Toward Perceived Value-based Pricing of Geographic Information Services

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ABSTRACT

This paper introduces the concept of perceived value-based pricing into the geographic information (GI) community. We discuss the objectives and benefits of this approach to GI services. In this context, we emphasize the concept of versioning, which is synonymously referred to as quality discrimination. We conclude that if a commercial exploitation of GI services is aimed, versioning of GI services will become integral to a perceived value-based pricing. However, the research effort on this topic is, at best, in its infancy.

KEYWORDS: *Geographic information services, pricing, perceived value, versioning (quality discrimination)*

INTRODUCTION

In the international geographic information community one of the challenges is to develop and deploy distributed technology solutions that provide means for accessing, exploring, and utilizing distributed geographic information and geoprocessing sources 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 GI services). The proceeding diffusion of GI services is likely to turn geographic information and geoprocessing algorithms from a formerly scarce and expensive resource into a ubiquity.

Although researchers and engineers deal with an array of technical issues that are indispensable for bringing GI services to customers (for early contributions on this topic see e.g. Günther & Müller, 1998 and Abel, Gaede et al., 1999), the community lags behind with the research on GI service marketing. The commencing discussions around the GI service technology indicate that one key question still remains unanswered: What is the economically viable price model for GI services?

Meanwhile, commercial geographic information providers transform to GI service providers by starting to enhance the access to their spatial databases and geographic processing capabilities through GI services. However, this situation is very much like the newspaper publishers' rush to the Internet in the mid-1990s (see e.g. Mings & White, 2000). At the beginning these enterprises also had little understanding about appropriate revenue generation mechanisms for their online services.

In the following, we examine the concept of perceived value-based pricing and how this approach applies to GI services. We primarily target GI service providers in the private sector. We assume that the dynamic market environment on the Internet, increasing competition due to low barriers for market entry, few legal constraints on pricing strategies, and profitability as the key survival prerequisite will first push the private organizations toward novel price models for GI services.

PRICING OBJECTIVE

In this paper, we make use of the price concept that is an integral element of the marketing mix (Kotler, 1997). Simon (1989) defines price as the amount of monetary units that customers have to pay to obtain one unit of the product. While we generally define a price model as a formal description of the relationship between a price determinant (market structure, customer characteristics, competition, legal conditions, costs, product characteristics, etc.) and the optimal price, we see pricing in the first instance as the managerial craft of establishing prices for a particular product in accordance to a price model.

The ability to charge for access to GI services is a crucial driver for any GI service provider's profitability. An economically viable and transparent price model is therefore of need if a sustainable funding and maintenance of for-profit GI services is to be assured in the years ahead. The traditional cost-plus price model is about to fail if fixed costs dominate, marginal costs are virtually absent, and the average unit costs per service response asymptotically decrease with increasing number of service requests. As the consequence, a percent mark-up on the marginal costs or unit costs is not practicable (Shapiro & Varian, 1999).

GI services can be claimed to share such a cost structure. Due to their distinct economics, suitable pricing does not only call for accommodating GI services with e-commerce services like the Web Pricing and Ordering Service, WPOS (OGC, 2002a). The need still remains to develop and implement a suitable price model. 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, instead of taking costs as the determinant for the price (Morris & Morris, 1990).

The ideal for a profit-maximizing business is to charge the maximum a customer is willing to pay (i.e. the monetary equivalent of the perceived value) for what is offered. This prerequisite rules also out the quantity driven area-, feature- and zone-based price models, which are widely used in the geographic information community (see Wagner, 2003 for a detailed description of these price models), because they fail to mirror the value of the product to the individual user.

ECONOMIC VALUE OF GEOGRAPHIC INFORMATION

In general, a GI service can be seen as a source of geographic information. An OpenGIS compliant Web Feature Service (OGC, 2002b), for instance, returns a GML document that conveys the mark up representation of the requested geographic features. Such a service response becomes geographic information if the human recipient cognitively processes it into some stimulus that is capable of changing his state of knowledge.

