

## Reorganizing the Topographic Databases of the Institut Cartogràfic de Catalunya applying generalization

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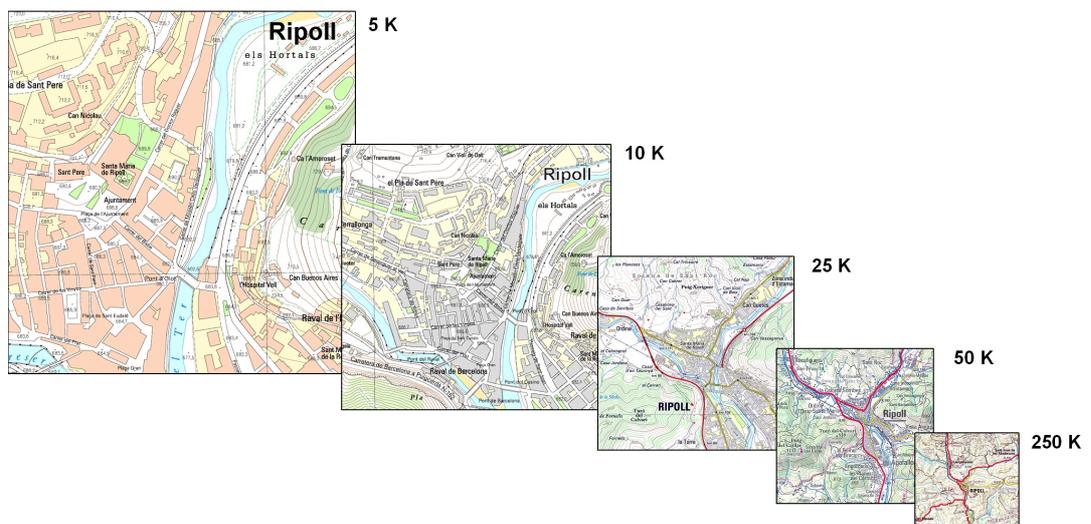
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### Introduction

Since their foundation in 1982, the Institut Cartogràfic de Catalunya has been producing and continuously updating three vector topographic databases covering Catalonia at scales 1:5.000, 1:50.000 and 1:250.000. The 1:250.000 database is used for general applications that need a full coverage of the country at small scale. The 1:50.000 is used for most of the GIS applications in the public administration and the 1:5.000 scale is used for public work planning and GIS applications to complete larger scales coverage, like 1:1.000 and 1:500.

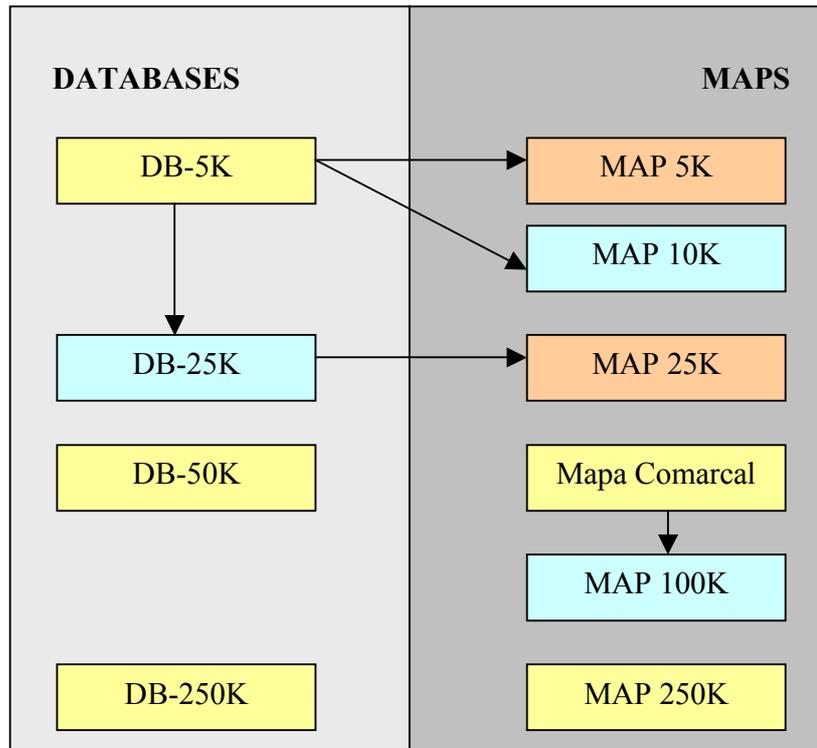
In the year 2003, the ICC started the generation of the 1:25.000 database for new GIS applications and mapping applying generalization to the 1:5.000 database. This database has more detail than the 1:50.000 and is more manageable than the 1:5.000. Moreover, as elevation data is becoming essential for visualization and analysis applications, the topographic database at 1:25.000 scale maintains the 2.5D character of the original data. After two years producing the 1:25.000 database applying generalization, the results are really good: the product fulfills the user requirements about quality and reduced data volume, and the productivity obtained is about three times higher than compiling all the information using photogrammetry and other methods.

