Geographic and Cartographic Contexts in Generalization

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Dan Lee

ESRI, Redlands, USA

(dlee@esri.com)

- Introduction
- Generalization onsidering geographic context
- Generalization considering cartographic context
- Working towards adaptive processes

Generalization – the traditional practice

“Due to scale restrictions, the cartographer makes a selection, classifies, standardizes; he undertakes intellectual and graphical simplifications and combinations; he emphasizes, enlarges, subdues or suppresses visual phenomena according to their significance to the map. … he reorganizes the many elements which interfere with one another, lie in opposition and overlap, thus coordinating the content to clarify the geographical patterns of the region (Imhof,1982).”

Generalization – the GIS-based approach

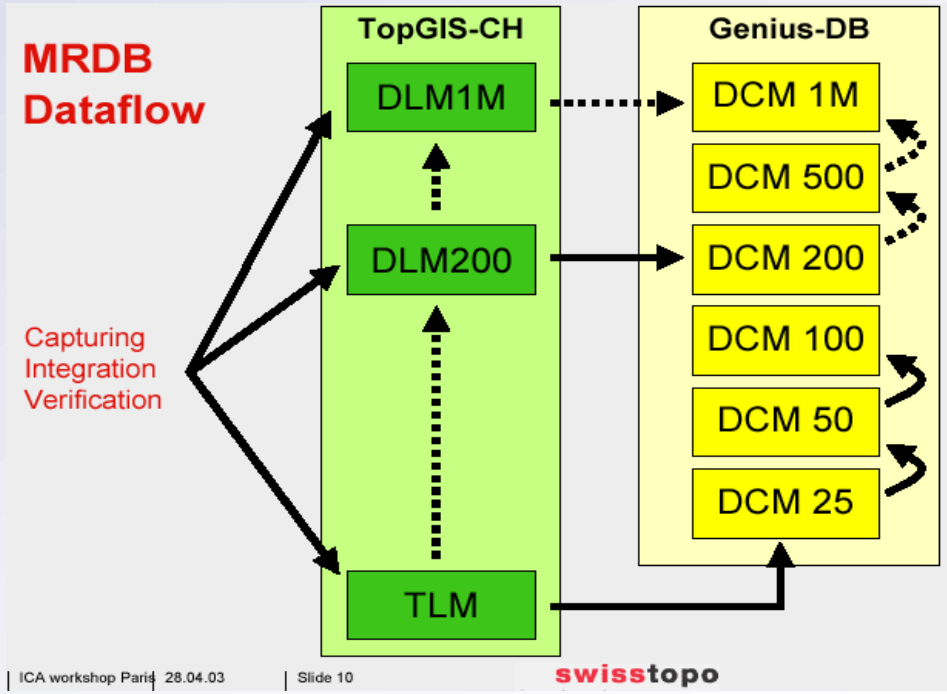
- Building digital geographic models and deriving multiple outputs
- Pursuing as much automation and flexibility as possible

Database generalization

- data transformation, abstraction, and reduction:
  - *data capture -> master DB*
  - *master DB -> new DB or data set*
- focus: *geographic context*

Cartographic generalization

- visualization and map production:
  - *data -> computer display -> cartographic products*
- focus: *cartographic context*



Swisstopo's MRDB data flow, (Kreiter, Paris, 2003)

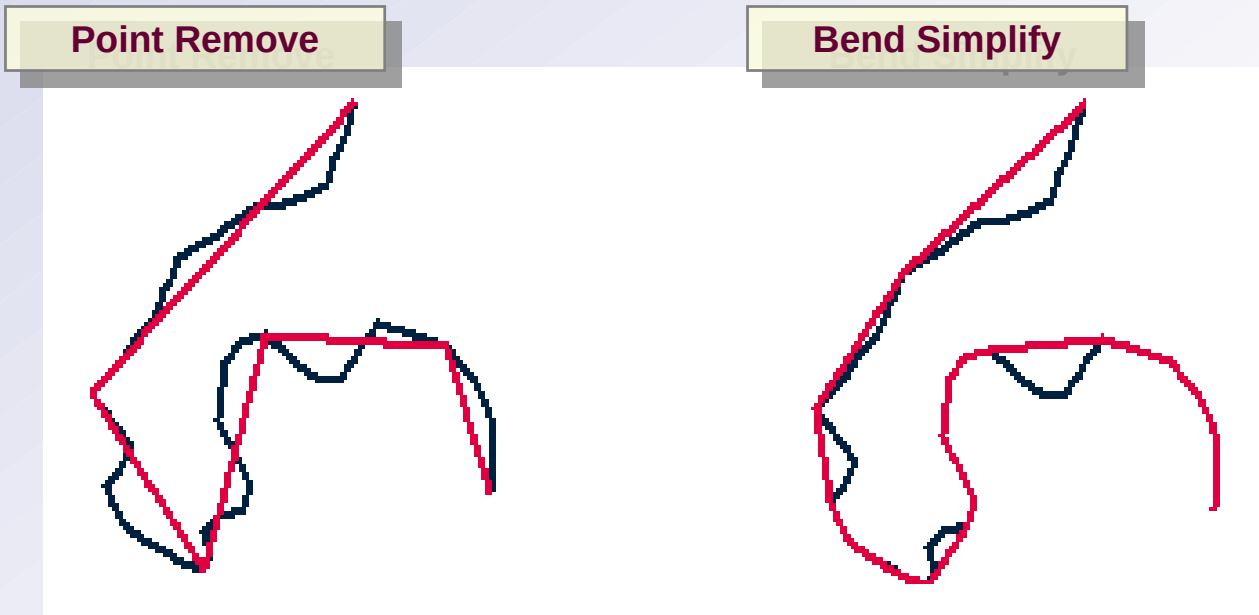
What's in common

- scale restriction
- geographic characteristics

Considering geographic context ...

- Spatial relationship
  - *Ensuring correct topology (feature association: adjacency, intersection, etc.) in generalization processes*
  - *Fulfilling spatial constraints (conditions and restrictions) through analysis and procedures*

Simplify Line tool – dealing with topological errors ...



