successful enterprises will be those who approach pricing as an act of innovation (Jonason 2001), recognizing that profit opportunities lie in aligning the price with customer perceived value (Morris and Morris 1990), instead of taking a flawed determinant for the price, like for example the number of geographic features or the size of the geographic area requested by the user. The ideal for a profit-maximizing business is to charge the maximum the customer is willing to pay (i.e. the monetary equivalent of the perceived value) for what is offered.

However, although there is much enthusiasm about the commercial potential of GI services as the middleware between the provider and requestor of geographic information and geoprocessing resources within a spatial data infrastructure (see e.g. Abel et al., 1999), economically viable marketing practices remain a rare case. The commercial marketing of GI services requires the application of versioning if a perceived value-based pricing is pursued (Sliwinski 2004). The paper in hand is based on the quoted piece of work and continues with concepts and mechanisms that support the modelling and marketing of multiple GI service versions as elements of a GI service product line.

VERSIONING (VERTICAL DIFFERENTIATION) OF INFORMATION GOODS

The concept of versioning as used herein has nothing in common with the concept as used by software developers. In our research, versioning refers to the marketing of a GI service in different quality versions for different prices in order to satisfy different customers with different willingness to pay (Shapiro and Varian 1998 and 1999, Varian 2000). But every user who requests the same GI service quality pays the same price. This approach is also referred to as vertical differentiation or price-quality discrimination.

In this context, we take up two definitions to describe the nature of the quality of GI service. On the one hand, service marketing scientists define the quality of service as the totality of technical service characteristics (what service output does the user receive; e.g. with regard to a GI service response) and functional service characteristics (how does the user receive the service output) that bear on its ability to satisfy user needs (see e.g. Grönroos 1984). On the other hand, the QoS (Quality of Service) community defines quality of service as a group of quality characteristics that are user requirements placed on the behaviour of one or more objects (see e.g. Putman 2001, chapter 17). With regard to versioning, quality of GI service can thus be understood as a set of technical (e.g. comprehensiveness of information) and functional (e.g. capability of operations) GI service characteristics which together are necessary to fulfil user requirements that arise from a particular spatial decision making situation.

Individuals and businesses desire a certain quality from a GI service for which they are willing to pay a certain amount of money. If that GI service fails to meet the expectations in terms of quality and price, the service requestor is likely to patronize another provider. The availability of gradually differentiated quality versions of a GI service offered by a provider as a GI service product line enforces the user to self-select the price-quality combination that satisfies her or his needs. By self-selection each user also approves the chosen GI service version as fit for use, and simultaneously discloses her or his individual willingness to pay for the given version.

The key economic assumption made here is that the user's willingness to pay positively varies with the quality level of the geographic information or geoprocessing resource that is necessary to be consumed. While users with a high willingness to pay choose a superior quality GI service version and pay a premium price, users with a lower willingness to pay choose an inferior quality GI service version and pay a lower amount. By offering an inferior GI service version, the provider can serve users who are not willing to utilize the superior version, without considerably decreasing the demand for the superior version.

The publish-find-bind pattern (OGC 2003) governs the interactions between actors within a spatial data infrastructure. It depicts a mechanism how supply of and demand for geographic information and geoprocessing resources can meet in a distributed GI service environment. This pattern usually consists of three roles (GI service provider, GI service registry, GI service requestor) and three operations performed by actors while playing a certain role (publish, find, bind). In figure 1 we enhance this pattern to accommodate a fourth operation, i.e. version, performed by the GI service provider. The GI service provider establishes a product line of vertically differentiated GI services and advertises them to a broker as different marketing propositions in order to satisfy heterogeneous market demand.

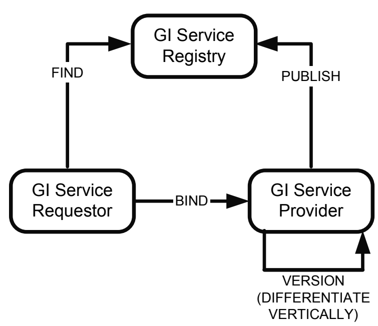

Figure 1: Versioning within the publish-find-bind pattern.

