



Category:	Topological Processing User Manual
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1. INTRODUCTION

AusGIS is a purpose built GIS to facilitate Spatial Upgrades and Topological Processing. AusGIS has been built solely to act as the front end GIS to SAM and other tools being developed by Spatial Tapestry.

The Topological Manager (Topo) provides a flexible, powerful and well-proven mechanism to clean up topology and (re-)create Vertical Topology, by either snapping either polyline or polygon themes to one or more other polyline and polygon themes.

This document describes the process in more detail. Note that this process augments the SAM/SAE environment described in the SAM/SAE White Paper.

There are several key aspects to this discussion, being:

- The original scale of the data being digitised
- The current scale to which it is being compared
- The variance in the number of nodes between the various themes
- The variance in the link length
- The cleanness of the older dataset
- The number of themes to which the old theme must now fit
- The degree of detail between the old and new themes
- The correlation of detail between old and new
- The degree of evolution of the datasets involve – new subdivisions lead to evolution in many themes

2. PLACEMENT OF AUSGIS IN THE TOPO WORK-FLOW

This workflow requires the user to have selected the data out of the master dataset into some supported format. SAM is the used to connect to that dataset, and from that the SAM-Cad, SAM-Ortho

3. TOPOLOGICAL CONCEPTS

The concept of cleaning topology is not new. Early digitising of spatial data created many instances of polygons that overlapped or had gaps between them. Genamap and ESRI had two excellent toolsets to deal with cleaning topology within the one theme.

Other geometries such as dangles and bowties are seen as undesirable.

The Topological Manager (Topo) in AusGIS seeks to be a general purpose topological cleaning tool as well as a topological snapping tool.

Many themes have been derived from a base theme, such as the digital cadastre, and held separately over time whilst the original theme has been upgraded spatially. This leads to the circumstance where the old theme no longer is well aligned to the new theme, thus reducing its value for mapping and analysis purposes.

Topo introduces a number of concepts to assist GIS Managers keep their themes in vertical alignment.

3.1. Nodes and Links

All polyline and polygon themes comprise coordinates and the straight lines between them.

The coordinates are often duplicated in a given theme, an example being the back corner of many parcels of land being used 4 times.

A **Node** is a unique instance of each coordinate for each theme.

A **Link** is a non unique join between these nodes.

3.2. The Active Theme

The Active Theme is the polyline or polygon theme being improved.

The improvement may be either to make it more consistent within itself (i.e. cleaning) or to realign it to one or more other polyline or polygon themes.

3.3. The Protected Theme

The Protected Theme is a theme with polylines or polygons whose features are known to be correct. Using such a theme in this process ensures matching nodes and links in the Active Theme are not moved or changed in any way during the 'Snap To' processing functions.

3.4. The Snap To Theme

The Protected Theme is a theme with polylines or polygons whose features are known to be more desirable.

Using such a theme in this process and running 'Snap To' processing functions will cause the Active Theme to take on the nodes and links of the Snap To Theme.

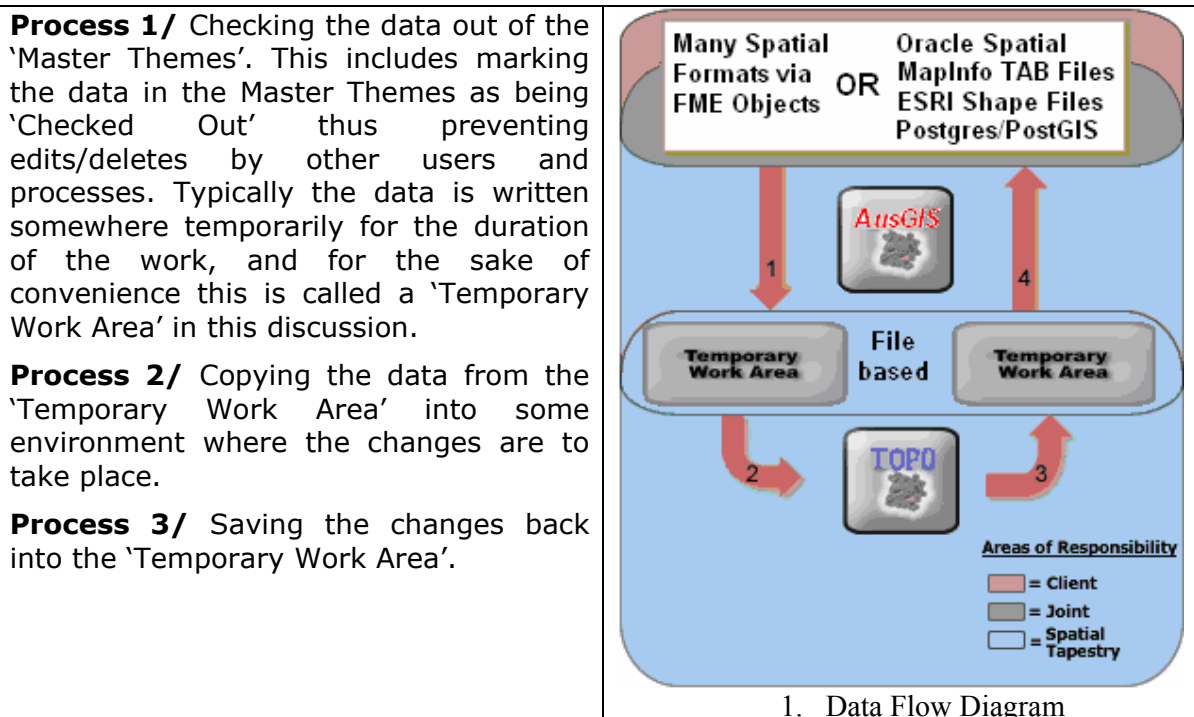
3.5. The Temporary Work Area Polygon

The Temporary Work Area Polygon is a polygon outside of which the Active Themes nodes and links will not change. i.e. only nodes and links within the TWA Polygon can change.

4. THE AUSGIS TOPO WORK FLOW PROCESS

We all seem to be familiar with the necessary processes of 'checking' spatial data out of the master themes, editing the data, and 'checking' the spatial data back in. Each GIS vendor has various processes in place to assist their customers achieve this.

There are (at least) four distinct processes in the Work Flow.



Any Feature can be viewed on the 'Progress' Tab by clicking its record under the 'ZoomTo' column.

It is recommended that the user clicks on the first record to see the feature with potentially the largest geometric upgrade problem first, then use functionality on the 'Progress' Tab to scan the other records.

4.1. Viewing Original and Processed Themes

The following image shows the original and upgraded themes which is displayed after running the 'View Upgraded Themes' button.