The usefulness of geographic information is undoubted. With purposeful geographic information 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 when we are engaged in sightseeing tours, vehicle routing, or any other kind of human way finding. Consequently, geographic information can be claimed to have economic value. This is the case if geographic information leads to a more appropriate action within a spatial decision making situation, and the resulting payoff exceeds the payoff that would have resulted under the prior action.

Krek (2002) proposes an agent-based model for quantifying the economic value of geographic information. For a vehicle routing scenario she determines the improvement of agent's moving through a road network from one location to another. The improvement is attributed to distance reduction that otherwise would not have been achieved if partial or no geographic information about one-way roads were available to the agent.

At the first glance, the possibility to quantify the economic value of particular geographic information casts a promising approach to pricing. One may ascertain the price for accessing a GI service based on the economic value which the user actually extracts from each service response. However, Krek's model quantifies the ex-post economic value, i.e. the actual value, of geographic information. This approach stems from decision theory (see e.g. Lawrence, 1999). Consequently, the price can only be determined if the information transaction already took place.

Since prices are one of several criteria which consumers take into account prior to any purchase decision, the price cannot remain non-transparent. Nobody buys a pig in a poke. In any market, the exchange of products and services is governed by prices and competition. Therefore prices are set before a market transaction terminates. This is usually done either unilaterally by the provider, bilaterally through a bargaining between the provider and consumer, or multilaterally through an auction.

COMPUTATIONAL AND MARKETING PERSPECTIVE OF GI SERVICES

Krek & Frank (1999, 2000) and Frank & Jahn (2003) discuss pricing opportunities for spatial data. The evolving GI service architecture, however, allows us to take the product characteristics of GI services into pricing, instead of assigning a price directly to spatial data records. This novel pricing base is justified by a twofold perspective of GI services, i.e. the computational and service marketing perspective. While the computational perspective is common with regard to GI services, the service marketing perspective constitutes a new approach to describe the nature of this technology.

Computational Perspective

GI services constitute a recent technology innovation. The underlying architecture allows users to gain remote and seamless access to distributed spatial databases and geoprocessing capabilities by means of client applications over a communication network. The OpenGIS Consortium™, Inc. and the Technical Committee 211 at the International Standardization Organization define a GI service as an interoperable and modular software entity that provides access to its functionality through an open and standardized interface. The ISO 19119 draft standard distinguishes between six basic GI services categories in line with their core functionality (ISO/TC 211 & OGC, 2002). The functionality may enable the discovery, retrieval, processing, manipulation, integration, analysis, or visualization of spatial data from multiple sources.

A single GI service can itself possess a considerable functionality. However, it does normally constitute a part of a greater whole. This is often the case if more sophisticated tasks need to be accomplished. The contemporary state of the art of technology enables several instances of different GI service types to be tightly aggregated to form an opaque service chain (Alameh, 2003). Such opaque chains encapsulate a functionality sequence that can be invoked by a client application or other services by passing over a valid request.

From the point of view of the service requestor, a static service chain behaves very much like a single GI service. There is no need to control the order of service executions by the service requestor. However, the service requestor has also no control over the chain. For instance, a human user of the client application has no possibility to bypass or to extend the encapsulated functionality sequence, or to substitute service instances inside the chain. Such static service chains can be viewed as aggregate services which, for simplicity, we also call GI services. Examples of static service chains are demonstrated by Bernard, Einspanier et al. (2003) for the estimation of road trafficability after wind storms, and by Bernard (2002) for the visualization of forestry data.

Service Marketing Perspective

Beside the computational perspective of GI services the field of service marketing may cast additional light on this technology. The characteristics of services, as they are generally accepted by marketing scientists (e.g. Grönroos, 2000; Lovelock, 2001; Hui & Chau, 2002), complement the characteristics of GI services as defined in ISO 19119 (ISO/TC 211 & OGC, 2002) and in the Reference Model of the OpenGIS Consortium (OGC, 2003).