Simplify Line tool – dealing with topological errors …

Topological errors

crossing *coincident* *collapsing (0-length)*

FLAG_ERRORS option

SimpLnFlag – 0 means no problem; 1 means line-crossing or coincident.
No SimpLnFlag – no errors found.

KEEP_COLLAPSED_POINTS option

Keeping track of zero-length lines and storing as point features

Simplify Line tool – dealing with topological errors …

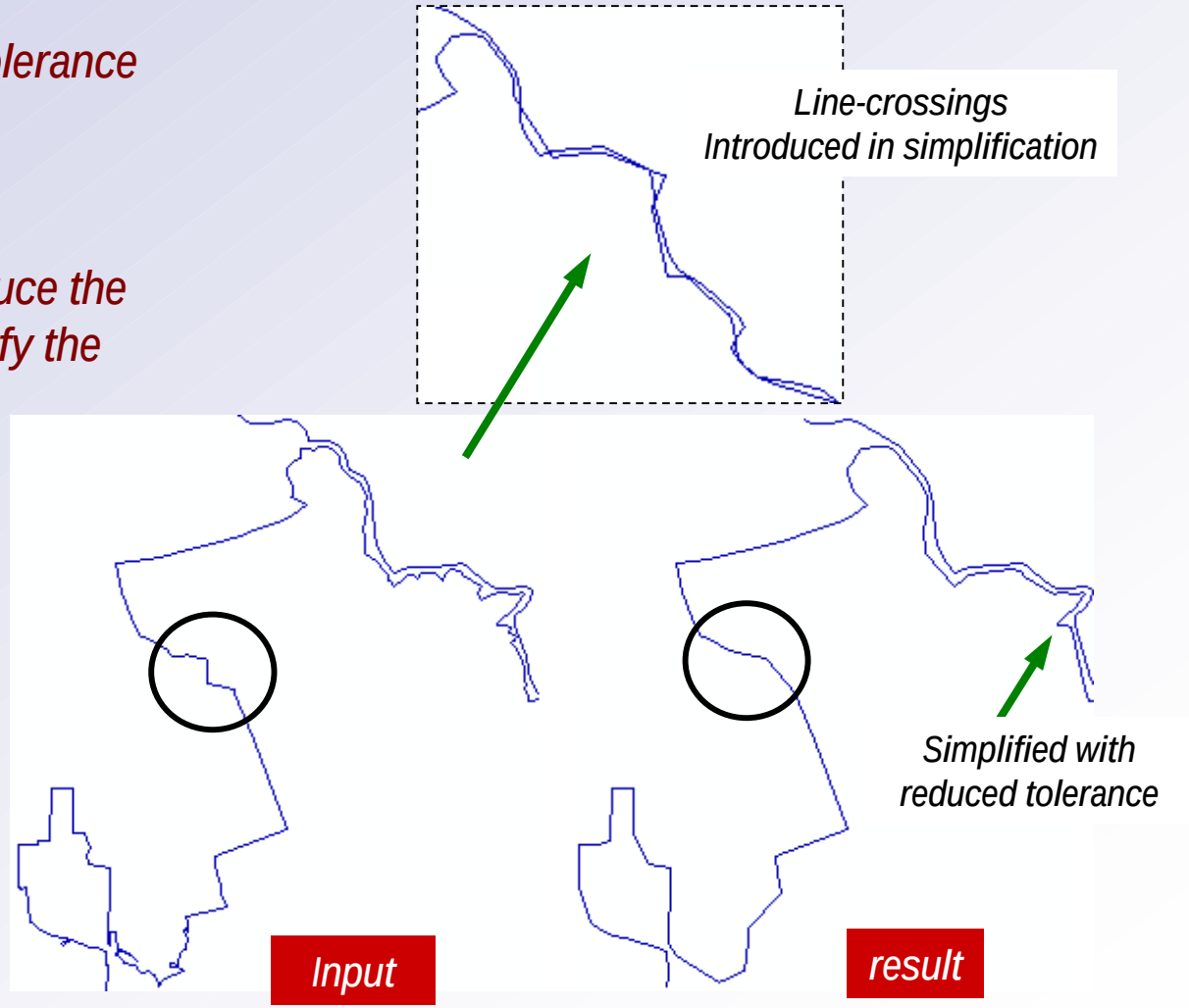
RESOLVE_ERRORS option …

Simplify with the specified tolerance

Detect topological errors

Find the local segments, reduce the tolerance by 50%, and simplify the segments again

Iterate until no more errors



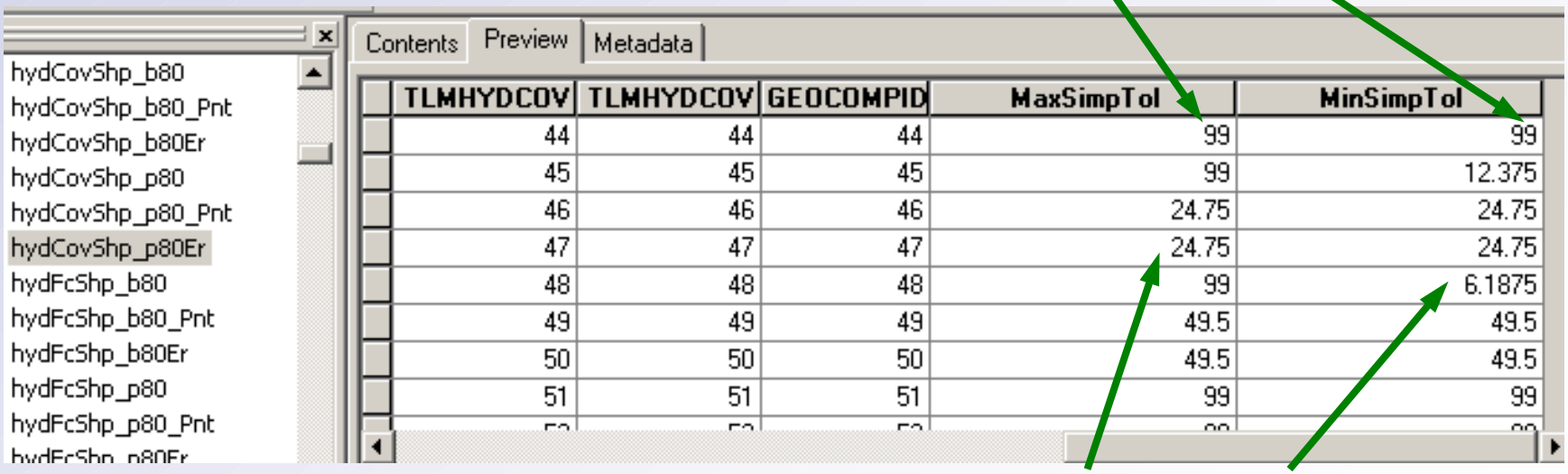
Simplify Line tool – dealing with topological errors …