But the production of the 1:25.000 database has opened a discussion at the ICC about the need to maintain the 1:50.000 database, because both scales are too close. The following paper presents a proposal to maintain only the topographic database at 1:25.000 and to obtain all the products derived now from the topographic database at 1:50.000, applying generalization methods to the 1:25.000 database.



## Topographic databases and derived products at the ICC

The current databases and their derived products at the ICC are illustrated in the following figure.



The figure shows in yellow the databases or maps compiled directly using photogrammetric systems (DB-5K) or digitized on top on orthoimages (DB-50K, DB-250K, Mapa Comarcal, MAP 250K). In blue, the derived products applying generalization and manual editing (DB-25K, MAP 10K, MAP 100K). In orange, the products derived automatically with no manual editing at all (MAP 5K, MAP 25K). The arrows show the relationships between the products. There are few relationships between different products and it means high cost in the updating processes and poor consistency between scales.

### The Topographic Database of Catalonia 1:25.000

The availability of the 2.5D Topographic Database at 1:5.000 and the previous experiences at the ICC implementing generalization workflows, allowed the production of the first version of the 1:25.000 database using generalization processes.

The database model was designed following the data model of the existing ICC vector databases. The definition of the concepts maintains, as much as possible, the semantics of the topographic objects across the different scales. The database documentation, like in the other ICC databases, includes detailed information about the product and the elaboration process. In this case the guidelines for data generation includes for each concept two methods: the generalization from the Topographic Database at 1:5.000 and the photogrammetric data capture from stereoscopic images, to be used during updating

processes. For the generalization process, the guidelines give the sequence of operations with their parameters and some considerations about the related concepts.

Comparing with the previous generalization experiences at the ICC, the workflow entailed two challenges: to obtain a database, and not only a map, and to derive 2.5D data instead of 2D data. The main difference between generalization to obtain a map or a database comes from having to preserve the topological structure of the data and their attributes. The 2.5D characteristic of the generalized data required a new software development and a careful editing process. The efforts devoted in the first aspect were small compared with the preservation of the 2.5D characteristic. In the generation of the generalized database, it was not possible to establish a relationship between the original and the generalized dataset, so we lost the opportunity to have a multi-scale topographic database from the 1:5.000 data.

After this experience, the proposal described in this paper is a first approximation to achieve a multi-scale database from the 1:25.000 database.

### **The Topographic Database at 1:50.000 and the Topographic Map**

In 1992, the ICC initiated the project to publish the *Mapa Comarcal de Catalunya 1:50.000*. It was decided the creation of a digital cartographic database for GIS purposes and the same information was used, after some cartographic editing processes, to publish the maps. The data was digitized on screen using orthophoto images at 1:25.000 in B/W and color, with pixel of 1.8 meters on the ground. The method used in data capture was 2D heads up digitizing. The altimetry was obtained by applying generalization to the ICC DTM database. The data was further completed and enriched by adding information collected on the field and from external sources. The database has been updated continuously and nowadays the average updating period is two years.

As these database was the first digital vector dataset covering Catalonia completely, from the beginning it was widely used by the different agencies of the Catalan Government (Transportation, Land Planning, etc.). The derived *Mapa Comarcal de Catalunya 1:50.000* has also a wide diffusion, at this moment the 6<sup>th</sup> edition is published and it is been used to derive other cartographic products like atlases. The first version of the map was derived from the database applying manual editing and automatic symbolization, but as there were not relationships between the database elements and the map elements, both products have been always updated separately.

