ICC Topographic Databases: First steps in the design of the ICC topographic MRDB

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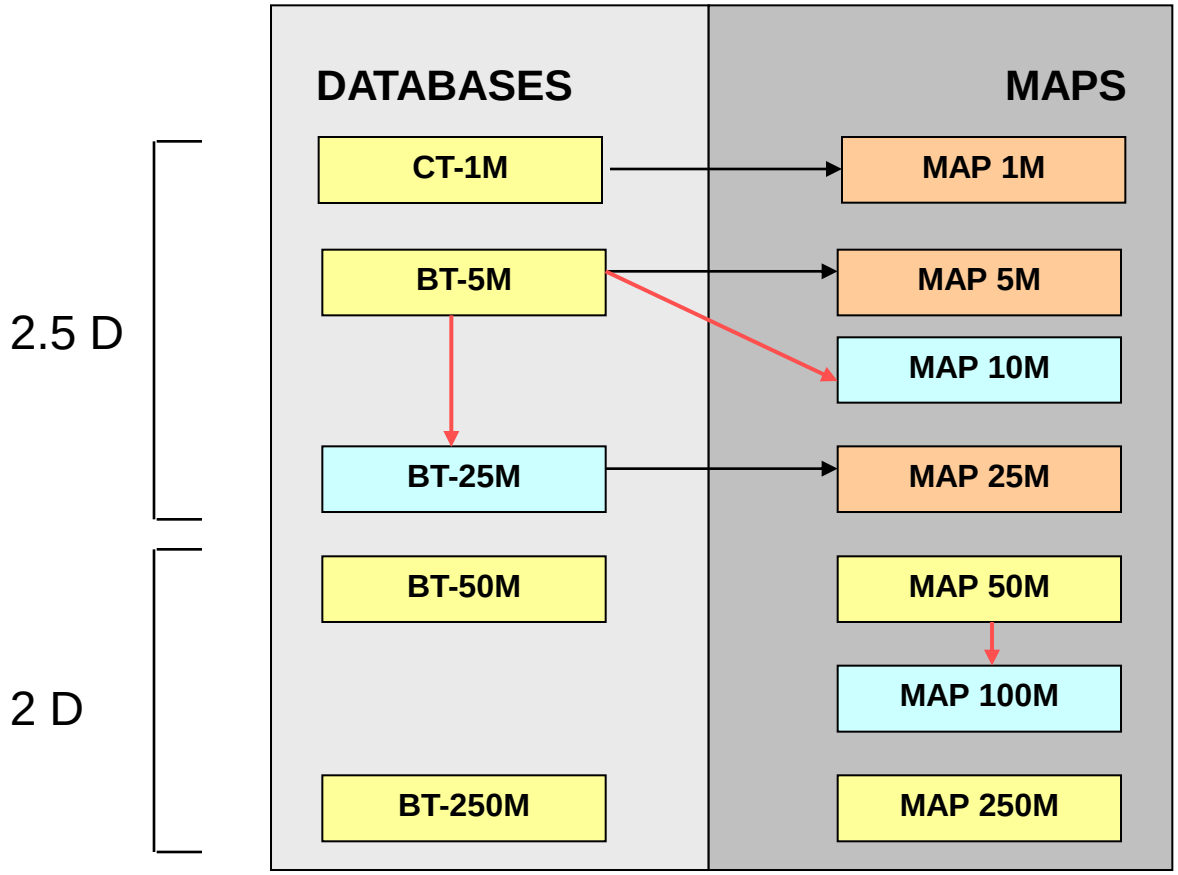
ICC Topographic Data

ICC Topographic Data



Yellow Products compiled
Blue Derived products applying generalization and manual editing
Orange Products derived automatically, with no manual editing

ICC Topographic Data

- Data models of the Topographic databases:
  - At the beginning of the ICC topographic data production, a first generation of data were collected using spaghetti data models on top of CAD systems. After, more complex data models were designed and implemented for allowing new data exploitations using GIS systems.
  - Coherence between data models at different scales, at geometric, topologic and semantic level.
  - But, **no explicit relationships** between the representations of the same geographical object in different scales.
- Maps are derived from the topographic databases

Generalization and MRDB at ICC

ICC Topographic Data

- Since 1993 generalization is applied to derive maps and databases:
  - Specific applications were designed and implemented for each generalization workflow combining commercial generalization tools and software developed internally at the ICC.
  - The generalized databases are updated separately from the original ones, because different updating cycles.
  - Because of the lack of commercial tools and the different updating cycle of each database, the implementation of a MRDB in the production environment never was considered.