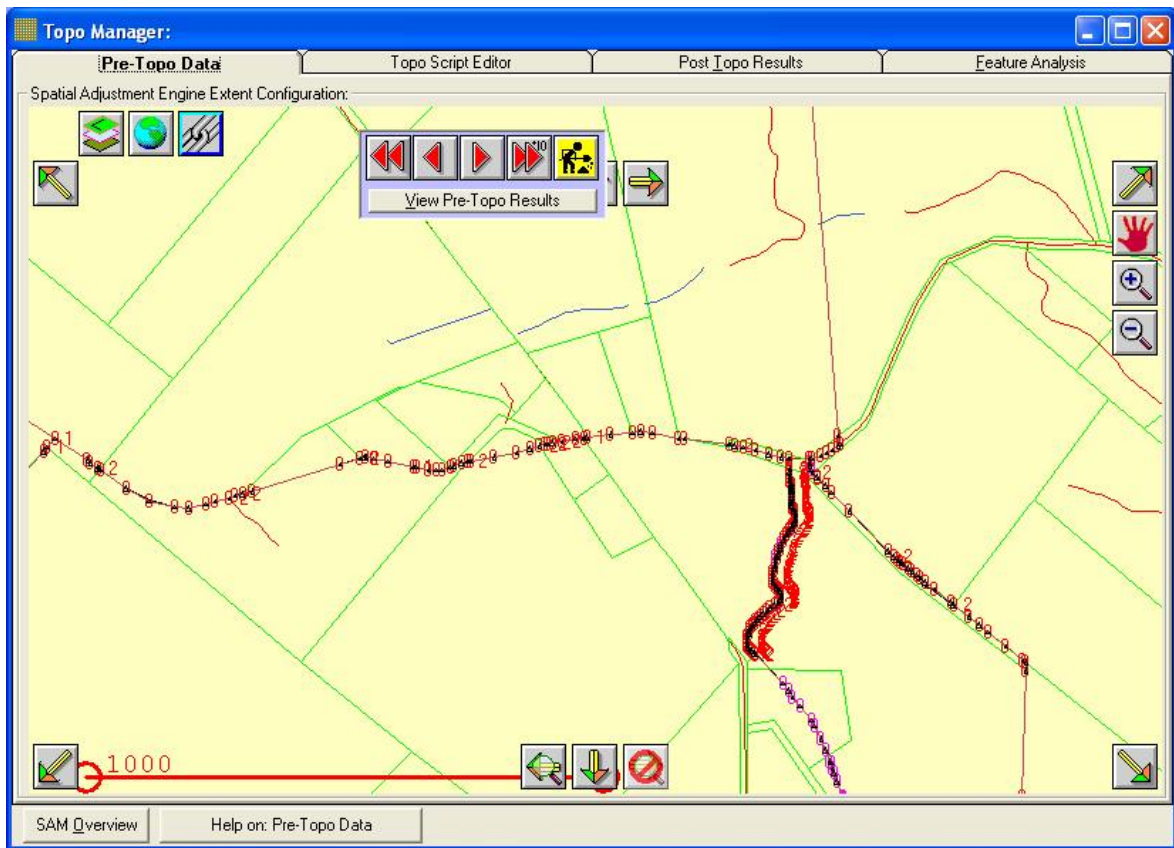


Figure 1 Viewing Original vs Processed Geometries

The following buttons are available on the 'Feature Scanning Tool'








-  Return to the Feature with the largest parameter being looked at
-  Return to the 'Previous' Feature
-  Move to the 'Next' Feature
-  Move to 10th Feature further down the list (or the last one)
-  Record this feature for subsequent editing in the host GIS

Figure 2 Icons used to track errors to be fixed in the GIS

4.2. Topological Processing Tools

To access the Topological Processing Manager, choose the ToolBox button () then the Topo Run button () in the AusGIS application.

Need to explain setting up a TWA Polygon here???

4.3. The Pre_Top Data Tab

This Tab can be used to view the original themes as they were before any topological processing was undertaken. The extents of the viewing area are kept in-sync with that of the Post Topo Results Tab

4.4. The Topo Script Editor Tab

The Topo Script Editor Tab can be used to sequence the wide variety of spatial functions supplied by the Topological Processing Manager.

The Tab appears as:

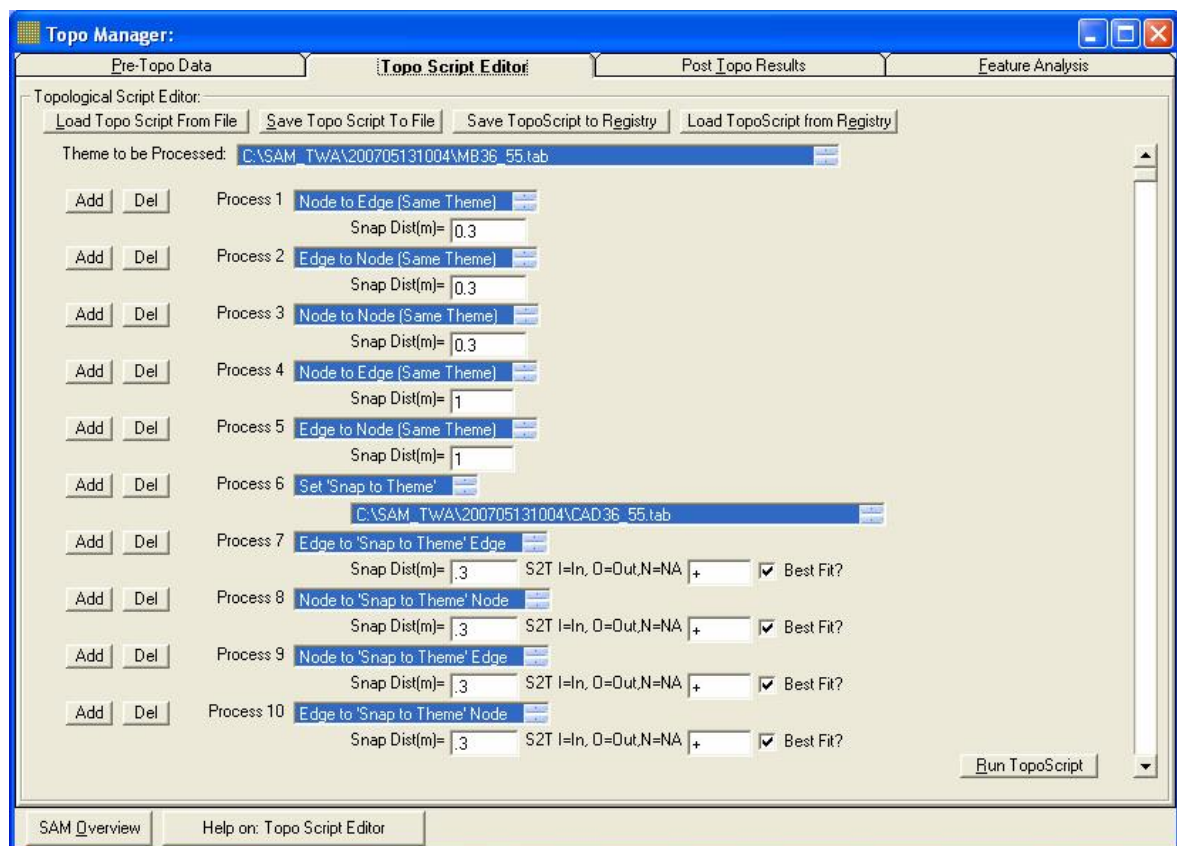


Figure 3 The Topo Script Editor

The Topo Script Editor provides a GUI environment that allows a script to be developed, with interactive runs, by adding and deleting function calls.

The script is saved to the user's choice of filename or to the registry, and may be loaded from both locations.

4.4.1. Loading a Topo Script from File

Saving Scripts to file allows them to be moved between computers and archived, and for various versions to be evolved.

Clicking this button causes the following form to be displayed allowing the user to select from the available scripts.

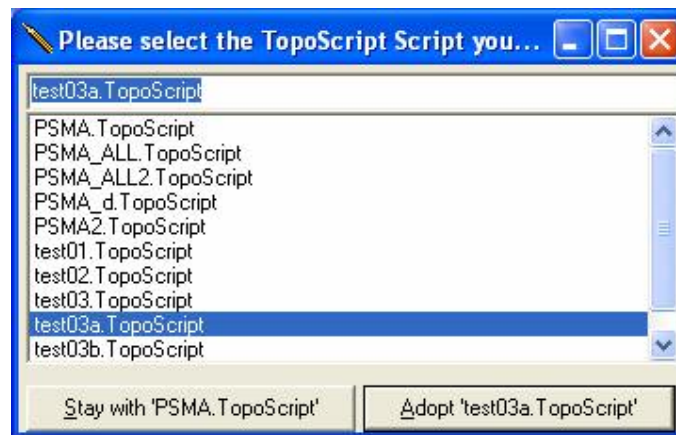


Figure 4 The Topo Script Selection Tool

Simply choose the appropriate script by clicking on it and then click the "Adopt" button.

Line Numbers are automatically assigned during the loading process.

Limited capability exists to automatically port scripts based on one TWA to other TWAs. This is done by selecting the new Active Theme before loading a script.

4.4.2. Save a Topo Script to File

Click the 'Save Topo Script to File' button to display a 'Save As' dialog, and save the script in the default directory.

Saving scripts to file has the added advantage that the script can be edited by any text editor and reloaded.