The ICC has inquired the 1:50.000 database user community about the convenience to switch over the 1:25.000 database. To date, most of them are using the topographic data as reference backdrop without neither having attached their own thematic information to the topographic elements nor extended the attributes of the database. Therefore, they all agree with the change and appreciate the more detailed database. For the very few users that have integrated their own information, the change will have of course an additional cost, so the ICC will try to provide some tools to help them in the migration.

One frequently cited user requirement is to map their thematic data on top of the topographic database at smaller scales, from 1:50.000 to 1:100.000. With the existing 1:50.000 database, they can generate the maps on their own with minor difficulties, at least at 1:50.000 scale, but with the new database at 1:25.000 this can become more complex requiring to apply generalization. So, from the user point of view, the database at 1:50.000 could be replaced by the 1:25.000 if the ICC could provide the generalization tools to symbolize automatically the data at smaller scales.

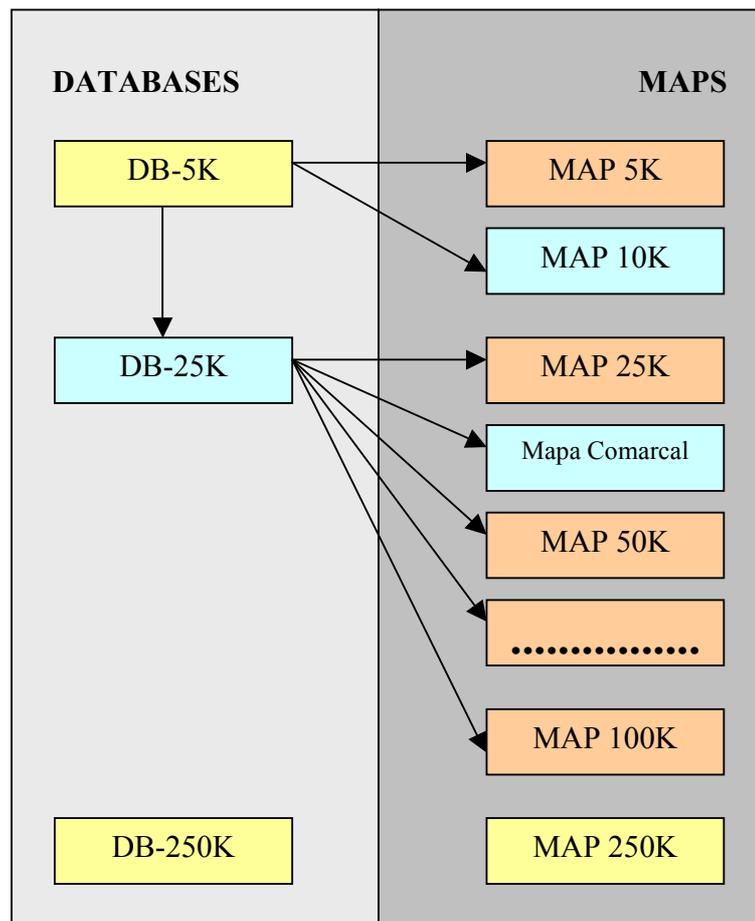
On the mapping side, the main ICC product related with the 1:50.000 database, but not directly derived, is the *Mapa Comarcal de Catalunya 1:50.000*. The proposal is that the map should be derived directly from the 1:25.000 database while creating and maintaining the relationships between the database and the map elements. These relationships will allow to update the database and to propagate the changes to the map.

### Changing the general workflow

Taking into account both user and internal requirements, the proposal is to produce only the 1:25.000 database and to derive the maps at smaller scales by generalization.

The proposal has two main goals:

- 1.- Replace the database 1:50.000 by the 1:25.000 ensuring the semantic coherence of the topographic objects, and providing online generalization tools to our users for symbolizing automatically the 1:25.000 database at smaller scales in order to produce maps on demand.
- 2.- Derive the *Mapa Comarcal de Catalunya 1:50.000* from the 1:25.000 database creating and maintaining the relationships between the database and the map elements.