ICC Topographic Data

- New requirements are costly to achieve with current models:
  - Huge demand of updated information.
  - High pressure to obtain derived products for visualization in internet and mobile devices.
- The implementation of a MRDB that integrates different topographic databases could be a solution to fulfill these requirements:
  - Better management of the updating processes.
  - Optimization of the generation of derived products using generalization, including on-the-fly processes for intermediate resolutions, used mainly for visualization.

Design of the ICC Topographic MRDB

Design of the ICC Topographic MRDB

- Two related databases have been considered in the first design of the ICC Topographic MRDB:
  - Topographic Database at 1:5.000 scale (BT-5M)
  - Topographic Database at 1:25.000 (BT-25M)

Design of the ICC Topographic MRDB

- Topographic Database at 1:5.000 scale (BT-5M):
  - The first version started in 1985 and was completed in 1995.
  - Digital vectors were compiled using analog and analytical stereoplotting on top on a CAD system, and the information never was structured to create a geographical database for GIS purposes.
  - Using the collected topographic information, a digital terrain model (DTM) and a digital surface model (DSM) was produced.
  - For the updating process, started in 1996, some changes were introduced in the data model for allowing GIS exploitations and for facilitating further generalization at smaller scales.
  - The current updating cycle is 4 years.

Design of the ICC Topographic MRDB

- Topographic Database at 1:25.000 scale (BT-25M):
  - Started in 2004 based on generalization from BT-5M:
    - Demand of updated base data at 1:25.000.
    - Existence of a production program for the BT-5M.
    - Experience at the ICC in implementing generalization workflows.

Design of the ICC Topographic MRDB

- Topographic Database at 1:25.000 scale (BT-25M):
  - Started in 2004 based on generalization from BT-5M.
  - The workflow entailed two challenges:
    - To obtain a topographic database, not only a map → preserve the topological structure of the data and their attributes.
    - To generalize 2.5D data instead of 2D data → development of new software and implementation of a 2.5D editing process.

Design of the ICC Topographic MRDB

- Topographic Database at 1:25.000 scale (BT-25M):
  - Started in 2004 based on generalization from BT-5M.
  - The workflow entailed two challenges.
  - There are no explicit mechanism linking the original and the generalized datasets:
    - At that time, the lack of tools for compiling photogrammetric data in a GIS production environment, forced to keep using a photogrammetric CAD system.
    - The desired improvements in the datamodel, such as unique identifiers for the objects and metadata at object level, were not implemented at that time because they could not be managed efficiently in a CAD system.

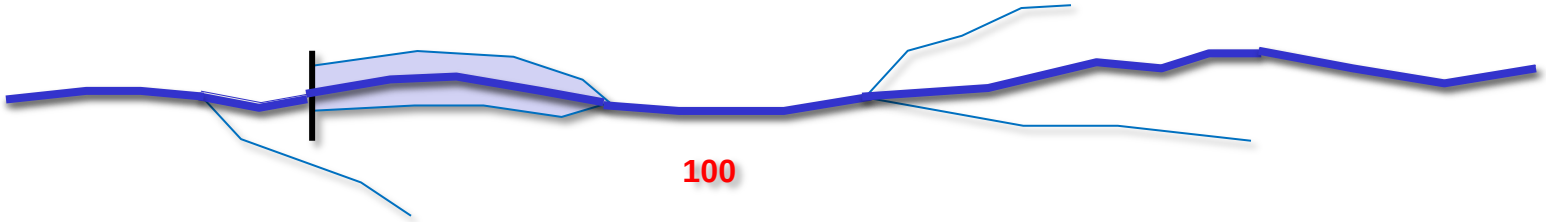
Design of the ICC Topographic MRDB

- In the last few years, the availability of GIS based photogrammetric tools delivering reasonable productivities has encouraged the ICC to think in a new version of the datamodel that should include the main aspects of a MRDB.
- After the complete implementation and deployment of the MRDB production workflow for 1m and 2,5m resolution data, if reasonable productivity ratios are achieved, the workflow will be extended to ICC topographic data at other resolutions.