From a service marketing point of view, a GI service can be seen as an intangible process that involves multiple interactions (request / response) between the user and the information technology of the GI service provider. The demand for geographic information and geoprocessing capabilities is thereby satisfied in a piecewise and interactive fashion with every consecutive GI service request-response pair.

Each GI service response constitutes a process output and is produced and consumed simultaneously, at least to some extent. A response will only get generated if a valid request was passed over to the GI service. Given a certain GI service and the almost unlimited number of different service requests implies that the totality of different GI service responses cannot be produced in advance, kept in stock, and offered at a later point in time, as it is the case with physical information goods like paper maps.

The inseparability of production and consumption means that the user participates in the process as an active production resource, because the user parameterizes service requests and thus considerably influences the respective service responses. This makes the interaction with a GI service a quite open process.

PERCEIVED VALUE-BASED PRICING

Usually, different users will formulate heterogeneous requests, though the same GI service implementation may be used. And even if different users by chance formulate an identical request and receive an identical data encoding, the extracted geographic information will provide an ex-post value whose amount is likely to vary among different users.

To take up again Krek's example, geographical information about one-way roads may be of little value for a pedestrian who explores a medieval city centre or a commuter who frequently uses a major route between two locations. However, this information may be of high value for a vehicle driver who navigates through an unfamiliar environment and is thereby able to avoid the taking of a wrong route. Thus, the economic value of the geographic information, which can be attributed to a GI service response, is very idiosyncratic, subject to the decision making situation, and dependent upon the user's initial knowledge.

Among a multitude of scholar researchers Simon (1989), Morris & Morris (1990), Kortge & Okonkwo (1993) and Berry & Yadav (1996) propose an alignment of pricing with the value which service takers perceive. They argue that price is a statement of value and not a statement of any other determinant. According to Morris & Morris (1990, p.3), the perceived value can be seen as "buyer's overall evaluation of the utility of a product or service [GI service] based on perceptions of the net benefits received and what must be given up [price]" (text in brackets is inserted by the author). Thus, customers will only make use of GI services if the perceived value is greater than the price.

Simon & Dolan (1998) contend that any price model that favors a one-price policy does not fulfill the requirements of perceived value-based pricing. Such a policy cannot exhaustively capture the perceived value and the respective willingness to pay (in monetary units) if these extremely differ among users in the market. Consequently, a single price for the access to a GI service is likely to sacrifice profit opportunities. On the one hand, service requestors with a lower willingness to pay than the ascertained price will not be served. On the other hand, service requestors with a higher willingness to pay than the price will gain an access to the GI service on easy terms. This situation justifies the economic rationale to set different prices for different service requestors. Ideally, different requestors pay different prices amounting at each consumer's monetary equivalent of the perceived value.

With differential pricing the GI service provider can, at least theoretically, adjust prices to individual customers' willingness to pay. In comparison to a one-price policy, differential pricing yields profit improvement (Varian, 1996). The goal is thereby to design a price model that reduces the surplus of each customer, which is the positive difference between what the customer pays and what she or he would actually have been willing to spend for using the GI service.

SHAPIRO AND VARIAN'S CONCEPT OF VERSIONING

How can a GI service provider discriminate among its customers, which are characterized by heterogeneous value perceptions and thus different willingness to pay, and charge different prices for an access to basically the same GI service without alienating other customers?

Versioning (Shapiro and Varian, 1998, 1999; Varian, 2000) constitutes one of the most fertile research directions on the marketing of information goods in electronic markets (Kauffman & Walden, 2001). The concept of versioning as used in this paper is not identical with the concept as used by software developers. In our research, versioning refers to syndicating (in the sense of Werbach, 2000) a GI service in different quality versions for different prices in order to satisfy different customers with different value perceptions, i.e. willingness to pay. But every user who requests the same GI service quality pays the same price. This approach is also referred to as quality discrimination.

