Analysys

Instructions for key processes in geoanalysis for the fixed LRIC cost model – Version 2.0

Contents

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1   Introduction

This document contains instructions for completing key data processing as part of the geoanalysis, which informs the access network calculations in the Analysys cost model. The following processes are described:

- Section 2 describes a selection of useful diagrams that can be plotted in MapInfo using the outputs generated by Visual Basic.

- Section 3 describes how to update the Location and Demand Database, should the assumptions change.

- Section 4 describes how to prepare the location data for an Exchange Service Area (ESA), to be processed by the geoanalysis and access network module.

- Section 5 describes how to update the sample of ESAs to be processed by the geoanalysis and access network module.

- Section 6 briefly describes how to split an ESA served by multiple copper centres into sub-ESAs each served by one copper centre, using a Voronoi construction in MapInfo

- Section 7 describes how outputs from the geoanalysis and access network module are used to calculate the distributions of copper gauges deployed in the access network

- Section 8 details the pre-processing of StreetPro that was completed in order to evaluate the extent of overlap in the access and core trench networks.

The report also includes a supplementary annex with a transcript of MapBasic:

- The transcript in Annex A was used to automate the identification of the co-ordinates of the Geocoded National Address File (G–NAF) locations having been mapped onto streets.

This documentation assumes that the reader has some familiarity with the basic use of queries in both MapInfo and Microsoft Access.

2 Plotting outputs in MapInfo

This section describes some of the pictorial representations that can be created in MapInfo using the outputs of the Analysys cost model. For each ESA that is calculated, detailed outputs are plotted in the worksheet allotted to the ESA in the relevant data workbooks. Specifically, the data for the kth ESA in the nth geotype is stored in the worksheet 'ESA.Gn.k' in the file *Access – DATA Gn.xls*. This data not only includes total asset volumes required for a fixed network deployment, but also gives geographic data on the actual network deployed. This is to be found at two main places on the worksheet:

- location data in columns B to K, starting in row 37
- data on spanning trees connecting address locations in columns BE to BU, starting in row 37.

The data specified in these places are stated in Table 2.1 below:

Worksheet destination	Description of data
Location data	Co-ordinates of location on the street network
Location data	Co-ordinates of location based on original G–NAF co-ordinates
Location data	Whether location is served by copper / fibre / wireless / satellite
Location data	DP (distribution point) cluster (urban only)
Location data	Pillar cluster
Location data	Nature of location (FDP, pillar, other node)
Data on spanning trees	Co-ordinates of endpoints of all trenches in spanning tree
Data on spanning trees	Co-ordinates of all wireless backhaul links (rural only)
Data on spanning trees	Nature of link (within DP, pillar-pillar etc.)
Data on spanning trees	Number of duct in trench by purpose

Table 2.1: Data useful for plotting outputs in Mapinfo [Source: Analysys]

Both of these tables can be imported in their entirety into MapInfo. The maps that can be plotted with these two tables of data are explained in the next two sub-sections, as set out below. Examples are given for ESAs plotted using both the urban and rural deployments.

2.1 Plotting the location data

The location data in the table is in the relevant zone of the Map Grid of Australia. The table must be mappable in this co-ordinate system in order to plot the points for an ESA.

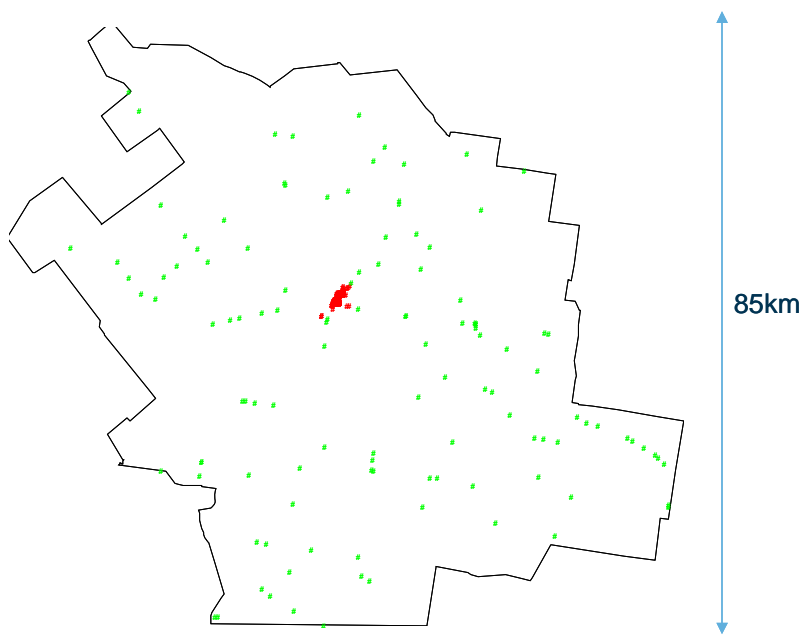*Analysys*

2.1.1 Serving technology

Each location is designated as being served by a particular technology. This is shown in the column conditionally labelled as 'Served by copper or wireless' or 'Served by copper or fibre' for urban and rural deployments respectively.

- in the urban deployment, the options are copper or fibre
- in the rural deployment, the options are copper, fibre, wireless or satellite.

If a map window is open and active, then a thematic map of the locations based on this field can be constructed using the following process:

- Press F9.

- In the dialog box, select the type of thematic map to be 'Individual,' click a suitable template for points and click 'Next'.

- In the next dialog box, select the table to be that containing the locations, select the correct field and click 'Next'.

- In the final dialog box, edit the style of the thematic if desired and click 'OK.'

An example for the Dirranbandi ESA is shown below.

