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GEO-COMMUNICATION AND WEB-BASED GEOSPATIAL INFRASTRUCTURE

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The introduction of web-services as index-portals based on geoinformation has changed the conditions for both content and form of geocommunication. A high number of players and interactions (as well as a very high number of all kinds of information and combinations of these) characterize web-services, where maps are only a part of the whole. These new conditions demand new ways of modelling the processes leading to geo-communication. One new aspect is the fact that the service providers have become a part of the geo-communication process with influence on the content. Another aspect is that there no longer is a given relation between producer and end user, as it was the case in the 'good old days' when maps were maps. A third aspect of the new way of modelling is the distinction between active and passive components in the infrastructure.

INTRODUCTION

The role of geo-information and the distribution of geo-information have changed dramatically since the introduction of web-services on the Internet. In the framework of web-services maps should be seen as a part of an index to further geo-information. Maps are no longer an aim in themselves. In this context web-services perform the function as *index-portals* to further information. This index-function is based on geo-information, e.g. maps. The introduction of web-services as index-portals based on geo-information has changed the conditions for both content and form of geo-communication. A high number of players and interactions (as well as a very high number of all kinds of information and combinations of these) characterize web-services, where maps are only a part of the whole. These new conditions demand new ways of modelling the processes leading to geo-communication.

WHAT IS GEO-COMMUNICATION?

The purpose of any communication is to conduct the behaviour of the user. This is done by submitting detailed and precise information, on the basis of which the user may act. Decision and action is conditioned by this supply of information and the realisation of the connection with previous experience. In order that the producer may communicate the necessary information to the user, he must be able to analyse the phenomenon of which the communication consists and be able to describe the result of this analysis in detail. The purpose of the analysis is to select the kind of information that makes the user able to make decisions and act accordingly. Geo-communication is the transmission of this kind of information in writing or in graphical form.

The user may want a basis for decision on a possible trip, i.e. a suggestion of an itinerary, and he starts a web-service intended for this use. The user types the start point and the end point of the trip, date and time, and after a short time, he will receive a number of proposals for the itinerary. On this basis he has to make the decision, "Yes" or "No", to travel. Behind the interface of the web-service several things happen which the user need not to know about. On the basis of the algorithms of which the web-service consists, a number of questions are send to some databases about certain geo-information, such as timetables, maps, road work, etc. By means of other algorithms these information are controlled against one another, resulting in a number of tables, some text, and some graphics, which together acts as the wanted itinerary. It is important to note that the user does not ask for a certain timetable or a certain map, but only for the *meaning* of these in relation to the trip he wants to make. The *meaning* for the user is to have a foundation on which first to make the decision to travel or not to travel, and if he decides to travel, then to know how to do it.

The figure below illustrates the above example of travel planning. The figure consist of the passive elements of geo-communication (plus a user), i.e. geo-information and *infrastructure*. All processes shown in the illustration can be iterative. The illustration can be seen as a longitudinal section of the overall process.

