ICGC MRDB for topographic data: first steps in the implementation

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esri

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Introduction

Introduction:
Institut Cartogràfic i Geològic de Catalunya (ICGC)

- The ICGC is a public law entity of the Generalitat de Catalunya, the Autonomous Government of Catalonia.
- Their duties are related to the competences of Geodesy and Cartography and about the Spatial Data Infrastructure of Catalonia, and also the competences of promoting and carrying out the actions related to the awareness, survey and information about the soil and subsoil.

Introduction: the ICGC MRDB

- In the scope of data production, the ICGC is working continuously in the improvement of the production workflows.
- During the past few years, the ICGC has been analyzing the implementation of a MultiResolution DataBase (MRDB) for integrating the ICGC topographic databases.

Introduction: the ICGC MRDB

- Contents:
  - Topographic Database at 1:5000 (BT-5M), 3D data
  - Topographic Database at 1:25.000 (BT-25M), 3D data
  - In the future:
    - Topographic Database at 1:1.000 (BT-1M)
    - Topographic Database at 1:50.000 (BT-50M)
    - Topographic Database at 1:250.000 (BT-250M)
- Workflow:
  - Definition of the conceptual model
  - MRDB implementation

Introduction: the ICGC MRDB implementation

- ICGC MRDB implementation steps:
  - Setting up of the data model according to the conceptual model.
  - Migration of the existing data to the new data model.
  - Migration of the photogrammetric data collection system from CAD to GIS.
  - First MRDB link establishment
  - Integration of generalization tools into the new system.
  - Development of the tools for the management of the MRDB relationships.

Introduction: the ICGC MRDB implementation

- The first topographic databases to be integrated into the MRDB are the BT-5M and the BT-25M, both with full coverage of the country.
- The link establishment will be done using feature matching techniques

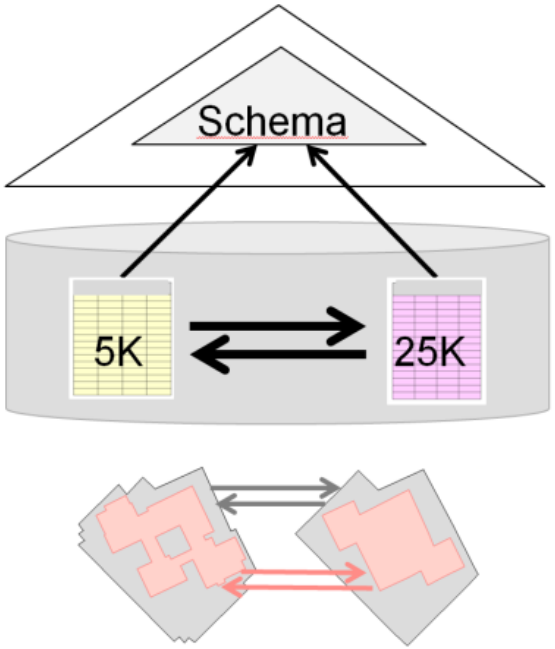
Commercial conflation tools from Esri are being tested for performing the matching

- For future updating processes the links will be managed by the updating or the generalization process.

Data model implementation

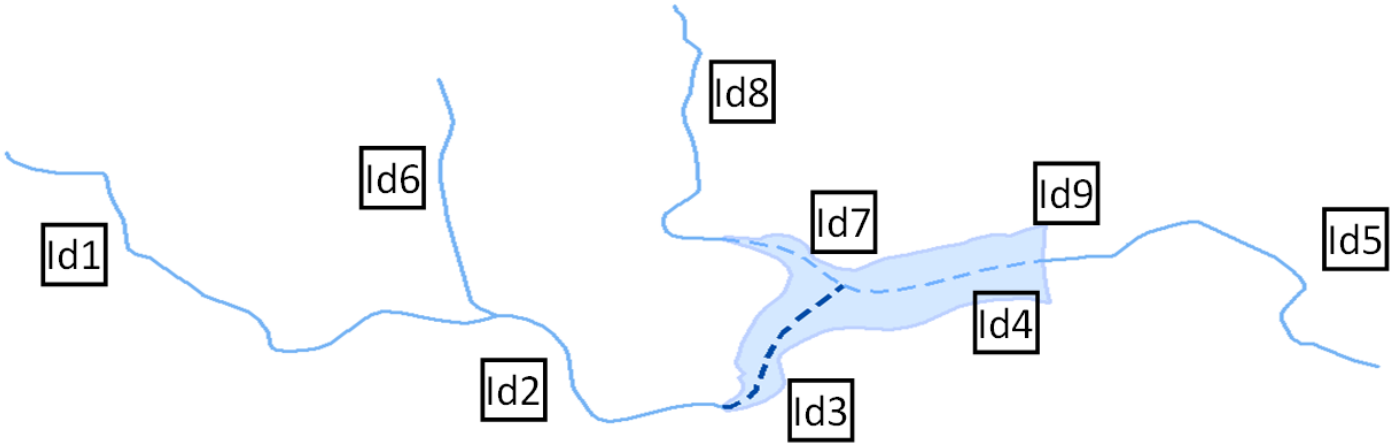
MRDB design and implementation: ICGC MRDB data model