85km

Figure 2.1: Thematic map by technology served (red locations are served by copper, green locations are served by wireless) [Source: Analysys]

2.1.2 Pillar clusters

Similarly to section 2.1.1, the pillar clusters can be displayed with a thematic map of the pillar index field, as shown below for Waymouth in Figure 2.2.
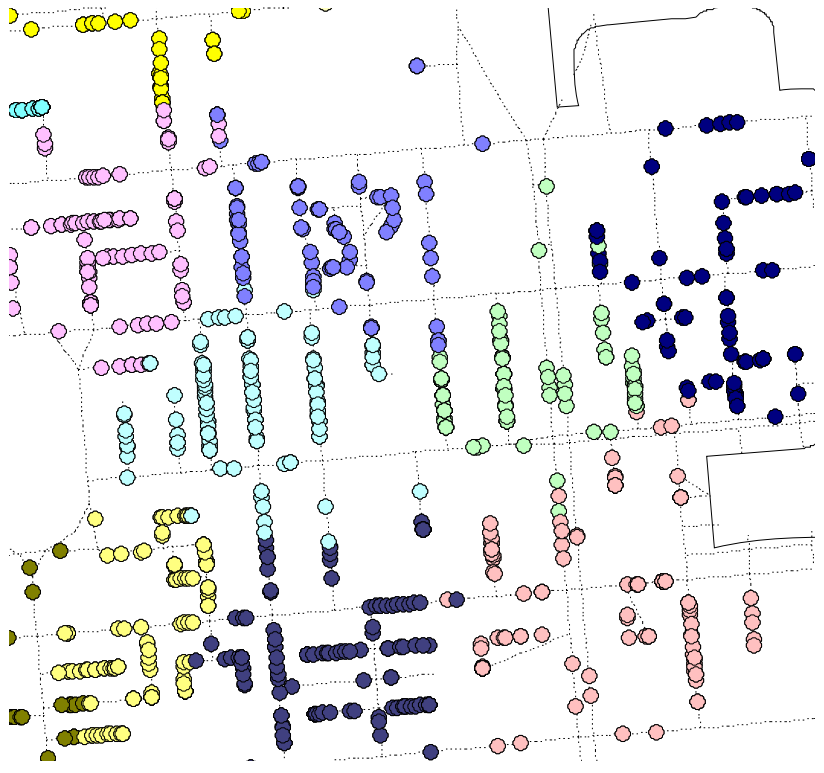
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Figure 2.2:
Demonstration of clusters
for Waymouth [Source:
Analysys]

Similarly, a thematic map of the DP clusters can also be plotted for urban deployments. However, since there can be hundreds or even thousands of these clusters in an ESA, the colours can be heavily repeated and the map can become less informative.

2.1.3 Node type

A thematic map can also be made to demonstrate the different uses of the locations in the deployed network, using the 'Location type' column. Specifically, this can highlight normal locations (final drop points, or FDPs), DPs and the various nodes in the access network. In addition, the major nodes can be isolated using a select query. Examples for Waymouth are shown below.

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Figure 2.3:   *Type of location in network and major nodes in network (green points are FDPs, red points are DPs, blue dots are pillars and the black dot is the local exchange (LE) [Source: Analysys]*

2.2 Plotting the data on spanning trees

The spanning trees are captured by stating the co-ordinates of the endpoints of every edge. The co-ordinates are captured in the relevant zone of the Map Grid of Australia (AMG). Having imported the table, a spanning tree can be generated by the following process:

- Click 'Options' → 'Show MapBasic Window' to display the MapBasic Window.

- Copy the following MapBasic code and paste into the MapBasic Window:

Drop Map *TABLE* Browse * From *TABLE* Set CoordSys Earth Projection 8, 116, "m", *NUMBER*, 0, 0.9996, 500000, 10000000 Bounds (-7745844.29605, 2035.05684549) (8745844.29605, 19997964.9432) Create Map For *TABLE* CoordSys Earth Projection 8, 116, "m", *NUMBER*, 0, 0.9996, 500000, 10000000 Bounds (-7745844.29605, 2035.05684549) (8745844.29605, 19997964.9432) Update *TABLE* set obj = createline (*v1x, v1y,v2x, v2y*) Map From *TABLE*

- Replace *TABLE* with the name of the table in MapInfo containing the data.

- Replace *NUMBER* with the value 6Z–183, where Z is the relevant AMG zone.

- Replace *v1x, v1y,v2x* and *v2y* with the corresponding field names of the endpoint co-ordinates text.

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- Highlight this code in the MapBasic Window and press Shift + Enter. This code drops any existing co-ordinate system for *TABLE* and creates a new one in the appropriate co-ordinate system. It then plots the lines in this co-ordinate system.

In the rural deployment, the last links may be wireless: they will be labelled as:

- BTS–RAU
- BTS–BTS
- wireless LPGS–wireless LPGS
- wireless LPGS–RAU
- wireless LPGS–BTS.

These links should be plotted separately, as they have no associated trench.

