The French SIGMA-Cassini Research Group
The Agenda for 2005-2008

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INTRODUCTION

For nearly twenty years, occidental countries have developed research groups to federate national works in Geographical Information Systems such as: NCGIA – National Center for Geographical Information and Analysis, (NCGIA) and later UCGIS - University Consortium fo Geographic Information Science (UCGIS), in the United States of America, RRL – Research Regional Laboratories, (RRL), in United Kingdom, Nexpri, (Nexpri) and then RGI Space for Geo Information (RGI), in the Netherlands, Géoïde Network, (Geoide), in Canada, the Cooperative Research Centre for Spatial Information CRC - SI, (CRC-SI), in Australia, NCG - National Center for GeoComputation in Ireland (NCG), SIGMA-Cassini in France (SIGMA-Cassini)…
AGILE (AGILE) is an attempt at the European level based on laboratories. The Bologna process in education enforces the international visibility for the research laboratories in the geomatic field.
A tentative is now performed to establish links between these different groups at a worldwide level. A meeting of representatives of such groups took place in Banff on May 31 2006, guided by N. Chrisman. The idea is similar to GSDI - Global Spatial Data Infrastructure (GSDI) but more in a research-oriented field.

From the historical point of view, France has always been present in this domain mainly by the expertise of the Institut Géographique National (IGN) and the participations in different normalization groups or exchange groups as well as in commissions such as the International Cartographical Association (ACI) or EuroSDR (EuroSDR). The renewal of the accreditation of the SIGMA-Cassini research group (SIGMA-Cassini) is embedded in this movement. SIGMA means Système d'Information Géographique : Méthodologies et Applications – Geographical Information System : Methodologies and Applications – Cassini is the previous name used to denote this group in the early years.

This document presents the SIGMA-Cassini research group. We start with the organization and then present the different researches: Sharing data, Mobility, Multiple representations, Location-based services, Earth observation, Dynamic cartography, Risk and Territory management. We conclude with the perspectives of this research group.

THE ORGANIZATION

The goals of the SIGMA-Cassini group can be summed up as: "to favor the links in the Geographical Information research domain between the different laboratories working in this field. It leads laboratories to work together and to promote the results of these researches".
It regroups CNRS (French National Center for Scientific Research) laboratories oriented towards computer science, towards human sciences or laboratories that are not supported by the French

National Education ministry (16 computer-sciences laboratories, 14 geographical laboratories and 8 laboratories outside the French National Education ministry).
The organization is based on two orthogonal structures: the Classes of Scientific Problems and the Working Groups. These structures are closely linked together from the scientific point of view.

The Classes of Scientific Problems

The scientific problems tackled by the SIGMA-Cassini group are divided into three classes of scientific problems. The approaches are although conceptual and theoretical: (1) the exchange – the building - the sharing of geographical information; (2) the mobility, the reactivity and real time; (3) The multi-representation of geographical information.
This principle allows formalizing the members' questions in a deep reflection.

The Working Groups

The number of the Working Groups is not fixed (from the scientific point of view and from the duration – no more than 4 years). The approach is based on a transversal reflection. The Working Groups results are the principal scientific productions of the SIGMA-Cassini group. These Working Groups provide the visibility from the external or internal point of view. They rely on a displayed scientific problem, on identified teams and clear objectives. They must have a relevant reactivity to achieve their goals within a given duration. The definition of the objectives may be very wide: research project, book writing, state of the art … Of course new Working Groups may appear during the life of the SIGMA-Cassini group.

The retained Working Groups are the following: (1) location-based services; (2) Earth Observation; (3) Dynamic cartography; (4) Risks; (5) Territory Management.

The works of the SIGMA-Cassini group is related and complementary to other existent French GDRs : The I3 research group (I3), computer science oriented, with the social usability dimension and the inherent multi-disciplinary structure of the SIGMA-Cassini group. The ISIS research group (ISIS), image and signal processing oriented, with the observation more than the image processing provided by the Working Group Earth Observation. The LiberGéo group, presently European research group S4, Spatial Simulations for Social Sciences (S4), is an old fellow of the SIGMA-Cassini group.