The availability of gradually differentiated quality versions of a GI service 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 to be consumed. While users with a high willingness to pay choose a superior quality version, users with a lower willingness to pay choose an inferior quality version. 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.

In this context, we take up the service quality definition of Grönroos (1984) and define the quality of a GI service as the totality of technical service dimensions (what service response does the user receive) and functional service dimensions (how does the user receive the service response) that bear on its ability to satisfy user needs. This definition goes far beyond the quality concept defined in the ISO 19113 draft international standard (ISO/TC211, 2002). The data quality elements considered therein, i.e. completeness, logical consistency, positional accuracy, temporal accuracy and thematic accuracy, can be seen to form a subset of technical service dimensions.

Shapiro & Varian (1998, 1999) list ten general (service) dimensions. We select four examples, i.e. convenience, speed of operation, comprehensiveness, and capability, in order to put in concrete terms what is meant with quality of GI services.

Convenience encompasses all mechanisms that are capable of restricting the access periods, access durations, or access means to a GI service. Speed of operation involves means for an intentional limitation of the GI service's response performance. Comprehensiveness relates to information generalization and the limitation of the geographical or thematic coverage of the spatial data carried by the service response. Capability comprises all actions that decrease the set of available GI service operations or restrict the functionality of offered service operations. While convenience and speed of operation can be classified as functional service dimensions, comprehensiveness and capability come under the technical service dimensions.

As versioning is a very product-specific strategy there does not exist a general blueprint of technical and functional service dimensions that also apply to GI services. Consequently, versioning requires the GI service provider to identify those dimensions of its GI service together with the respective quality levels, which are valued differently by different users in terms of the appeal they hold.

Deneckere & McAfee (1996) provide several examples of versioning. They investigate the "damaging" of the quality of superior products (subtraction of value) in order to obtain inferior, less priced products that target other user segments than those done by the superior ones. They conclude that it is more cost effective for providers to downgrade the quality of the existing product to develop an inferior version than to improve the quality of an inferior product to obtain the superior version.

A PRIMARY EXAMPLE

For an introductory examination of GI service versioning let us consider a simple service that provides access to vector-based spatial data. The signature of the main operations of the service together with the relevant data type declarations and type synonyms is illustrated in the following code snippet[50]. By invoking the getPointByBBox or the getPointByAttribute operation the user retrieves a list of point features (defined for the Euclidean plane) from a point dataset. While the getPointByBox operation requires the definition of the geographic area under the user's request (bounding box) in terms of the coordinates (x, y) of its lower left corner as well as its width and height, the getPointByAttribute operation demands a list with the definition of attribute values that the point features to be returned must all match.

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

data BBox = BBoxGeometry Coord Width Height
type Height = Float
type Width = Float

data Coord = Crd X Y
type X = Float
type Y = Float

data Point = Pt Id Coord [Attribute]
type Id = Int

data Attribute = AttrN AttributeName NominalAttr
      | AttrO AttributeName OrdinalAttr
      | AttrI AttributeName IntervalAttr
      | AttrR AttributeName RationalAttr