2.2.1 Trench network

First and foremost, this plot allows the user to get some idea of the trench network. A thematic map on the column for the 'Link' type can indicate the different links in the tree. This map requires the type of thematic map to be 'Individual,' but a suitable template for lines should be chosen. An example for Waymouth is shown below.
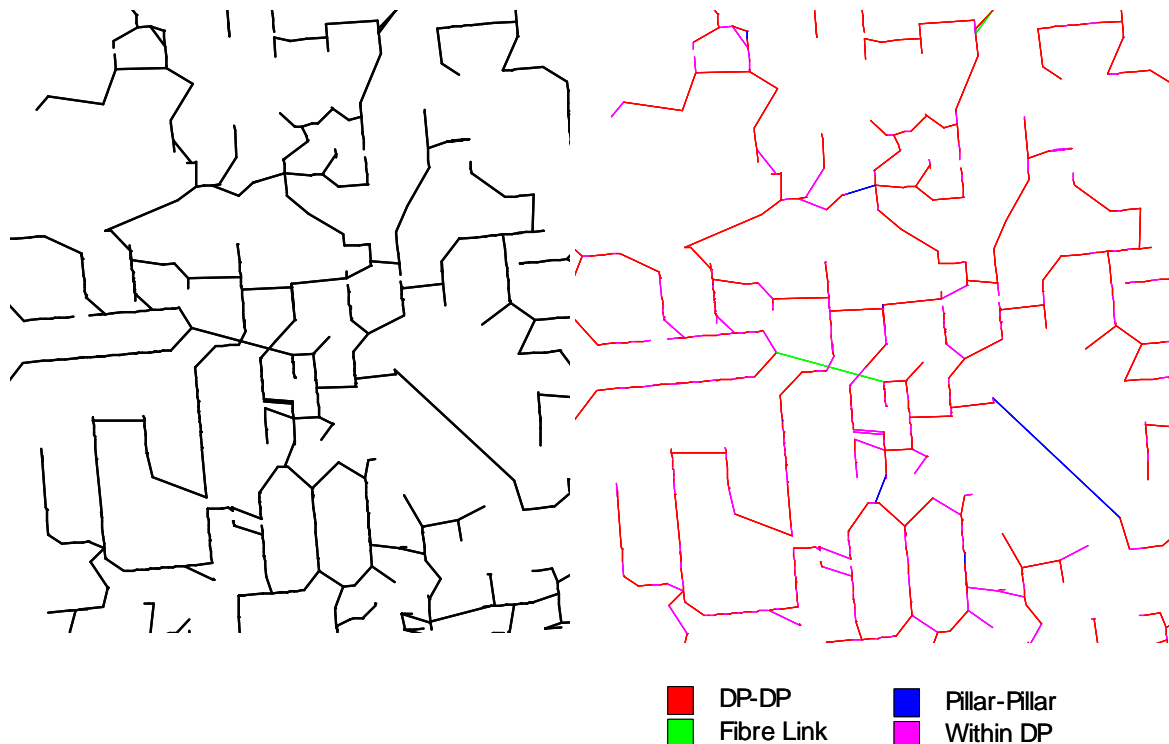

Figure 2.4:   *Part of a minimum spanning tree for Waymouth, including a thematic map by link type [Source: Analysys]*

Since the links are plotted as "crow-flies, " they will not always follow the roads. However, only the lengths of Within DP links are calculated using crow-flies distance; all other trench/cable lengths are calculated in the model using the p-function. As a result, although a plotted link may appear to cut corners, their associated length in the model will be longer than crow-flies distance.

Other plots can be made of the tree, using the duct values also present in the table.

2.2.2 Total ducts provisioned in each trench

Plotting a thematic map by the total amount of duct provisioned allows some understanding of where the cable is aggregating back to the pillar and then on to the RAU. An example is given below for City South.
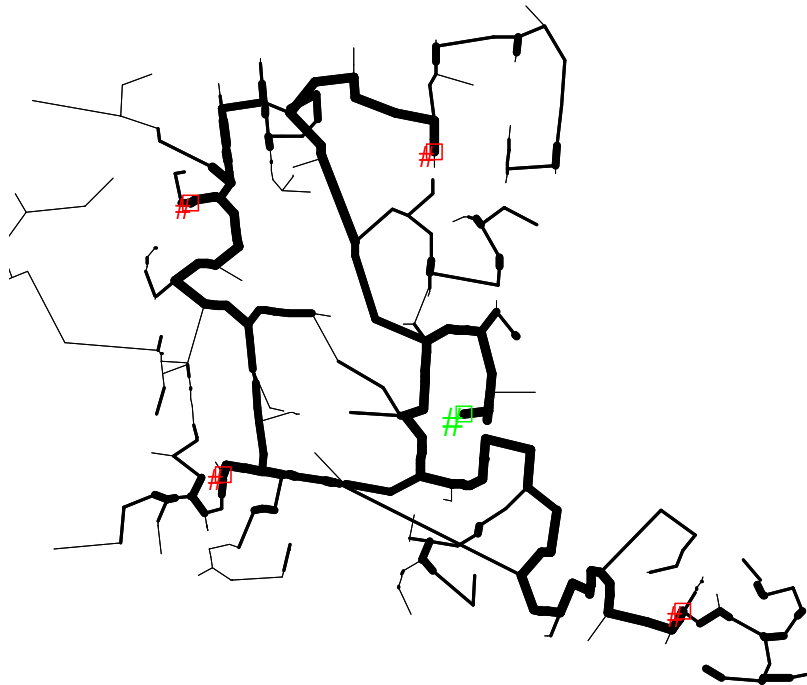
Figure 2.5:
Duct network for City South (red dots are the pillars and the green dot is the RAU) [Source: Analysys]

This is a 'Ranges' thematic map, using line widths of varying type given the number of duct provisioned in each trench.

2.2.3 Feeder network

Using a select query to isolate the trenches which contain inter–pillar duct for copper, the route of the cable in the feeder network can be determined, as shown below for City South in Figure 2.6.
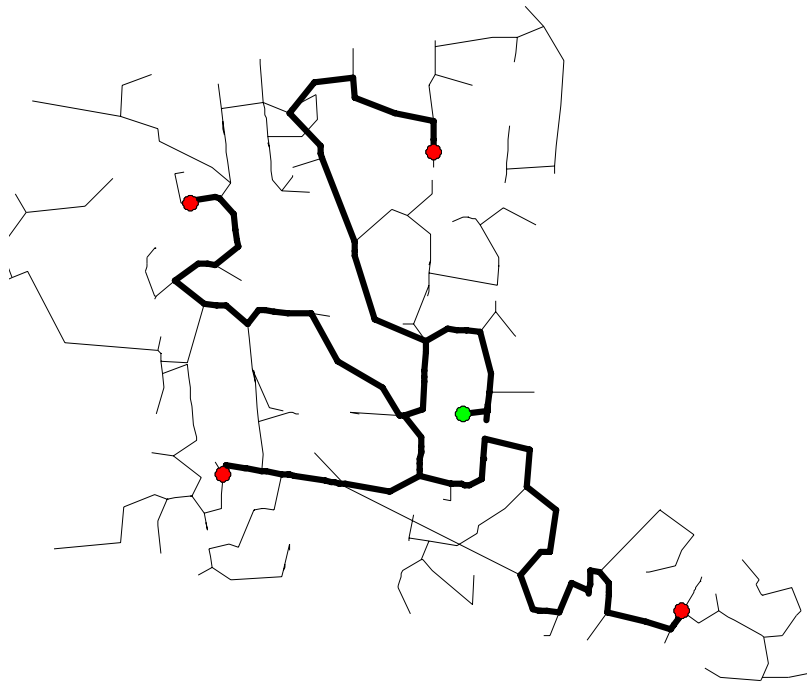
Figure 2.6:
Route of the feeder
network [Source:
Analysys]