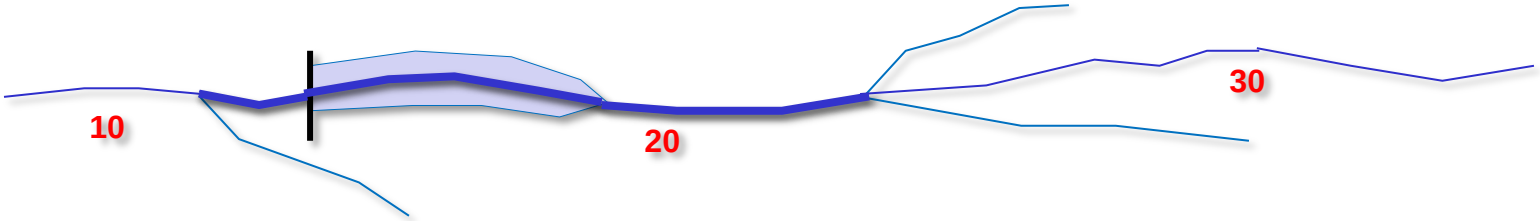
ICC MRDB
Data model

ICC MRDB Data model: Object defintion

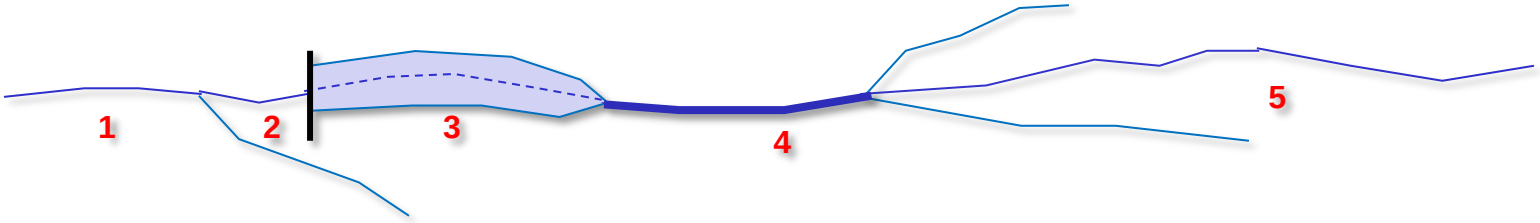
1. The whole river



2. Each river stretch between two tributaries



3. Each river stretch with common characteristics between two tributaries

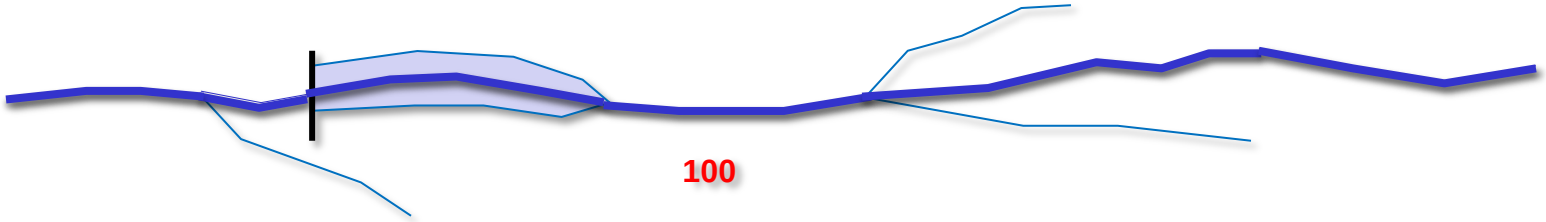


ICC MRDB Data model: Object definition

- Depending on the use cases to which a model must respond, real world phenomena can be modeled in different ways.
- In addition, as a result of the use cases requirements, the conceptual model may include several modeling of the same real world phenomenon. Features may be aggregated in “complex features”, which are, in turn, features.
- As “complex features” are strongly dependent on the use cases, and moreover, because it is a complex structure that could reduce the performance, it was decided that the new data model will be based on simple features with common attributes.