4.4.3. Save a Topo Script to the Registry

Whilst developing a script for a particular dataset it is convenient to save and load the script to the registry.

Use this button to save the script to the Registry.

4.4.4. Load a Topo Script from the Registry

Use this button to load the script from the Registry.

4.4.5. Theme to be Processed:

The Drop Down List Box associated with this contains a list of all the themes being displayed in the Topo Manager. These themes must be extracted from the themes in the AusGIS view using the TWA Polygon function.

One and only one of these themes can be processed through the topological processed per script.

This theme is referred to as the 'Active Theme' in this document, and must be selected in this List Box. When selected correctly the theme has the blue background.

4.4.6. Adding a Scripted Function

Adding a Scripted Function adds an entry after then line's button being pressed, with any following lines being pushed down by one.

4.4.7. Deleting a Scripted Function

Deleting a Scripted Function deletes the line whose button is pressed, with any following lines being moved up by one.

4.4.8. Run Topo Script

This button causes the script to be processed.

It is recommended that small sample and representative areas be used while developing the topological processing scripts as long scripts and large areas can take lengthy times to complete.

During processing, it may be best to monitor the progress using Spatial Tapestry's Monitor application. The Monitor can give live feedback from the compute bound application, as well as giving some control over it as well.

4.5. Scripting Functions

The following is a list of the available functions provided by the Topological Processing Manager.

It is seen that additional functions can be added as required.

There are several common options for the various functions provided, being:

Snap Dist(m)= This is the distance to be used in the function being called.

Best Fit? This tells the function to exercise best fit restrictions, often leading to fewer but better topological snapping results.

S2T I=In, etc

"I" means that the function can only manipulate nodes and links inside the polygons of the Snap To Theme.

"O" means that the function can only manipulate nodes and links outside the polygons of the Snap To Theme.

Not specifying either means all nodes and links are able to be processed ignoring this constraint.

"+" means that any nodes created or moved are to be flagged as having being actioned in the function being called.

"-" means that any nodes previously flagged as having being actioned are not to be actioned again in the function being called.

Not specifying either means all nodes and links are able to be processed ignoring this constraint.

4.5.1. Load 'Protected Theme'

This function allows a theme to be loaded and matching nodes in the Active Theme are held fixed for the remainder of the script.

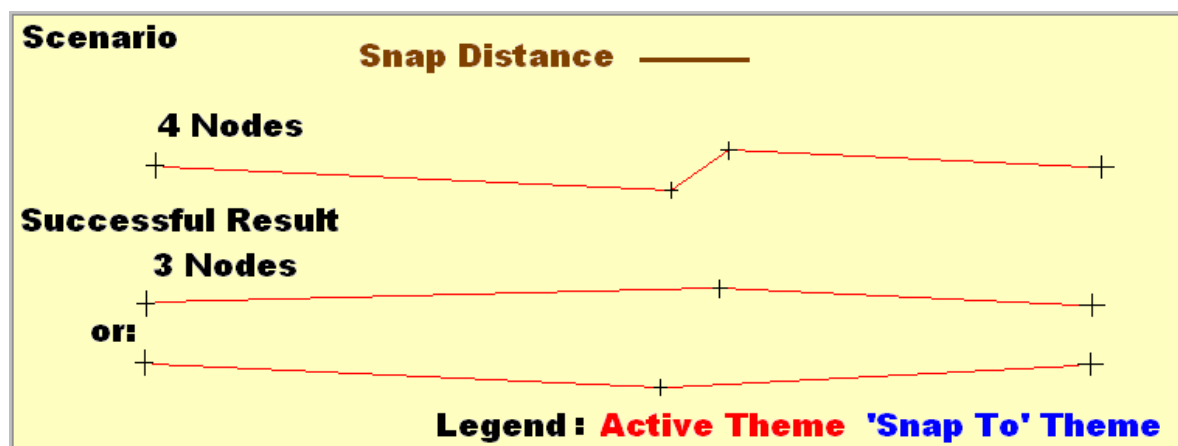
This means they will not move for any reason.

This may be used to protect features and links that are known to be correct, and therefore should not move for any reason.

The Protected Theme must be selected from the List Box.

4.5.2. Node to Node (Same Theme)

This function matches nodes in the Active Theme to other nodes, thus collapsing geometries to a simpler structure.

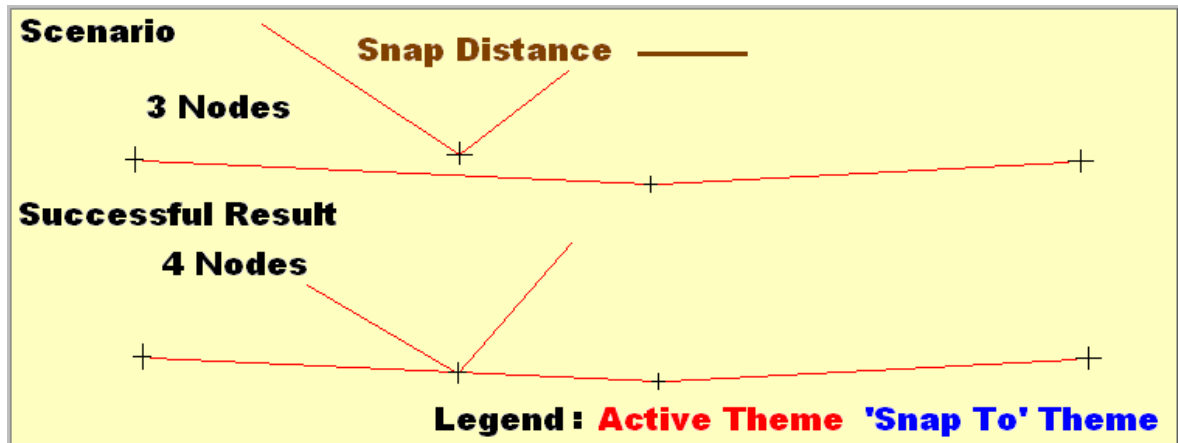


Rules:

The node must be within the snap distance specified node being compared.

4.5.3. Node to Link (Same Theme)

This function inserts nodes in the Active Theme's links where the square-off distance is less than the distance specified. The node is moved to the link, and is placed at the square-off position along the link.



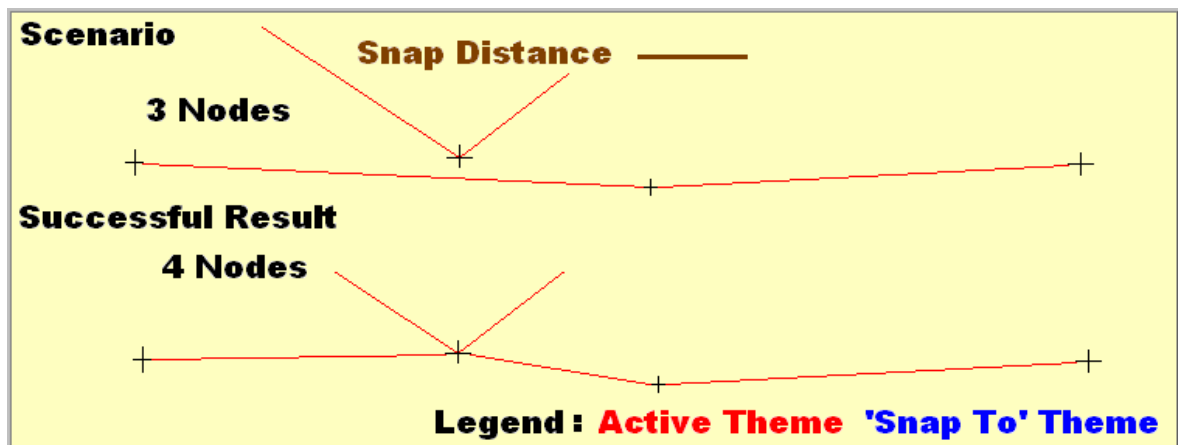
Rules:

This is a recursive function, in that it re-parses the process until no new insertions are carried out.

The node must be within the linear extent of the link being compared, and have a square off distance less than the snap distance specified.