2.2.4 Fibre rings

In those ESAs which deploy fibre rings, a schematic of the fibre rings can be obtained by isolating those edges which contain inter-pillar duct for fibre with a select query, as shown below for Flinders.
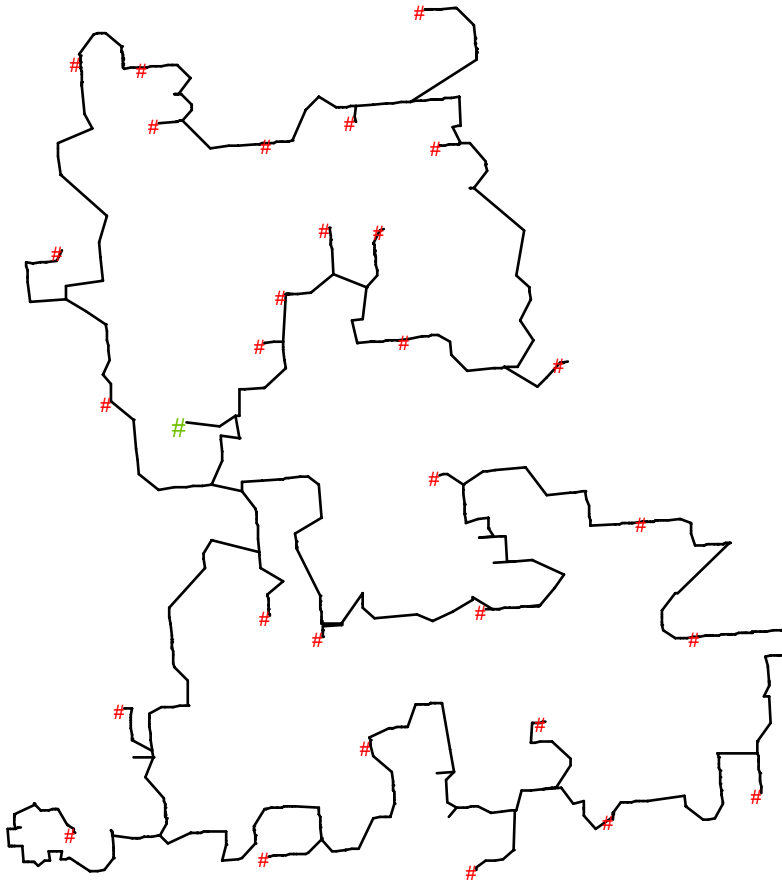
Figure 2.7:
The Flinders fibre ring
(red dots are the pillars
and the green dot is the
RAU) [Source: Analysys]

2.2.5 Trench within DP clusters

The urban deployment algorithm used in the model employs crow-flies distance to measure the length of trench links within DP clusters. We justify this on the basis that DP clusters currently contain at most four locations within a 100m radius, meaning that it is likely that these clusters will lie along a single road. There will still be some differences, since a DP cluster may lie across the intersection of two roads at a junction, which will lead to corner-cutting, as demonstrated below in Figure 2.8.

Figure 2.8:
Example of corner-cutting
by trench links within DP
clusters, for the
Deepdene ESA [Source:
Analysys]

KEY
— Road network from StreetPro
— 'Within DP' links

In order to correct this, we have derived a trench-sharing coefficient as part of the p-function to calibrate the total trench requirements to actual road distance.

2.2.6 Deriving actual road distances with RouteFinder

A process that requires more effort, but nonetheless can be a useful cross-check of the trench distances, is to calculate the road d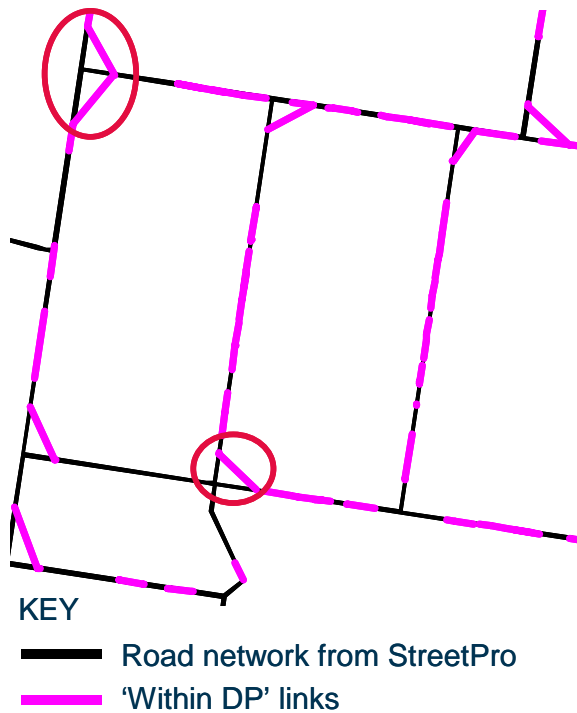istances associated with the links calculated for the sampled ESAs. This can be done using a network analysis system such as RouteFinder. Analysys has calculated these distances for a selection of ESAs. The calculation involves several stages:

- Identify the road network from the set of StreetPro line segments that lie within the ESA using the process described in section 4.2.2.