- The ICGC MRDB data model is based on one single schema with linked data, where one feature belongs to one single resolution and has a link to one or many features of the other resolution.



MRDB design and implementation: ICGC MRDB data model

- The data model is based on simple features, which are defined by a part of a real world phenomenon with common attribute values.



For example: Each stretch of the river network with common attributes between two intersections corresponds to a feature instance.

MRDB design and implementation: ICGC MRDB data model

- Each feature instance holds:
  - An identifier: unique and persistent
  - Spatial attributes: geometric representation.
  - Temporal attributes: life-cycle information describing temporal characteristics, allowing data versioning.
  - Metadata attributes: information related to data lineage and quality.
  - Thematic attributes: to characterize features.

MRDB design and implementation: the database

- The data model is being implemented on an Oracle Spatial Database.
- Steps:
  - Schema creation
  - Migration of the BT-5M and BT-25M data to the new data model and loading into the database.

MRDB design and implementation: the database

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  - ✓ Schema creation
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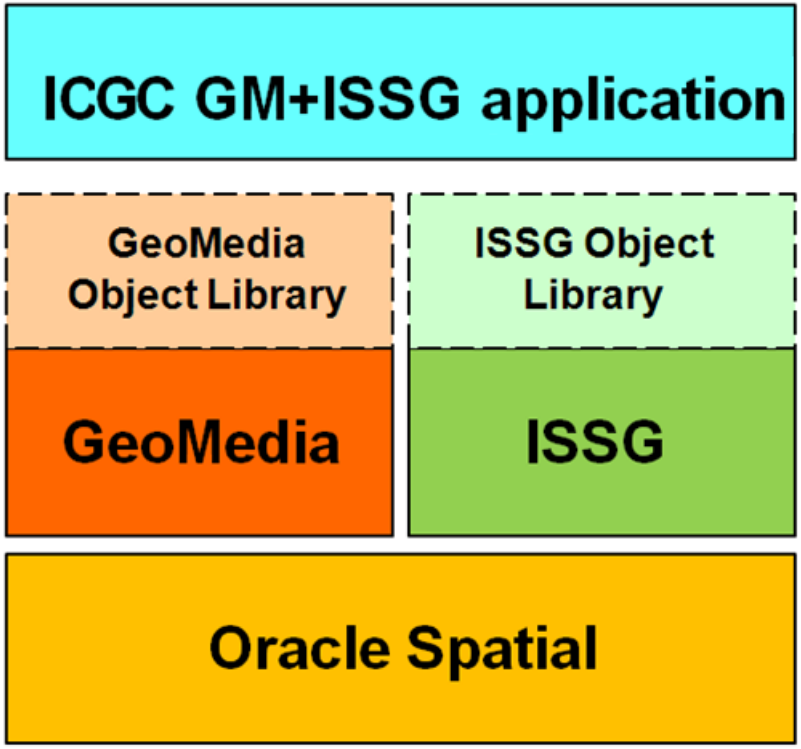
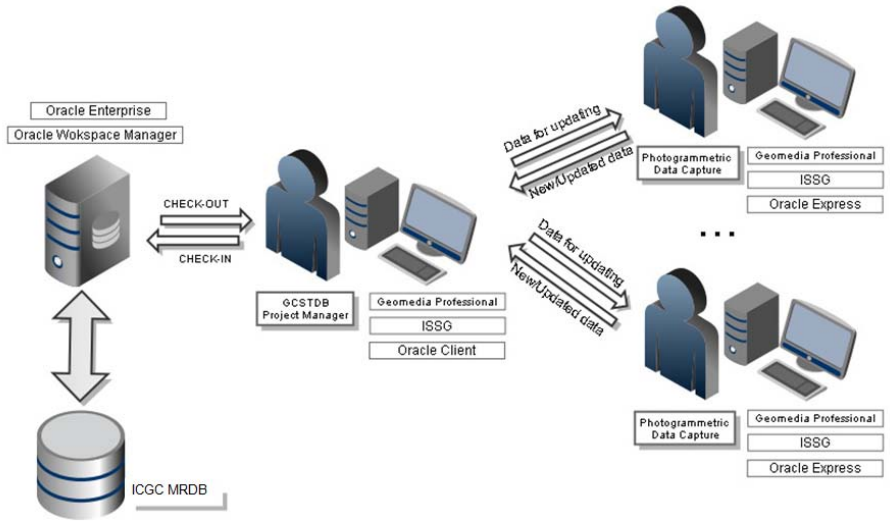
Migration to a GIS photogrammetric data capture system