4.5.4. Link to Node (Same Theme)

This function moves nodes in the Active Theme's to its links where the square-off distance is less than the distance specified. The node is not moved, with the original link being replaced with two links incorporating the newly inserted node.



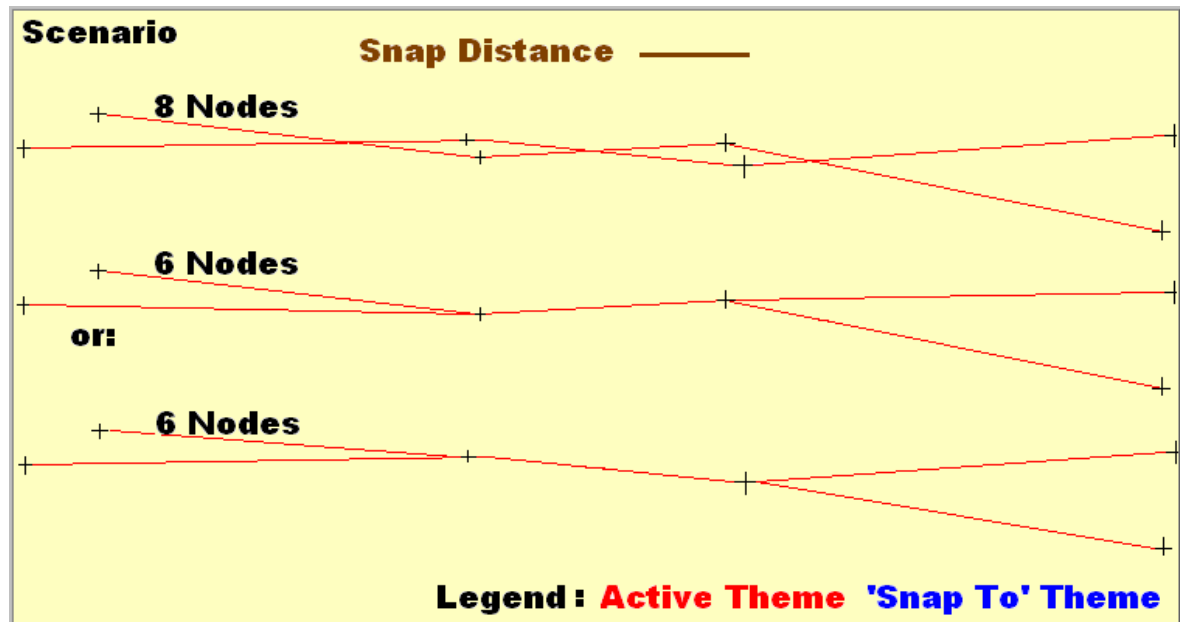
Rules:

This is a recursive function, in that it re-parses the process until no new insertions are carried out.

This function inserts nodes in the Active Theme's links where the square-off distance is less than the distance specified.

4.5.5. Link to Link (Same Theme)

This function moves nodes in the Active Theme's links where there is another link with end points within the distance specified.

**Rules:**

The two ends of one link must each be within the snap distance of two ends in another link, and each link must have a length at least 3 times the snap distance.

4.5.6. Set 'Snap to Theme'

This function loads a theme, being displayed in AusGIS, as the Snap to Theme. This is required before any of the Snap To operations can be carried out.

The requirement for this may be to snap suburb, zoning and other polygon layers to a shifted cadastre. Snap To Themes cannot move, and only nodes and links (not protected by a Protected Theme) in the Active Theme will be manipulated to fit the Snap To theme.

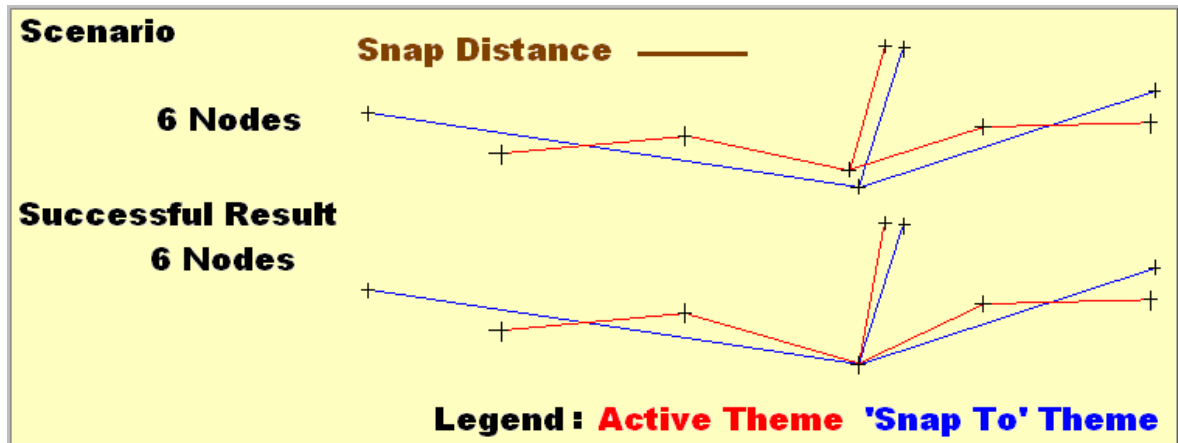
Loading subsequent Snap To Themes overwrites previously loaded Snap To Themes.

Rules:

The Snap To Theme is loaded and nodes within the theme closer than 0.001 are collapsed to a single node.

4.5.7. Node to 'Snap to Theme' Node

This function moves nodes in the Active Theme to nodes in the Snap To Theme.



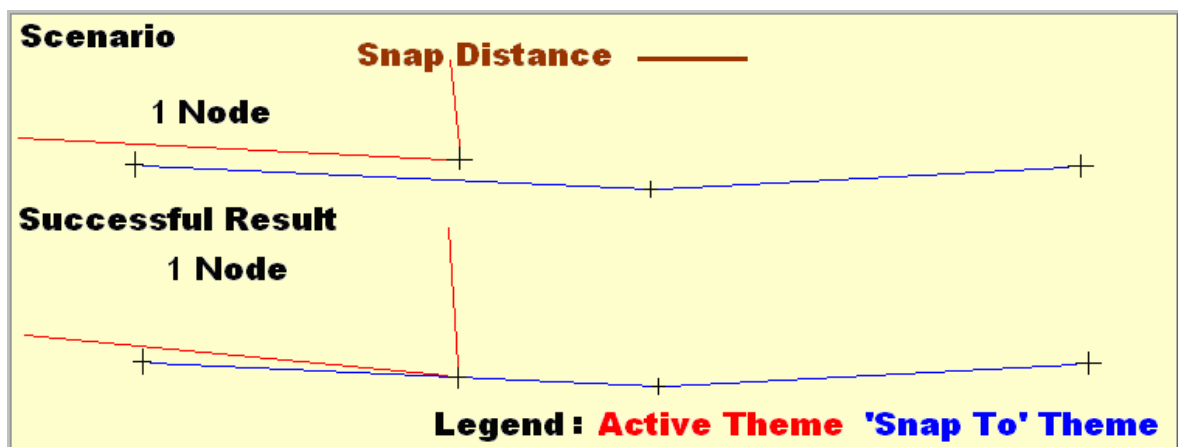
Rules:

The two nodes must be within the snap distance specified.

Optionally, there must be a correlation of outgoing bearings between the two nodes. **Expand later...**

4.5.8. Node to 'Snap to Theme' Link

This function moves nodes in the Active Theme to links in the Snap To Theme.