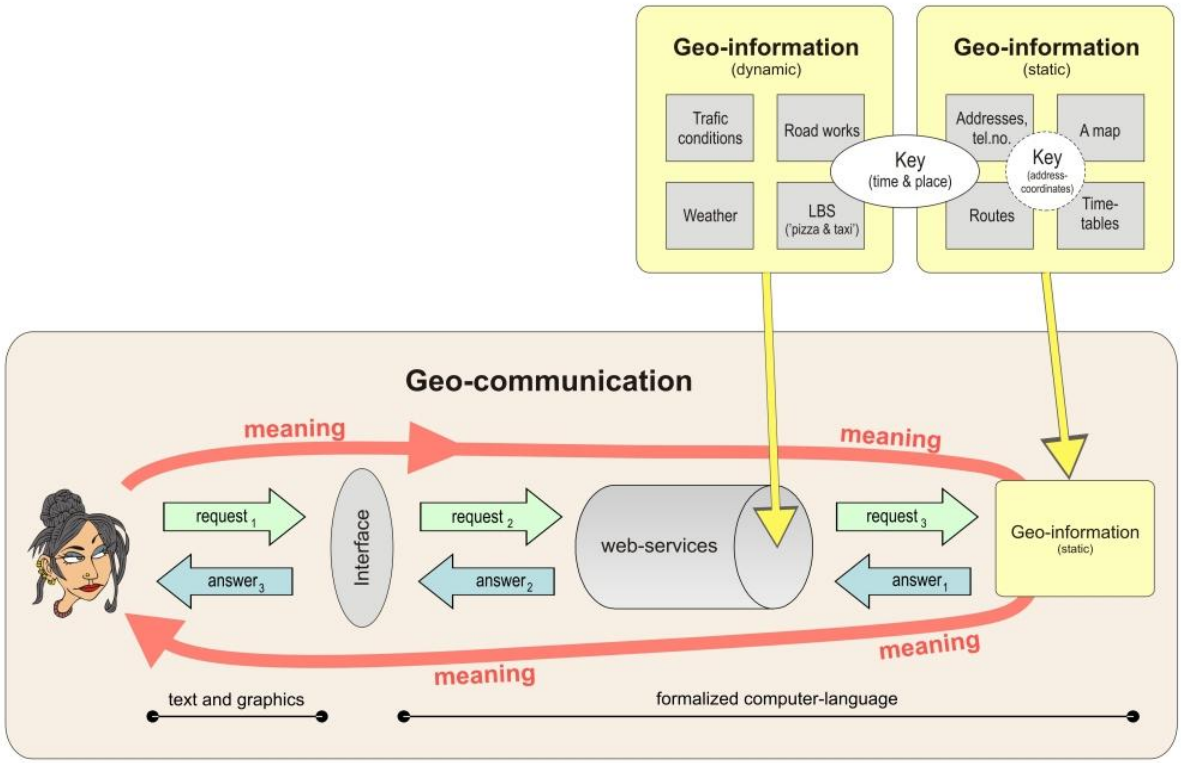

Figure 1. The elements of a geo-communication illustrating the example of planning a trip. The user is looking for information enabling her to decide whether to take the trip or not. The primary problem for the producer is to catch this problem and to deliver the exact information having this meaning. The secondary problem is to master the complex network of processes and their mutual dependence. All processes may be iterative.

THE SPATIAL DATA INFRASTRUCTURE (SDI)

Compared to the 'old days' when maps were maps, one new aspect is the fact that the *service providers* have become a part of the geo-communication process with influence on the content, and that there are several new producers active. Another aspect is that there no longer is a given relation between producer and end user, as was the case in the 'old days'. A third aspect of the new way of modelling is the distinction between active and passive components in the SDI (spatial data infrastructure). All three aspects will be discussed in the following.

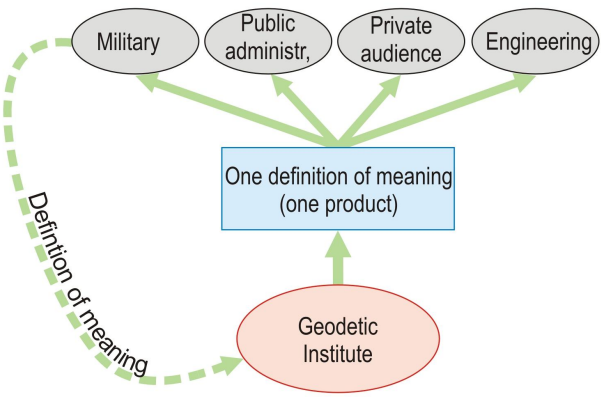

Figure 2. Up to approx 1990: One producer, one definition of meaning, and several users.

Up until approximately 1990 there was in Denmark *one* producer of geo-information. The Geodetic Institute's production was linked strongly to the demands of the military, i.e. the military's definition of meaning (of the information) was the basis for all production. More or less everybody else had to be satisfied with those military-oriented maps and other products. This situation was due to the fact that the Geodetic Institute had a monopoly in map-production, partly supported by legislation, and partly because of the extremely expensive production.

Since then things have changed dramatically. The monopoly has been removed. The law concerned was cancelled, and the costs of he means of production were reduced dramatically. Several producers are now active in producing geo-information, and several web-service-providers are carrying out the transmission of this geo-information to a large number of users. Not only a lot of producers and service providers are active, the most important aspect of the new era is that there are thousands of new users. In the old days maps were expensive, and therefore is was reserved for the few. Today with the web-based infrastructure the admission to information is open to more or less everybody. This higher number of producers, service providers and users can be put into a diagram showing a part of the complexity of the new situation.