Migration to a GIS photogrammetric data capture system: components



Migration to a GIS photogrammetric data capture system: architecture

- System architecture:
  - Central database on Oracle Enterprise, where data is consolidated.
  - Several disconnected photogrammetric data capture working sites using Oracle Express.

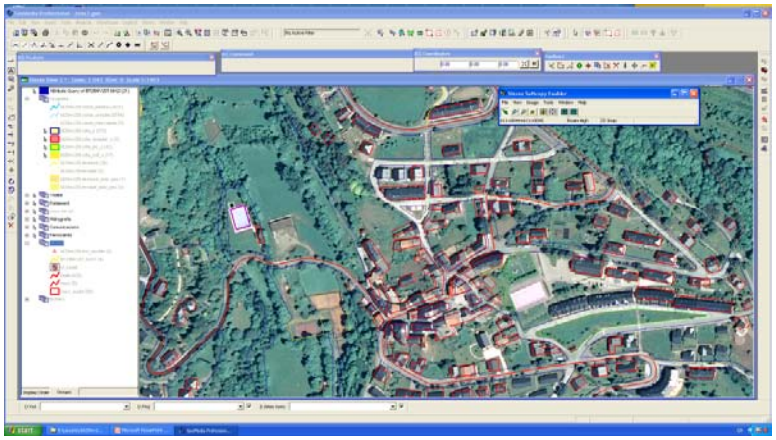


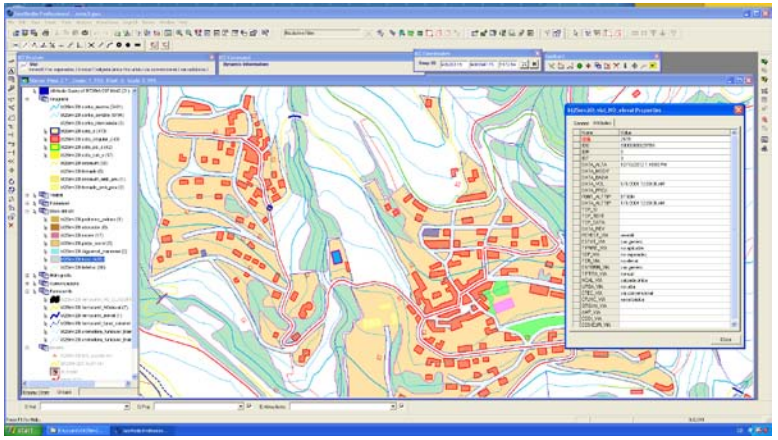
Migration to a GIS photogrammetric data capture system: tools

- The system is based in an ICGC customization of the commercial software for improving productivity, that:
  - Extends the functionalities of GeoMedia and ISSG.
  - Solves the 3D shortcomings of GeoMedia and Oracle Spatial.
  - Reduces the vector data visualization problems of ISSG.
  - Optimizes the data capture and management.
  - Ensures the data quality by application design.

Migration to a GIS photogrammetric data capture system: status

- Fully in production.
- Cartographers highly satisfied.
- Expected productivity achieved.
- Richer data model widening the range of exploitations.
- Successful system migration.