- Split the line segments into smaller pieces so that it recognises all intersections (i.e. no line segment passes straight through a street junction) and use these split segments to create a network in RouteFinder.

- Use the calculated output from the network deployment algorithm to create two tables of link endpoints in MapInfo and then use the 'Route Pairs' batch function in RouteFinder to plot the road routes representing each link and their length.

An example output is shown below in Figure 2.9 for the Bulmer ESA.
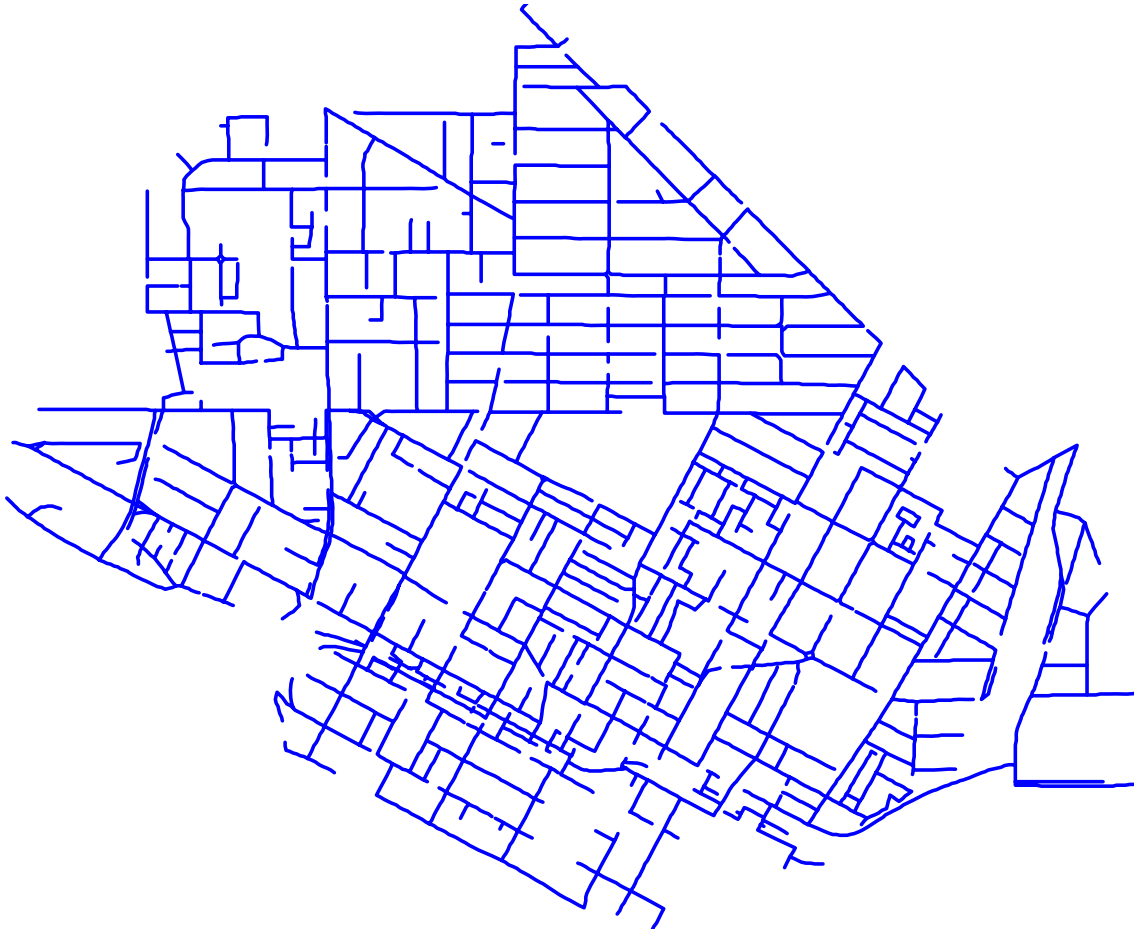
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Figure 2.9:   *Trench network mapped onto the actual street network for the Bulmer ESA [Source: Analysys]*

This produces a representation of the trench network for the whole ESA whose total length can be compared with the total trench derived in the model outputs. The methodology employed for each of the two main steps for this process are explained in more detail below.

Breaking up the street network

Having isolated the street network for the ESA and saved it as a table (say *ESASt.TAB*), MapInfo processes can be used to break up the network so that is recognises all intersections:

- Select *ESASt.TAB* as editable in the 'Layer Control' window.

- Select all the objects in *ESASt.TAB* and click 'Objects' → 'Select Target'.

- Select all the objects in *ESASt.TAB* again and click 'Objects' → 'Snap/Thin', check 'Enable Node Snap,' select the inputs as shown below in Figure 2.10 and click 'OK.' This ensures any small breaks in the roads at junctions are filled.

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- Click 'Objects' → 'Disaggregate,' tick 'All Objects' and 'Retain Holes in Regions' and click 'OK.' This breaks up any broken polylines in *ESASt.TAB* into separate unbroken polylines.

- Click 'Objects' → 'Overlay Nodes.' This will ensure all junctions in the road network are recognised by MapInfo.

- Click 'Objects' → 'Buffer' and create a 0.1m buffer about all of the line segments. Save this table as *ESAStBf.TAB*.

- With all of the objects in *ESASt.TAB* still as the target, select all of the objects *ESAStBf.TAB* and click 'Objects' → 'Split' and click 'OK.' This will split the road network using the thin buffers, which will separate the junctions in the network.