RESOLVE_ERRORS option

MaxSimpTol, MinSimpTol – range of tolerance used; suitability; post-editing, or other type of generalization operations?

No MaxSimpTol, MinSimpTol – no errors introduced.

Simplified with the given tolerance

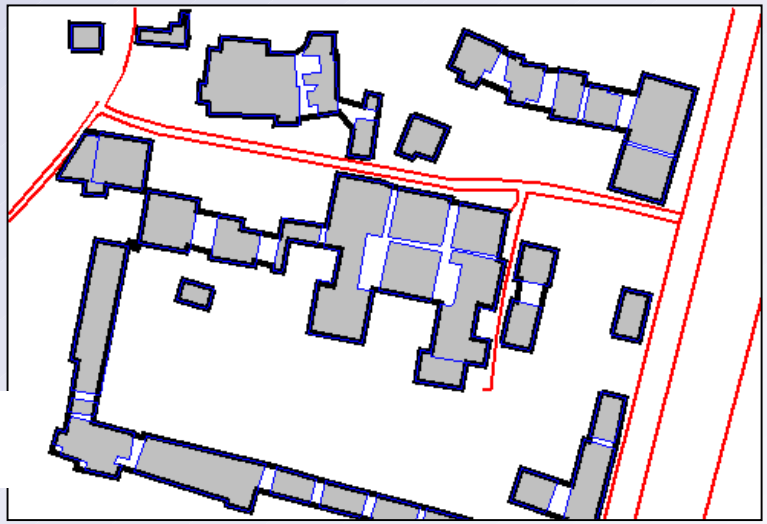


TLMHYDCOV	TLMHYDCOV	GEOCOMPID	MaxSimpTol	MinSimpTol
44	44	44	99	99
45	45	45	99	12.375
46	46	46	24.75	24.75
47	47	47	24.75	24.75
48	48	48	99	6.1875
49	49	49	49.5	49.5
50	50	50	49.5	49.5
51	51	51	99	99

Less simplified; tolerance too big; congested areas

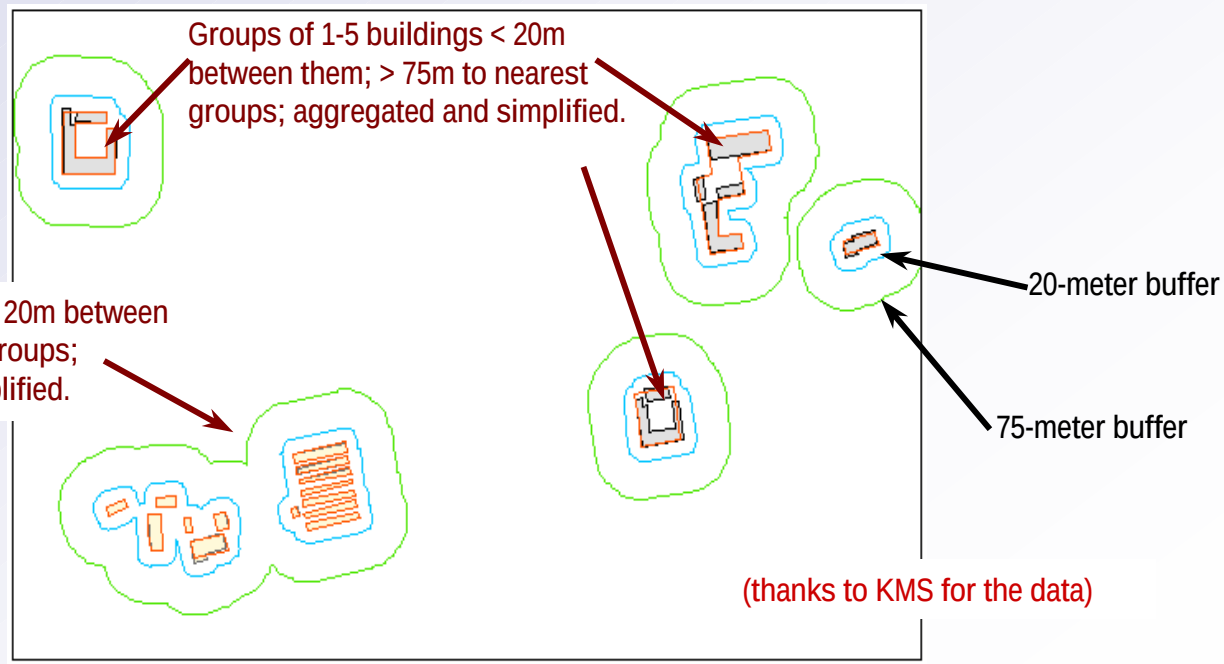
Dealing with spatial constraints …

Building aggregation without crossing streets



(thanks to HK LIC for the data)

Generalization of farm buildings based on spatial configuration



Considering geographic context ...