The figure shows in yellow the databases or maps compiled directly using photogrammetric systems (DB-5K) or digitized on top on orthoimages (BD-250K, MAP 250K). In blue, the derived products applying generalization and manual editing (DB-25K, MAP 10K, Mapa Comarcal). In orange, the products derived automatically with no manual editing (MAP 5K, MAP 25K, MAP 50K, MAP 100K, ...). The arrows show the relationships between the products. Excluding the topographic database and map at 1:250.000, which will be analyzed in a near future, all the products are related. This way enforces the consistency between scales and products, and will reduce substantially the cost of the updating processes.

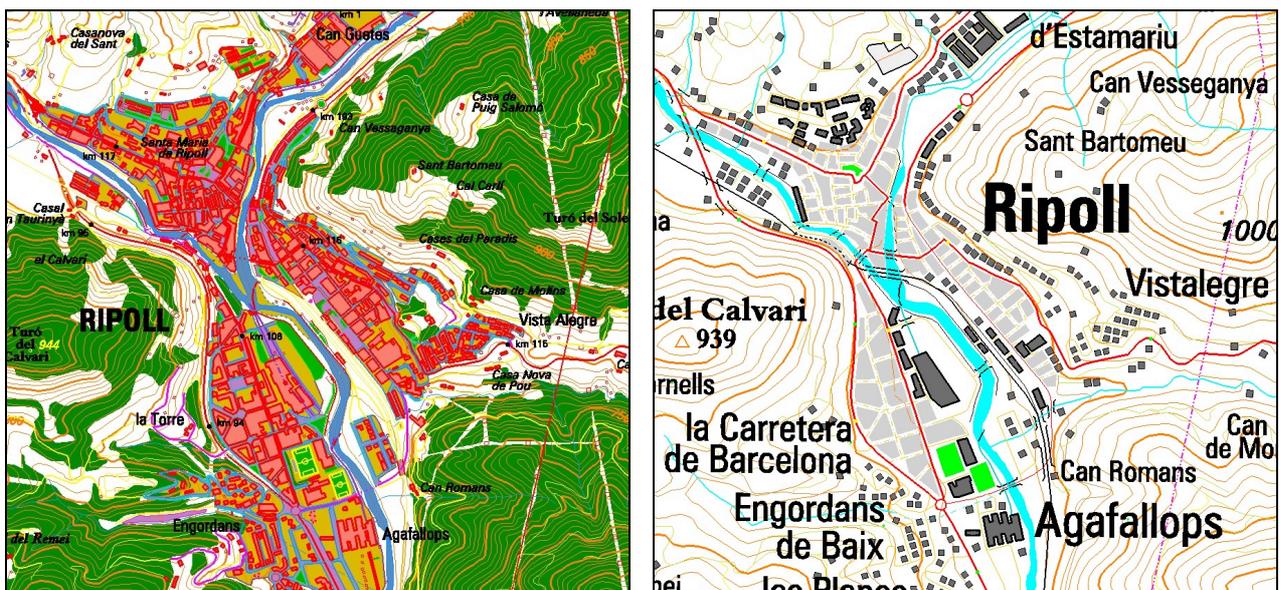
### Replacing the database 1:50.000 by the 1:25.000 database

As it is mentioned previously, the 1:25.000 database model was designed following the data model of the ICC vector databases that maintains as much as possible the semantics of the topographic objects across the different scales.

The difference between both databases, 1:25.000 and 1:50.000, is that the 1:50.000 database includes field data. After adding this information to the 1:25.000 database, the users will be able to replace the databases without losing information.

Another requirement for using the 1:25.000 database as a multi-scale database, is to introduce more hierarchy in the object classification based on the level of detail and the significance of the element, in order to improve the automatic generalization.

In most cases, the maps generated by the GIS users show thematic information on top of the topographic data. The ICC previous experiences on automatic generalization allow us to be optimistic regarding the development of an application for helping our users to generalize this topographic layer and use it in their maps.