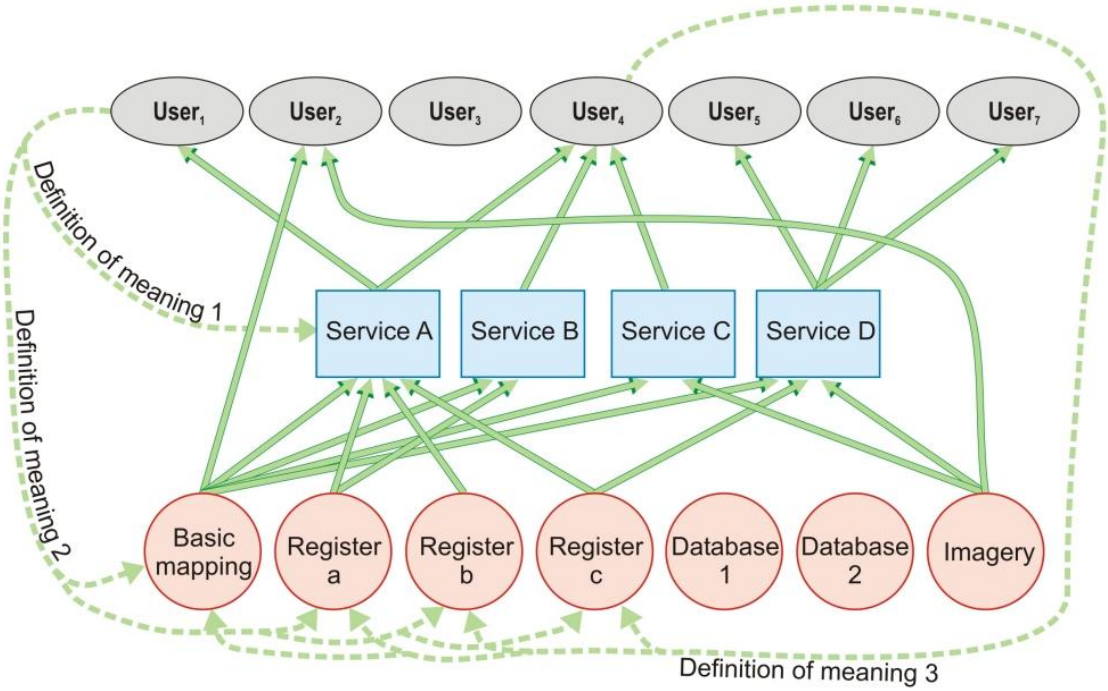

Figure 3. Today there are several producers of geo-information, several web-service providers carrying out geo-communication and a huge number of users all trying to find that meaning of information that satisfies their particular needs. Therefore the producers have to cope with several, different types of *definitions of meaning*.

The first point made her is that the world of geo-information has become extremely much more complex, because of the higher number of users, service providers and producers. The web in the figure above illustrates a *simple* version of a web-based geo-communication community. The second point made here is that there is no longer only *one* definition of meaning with which everybody has to be satisfied. All the users have the possibility to find a producer or a service provider who accepts to take care of *that* particular definition of meaning.

Now, the good question is what to do about this increasing complexity? We think the way forward is to create models and theories that describe the new structure in geo-communication. It is a complete new way of dealing with information, and therefore new theories and models are needed. The old theories and models are no longer sufficient!
GIS is often understood as the combination of *software, data and methods*, as the red dotted line in figure 4 shows. This might well be so. We just think that this is no longer sufficient to be able to understand the complex era of modern geo-communication based on SDI. The above figure 1 can be seen as a longitudinal section of the geo-communication process. The accompanying cross-section of the geo-communication could look like figure 4. We think that geo-communication should be seen and understood as consisting of GIS plus several other elements, as the figure 4 illustrates.