The airline industry is probably the most prominent industry sector which applies the principles of versioning. Even if a carrier takes its passengers from one location to another on the same flight and all people aboard enjoy the same transportation service, different fares are usually charged. For instance, many European airlines oblige travellers to stay over a Saturday night in order to grant them a discounted fare for the route. The presence of this restriction makes the ticket less attractive to business travellers (consumers with a high willingness to pay), but the restriction is in many cases acceptable to tourists. The quality characteristic addressed here is convenience; the quality parameter that concretizes convenience is minimum stay between flying date and return date. With these two service versions the airline draws substantially more revenues than if it had to offer each ticket at a flat price.

Recently, the principles of versioning were applied to spatial datasets (Frank and Jahn 2003). The results indicate that versioning is a suitable means to achieve market segmentation through vertically differentiated versions of a basically same dataset. In the quoted work, the authors obtained two different versions of a spatial dataset by degrading the quality of the copy through noise. The level of noise in data constitutes thus their decisive quality parameter (i.e. concretization of data usability as the targeted quality characteristic). While the degraded dataset version preserves its suitability for a predefined customer segment, other segments are excluded from using the degraded version because it does not exceed the required quality threshold for their decision making situation. The latter segment must instead choose the original, higher priced dataset version that is expected to fulfil their quality requirements.

A SIMPLE GI SERVICE PRODUCT LINE

In the following, we put in concrete terms how versioning can be applied to GI services. Let us therefore consider a simple GI service that provides access to vector-based spatial data. By invoking the service's main operation *getPointByBBox* the service requestor retrieves a list of point features (defined for the Euclidean plane) with the associated attributes (nominal, ordinal, interval and / or rational) from a point dataset. The invocation of this operation requires the definition of the geographic area under the user's request (bounding box) in terms of the coordinates (x value, y value) of its lower left corner as well as its width and height. The signature specification of the operation is listed in the following code snippet in the Haskell syntax[1]. In the following, we refer to this exemplary GI service to as *getPoint* service.

```
getPointByBBox :: BBox -> [Point] -> [Point]
```

This simple *getPoint* service may undergo a versioning to obtain a quality differentiated GI service product line. Therefore, we choose Shapiro and Varian's general quality characteristic referred to as *capability* (Shapiro and Varian 1999). We assume that any interference imposed upon the *getPoint* service, which is likely to constrain the *capability* of the offered *getPointByBBox* operation, directly results in a decreased GI service quality.

Let therefore A denote the superior, premium priced GI service version for the customer segment C_A that has unconstrained access to the *getPoint* service; and let B denote a lower priced inferior version for the customer segment C_B. Thereby, let B allow its users to retrieve point features only if the bounding box does not exceed a predefined maximum extent (in terms of the area in square units). Let thereby the quality parameter *max_extent_bbox* concretize the quality characteristic *capability*.

[1] http//www.haskell.org

In order to expand its product line beyond these two basic GI service versions the provider may further vertically differentiate the *getPoint* service by quality with the goal to obtain another version and satisfy the needs of a different customer segment. With reference to Shapiro and Varian (Shapiro and Varian 1999), we assume that any interference of the general quality characteristic called *information comprehensiveness* directly results in a decreased quality of the GI service. A quality constrain imposed upon this characteristic may either result from an information generalization, limitation of the spatial, thematic, or temporal coverage of geographic information, an accuracy loss of geographic features, or an intentional decrease in precision.

While *A* and *B* preserve their defined quality levels, let *C* denote a least qualitative / least priced version for the customer segment C_C. In object-oriented terms, let *C* represent a specialization of *B* where the positional precision of the retrieved point features (level of measurement and exactness of description in a database) is intentionally decreased by value rounding to the closest natural number. Let thereby the quality parameter *rounding* concretize the quality characteristic *information comprehensiveness*.