Links between Classes of scientific problems and Working Groups

Working Groups tackle a geographical information system problem from a particular point of view. They are required to study this problem more specifically on at least two retained Classes of scientific problems. Classes of Scientific Problems are required to merge, to analyze and to synthesize the different works performed in the Working Groups. They can add their added value in these scientific problems.
Each Class of Scientific Problem and Working Group has its web site accessible from the main site of the group (http://www.sigma-cassini.org) to inform members of the French Geographical Information community. A mailing list is used to communicate with members and affiliated persons or groups.

THE SHARING, BUILDING AND EXCHANGE OF DATA

Context

Geographical information is now used in a large range of applications. These applications involve a set of different resources. These resources can be for example: an expertise, several models, data or software. A point of view is a comprehensive context or a use case by a human actor (not a software). It can be characterized by one or several objectives, different abilities or concepts for modeling a specific domain. This domain may use particular data, way of modeling data or resources.

Objectives

This Class of problem is very wide. The main interest is the collaborative use of geographical data within different points of view. Several solutions can be provided such as a common model, a thesaurus, ontology, a collaborative method, a dialogue method or software designed to provide collaborative works. The building component leads to the conception of tools to share existent resources such as the development of a catalog and an ontology, … But it can also leads to the creation of new resources provided by this sharing or by the emergence of a new idea or concept due to a common brain-storming or the identification of a correlation between two phenomena described with the same formalism.

The objectives are to analyze, to survey and to monitor the different works performed on this subject. They provide to the different Working Group a collaborative tool based on a Wiki. This tool allows the different groups to communicate from two points of view: a written component and a communication component.

The written component is provided as a conventional Wiki tool to share papers, reports, … between the different groups.

The communication component is based on a tool designed to allow the visual and audio communication as a conventional audio-video conference tool. It is provided for the different Working Groups and Classes of scientific problems. The main difficulty is to provide the exchange of geographical data within this context.

All Working groups are concerned by this problem of sharing and exchanging data.

MOBILITY, REACTIVITY AND REAL-TIME

Context

The development of Internet and the various devices provides an increasing available set of data in a new context. The whole components may be mobile: the human beings, the machines and the data sets. The mobile communications can be in both ways: from the GPS (Global Positioning System) to a central information system and between the different mobile devices. The development of wireless communications is a challenge since numerous geographical applications are concerned. This dynamic aspect requires managing data with real time constraints (such as for example during a crisis). Classical approaches cannot be used anymore.

Objectives

As a Class of scientific problem, the goal is to synthesize, extract and formalize the different propositions in the Working Groups dealing with the mobility concept. A conclusion could be the proposition of a new Working Group on a specific scientific problem.

The approach is based on the study of (1) the mobility of the different systems, tools and persons; (2) the reactivity of systems and software; (3) the real-time management of the systems and data.
Four main interest points are studied: the architecture of computer-based system, the intelligent display, real-time simulations and dynamic accessibility.
The specifications of computer-based system architectures (e.g., mobile platforms, communication networks) and real time data management (e.g., acquisition, storage, modeling, queries) cannot be avoided. This aspect is mainly provided by the Working Group Location-based Services. The intelligent display or the definitions of new representations to take into account the mobile characteristic of data (spatial and real time). This aspect is mainly provided by the Working Group Risks. Real-time simulations (data and process), decision-making are provided by the Working Groups Risks and Territory Management. Dynamic accessibility and reliability for real time data are mainly provided by the Working Group Dynamic Cartography.

MULTIPLE REPRESENTATIONS

Context

The electronic or graphic representation, of data is a central point while providing the explanation of a complex process. The multi-representation concept is used when we have (or we would like to have) different representations of the same space within different levels of detail or different point of views. This concept can also be used to provide several representations of the same process. This concept is a key to user-oriented application designs.
In a first approach, multi representation is used to propose several representation of a same « object ». These representations depend on applications or needs (model, specifications). It can vary on the level of detail, different point of view, representation of simulations, temporal representation or symbolized representations.