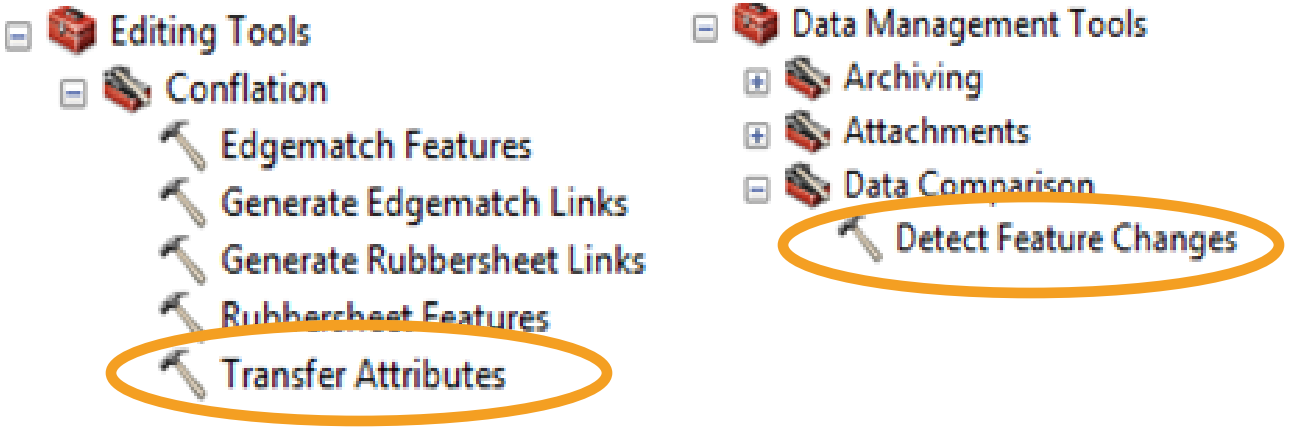
MRDB link establishment

Esri conflation tools and geoprocessing tools

MRDB link establishment: conflation tools and feature matching (FM)

- The goal is to match corresponding features and assign a unique ID as the link to each matched group of features.

FM is at the core of Esri conflation tools; two of the FM-based tools used in this paper are “Transfer Attributes” and “Detect Feature Changes”.



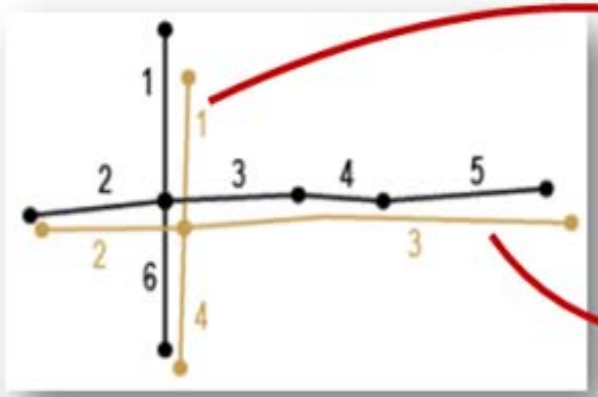
MRDB link establishment: conflation tools and feature matching

- A match table can be produced by either tool, storing the FM information:
  - Source and target feature IDs (SRC_FID; TGT_FID)
  - FM_GRP (unique match group ID)

The FM_GRP values are to serve as links between corresponding features.

  - FM_MN (match relationships)
  - FM_CONF (match confidence level)

MRDB link establishment: conflation tools and feature matching

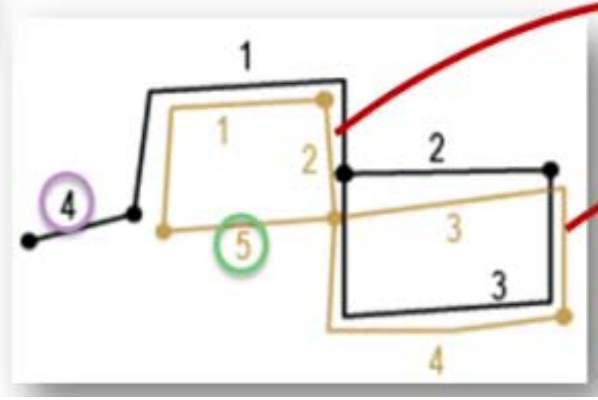


Source feature

Target feature

1:1 and 1:m matches

OBJECTID *	SRC_FID	TGT_FID	FM_GRP	FM_MN	FM_CONF
1	1	1	1	1:1	100
2	2	2	2	1:1	100
3	3	3	3	1:3	100
4	3	4	3	1:3	100
5	3	5	3	1:3	100
6	4	6	4	1:1	100