- Geographic patterns

  Natural formation (mountain and valley)

  Cultural division (urban and rural areas)

  Covering relatively large extent (hydrographic network)

  Covering relatively small space (buildings in a street block)

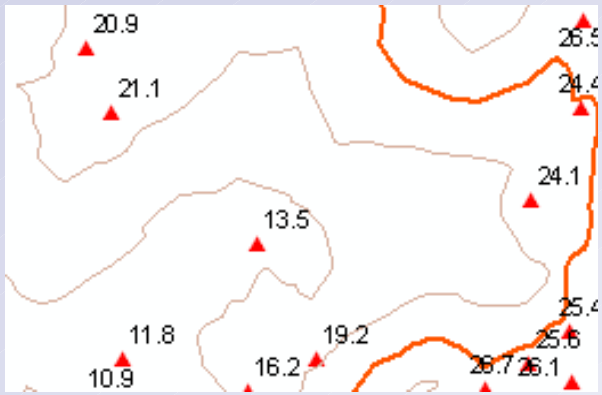
  No recognizable form (random trees, soundings)

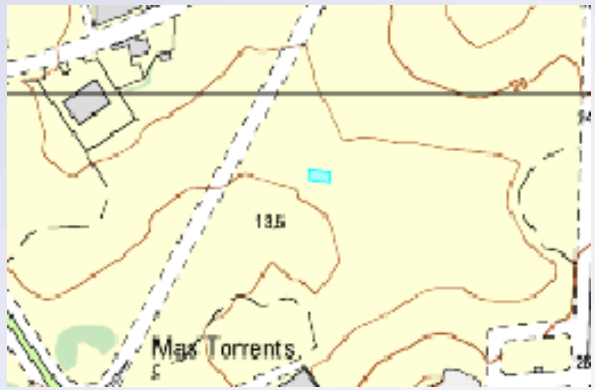
  With obvious form (buildings aligned with road)

Example specifications

Spot height selection in terrain contexts

"In open area, raised areas, leveled areas, and rustic parcels, consider keeping the most centered ones."





From the Institut Cartogràfic de Catalunya

Features in natural or cultural contexts

"In arid and undeveloped areas, depict as many drains as possible."

"In areas where numerous tanks exist, a representative pattern is used which will retain the general layout of the entire tank area."

From NIMA: Military Specifications – 1:100,000 Scale Topographic Maps

Considering geographic context ...

- Challenge to automation

  No clear boundaries of geographic patterns, e.g. “open area“; therefore terrain analysis, cultural analysis may be helpful.

  No subdivision features or attributes, e.g. areas of “numerous” features, therefore cluster, density analysis may be needed.

  No indication of obvious forms, e.g. “buildings in a row”, therefore pattern recognition is necessary.

  Lack of well-defined solutions, e.g. retaining “general layout”, therefore techniques and measures are needed to derive and evaluate the “representative patterns”.

The solution space (the extent of a geographic pattern) is essential to contextual generalization.

Enriching database could support the automated decisions.

Considering cartographic context

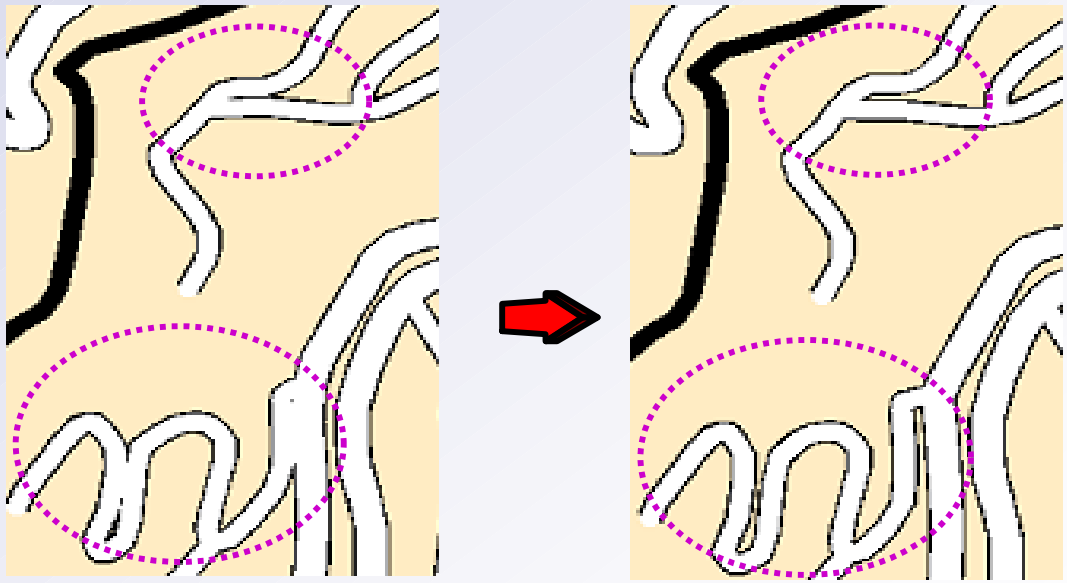
- Symbolization and clarity

  A symbol must maintain a minimum dimension. - readability

  A symbolized feature may occupy more space on map than it does on the ground and therefore cause conflicts and confusion. - clarity

- Initial experiment in symbolized context

  Considering line width and minimum line spacing in displacement



Working toward adaptive processes

- Reverse engineering study

  What the cartographers might have thought in generalizing existing maps.

- Process modeling

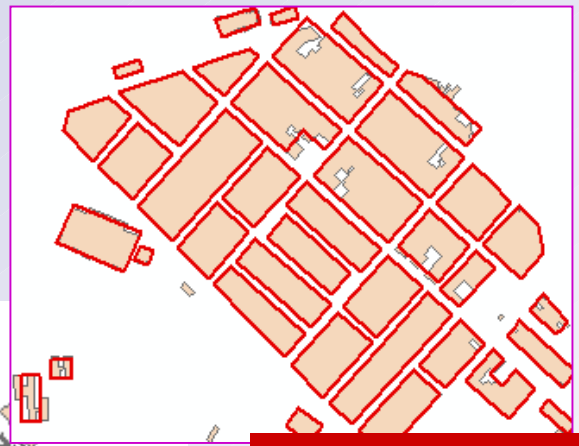
  Making logical selections, analysis, and generalization actions.