ICC MRDB Data model: Object definition

1. The whole river



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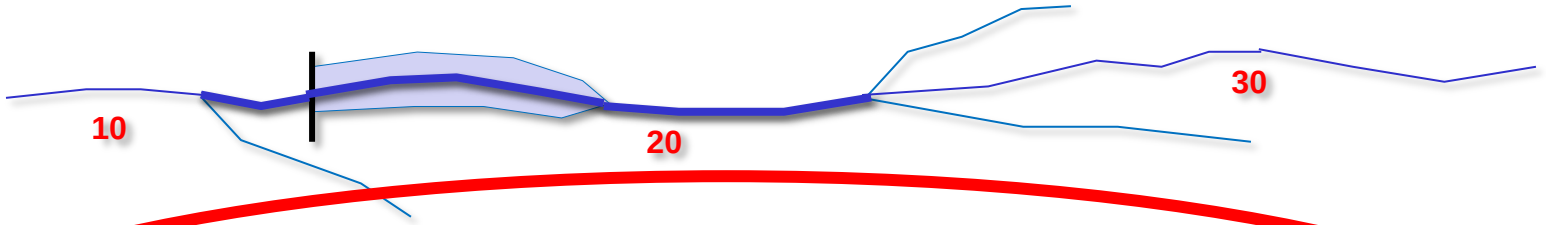

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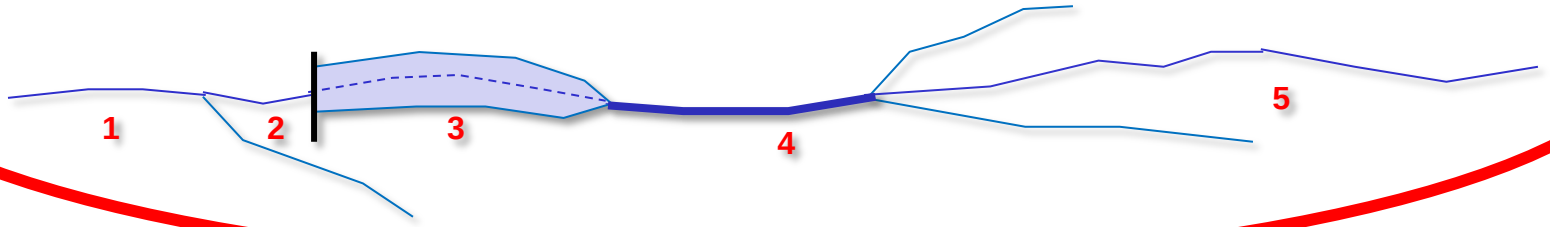


ICC MRDB Data model: Attributes

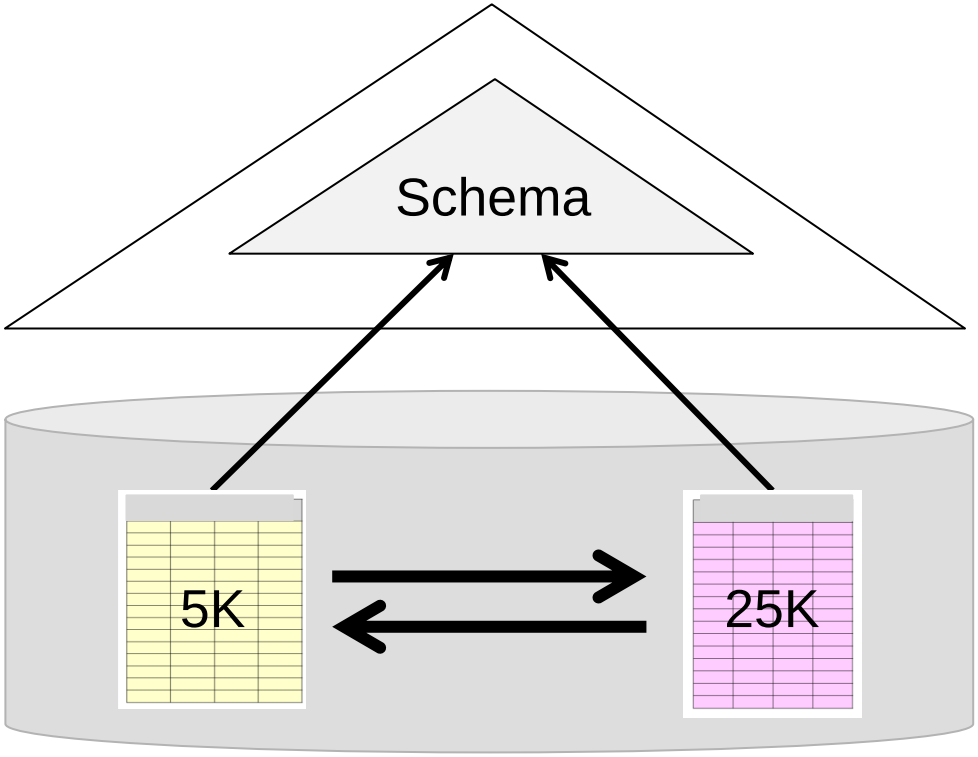
- Unique identifier
- Spatial attribute
- Temporal attributes
- Metadata attributes
- Thematic attributes