m:1 and m:n matches

OBJECTID *	SRC_FID	TGT_FID	FM_GRP	FM_MN	FM_CONF
1	1	1	1	2:1	100
2	2	1	1	2:1	100
3	3	2	2	2:2	100
4	3	3	2	2:2	100
5	4	2	2	2:2	100
6	4	3	2	2:2	100
7	5	-1	-1	N/A	0
8	-1	4	-1	N/A	0

MRDB link establishment: test scenarios

- Three test Scenarios:
  - Scenario A → establish links for road centerlines of BT-5M and BT-25M and transfer classification attributes from BT-25M to BT-5M
  - Scenario B → establish links for watercourse centerlines of BT-5M and BT-25M
  - Scenario C → establish links between buildings of BT-5M and BT-25M
- The test is in the first stage and more scenarios, with data covering different geographic areas and other feature types, should be processed to have more reliable results.

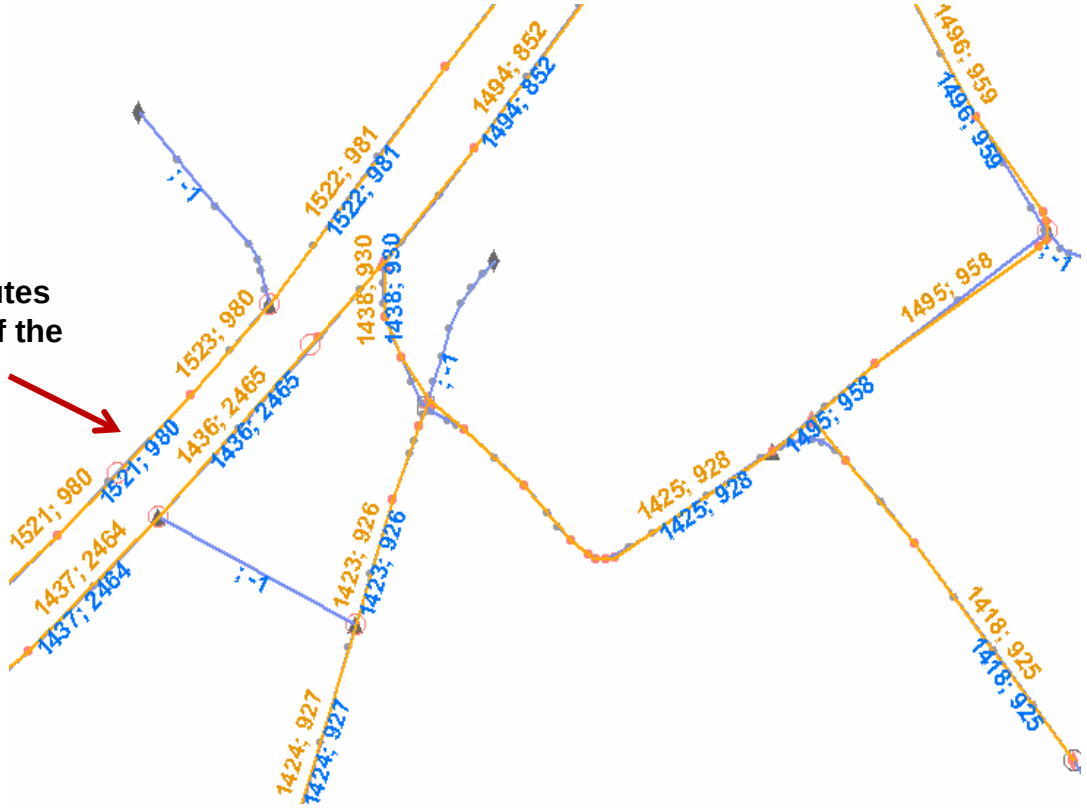
MRDB link establishment: test scenarios

- **Scenario A** – establish links for road centerlines of BT-5M and BT-25M and transfer classification attributes from BT-25M to BT-5M
- Conflation and evaluation
  - Automatic (via GP model)
  - Transfer Attributes tool → match table and attribute transfer
  - Three areas are evaluated:
    - potential FM issues
    - potential missed matches
    - attribute transfer in M:N relationships