- Select all the objects in *ESASt.TAB* again and click 'Objects' → 'Snap/Thin,' check 'Enable Node Snap,' select the inputs as shown below in Figure 2.10 and click 'OK.' This removes the small 0.1m lines at road junctions created by the splitting process, but keeps the line segments broken-up at the junctions.
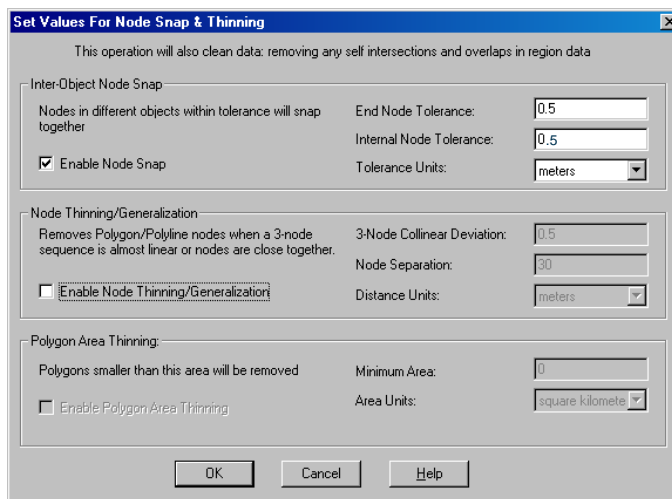
Figure 2.10: Settings for node snapping (left) and node thinning (right) [Source: Analysys]

Generating the road distances for each link

- Create a new field (as an integer) in *SL.TAB* called 'Speed' and update the field to take the same value (e.g. zero) everywhere.

- In order to use the table in RouteFinder, open *SL.TAB* in MapInfo and click 'RouteFinder'→'Create Network' and select *SL.TAB*. When asked to select an attribute field, select the field 'Speed.'[1]

- From the output table in Columns BE–BV for the ESA, copy the columns of data labelled *v1*, *v2*, *v1x*, *v1y*, *v2x* and *v2y* for all of the trench links in the spanning tree.

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[1]   RouteFinder is capable of calculating both distances and times for routes, if it is given a speed limit for each road. However, we are only interested in distance, so we assign the same speed to each road.

- Split these columns into two tables containing the columns *v1*, *v1x* and *v1y*, and *v2*, *v2x* and *v2y* respectively. The order of the points in each table must be preserved.

- Import these two tables into MapInfo (named, say, *Pt1.TAB* and *Pt2.TAB*) and plot the points in the identified zone of the Australian Map Grid.

- Activate RouteFinder and click 'RouteFinder' → 'Options' → 'Routes.' Select the 'Route Type' to be 'Exact.' This means that the software can identify the distance between two points lying on a single line segment.

- Click 'RouteFinder' → 'Batch Functions' → 'Route Pairs.' Select *Pt1.Tab* and *Pt2.TAB* as the two tables, with *v1* (respectively *v2*) as the identifier columns. Check the box for 'Plot routes' and click 'OK.' This will plot a link between the corresponding points in *Pt1.Tab* and *Pt2.TAB* following the road.

- When the calculation is finished, save the table, say as *ESARt.TAB*. Update the 'Time' field to be a constant value.

- Draw a 0.5m buffer about each individual link and save it into a new table, say *ESARtBf.TAB*.

- For this new table, click 'Table' → 'Combine Objects Using Column' and use the field 'Time.' This will combine all the buffers into a single object. Save in a new table, say *ESARt1Bf.TAB*.

- Open a Map window for the objects in *ESARt1Bf.TAB* and set the layer to be editable.

- Click 'Object' → 'Clean' and check 'Enable Overlap Removal' in the dialog box. Click 'OK'.

- Calculate the area of this combined object using Area(obj, "sq m"). This will be a very close estimate[2] of the length of the trench required in the ESA and avoids the possibility of double-counting as can occur using the ObjectLen() function on combined line objects.

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[2] Calculating the buffer area rather than the length directly will lead to a slight over-estimate from the excess 0.5m of buffer at the endpoints of the combined object.

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3   Revising the Location and Demand Database (LDD)

3.1   Introduction

The file *Location and Demand Database.mdb* is a Microsoft Access Database containing all the unique identifiers (GNAF_PID) of the entries in the G–NAF that have survived the sifting process, which is detailed in the *Fixed LRIC cost model documentation*.

The purpose of the database, which we will refer to as the LDD, is to provide a tool for mapping units of demand onto every address contained within it. This provides a theoretical demand map for the whole of the country. This database contains several tables, as detailed below in Table 3.1.

Table Name	Description
TaAssumptions	Contains a single record, detailing the current assumptions used in the LDD
TaBusSize	Lists the business sizes used in the database
TaESA	Lists locations, residential addresses and SIOs for each ESA
TaGNAFDemand	Main table in the LDD. It contains the ESA, GNAF_PID, site type and attributed demands for each G–NAF entry that has survived the sifting process
TaGNAFMesh	Linked in from *GNAF.mdb*. Lists the GNAF_PID, co-ordinates, mesh block type, ESA and distance to the closest copper centre for every entry in the May 2007 release of the G–NAF.
TaLineRequirements	Stores the current assumptions used, on a geotype and site type basis, that have been applied to the entries in the table TaGNAFDemand
TaNumRegBusiness	States the number of registered businesses, by business size, calculated to lie in each ESA
TaOldLinePerSiteAssumptions	Stores sets of assumptions previously stored in *TaLineRequirements*
TaRandomNumbers	Contains the first 50 000 integers in a random order, for the purposes of random allocation
TaSiftedGNAF	Contains the list of GNAF_PIDs that survived the sifting process
TaStPtforSample	Contains the latitudes and longitudes of each address mapped onto the street for the purposes of the sampled ESAs
TaUpdateLog	Lists old assumptions used in previous mappings of demand to locations

Table 3.1: List of tables in the LDD [Source: Analysys]

Each entry has been mapped to both an ESA (using ExchangeInfo) and a land use (using Mesh Blocks). The latter allows an estimate to be made as to whether it is a residential or non-residential entry. Moreover, each entry has been attributed to one of seven "site types":

- residential
- non-residential

![Analysys logo]

- main business site for 10-19 employees
- main business site for 20-49 employees
- main business site for 50-99 employees
- main business site for 100-199 employees
- main business site for 200+ employees.

The process for this assignment is also described within the *Fixed LRIC cost model documentation*.