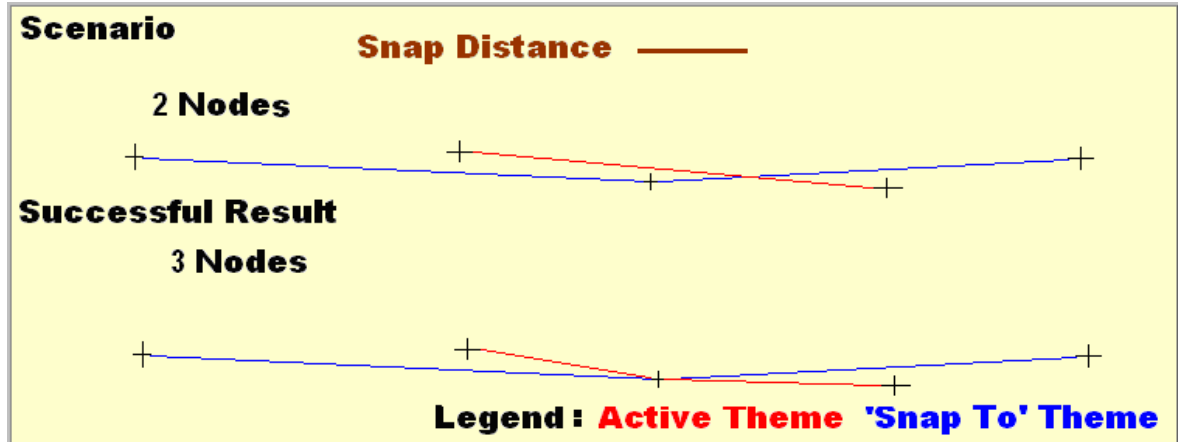


Rules:

The node in the Active Theme must be within the linear extent of the Snap to Theme link and have a square-off distance less than the snap distance specified.

4.5.9. Link to 'Snap to Theme' Node

This function moves links in the Active Theme to nodes in the Snap To Theme. i.e the node in the snap to theme is incorporated into the Active Theme's link.

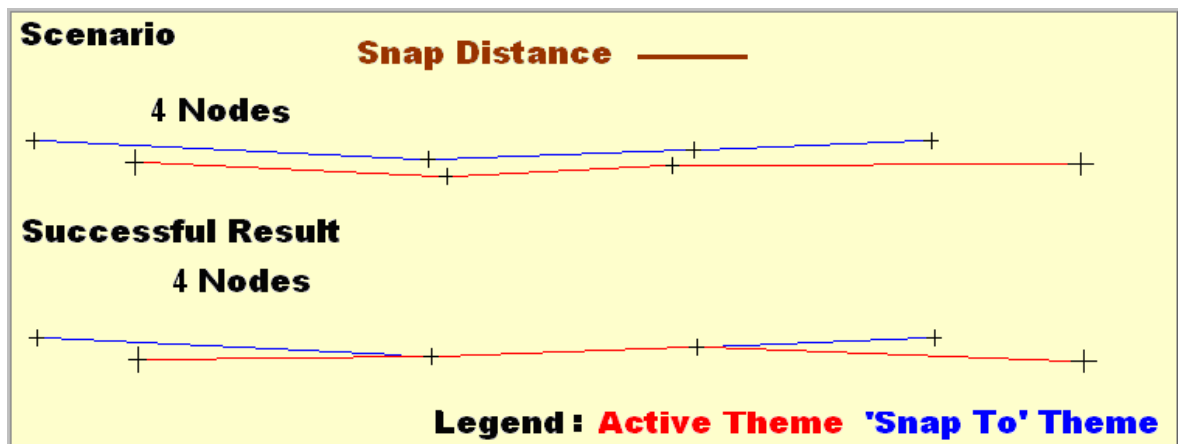


Rules:

The node in the snap to theme must have a square-off distance to the Active Theme's link less than the snap distance specified.

4.5.10. Link to 'Snap to Theme' Link

This function moves links in the Active Theme to links in the Snap To Theme.

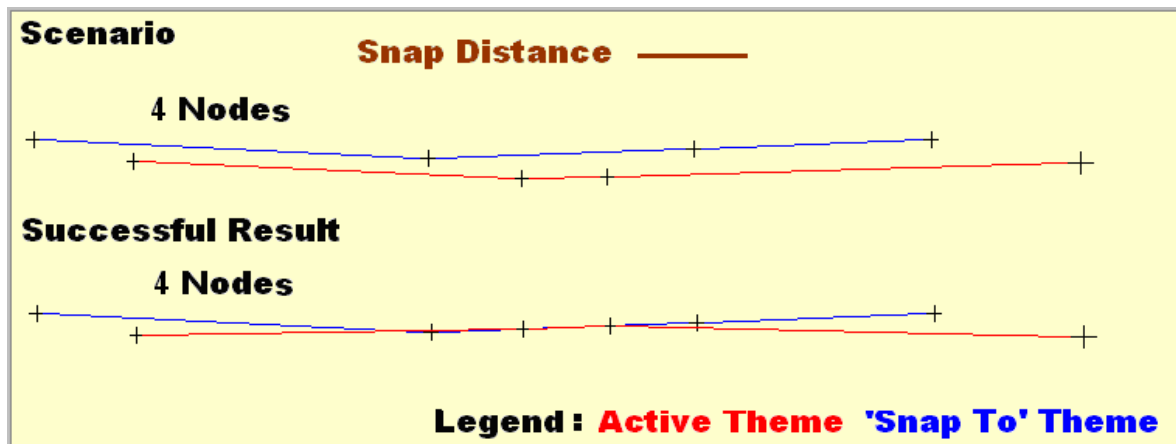


Rules:

Both nodes in the Active Theme link must be within the snap distance specified from the nodes of a single link in the Snap To Theme.

4.5.11. Link to 'Snap to Theme' 1Link

This function moves links in the Active Theme to links in the Snap To Theme.



Rules:

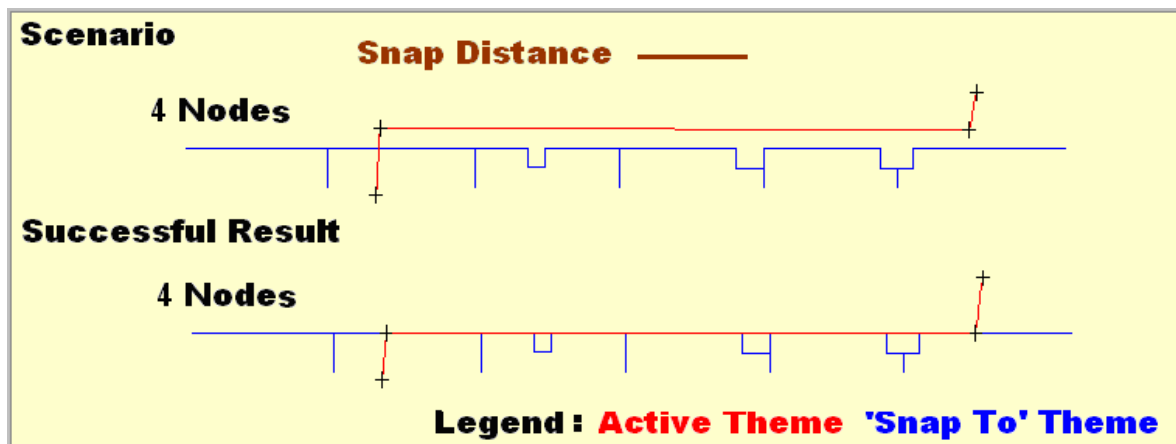
The Active Theme link must be within the linear extent of a Snap To Theme link.

Both nodes in the Active Theme link must be within the square off distance specified.

The bearings of the Snap To Link must be with a small tolerance of the Active Theme's link.

4.5.12. Link to 'Snap to Theme' 2Link

This function moves nodes in the Active Theme to nodes in the Snap To Theme.



Rules:

The Active Theme's nodes at the end of an link must straddle two separate, and not necessarily abutting, links in the Snap To Theme.