ICC MRDB Data model: Standards

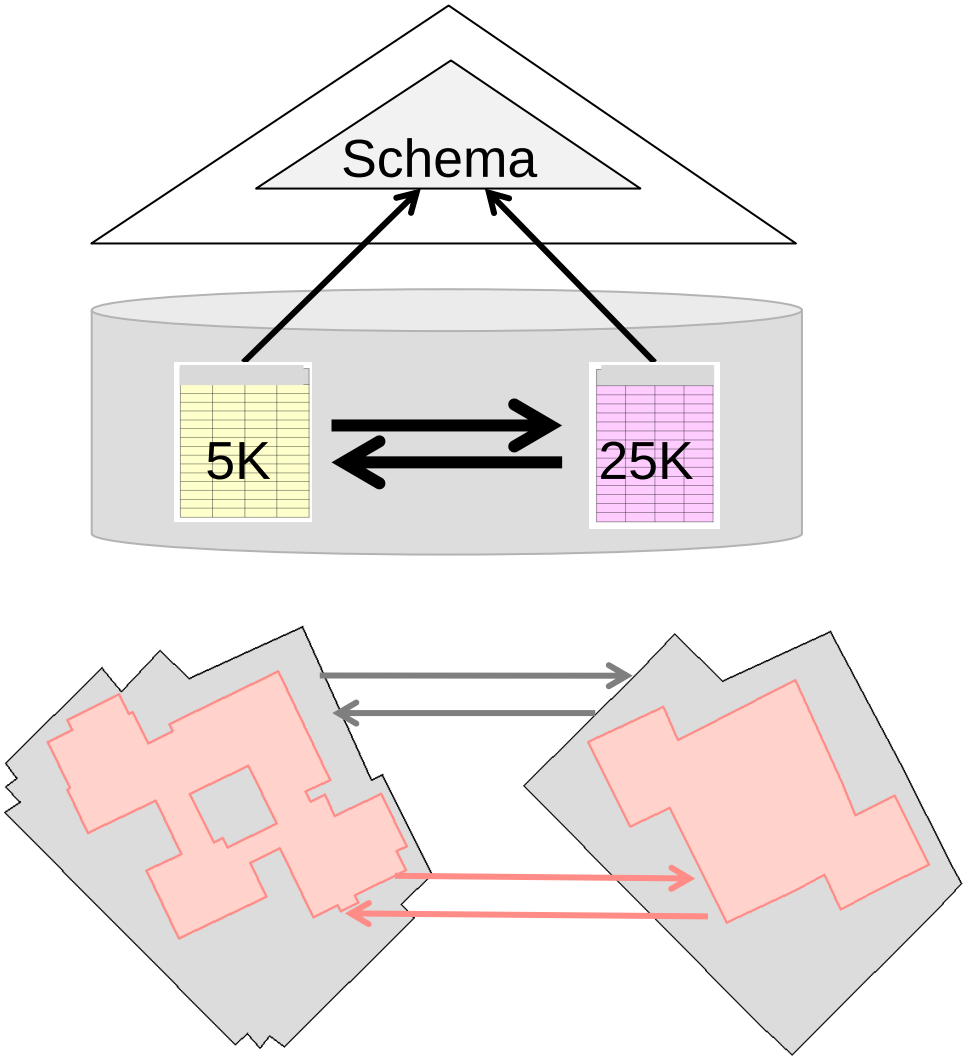
- National and international standards have been taken into account to guarantee interoperability.
- The new model will be compatible with:
  - The Base Topográfica Armonizada (BTA), the Spanish standardized model for topographic data.
  - The European INSPIRE data models.