type AttributeName = String
type NominalAttr = String
type OrdinalAttr = Int
type IntervalAttr = Float
type RationalAttr = Float
```

This simple GI service may undergo a versioning in accordance with Shapiro and Varian's general quality dimension referred to as capability. Let *A* denote a higher priced version for the customer segment C_A that is authorized to invoke both operations; and let *B* and *C* each denote a lower priced version for the customer segment C_B and C_C, respectively. The latter two versions provide an access either to the getPointByBBox (*B*) or getPointByAttribute operation (*C*). Provided that these three GI service versions are brought to the market, the potential users are forced to decide either for the full capability version or one of the restricted versions; or to reject any transaction.

In order to expand its product line beyond these three basic versions the GI service provider may further vertically differentiate the GI service by its capability with the goal to obtain other versions and serve other customer segments. While *B* and *C* preserve their defined quality levels, let *D* and *E* each denote a least qualitative / least priced version for the customer segment C_D and C_E, respectively. In object-oriented terms, let *D* represent a specialization of *B* with a restricted capability of the

[50] We use the functional programming language Haskell 98 (http//www.haskell.org) to formally describe the GI service discussed herein. The complete code listings can be copied from http://ifgi.uni-muenster.de/~adamsli/haskell/AGILE2004.zip.

getPointByBBox operation, and let *E* represent a specialization of *C* with a restricted capability of the getPointByAttribute operation. The question thus arises how to restrict the capability of *C* and *D*.

The parameter BBox in a getPointByBBox request of *B* and *D* accommodates four real numbers that specify the bounding box of the user's area under request. The getPointByAttribute operation of *C* and *E* requires the input of at least one attribute value that describes the nature of point features under request. Given these two distinct parameters and a limited value domain for them (limited by the geographical extent of the point dataset and the thematic range of each point feature), there still exists a vast number (in certain cases a mathematically infinite number) of possibilities what particular request the user may pass over to the service version.

With regard to *B* and *D*, the user is free to decide the precise location of the bounding box origin and the magnitude of its vertical and horizontal extent. Similarly, users from C_C and C_E are free to choose one, several or many nominal, ordinal, interval and / or rational attributes for the request. Thus, a limitation of the valid value domain for a parameter would constrain the capability of the entire operation, interfere the user's freedom in the request definition, and thus considerably decrease the overall quality of the service version.

For instance, version *D* could allow the users of C_D to request point features only by a bounding box size being equal to or smaller than a predefined maximum and / or by a bounding box extent being inferior of a particular geographic area. Version *E* could enable the users of C_E to retrieve point features by a limited number of attributes and / or by one or many predefined valid attribute combinations. In such case *B* and *C* are characterized by a higher quality than *D* and *E* with regard to the capability of the getPointByBBox and getPointByAttribute operation, respectively.

FUTURE RESEARCH

To our knowledge, the previous example represents a première on the versioning of GI services. However, it already raises two important questions: What are the concrete quality dimensions of this simple GI service in terms of convenience, speed of operation, comprehensiveness, capability and the other general quality dimensions formulated by Shapiro & Varian (1998, 1999)? Second, how can the GI service provider prevent C_D from posting requests to *A* or *B* and C_E from invoking operations of *A* or *C*?

The specification of any GI service version requires precise knowledge about its quality. Different GI service types and different instances of the same GI service type are likely to have different technical and functional quality dimensions. Therefore, future research has to investigate the concept of versioning with particular focus on the different GI service types as classified in the GI service taxonomy in ISO 19119.

For an operational quality discrimination of GI services we see a key challenge in developing a formal model that concretizes the quality dimensions proposed by Shapiro & Varian and unambiguously specifies the totality of technical and functional GI service dimensions, the interdependencies between the individual dimensions, and the domain range of each dimension. Once such a model is in place, the provider is able to demarcate the quality level of each of its GI service versions and ascertain different prices for the superior and inferior versions. In this context, we also expect research on technological mechanisms that enable a controlled access to GI service versions without making it necessary to replicate the GI service instance (in part or total) within every GI service version.

By then, a perceived value-based pricing will become feasible which accommodates the principles of versioning. We contend that the necessary work presented in this section constitutes the short-term research agenda on perceived value-based pricing of GI services.

CONCLUSION

It is widely claimed that a price must mirror the value of the product, not the costs incurred nor any other divergent price determinant. Nevertheless, the development of a transparent price model which captures the perceived value (expressed in monetary units as willingness to pay) of GI services is an open issue. In this paper we showed that there exist useful concepts and methods which may foster the way toward a perceived value-based pricing. A promising concept to achieve such pricing approach is versioning, synonymously referred to as quality discrimination. However, versioning is a very product-specific strategy. To our knowledge, the research effort undertaken to apply versioning to GI services is, at best, in its infancy. We contend that if a commercial exploitation of GI services is aimed, versioning of GI services will become integral to perceived value-based pricing.

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