MRDB link establishment: test scenarios

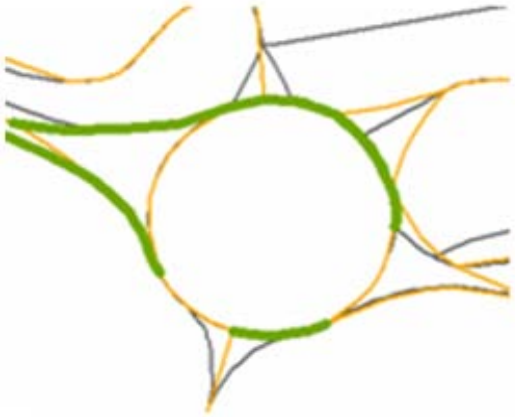
- **Scenario A** – Resulting road centerlines, labelled in the order of “feature unique identifier; FM_GRP” values.

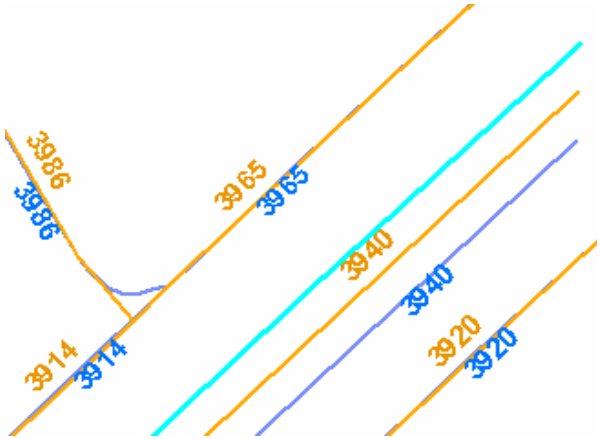
This is a 2:1 match. Attributes are transferred from one of the two sources to the target.



MRDB link establishment: test scenarios

- **Scenario A** – post-processing (interactive)
  - Review of potential FM issues (left below), flagging true issues.
  - Review of potential missed matches (right below), flagging true issues.
  - Review of attribute transfer in M:N relationships (indicated in previous slide).
  - Necessary editing were not done due to time limit.





MRDB link establishment: test scenarios

- **Scenario A** – matching accuracy and processing time estimates

Matched group count	Correct match count	Matched accuracy estimate (MA_est)	Unmatched count	Correctly unmatched count	Unmatched accuracy estimate (UnMA_est)
2788	2755 (2788 – 33)	98.8%	1845	1705 (1845 – 140)	92.4%
Overall matching accuracy estimate (average of MA_est and UnMA_est) = 95.6%					

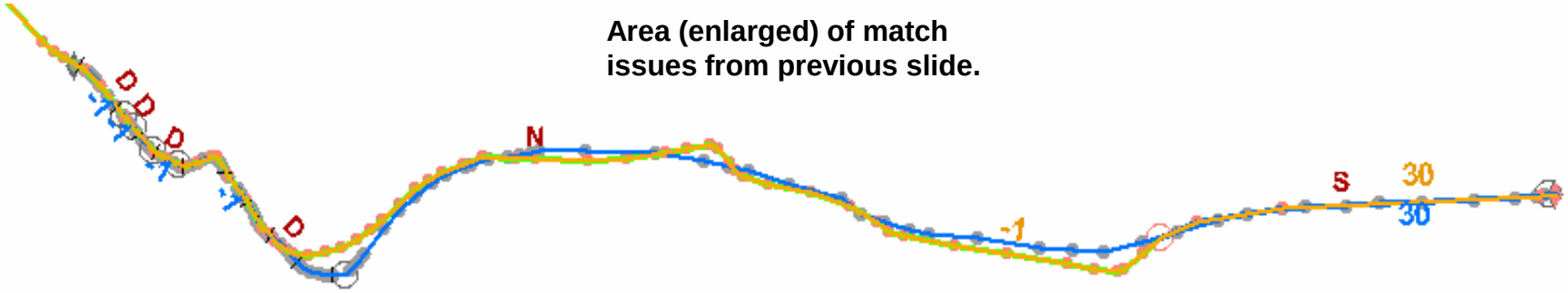
Conflation and evaluation	Review of potential FM issues total 69 cases; 2-3 cases per min.	Review of potential missed matches total 267 cases; 2-3 cases per min.	Total (Not including the time for reviewing M:N relationships and for making corrections)
1min 3sec	23-35 min.	89-134 min.	113-170 min. (2 – 3 hours)

MRDB link establishment: test scenarios

- **Scenario B** – establish links for watercourse centerlines of BT-5M and BT-25M
- Conflation and evaluation:
  - Automatic (via a GP model)
  - Detect Feature Changes → match table (left below) and helps visualize the match result through change types (right below).