Spatial Data Infrastructure as basis for geo-communication is both the *organizations* and the *public services*. SDI can further be defined as a combination of *active components* and *passive components:*

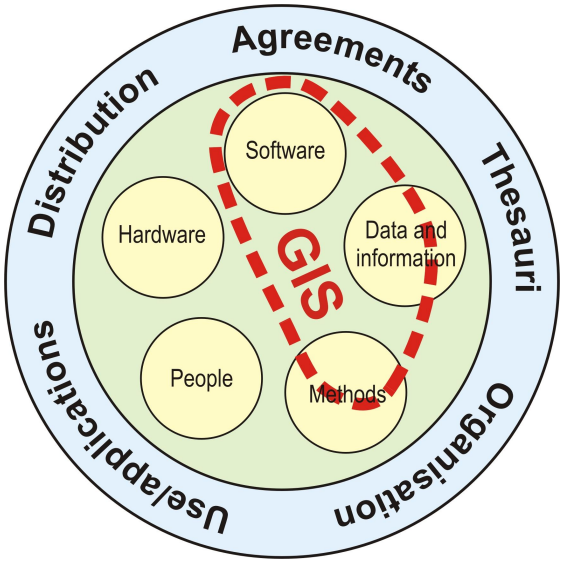

Figure 4. Modern geo-communication should be seen as the combination of GIS plus several other ele-

Infrastructure (SDI) consists of:
The basic organization, the system according to which a company, organization, or other body is organized at the most basic level.
Public services or systems, the large-scale public systems, services, and facilities of a country or region that are necessary for economic activity, including power and water supplies, public transport, telecommunications, roads, and schools.

The active components in SDI are those organisations that get things running. The active components have the *responsibility*, and they must be *active*. Otherwise nothing will happen. Organisations can be:

- International Organizations like UN, NATO etc.
- Governments
- National Mapping Agencies
- Standardization bodies
- Custodians for various services

The passive components in SDI are the following, here presented in their mutual dependency. The mutual dependency is of *iterative* nature. The passive components go from *general* to *concrete*; i.e. from legislation to geo-information.

1. Legislation
2. Collaboration (MoUs)
3. Standards
4. Models
5. Specifications
6. Services
7. Geo-information (data)

THE PASSIVE ELEMENTS OF SDI

The passive elements are the *results* of the activities of the active components. They are depending on the activities in the organisations. Therefore they are called passive. These components are not active in themselves.

(1)*The legislation* is made by the organisations, the active components. The legislation must act on a general level and take care of:

- Enacting the framework for the deeper structures of SDIs.
- Setting the *area of responsibility.*

(2)*Collaboration* (MoUs) is based on the framework given by the legislation. Without this framework it is basically not possible to establish partnerships. Collaboration is:

- Setting the *area(s) of interest.*
- Within the framework of legislation operational partnerships must be established.
- Collaborations must encompass services, as a full palette of joint government and commercial theatres
- Collaboration must cover agreements upon sharing information over services and registries

(3)*Standards* are the necessary basis for activity within SDI. Standards are a kind of agreement of 'What are we going to work on? How do we define our activities?' etc. Collaboration is a *declaration of intent;* it does still not say anything about *what* to work on. Standards are *general* and can therefore be used for several concrete projects, where a *specification* is concrete valid for one project. A few examples of standards (of which a few are Danish standards):

	Syntactic	Semantic
formal	DIGEST part 1 - 3 w3.org (XML) ISO 19100 series DSFL ASCII	DIGEST part 4 (FACC) ISO 19100 series FOT TK99 TOP10DK
de facto	OGIS (GML) guidelines (with tech-specs) Arc-GIS format MapInfo format	

Figure 5. A few examples of standards. Standards are the necessary basis for activity within SDI. Standards are general and can be used for several projects.

(4)*Models* describe how to use certain standards for a given project. Models bridge between standards and specifications.

Business process engineering:

- Information and resource flow
- Requirements driven service development

System Use Case:

- Application schemas
- (General) Feature models

Specifications:

- Implementation process

(5)*Specifications* are a description of what has to be done in a certain project. A specification can e.g. specify that things have to be done in accordance with certain standards. A specification is concrete and valid for one given project; standards are general and valid for several projects.

- Rules and content
- Categorization and classification of real world phenomenon (features) within a standardized universe of discourse
- Define attribute description level of the classified features
- Define information flow – sources; update strategy; components value assessment etc.
- Storage and security strategy
- Filtering and retrieval methodology
- Strategy for multistage representation (incl. semantically and geometrical granularity and generalization)
- Symbolization strategy, design manuals and legend drafting

(6)*Services* are the concrete, practical set-up of the passive components no. 1 through 5. The passive components no. 1 through 5 can all be carried out on a piece of paper; nothing practical, actual has happened until here. Services establish the technology; i.e. the software, the hardware, the user-interfaces etc. Compare also figure 4, the cross-section of the geo-communication.