Building generalization case

Dafa from Institut Cartogràfic de Catalunya

Input

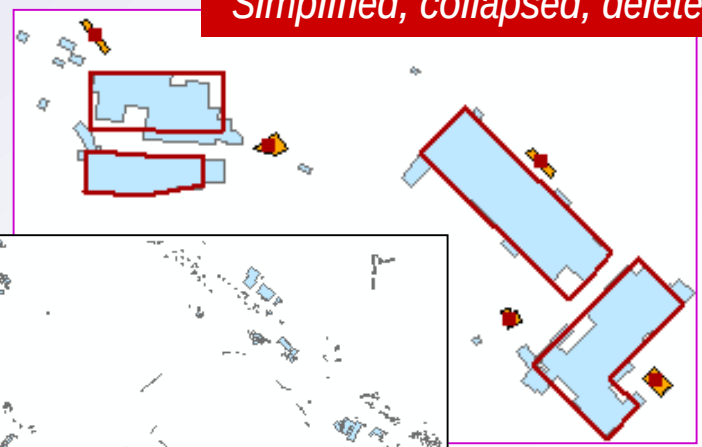
Aggregated blocks



Simplified; deleted

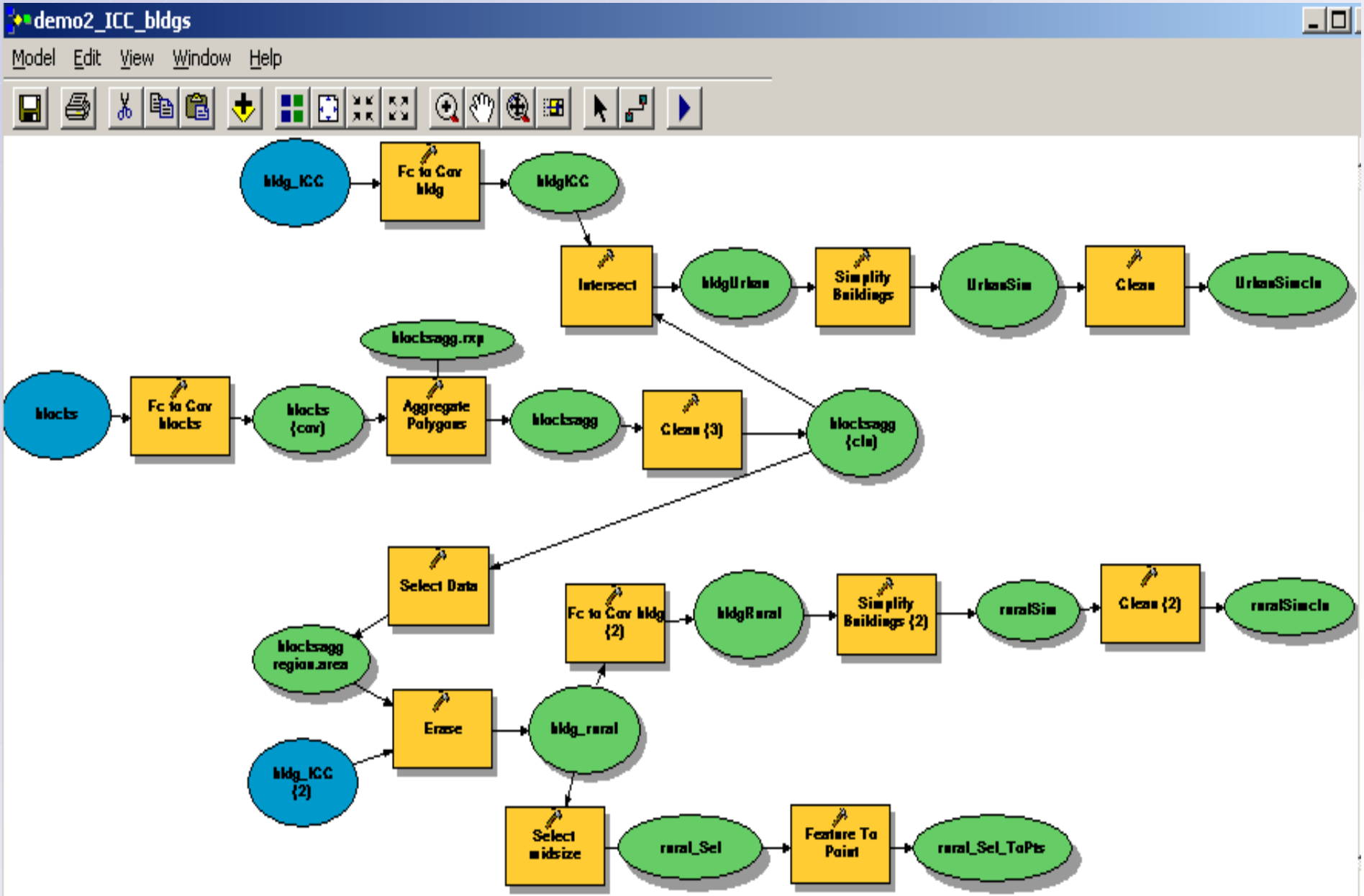
Urban buildings

Simplified; collapsed; deleted



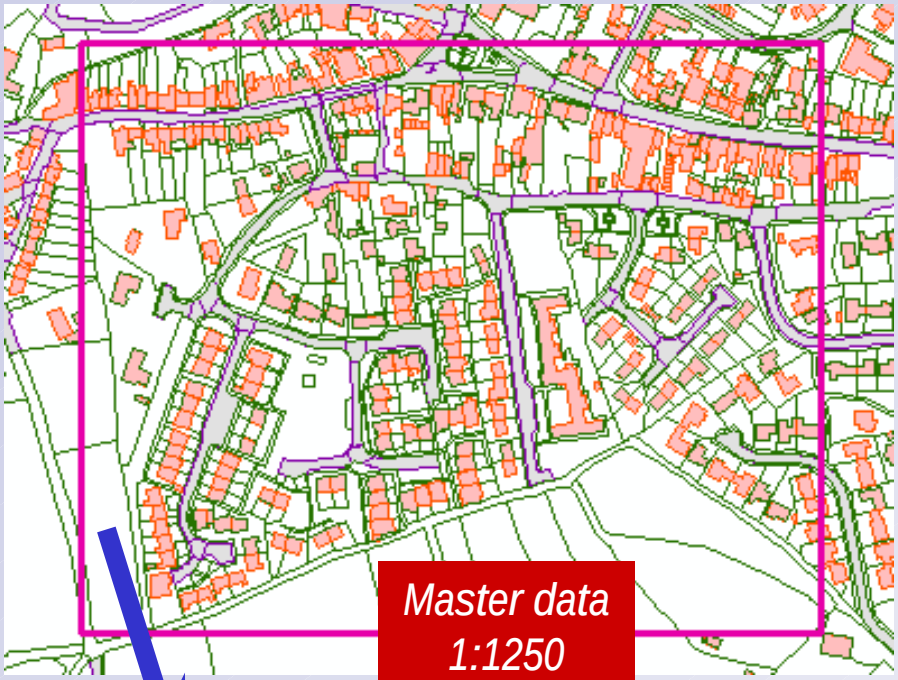
Rural buildings

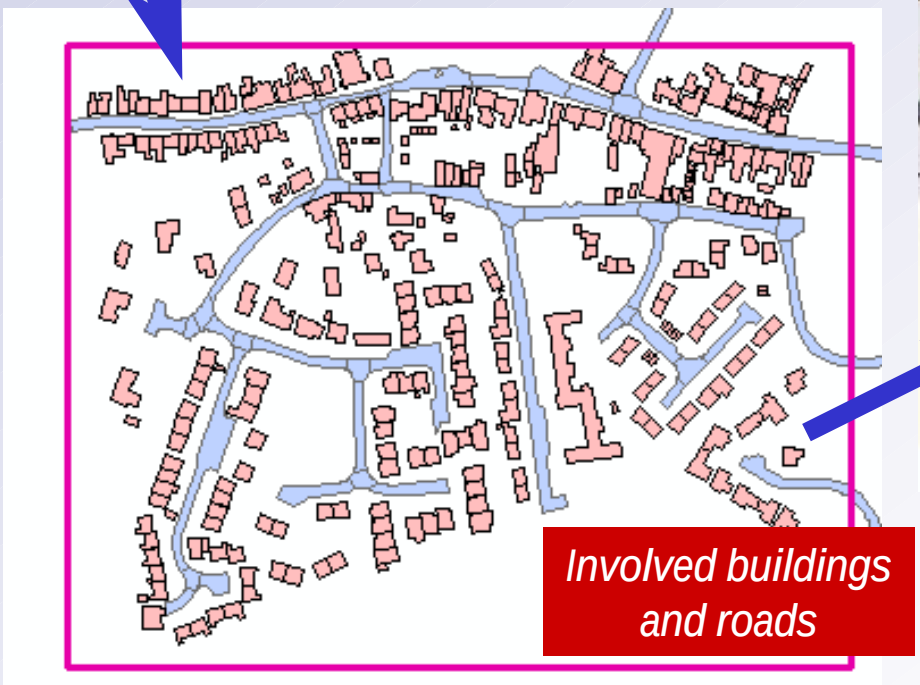