Objectives

The goal is to provide new methodologies to develop the use of multiple representations (data and process) depending on the various needs (e.g., PDA, mobile phone, multiple-source databases). Numerous applications use data coming from different sources. Therefore, the scales, the representations may be different within the same space. The merge of such information requires new formalisms. The representation may depend on the classification of end-users (e.g., citizen, decision-maker). The multi representation could be defined from a static point of view (i.e., data) or from a dynamic point of view (i.e., a process).
The main goals are to enrich and validate the terminology and the proposed solutions, to identify the research works that use the multiple representations or would like to use it, to structure the different use cases of multiple representations, to identify and to present the relevant methodologies and tools for emerging needs.
Seven levels are defined: a simplification of the reality, capture and production of data, capture and level of detail, deriving data (level of detail, point of view), symbolization at a same scale, multiple

representations in the same range of scales (i.e., graphical generalization), multiple representations and levels of details.

LOCATION-BASED SERVICES

Context

New sensors are involved in the location-based applications. For a mobile user (i.e., a hardware, a software or a human being), we must continually adapt the data he needs. These problems are in the heart of classes « Multiple Representation » and « Mobility, Reactivity and Real-Time ».
New services are provided by the increasing facilities provided by mobile communications (UMTS - Universal Mobile Telecommunications System, GPS – Global Positioning Systems, Galiléo…). The amazing precision provided by geo-localization systems allows new applications and therefore requires new modeling needs. The development of new devices such as PDA – Personal Digital Assistants, provides new opportunities to location-based services (e.g., geo-marketing).

Objectives

To offer a location-based service, this Working Group is dedicated to the architecture of the systems and the data management.

The architecture raises several problems such as the communication modes between a mobile computer and a central system or several operating systems. The architecture of the central system (if it exists) or systems is still to be defined. The mode and the update frequency define the validity of data (e.g., very useful while managing a crisis). The federation of heterogeneous geographical databases is mandatory due to the number of operators. This leads to study the inter-operability of geographical information systems. Depending on the restitution devices, the set of relevant data may be different.

Conventional Data Base Management Systems do not consider the concept of mobile « object » and query involving the mobility of the « objects ». Therefore, all conventional concepts must be revisited mainly: the data modeling, spatial queries or temporal queries depending on the position of an « object », query optimization using indexing techniques taking into account the mobility and the multidimensional aspects of the stored data. These concepts are closely link to the first class of scientific problems.

EARTH OBSERVATION

Context

The increasing number of data sources (aerial images, remote sensing with high spatial resolution) to observe the Earth raises new problems. The user must choose the relevant images to extract the relevant « objects ».
Nowadays, nearly all scales are covered by remote sensing images at very low costs compared to the previous ones. The wide spectrums allow to localize, to identify, and to analyze the observed « objects ». The temporal frequencies of acquisitions allow monitoring when several sources are

mixed. Conventional remote sensing methodologies must be reconsidered. The link with the signal processing is closer than ever.

Objectives

The objectives are organized within two aspects: the methodology and the applications.
The methodological aspect will be considered as the most important. From the methodological point of view, the main problem is the description of an image (i.e., to get the relevant objects) and data fusion to improve the data mining. Data quality should be reinforced (the link with the Class of Scientific Problem Sharing, Building and Exchange data is very strong). Coupling several models requires information such as the quality of data.
Introducing a spatial reasoning and a context-based image analysis is more and more relevant to improve the quality of data extraction. Due to the multi-source data, the link with the Class of Scientific Problem 3 Multi-representation is obvious.

From the application point of view, the variation of resolutions allows to capture more and more information that were not accessible before. Then, heterogeneity is also introduced in the land cover. Characterizing and quantifying surfaces require new methods and techniques adapted to new sensors. The various changes of the land use / cover are linked with the global changes of the Earth. They lead to reconsider the methodology used to study the various applications.

DYNAMIC CARTOGRAPHY

Context

Maps are still a key concept to transmit geographic data. The new devices introduce new concepts of representation. The dynamic representation of a map introduces a new dimension in the spatial representation of a process. New multi-media documents reinforce the expressive power of a user interface.