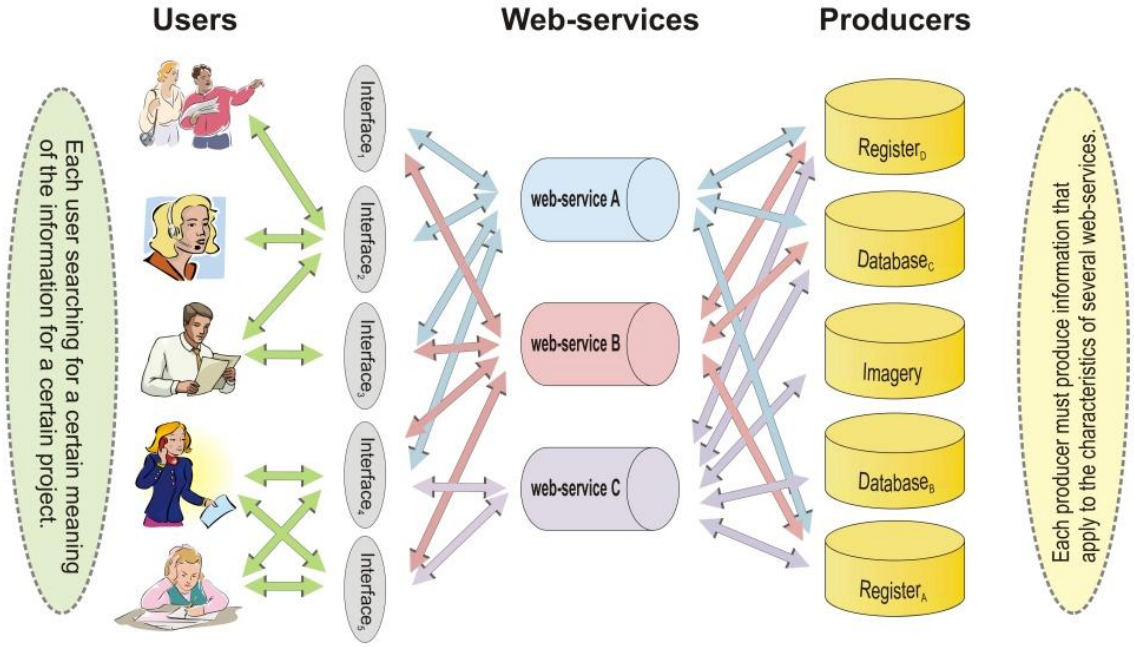

Figure 6. Web-services bridge the gap between producer's databases and the users. Web-services are the technology making the use of geo-information possible.

(7)*Metadata and Information* is the 'fuel' to put into the machinery (the services) once this has been created. Metadata and Information is *not* the technology! Metadata and information are the actual, practical, concrete result of a certain production carried out in accordance with the characteristics of the services, with the specification, with the model, with the standard, with the MoU, and with the legislation.

Metadata:

- Where to find information (data)
- Analyze its fitness for use; the characteristics of the information.
- Never create information (data) without metadata, and never separate the two!

Information (data):

- Information is the fuel for (value added) services.
- Information (data) is not products!

CONCLUSIONS

With the introduction of web-based geo-communication things have become most complex, compared to the 'old days' when maps were maps. The basis for web-based geo-communication is the *spatial data infrastructure (SDI).* SDI consists of both active components and passive components. The active components get things happening. The passive components are the framework, the standards, the technology and the information, which are the elements of the infrastructure and with it, the necessary basis for web-based geo-communication. As there is a mutual dependency between all the components none of them can be left out. If just one component is missing, the impact is that the geo-communication is based on a non-systematic and non-conscious foundation.

Modern web-based geo-communication and its infrastructure looks very complex. That is surely true. We think that it will get even more complex. Therefore there is a strong need for theories and models that can describe these things and give the necessary framework. There is also a strong need for political consciousness about these things because it is from there the legislation comes.