Building generalization

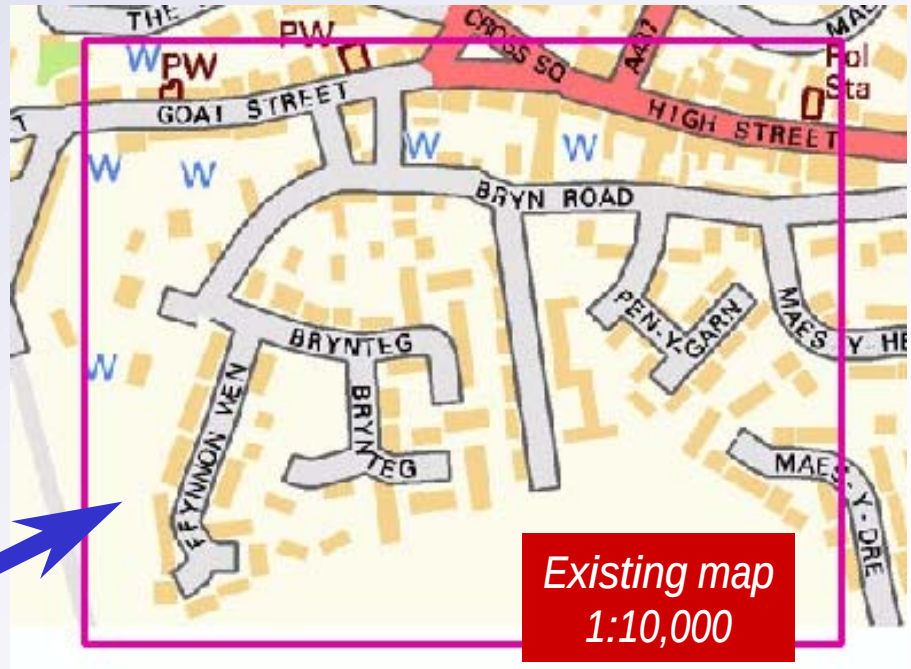


Building generalization with roads

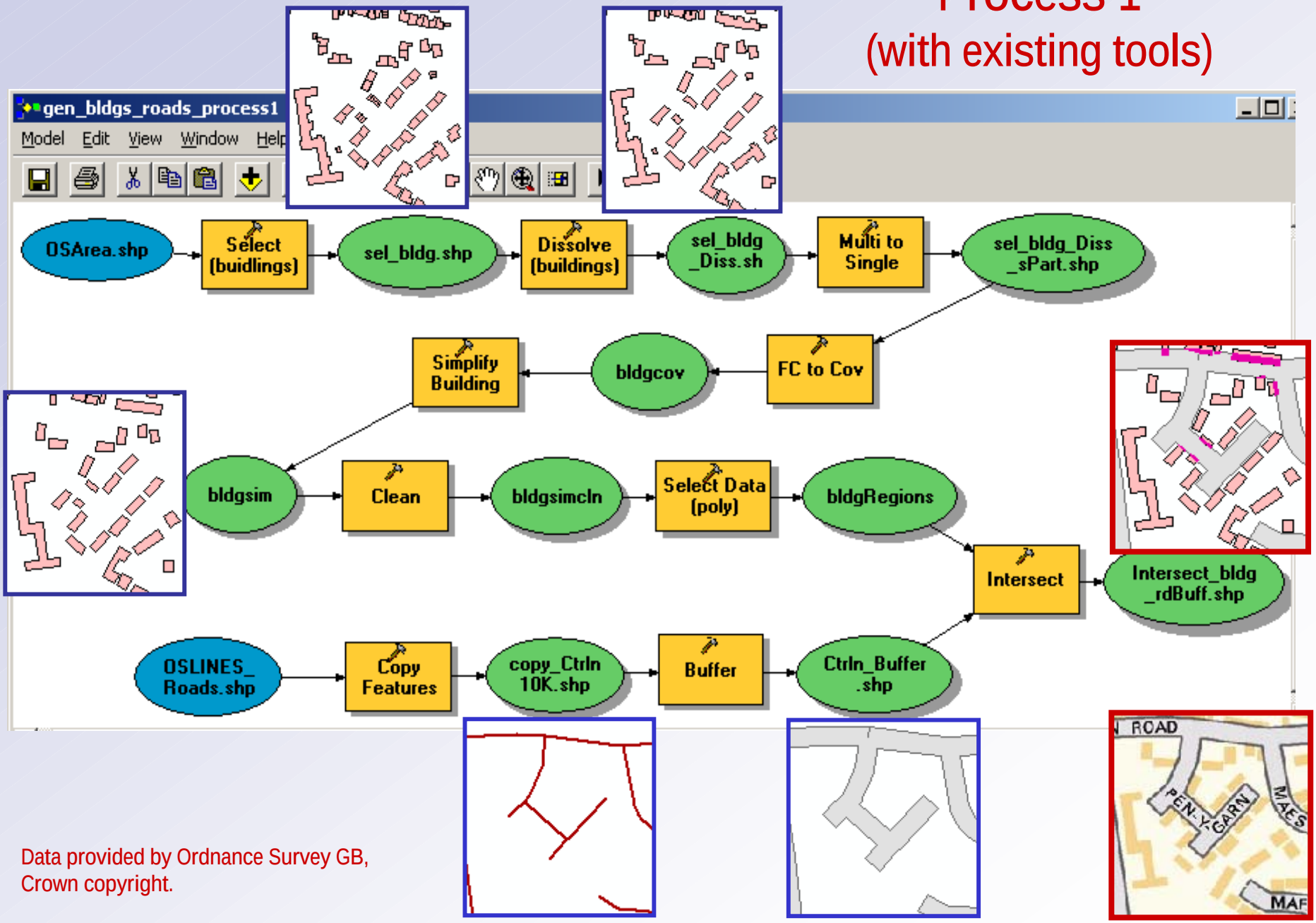
What needs to happen to achieve the result?