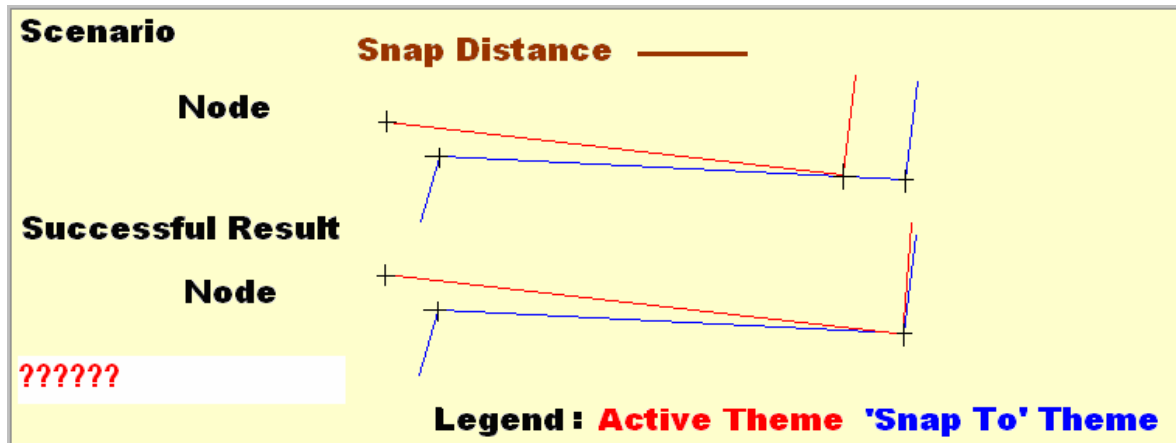
The Active Theme node must be within the linear extent of the two Snap To Theme links.

Both Nodes must have a square off distance within the Snap Distance specified.

The bearings of both Snap To Links must be with a small tolerance of the Active Theme's link.

4.5.13. Expand to 'Snap to Theme' Link

This function expands links in the Active Theme to links in the Snap To Theme.



Rules:

The Active Theme link must be exactly on the Snap To Theme link.

There are 3 variations on this, being:

- Both nodes in the Active Theme link are exactly on the Snap To Theme link's nodes, in which case nothing is changed.
- One node in the Active Theme link is exactly on the Snap To Theme link's node and the other is on the link and within the snap distance of the other node, in which case that node is moved to that end.
- Both nodes in the Active Theme link are exactly on the Snap To Theme link, in which case the nodes are snapped to the ends if within the snap distance.

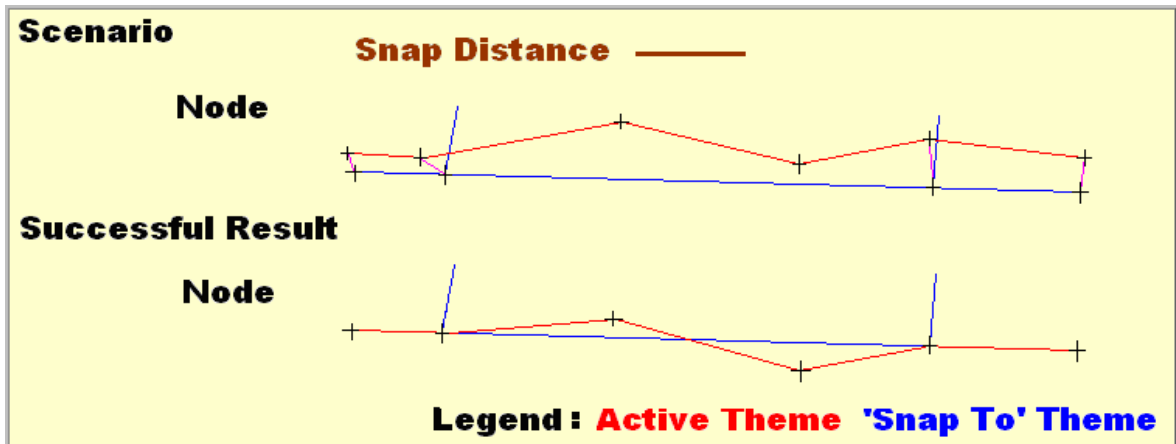
Look after this in the source code

"+" means that any nodes created or moved are to be flagged as having being actioned in the function being called.

"-" means that any nodes previously flagged as having being actioned are not to be actioned again in the function being called.

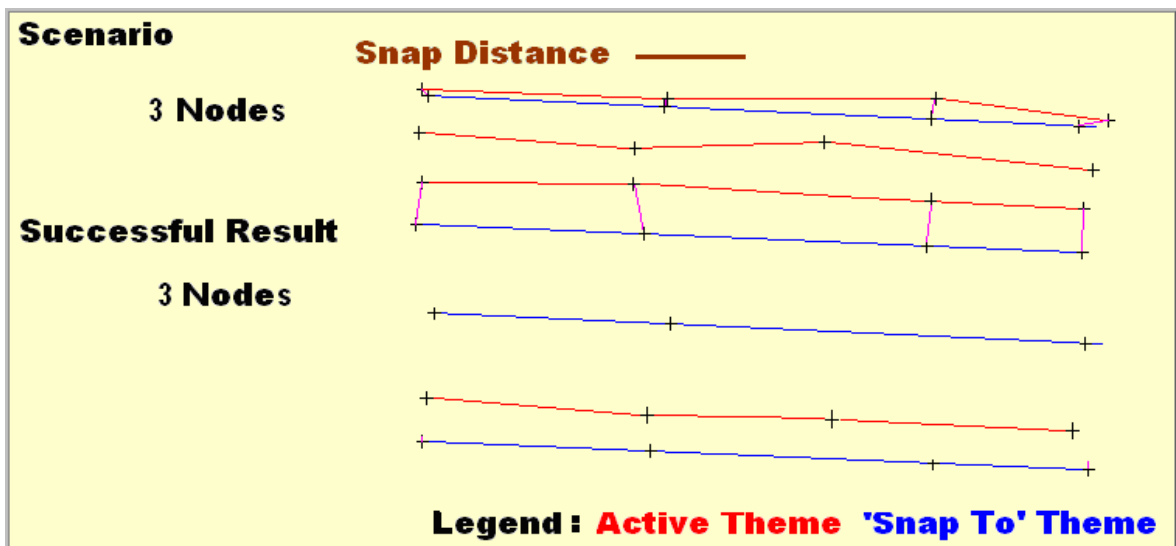
4.5.14. Bowditch Adjustment

This function loops through all the features in the active theme carrying out a simple similarity transformation for all nodes in-between two nodes that have been snapped. A maximum shift distance can be specified, e.g. 20 will mean that no point will move more than 20 metres from its original location.



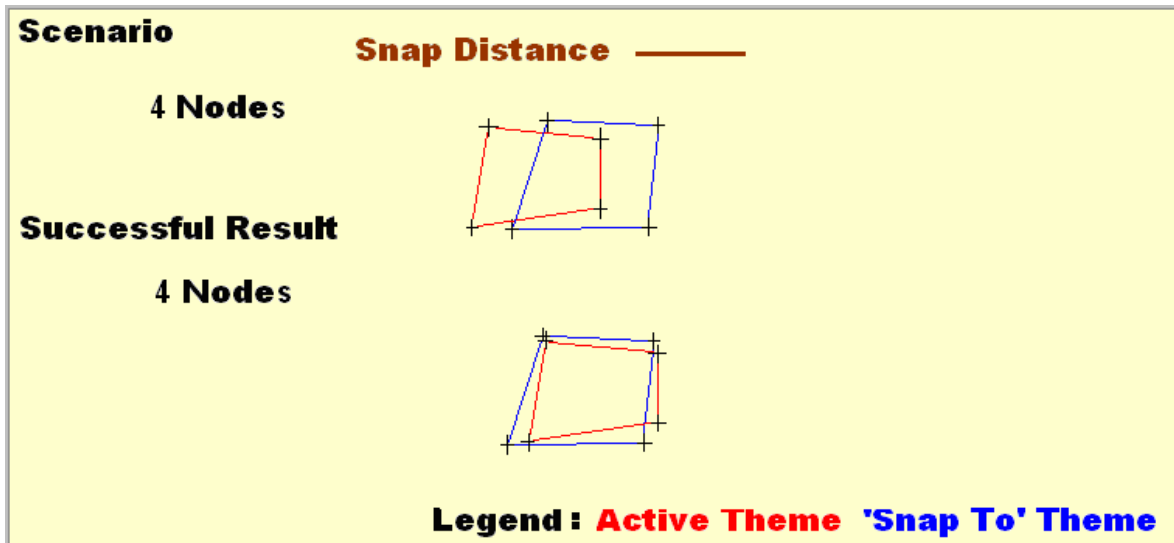
4.5.15. Best-Guess Adjustment

This function loops through all the nodes in the active theme setting the un-snapped coordinates to a simple best guess value.