In figure 2 a UML class diagram is used to model the structural associations between GI service, GI service version, GI service product line, and the quality constraints that govern the quality of each GI service version through interference imposed upon a GI service operation.

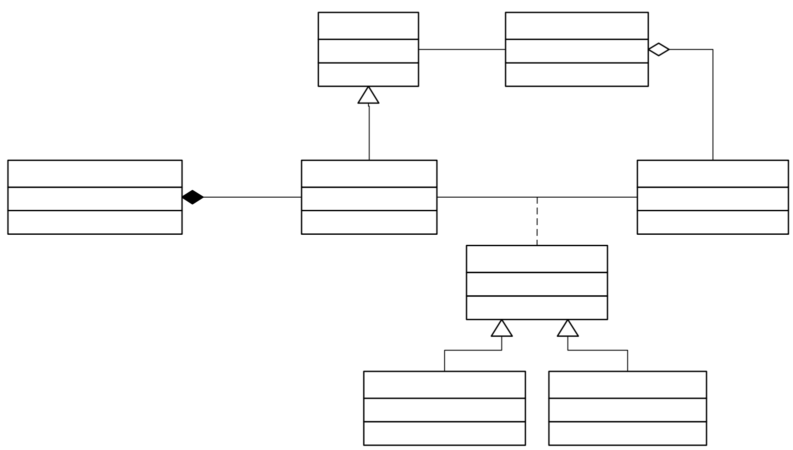

Figure 2: Quality of *getPoint* service and its versions

At this point we leave aside any discussion about the suitability of the chosen quality characteristics and parameters for the establishment of this simple *getPoint* service product line[2]. Even

[2] For instance, the level of precision required for a spatial decision making situation varies greatly. Engineering projects such as road construction require very precise information of geographic features, often measured to the millimetre. Demographic analyses can sometimes do with less. In such a case vertical differentiation by precision and the definition of differently priced GI service versions would segment the market appropriately.

if the three versions were parameterized by other quality constraints, two important questions would remain the same with regard to the marketing of different GI service versions. First, how can the GI service provider prevent GI service requestors from customer segment C_B from invoking the operation of *A* and GI service requestors from segment C_C from posting requests to *A* or *B*? Second, how can the provider prevent GI service requestors from customer segment C_C from receiving the same response as the GI service requestors from segment C_B do, without any replication or persistent manipulation of the underlying data? We examine both questions in the following section.

VALIDATION AND VIOLATION MECHANISM

In order to avoid the processing of unauthorized requests the GI service provider must check whether each single request has the proper right to be passed over to the declared GI service version. This problem is not unique. First steps toward the specification of an authentication and authorization procedure, which is applicable to loosely coupled GI services, has already been proposed by Drewnak and Gartmann (2003). We principally adopt the approach taken therein.

In any market transaction the customer will first gather information about the available GI service product lines offered in the market place. Once the customer has made a self-selection decision for a particular GI service version she or he negotiates the transaction conditions with the provider. If an agreement settles down, the provider has to issue a credential (login-password combination, customer number, etc.) to the customer, which lets the user pass the authentication and authorization mechanism and access the desired GI service version. In turn it enables the provider to charge the user's access appropriately.

Each credential shall thereby establish a link between the user's identity and the selected GI service version. Provided that a credential is enclosed with every service request, the provider is able to distinguish among different users and their requests. A validation mechanism can then match the arguments specified in the service request against the quality parameters of the GI service version, for which the credential was issued, and assess whether the request is authorized to be passed over to the given version.

In our example, the validation mechanism would be a precursor of the *getPointByBBox* operation of the *getPoint* service, and had to separate authorized from unauthorized requests. It checks whether the extent of the bounding box defined in the request of, for instance a GI service requestor from segment C_B, does not exceed the maximum extent that is assigned to the given GI service version; here *B*. If the request legitimacy is validated, the user receives the service response carrying the encoded point features as specified in the *getPointByBBox* operation. The validation mechanism is a suitable means to distinguish between different service requests if the GI service versions *A* and *B* are demarcated by capability constraints that limit the requestor's freedom of formulating service requests.