The database size constraint of 2GB does not allow the latitudes and longitudes of each entry to be stored in the LDD. These are stored in the database *GNAF.mdb* in the table *TaGNAFMesh*, which has been linked into the LDD.

GNAF.mdb contains every entry in the May 2007 release of the G–NAF. In theory, a sifting process different to that adopted by Analysys could be implemented, which would change the number of locations within the LDD. However, in practice, the modification of data for such a process would be a considerable undertaking. Although it is fairly easy to remove addresses from the LDD, using a delete query on *TaGNAFDemand*, inserting additional entries would require significant additional calculations. Therefore, this user guide will assume that the entries contained within the database are fixed, or will only be sifted further.

Section 3.2 will describe how the demand mapping onto this set of G–NAF entries can be revised using a user interface that has been custom-made for the LDD. This interface assumes that the location, parent ESA and identified site type are all fixed for each entry.

3.2 Using the LDD

3.2.1 Opening the database

To open the LDD, double click on the file *Location and Demand Database.mdb*. The Microsoft Access window will open and a form will automatically open, as shown below in Figure 3.1.

Figure 3.1:

The window viewed when opening the LDD [Source: Analysys]

This is the interface for the LDD and allows the user to:

- view the current assumptions of units of demand that are mapped to each site and delete / update them, as explained in section 3.2.2
- paste in updated data on the ESAs, including geotypes and services in operation (SIOs), as explained in section 3.2.3
- view old assumptions used on the database and the total demand that those assumptions generated, as explained in section 3.2.4
- update the demand across the entire set of entries using the displayed assumptions, as explained in section 3.2.5
- obtain all G–NAF entries for any given ESA, as explained in section 3.2.6.

Most changes can be conducted through the user interface. However, experienced users of Access can access tables directly by pressing F11 to view the Database Window.

3.2.2 Viewing and updating the assumptions for units of demand per site

As can be seen in Figure 3.1, the main fields of data displayed are the assumed units of demand per site attributed to each site type within the LDD. This data is currently varied with the ESA geotype and the site type. The assumptions of units of demand per site can be manually edited within the form by clicking on the relevant cells. However, for a substantial revision, it may be easier to copy the values in Excel, edit them and then paste them back into the form. In order to do this, click on the box in the left-hand corner of the table, as circled below in Figure 3.2.
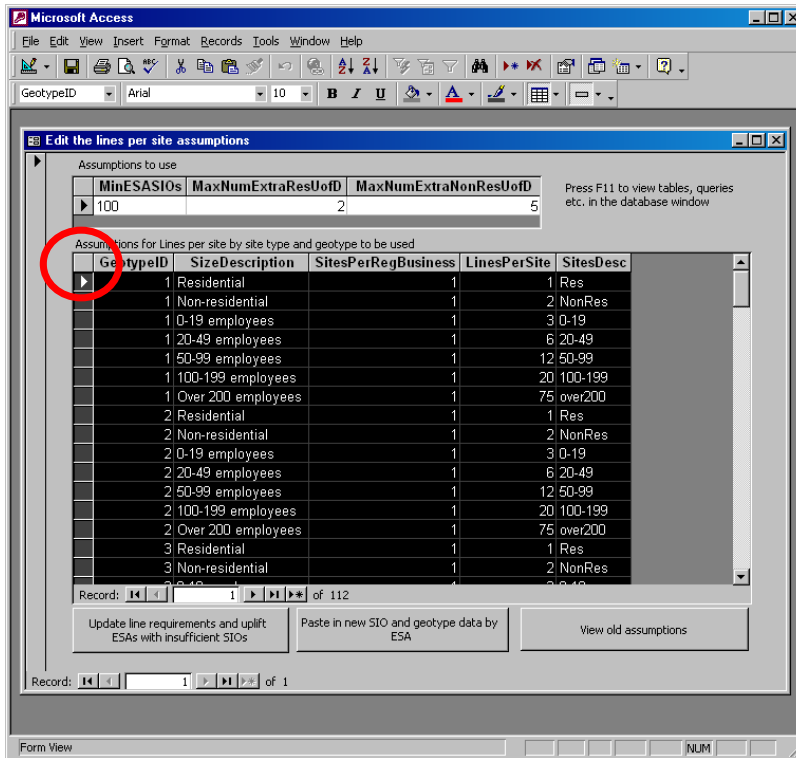
Figure 3.2:

Selecting all the data in

the table [Source:

Analysys]

This selects all of the records. Clicking 'Edit' → 'Copy' will copy the data and it can be pasted into Excel. Pressing 'Delete' will then delete the records, subject to clicking 'Yes' on a dialog box.

Once the data has been edited in Excel, copy the data, click on the box circled above in Figure 3.2 and click 'Edit' → 'Paste.' Subject to clicking 'Yes' on a dialog box, the new assumptions will be pasted in. Click on the left-hand side of the form, circled in Figure 3.3 below, to ensure that the data is written to the underlying table in the LDD.