4.5.16. Polygon to 'Snap to Theme' Polygon

This function identifies common polygons in the active theme and the 'Snap To' theme by comparing their centroid coordinates, their area and their extents. When a match is found all the coordinates in the active theme belonging to the polygon are move by the difference in the centroid coordinates.

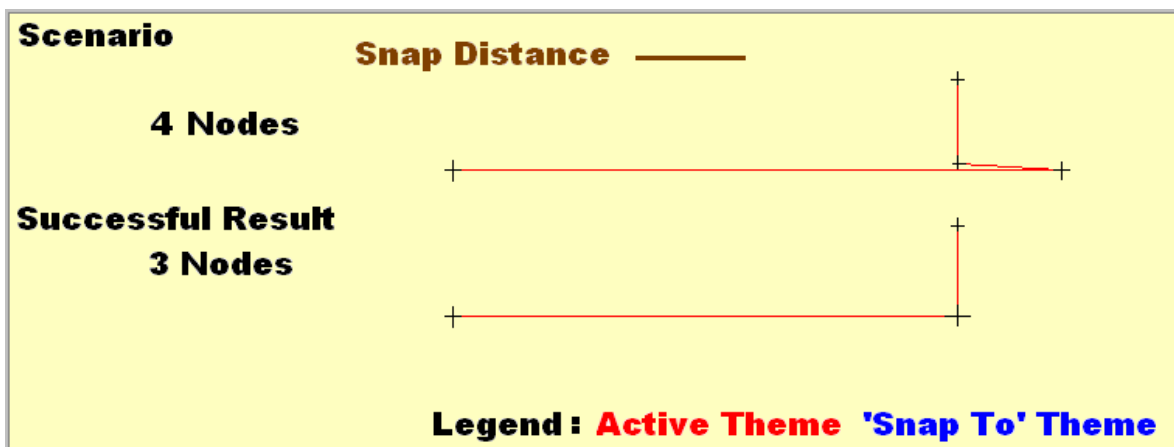


4.5.17. Shortest Path in 'Snap to Theme'

Not yet implemented

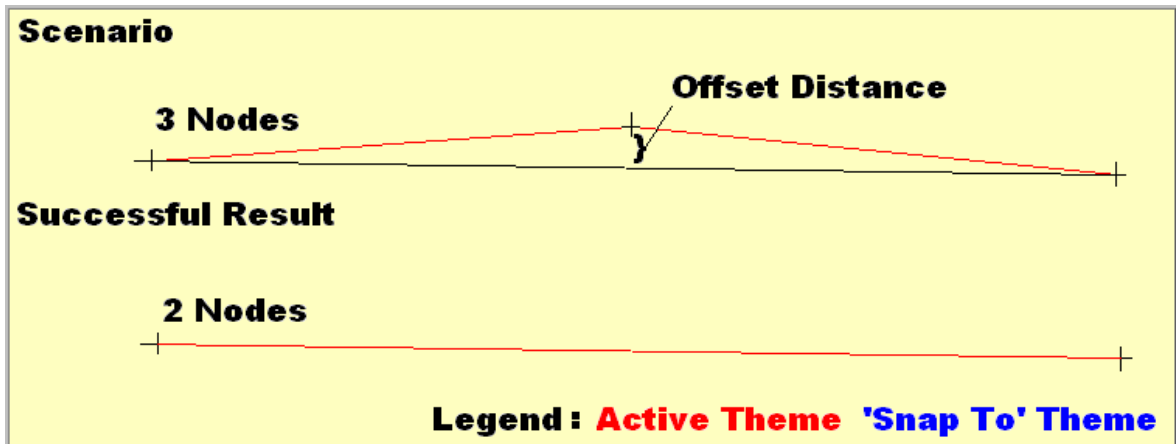
4.5.18. Remove Sharp Points (Splinters)

This function removes sharp points, collapsing the pointed corner back to more like a right angle.



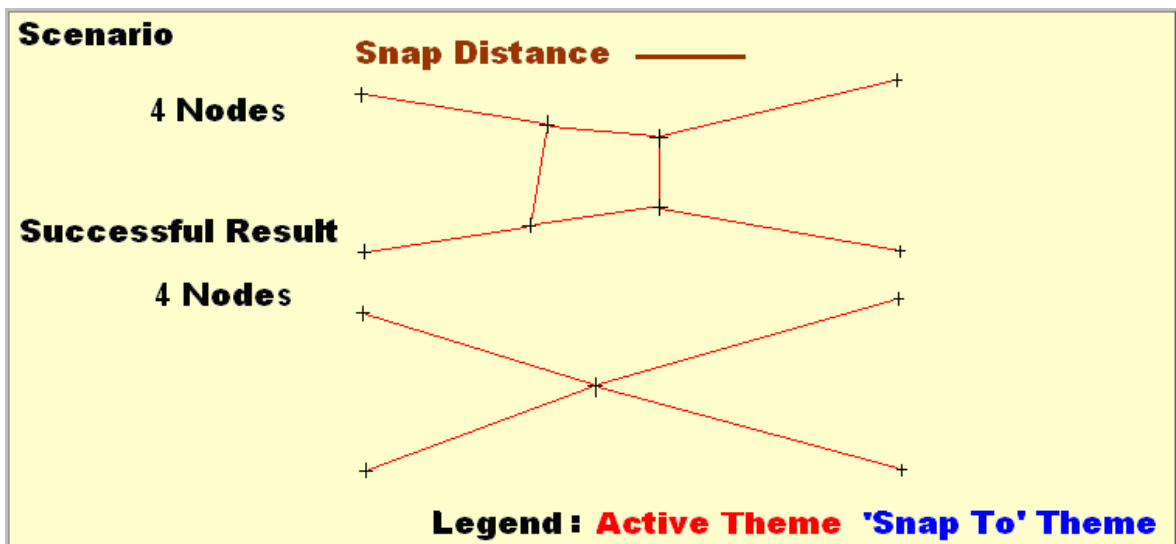
4.5.19. Remove Straight Line Nodes

This function scans through each feature in the active theme looking for sets of three nodes where the middle node has an offset within the specified tolerance, and where the middle node has only the two links attached. The middle node is removed from all features in the active theme.



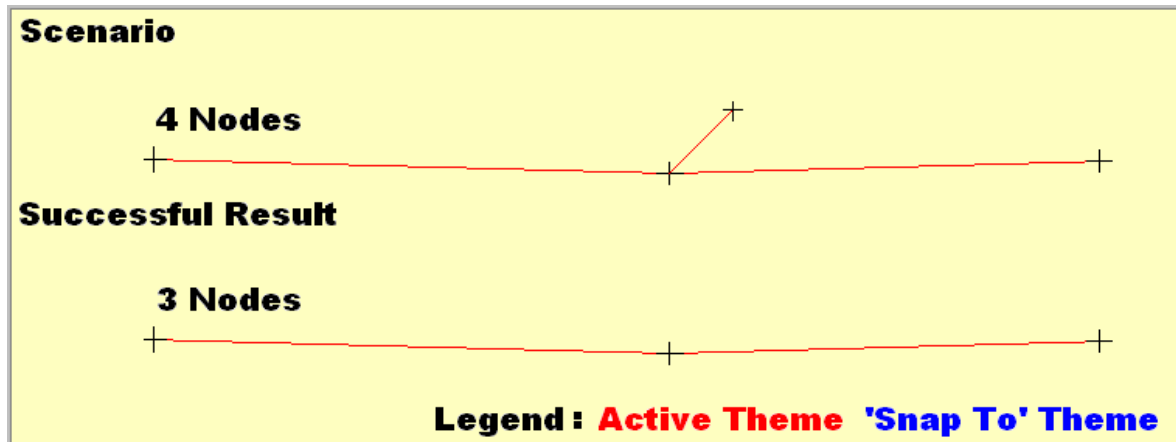
4.5.20. Remove Small Areas

This function collapses small polygons less than the specified area (in metres) in such a way that neighbouring polygons pick up the area being removed.