In general, the validation mechanism allows the provider to prove whether the requests made by the GI service requestors of C_A, C_B, and C_C confirm with the capability of *A*, *B*, and *C*, respectively. In this context, GI service requestors of C_B and C_C are entitled to formulate requests that share the same value domain for the arguments of the bounding box. However, the responses must comply with the definition of *B* and *C*, respectively, and must therefore differ. As the consequence, a second mechanism is of need for the generation of service responses from *B* and *C* to C_B and C_C, respectively, which neither makes it necessary to replicate the GI service instance nor to replicate and persistently manipulate the underlying spatial data.

In order to suit this precondition we introduce the violation mechanism. It aims at violating the precision of spatial data that is carried by the *getPoint* service response. Whether a response is subject to violation, is a matter of the version selected by the user. Therefore, the respective version *C* must include a violation argument that specifies the precision shift (e.g. rounding to the closest natural number) to be induced to the point features dispatched for the users of version *C*.

In our example, the violation mechanism is a successor of the *getPointByBBox* operation of the *getPoint* service. In accordance with the description of *C*, the violation mechanism iterates over the point feature list to be returned to the requestors from customer segment C_C and manipulates the position precision of the *x* and *y* value. This interference decreases the positional precision and establishes the quality difference between *B* and *C*.

ABSTRACT ARCHITECTURE

In order to demonstrate the practical potential of the ideas presented in the previous section we make use of an abstract integration of the validation and violation mechanism into the distributed GI service architecture. The UML sequence diagram in figure 3 illustrates the envisioned chronological interaction between the user and a GI service version with a particular emphasis on the two mechanisms.

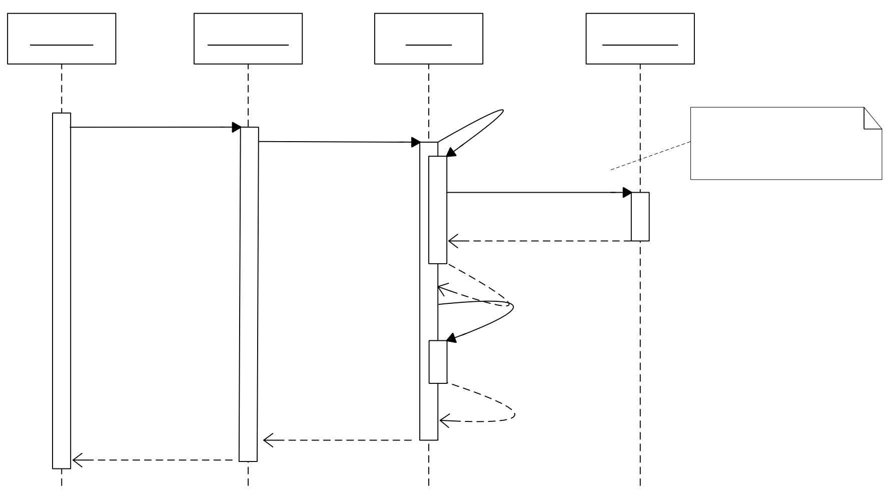

Figure 3: Validation and violation mechanism within the service interaction sequence

The sequential service interaction in figure 3 is initiated by the GI service requestor who formulates a request to the chosen version of the GI service by means of a GI client. Concurrently, the requestor discloses her or his identity and forwards the personalized credential by means of the Web Product Line Client (WPL client) to the Web Product Line Service (WPLS). The WPL client itself has a GI service facade, takes over the GI service request and encodes it together with the credential information to a WPLS request. The WPLS accepts the request and proceeds with the validation as defined in the previous description of the validation mechanism. If the validation procedure confirms the user's legitimacy to access the selected GI service version with the given service request, the WPLS decodes the GI service request and dispatches it to the GI service. In return, the WPLS receives the respective GI service response and proceeds with the violation mechanism as described in the previous section. Finally, the WPLS encodes the GI service response as an integral part of a WPLS response and returns it to the WPL client, which in turn decodes the WPLS response and passes over the pure GI service response to the GI client.