MRDB link establishment: test scenarios

- **Scenario B** – post-processing (interactive)
  - Review of potential FM issues.
  - Review of potential missed matches.



Area (enlarged) of match issues from previous slide.

MRDB link establishment: test scenarios

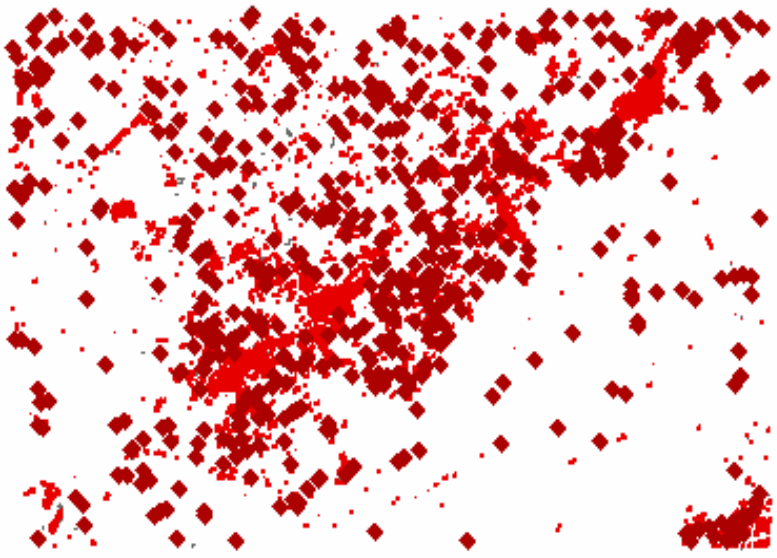
- **Scenario B** – matching accuracy and processing time estimates

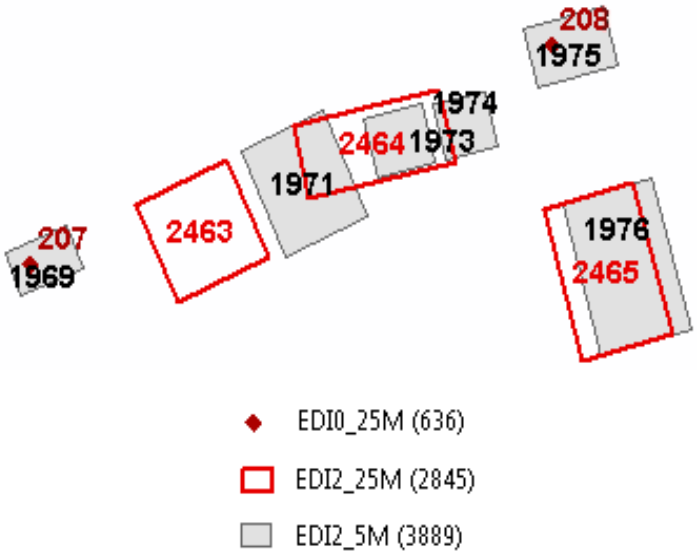
Matched group count	Correct match count	Matched accuracy estimate (MA_est)	Unmatched count	Correctly unmatched count	Unmatched accuracy estimate (UnMA_est)
76	76	100%	37	33	89.2%
Overall matching accuracy estimate (average of MA_est and UnMA_est) = 94.6%					

Conflation and evaluation	Review of potential FM issues total 5 cases	Review of potential missed matches total 13 cases	Total (including estimated time, 10 mins, for making corrections)
6 sec	2 min.	5 min.	less than 0.5 hour