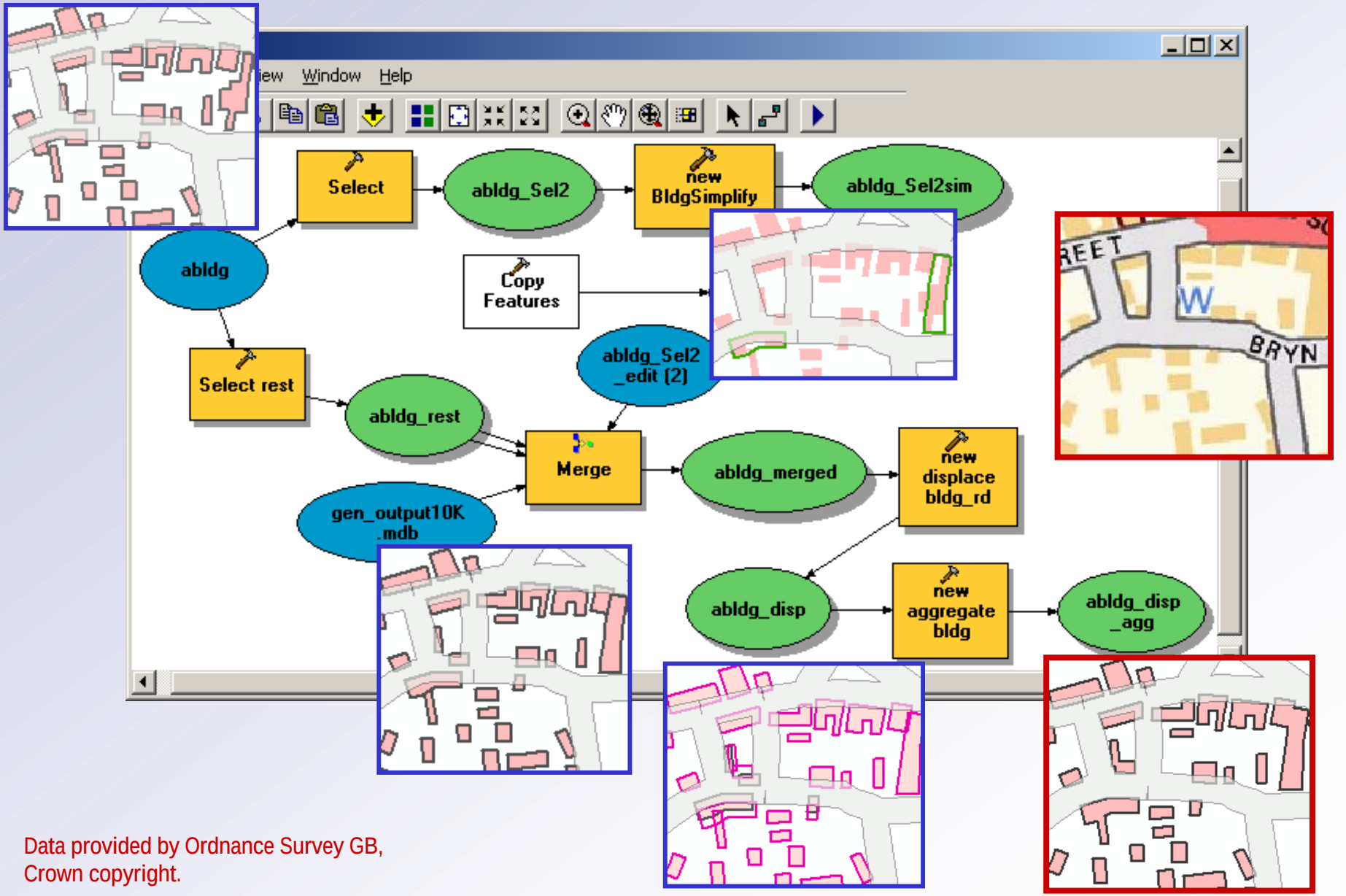




Process 1
(with existing tools)

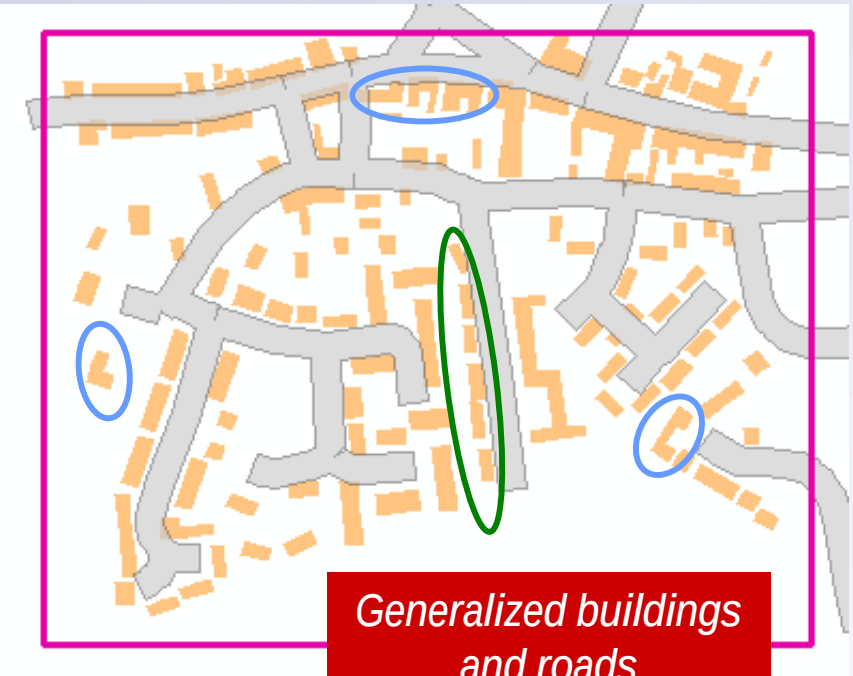


Process 2 (with tools in development)

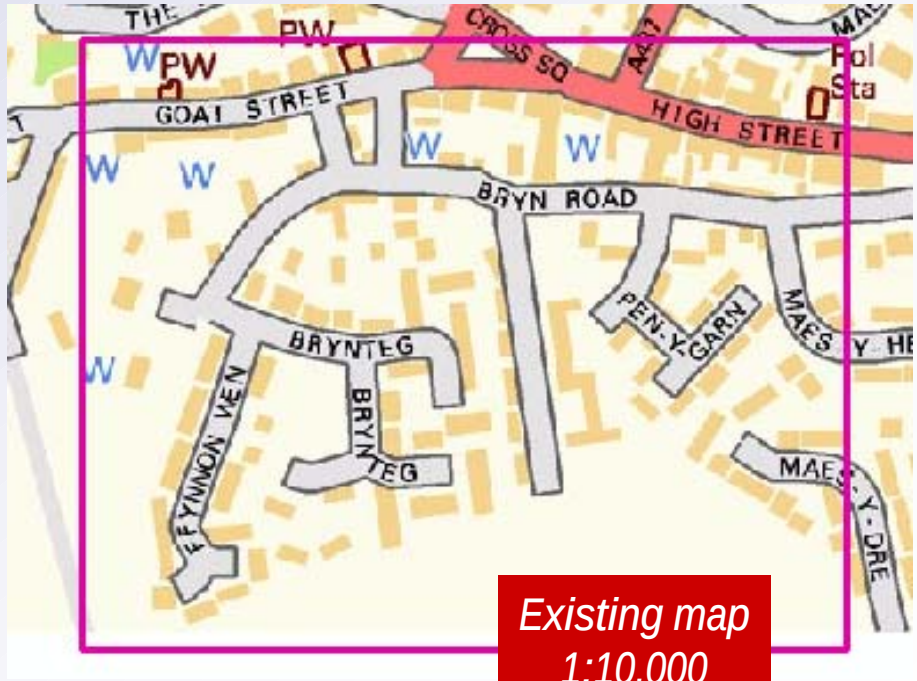


Observations, constraints, ...

- Conservative displacement (% of overlap area; movement)
- Selective aggregation (overlapping buildings only)
- More aggressive building simplification (in blue circles)?
- Further work – pattern, typification, shrinking (in green circle)?



Generalized buildings and roads



Existing map 1:10,000

Any comments or questions?