Topographic database at 1:25.000

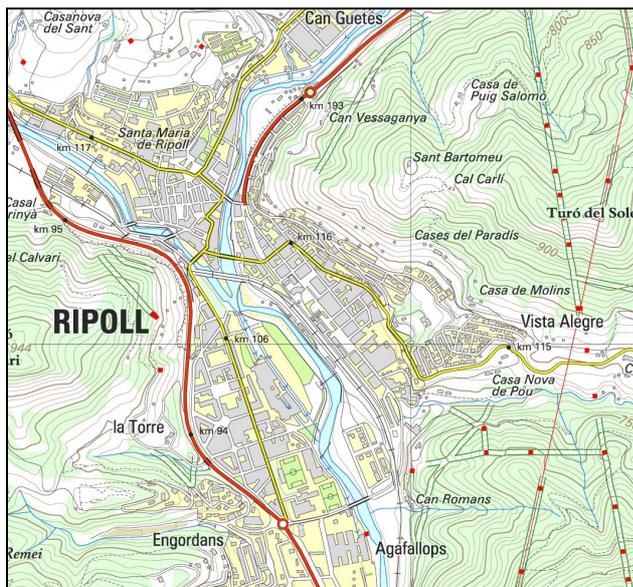
Topographic database at 1:50.000

### Deriving the Mapa Comarcal de Catalunya 1:50.000

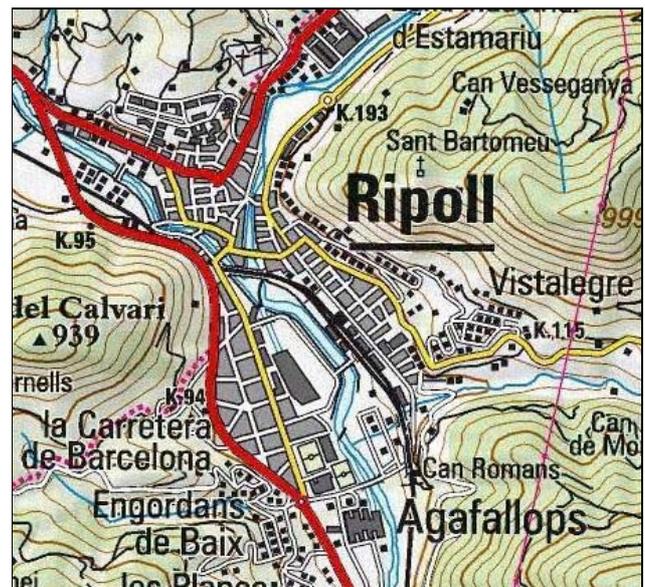
The *Mapa Comarcal de Catalunya 1:50.000* is a map designed following standards of high quality cartographic products, requiring large amount of manual editing to solve the conflicts introduced by the symbolization. The conflicts can increase if the map is derived by automatic generalization of the 1:25.000 database.

The proposal is to generate the map from the 1:25.000 database and to establish links between the elements of both products. The advantage of the approach is that the updating of the map will be faster, as changes at the database will be propagated. Moreover, the coherence between the database and the map will be enforced.

If we finally don't succeed in establishing the above mentioned links, the map will not be generated from the 1:25.000 database and the existing map will be updated separately from the database, as is done now with the database 1:50.000.



Topographic map at 1:25.000



Mapa Comarcal 1:50.000

### Prototype implementation

During next months, a prototype will be implemented in order to analyze the viability of the proposal. The firsts tasks in the development process will be:

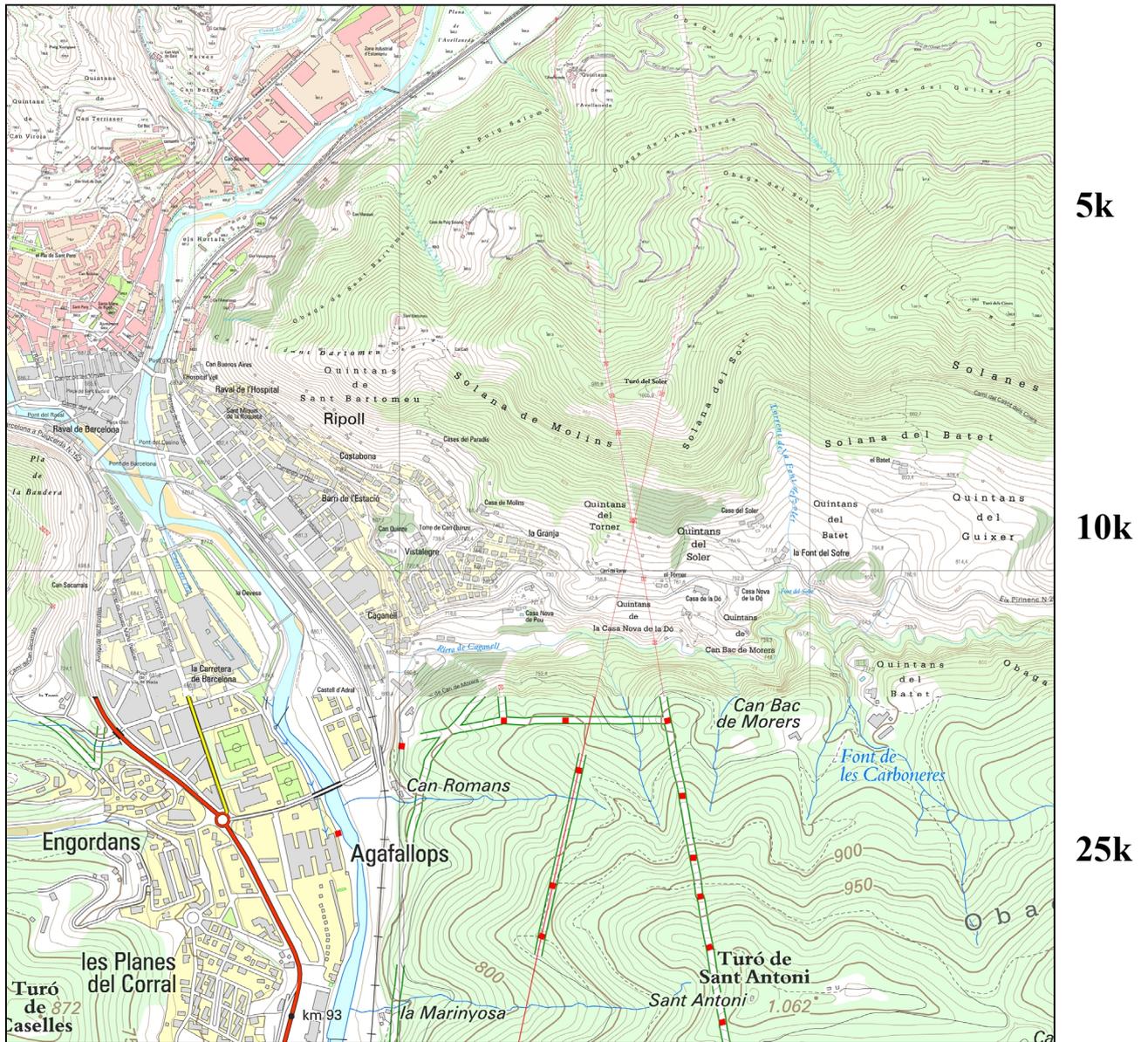
1. Adding of the information collected on the field or provided by external sources to the 1:25.000 database.
2. Apply a higher degree of hierarchy in the classification of the 1:25.000 database.

3. Design of the generalization workflow to obtain the *Mapa Comarcal de Catalunya 1:50.000* from the 1:25.000 database, which includes the establishment of the links between the elements of both products:
  - a. Automatic generalization and set up the links between elements.
  - b. Manual editing maintaining the links. This is the challenge of the proposal.
4. Design of an application for our users, based on the experience of the previous workflow, to obtain simple maps from the 1:25.000 database at smaller scales by applying automatic generalization with no manual editing:
  - a. Adapting previously developed generalization tools to the new requirements: full automatic generalization, no links required.
  - b. Implementation of the interface for online generalization and automatic symbolization for producing maps on demand.

## Summary

The new workflow has been designed to optimize the ICC databases production and taking also into account the customers needs. We foresee that the main problems will be related with the limitations of the current ICC data models and the development and implementation of more generalization tools. We have initiated contacts with other national mapping agencies to share experiences in common tasks, as the improvements and enrichments of the models and the generalization processes. About generalization, we are testing new functionalities of commercial software, as ARC/GIS or GEOMEDIA, improving and including new tools in our generalization software and, finally, starting to work together in some research projects with two universities, the Universitat Politècnica de València and the Universitat Autònoma de Barcelona.

If we succeed in the prototype implementation, that will cover the scales between 1:25.000 and 1:100.000, we will try in the future, to extend the prototype to include the larger, 1:5.000 and 1:10.000, and the smaller scales, 1:250.000.



The next step: the ICC multi-scale database