The bundling of the validation and violation mechanism within a separate Web Product Line Service (WPLS) and the interlocking of communication protocols aim at wrapping the GI service instance in a 1:1 relationship. This approach has a twofold benefit. First, it preserves the WPLS from committing an offence against the syntactic interoperability rules of the GI service architecture, because this novel service type does not have any impact on the standardized implementation specifications for GI service interfaces. Second, the validation and violation mechanisms are applied "on the fly" to service requests and responses, thus the underlying GI service instance must neither be replicated nor the associated spatial data have to be persistently manipulated to establish a quality differentiated product line.

FUTURE RESEARCH

The ideas presented in this paper are still at an early stage. However, they cast a vital field for research on the commercial marketing of geographic information and geoprocessing resources by means of GI services. In the following, we identify three topics that we contend will be necessary for the further research on the versioning of GI services.

First, by now neither the economics of GI services nor the technological requirements for a commercial marketing of geographic information and geoprocessing resources by means of GI services have been targeted in depth by an interdisciplinary, yet integrated academic research. Consequently, the ongoing research on the versioning of GI services requires the establishment of a necessary theoretical grounding that is to be based on work accomplished in economics, marketing, and computer science.

Second, for an operational versioning of GI services we see a key challenge in developing a formal model that defines the totality of technical and functional quality characteristics of GI services[3], unambiguously specifies the parameters that concretize the quality characteristics, discloses the interdependencies between the individual parameters, and establishes metrics for each parameter. Once such a model is in place, the provider is able to parameterize the level of quality of service for each of

[3] Based on Shapiro and Varian's general quality characteristics.

its GI service versions by imposing intentional quality constraints upon GI service operations and ascertain different prices for superior and inferior versions. In this context, we encourage research on a formal model for the quality characteristics of GI service types defined in ISO 19119; especially of geographic model / information management services and geoprocessing services.

Third, we do also expect further research on mechanisms that enable the marketing of different GI service versions but do not perturb the interoperability rules defined for the GI service architecture. Once a quality of GI service model emerges, concurrent research and development is likely to settle around the presented validation and violation mechanism. We expect major work to be conducted on a formal specification for the WPLS with the goal to provide a polymorphic validation and violation mechanism that supports the GI service quality parameter (to be defined) and is applicable to a wide range of different GI service types.

CONCLUSION

Recent market studies report about unexploited potential that resides in spatial data bases (Fornefeld et al. 2003). The spatial data infrastructure initiative GDI NRW in North Rhine – Westphalia, Germany[4] for instance aims at turning this potential into value by enabling a seamless, frictionless and affordable access to distributed geographic information and geoprocessing resources by means of GI services (GDI NRW 2004). In this paper we presented and discussed the importance of versioning (vertical differentiation) for such ongoing efforts to commercially market these resources by means of GI services within spatial data infrastructures. We also showed exemplarily how GI service providers may make use of the principles of versioning to model and market GI service versions, and thus to strengthen the re-use of the aforementioned resources as a response to the recent directive of the European Parliament and of the Council on the re-use of public sector information (European Parliament and Council 2003).

Although the scientific theory witnesses the relevance of versioning for an economically viable marketing of digital information goods, the GI service provider still neglect this approach and the research on the versioning of GI services is at best at an early stage. However, we are convinced that if the GI service paradigm is to become a common sense in the years to come, the commercial marketing of geographic information and geoprocessing resources by means of quality differentiated GI service versions will become a daily business for profit seeking organizations.

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[4] http://www.gdi-nrw.org

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