ICC MRDB Data model: MRDB modeling

- The ICC model is based in one single schema with linked data: one feature belongs to one single resolution and has a link with one, or more, features of the other scale.



ICC MRDB Data model: MRDB modeling



ICC MRDB Data model: MRDB modeling

- Model based in one single schema with linked data: one feature belongs to one single resolution and has a link with one, or more, features of the other scale.
- The links between corresponding feature instances at different level of detail will be determined by various cardinalities:
  - The allowed cardinalities are **1:1**, **n:1**, **1:n, 1:0** and **n:m**.
  - Cardinalities **0:1**, **0:n**, corresponding to the appearance/creation of new feature instances, or the derivation of one feature type from other ones are not considered, due to the small ratio between resolutions.

ICC MRDB Data model: MRDB modeling

- Model based in one single schema with linked data: one feature belongs to one single resolution and has a link with one, or more, features of the other scale.
- The links between corresponding feature instances at different level of detail will be determined by various cardinalities.
- Usually small scales require shorter updating cycles than large scales. This model allows to update data at any scale:
  - If large scale updated first, apply generalization to derive smaller scale and establish links
  - If small scale updated first, collect data collect data at larger scale and links must be established through a matching process

ICC MRDB Implementation

ICC MRDB Implementation

- The MRDB implementation includes two main aspects:
  - The migration of the photogrammetric data collection from a CAD system to a GIS system based on a DBMS.
  - The management of the data and the MRDB relationships.
- The MRDB implementation will be evaluated through a pilot project.

ICC MRDB Implementation: Migration from CAD to GIS

- The goal is to achieve productivity similar to the one of the existing CAD environment.
- It is required to customize the commercial system.
- An important aspect is the training of the production teams in the GIS system and in the customized tools.

ICC MRDB Implementation: Migration from CAD to GIS

- The commercial software used in the implementation is:
  - GeoMedia as GIS system
  - ISSG as photogrammetric software
  - ORACLE as database manager
- Why?

ICC MRDB Implementation: Migration from CAD to GIS

- ISSG & GeoMedia:
  - Team experienced in ISSG (=ISSD).
  - Cheaper than other GIS systems.
  - Easier integration with existing workflow of stereo images.
- ORACLE:
  - All the tasks that can be done on top of ORACLE will not be performed on GeoMedia:
    - Graphical environment independence.
    - Reduce the number of GeoMedia licenses.
  - Based on tools developed using ORACLE objects.
  - Main tasks: some quality control tasks and DB transactions.

ICC MRDB Implementation: Management of the data and the MRDB

- The links between the feature instances at different resolutions will be based on tables that store the relationships between features instances through unique identifiers.
- They will be established:
  - For the existing data, using matching techniques applied in the migration process to the new MRDB data model.
  - For later updating processes on the higher accuracy data, the lower resolution data generation and the links establishment will be managed by the generalization process.

ICC MRDB Implementation

- The implemented system will be evaluated taking into account the impact of the new data model on the performance in the production environment.
- The evaluation will be focused on:
  - The data capture based on a GIS system.
  - The management of the MRDB links.
  - The maintenance of the links in the updating operations.
  - The aspects related to the matching processes.

ICC MRDB Implementation (Istambul, Sept 2012)

Task	Status
Design of the model	Complete
Programming data capture tools	In progress, 2013 Q1
Training on data capture tools	In progress, 2013 Q2
Data capture implementation	2013 Q3
Analysis of the results on data capture	2013 Q4
Programming MRDB tools	2014
Training on MRDB tools	2014
MRDB implementation	2014
Analysis of the results on MRDB	2014

ICC MRDB Implementation (Barcelona, March 2013)

Task	Status
Design of the model	Complete
Programming data capture tools	Complete
Training on data capture tools	Complete
Data capture implementation	In progress, 2013Q3
Analysis of the results on data capture	2013 Q4
Programming MRDB tools	2014
Training on MRDB tools	2014
MRDB implementation	2014
Analysis of the results on MRDB	2014

Main issues

Main issues

- High effort to customize the commercial GIS systems used in the production environment, in two aspects:
  - Photogrammetric data collection.
  - Management of the data and the MRDB relationships.
- Lack of experience in production environments about topographic MRDB:
  - Productivity.
  - Manual tasks required in the matching processes.

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