MRDB link establishment: test scenarios

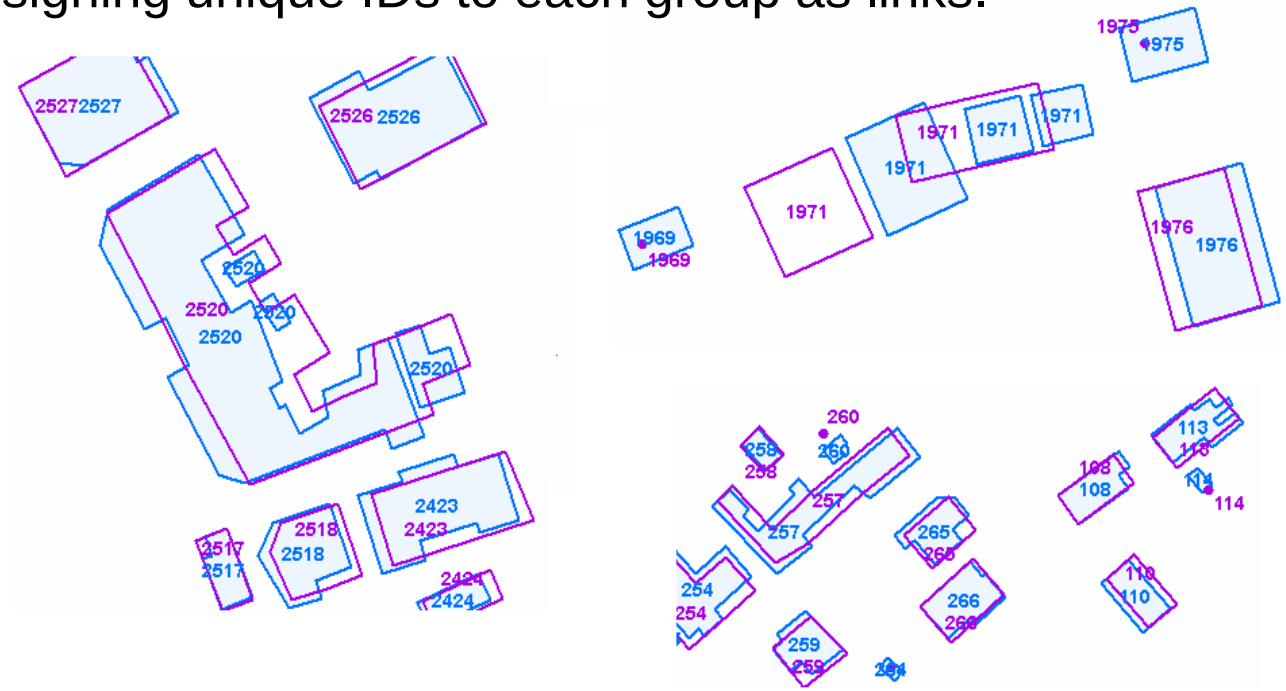
- **Scenario C** – establish links between buildings of BT-5M and BT-25M
  - At BT-5M all buildings are detailed polygons.
  - At BT-25M buildings are generalized polygons and points.





MRDB link establishment: test scenarios

- **Scenario C** – establish links (automatic via a GP model)
  - Finding groups of corresponding features through spatial analysis (overlay and near operations).
  - Assigning unique IDs to each group as links.



MRDB link establishment: test scenarios

- **Scenario C** – post-processing (interactive)
  - Review of unlinked features.
- Linking accuracy and processing time estimates

Matched group count	Correct match count	Matched accuracy estimate (MA_est)	Unmatched count	Correctly unmatched count	Unmatched accuracy estimate (UnMA_est)
3723	3722	100%	89	83	93.3%
Overall matching accuracy estimate (average of MA_est and UnMA_est) = 96.7%					

Conflation and evaluation	Review of potential FM issues total 3 cases	Review of potential missed matches total 89 cases	Total (including estimated time, 10 mins, for making corrections)
6.9 sec	1 min.	15 min.	less than 0.5 hour

Conclusions

Conclusions

- Implementation of the ICGC MRDB in successive phases:
  - design and implementation of the data model
  - migration of the production system
  - implementation of the MRDB links
- Conflation and other geoprocessing analysis tools have a great potential:
  - to facilitate the first link establishment for the MRDB
  - to harmonize attributes between multi-scale features
- Results of the test suggest that :
  - first link establishment can be highly automated
  - time for post-processing is expected to be reasonable.

Thank you for your attention!

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