Objectives

This group aims at providing a reflection on new usages of dynamic cartography. The definition of new modes of graphical representations, the usages of cartography within different contexts (e.g., teaching, expertise, politics), the adaptation of maps to different user profiles (e.g., beginner, professional), to graphical semiology, to devices (e.g., PDA, mobile phone) is our challenge. Due to the transversal definition of this Working Group, the three Classes of Scientific Problems are concerned. Four points are focused (they could be inter-related): (1) We want to reproduce phenomena (animation of maps or spatial processes) to discover state changes, speed of changes, breaking representation in time and space; (2) the dynamic exploration requires analyzing for example the topology, the spatial relationships. The multi-representation is highly concerned with this point; (3) to be able to locate mobile objects (the human being in his environment or for a global organization to be able to model mobile objects; (4) to model and reproduce complex organization based on mobile « objects » (as an individual or an aggregation of individuals) and their interactions.
Several conceptual problems are studied by this group: The methods and tools (e.g., what are the used technologies, improvement which could be performed, what are the links between time and space),

the user's point of view (e.g., what are the usages, what is the common expertise, how could we transform a static map into a dynamic map), The crossed relationship: user vs. methodology (e.g., how could we evaluate a tool, what are the different family of users).

RISKS

Context

The development of global changes studies reinforces the domain. The localization and the identification of risk areas are therefore the heart of the functionalities of a Geographical Information System. The legal context is more and more important.

Objectives

The following directions of the Working Group are: The update of geographical information during an intervention (e.g., what is the decision chain from the acquisition to the validation through the display, what sensors do we need). These problems are closely linked to the Class of Scientific Problem Mobility, Reactivity and Real-time. The availability of data is a key concept while people are concerned with an intervention. They must share data and exchange data (e.g., what are the meta-data, the inter-operability of the different information systems). These problems are closely linked to the Class of Scientific Problem Sharing, Building and Exchange data. The tremendous number of actors or actions to perform, to prevent or to cure a crisis leads to model the different perceptions of geographical spaces (e.g., several actors interact on the same geographical space, how do they represent this space, how do we formalize the interactions between the different decisions). These problems are closely link to the Class of Scientific Problems Multi-Representation. The return over experiences should provide very good materials in the case of prevention and therefore a methodology has to be designed.

TERRITORY MANAGEMENT

Context

Several actors are involved in the management of a territory. Every one can provide and can use geographical data or knowledge about a process. Several levels are involved in a decision from the citizen to the head of the state. Three new abilities are required: the creation of a space, the management of a space and the connection between networks and territory. Several methodological problems are raised: the exchange and diffusion of geographical information, the real-time monitoring of a process, and the multi-representation depending on the user.

Objectives

The aims of this group are to work on the knowledge aspect, the applicative aspect and the formation aspect.

The knowledge aspect is based on the analysis of a crisis: the analysis of the process (what are the current actions? what are the relevant actors? what are the produced spatial representations?), the evaluation of the situation (what are the spatial consequences of the current actions?).

The applicative aspect proposes to specify tools to define different ontologies (starting from a model of a territory), to define tools to simulate at multi-scale level spatial processes and decisions, to elaborate tools to extract knowledge (e.g., pattern matching, graph matching).
The formation aspect relies on the formalization of elementary learnings, translations of phenomena into a combination of spaces, fields and organizations. The formation is based on games. The aim is to merge different points of views like it was performed during the CQFD-Geo (CQFD-Geo) in Quebec in May 2005. Another approach is the use of a browser in multi-media documents to compare a conventional navigation defined by a professor and the navigation performed by a student. The comparison between the two navigations allows defining the basic key concepts, which have been understood by a student (i.e., graph matching).

PERSPECTIVES

By mid-2007, the SIGMA-Cassini group has achieved the mid-term of its accreditation. The different results already obtained by the different Classes of Scientific Problems or Working Groups have already been presented during the SAGEO conference cycle (SAGEO 2005, 2006). The next conference will be held in Clermont-Ferrand in 2007 (SAGEO 2007). Communications regarding the life of the different groups are available on the SIGMA-Cassini site (SIGMA-Cassini).
For its four years renewal, we would like to extend the group in two directions. The first one is to provide a similar integration as Geoide network and RIG did. A closer link between companies and research teams is to be defined. The main difficulty is to define a continuum from academic research to applicative research and development. Eighteen month-business plans and research works are not very often compatible. The second direction is to provide a closer integration with European or North American laboratories. This could be achieved with a closer link with AGILE (e.g., some common workshops, a more important participation of French laboratories in the different working groups or a common conference like in Lyon – 2003).

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