4.5.21. Remove Dangles

This function removes instances where links double track back onto the previous node.



4.5.22. Survey Dimension Processing

This function is implemented for another aspect of AusGIS and is not available from a topological processing perspective.

4.5.23. Save Theme

This saves the result to a MapInfo TAB File. This file is located in the TWA working directory, with the filename specified.

4.6. The Post Topo Results Tab

The Post Topo Results tab is used to inspect the processed Active Theme.

The usual AusGIS Tools are provided to zoom and pan around.

The Zoom In tool will also show details of the processing run as Map Text. This will include details of the function that moved a node and the internal segment number.

The Pan Button will display ground coordinates as Map Text.

The Post Topo Results tab appears as:

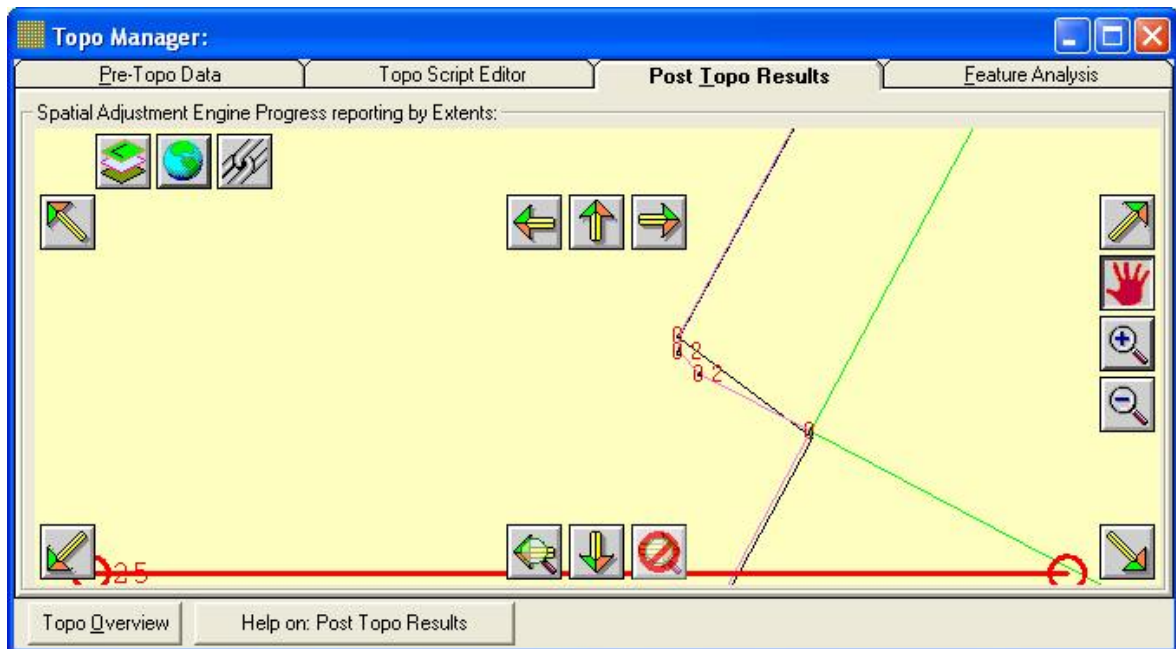


Figure 5 Post Topo Results Tab

There are no additional options on this tab.

4.7. The Feature Analysis Tab

The Feature Analysis Tab is used to look for likely problems in the Topological Processing run.

Features can be examined as a whole and comparisons made with their earlier spatial attributes against those after the Topological Processing run.

Links (the line between to coordinates) can also be examined and comparisons made with their earlier spatial attributes against those after the Topological Processing run.

The Feature Analysis Tab appears as:

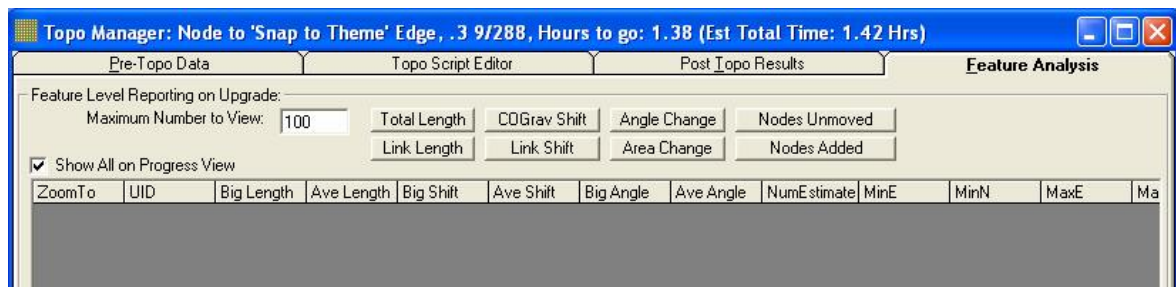


Figure 6 The Feature Analysis Tab

The following options are available to be used on the Feature Analysis Tab.

4.7.1. Maximum Number to View

This limits the number of lines in the Topo List Box below. Experience will determine how many will need to be looked at to get a determination of how well the scripted process worked with a given set of data.

4.7.2. Total Length

This lists the top features whose total length (polylines) or circumference (polygons) has changed, up or down, the most.

4.7.3. Link Length

This lists the top links whose length has changed, up or down, the most.

4.7.4. CoGrav Shift

This lists the top features whose Centre of Gravity (X & Y) has moved the most.

4.7.5. Link Shift

This lists the top links whose mid-point has moved the most.

4.7.6. Angle Change

This lists the top links whose abutting link has changed inclination the most.

4.7.7. Area Change

This lists the top features whose unclosed area (polylines) or closed area (polygons) has changed, up or down, the most.

4.7.8. Nodes Unmoved

This lists the top features that have the most nodes that have not been matched to any of the 'Snap To Themes' that have been processed.

4.7.9. Nodes Added

This lists the top features that have had the most nodes added either by self cleaning or to any of the 'Snap To Themes' that have been processed.

4.7.10. Show All on Progress View

Not sure

5. TOPOLOGICAL PROCESSING STRATEGIES

The process of getting the best result economically will vary depending on the input data and the desired results.

This is in part related to some of the functions having the ability to obtain the nearest for processing purposes, and others processing everything within the snapping tolerance.

Some datasets may be dealing with a fairly constant maximum shift, such as restricted areas where the cadastre has been upgraded. Other datasets may be partly originated in high scale digitising which have been improved to low scale, or even GPS accurate, themes. In such cases there may be areas requiring small realignment and large realignment, and just using a maximum snap distance early in the processing may cause features to move to the incorrect position.

Such scenarios require an iterative processing approach, with a gradually increasing snap distance being used.

There are two common and important arguments available to most topological processing functions, being the "+" and the "-" arguments.

The "+" argument means to mark each snapped node as having been snapped.

The "-" argument means to honour previously snapped nodes and not snap them again.

Thus repeatedly using these arguments over increasing snap distances prevents nodes being re-snapped simply because another matching geometric scenario is found at a greater distance.

The "O" argument means

The "I" argument means

The "1" argument means

The "2" argument means

5.1. Typical Scenarios

There are a number of scenarios that could be present in any one dataset, and no doubt there will be optimisations using the existing toolset and to the toolset itself.

This leads to the observation that is large topological processing runs if may be efficient to partition the data into smaller runs, along the following lines:

5.1.1. The Urban Scenario

The typical urban scenario is one in which the primary themes are reasonably accurate, and detailed too. This in turn means a higher level of workmanship can be



expected in themes derived from them, and smaller shifts required (generally) when the primary themes are upgraded.

In such cases it is reasonable to run the various processes with snap distances of 0.3, 1, 2, 4 until larger than the shifts involved.

5.1.2. The Rural Scenario

5.1.3. The Urban Scenario