Note that the order of the columns must be the same in the data pasted in as in the actual form: Access cannot order them. Attempting to paste the columns in a different order may lead to an error.
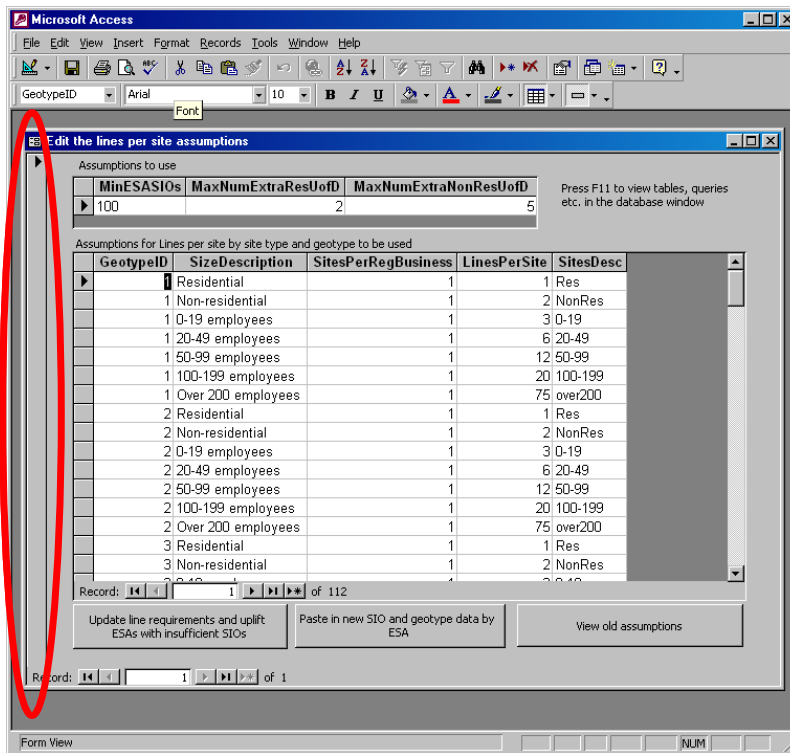
Figure 3.3:
Writing pasted data to the
underlying table [Source:
Analysys]

Three other inputs are displayed on the form. These are used in the uplift process described in the report, after the basic mapping of demand. These inputs are:

- *MinESASIOs*: any ESAs with fewer than this level of SIOs cannot undergo the uplift stage.

- *MaxNumExtraResUofD*: a residential address in an ESA cannot be given more than this number of units of demand, in addition to those it has from the basic mapping.

- *MaxNumExtraNonResUofD:* a non-residential address in an ESA cannot be given more than this number of units of demand, in addition to those it has from the basic mapping.

3.2.3 Updating the data stored on an ESA basis

As can be seen in Figure 3.4, the middle button on the main form is labelled "Paste in new SIO and geotype data by ESA."
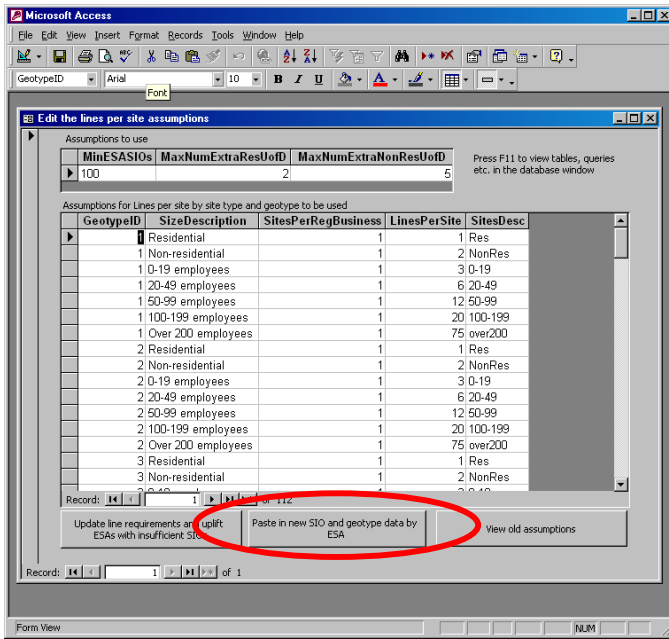
Figure 3.4:
Button for pasting in new
SIO and geotype data by
ESA [Source: Analysys]

Double-clicking on this button will open another form displaying the geotypes, ESA code, index and SIO for each ESA, as shown below in Figure 3.5.
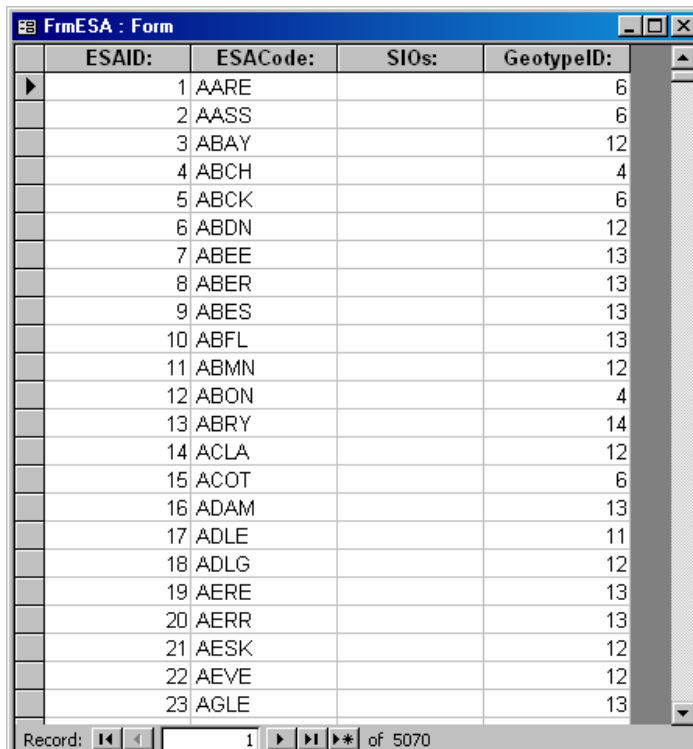
Figure 3.5:
FrmESA: displaying data
by ESA [Source:
Analysys]

ESAs are indexed alphabetically. Should this data need updating in the future, it can be deleted and pasted in the same way as described for the units of demand assumptions in section 3.2.2. However, the LDD could not maintain its integrity if, for example, an ESA's four letter code was altered or if new ESAs were introduced in the future. In both cases, there would need to be reprocessing of data within the LDD in order to ensure that the data was consistent. For the case of

a new ESA, all the entries would need to be re-identified with the ESAs in order to ascertain which entries lay within the new ESA.

3.2.4 Viewing old assumptions

As can be seen in Figure 3.6, the middle button on the main form is labelled "View old assumptions."
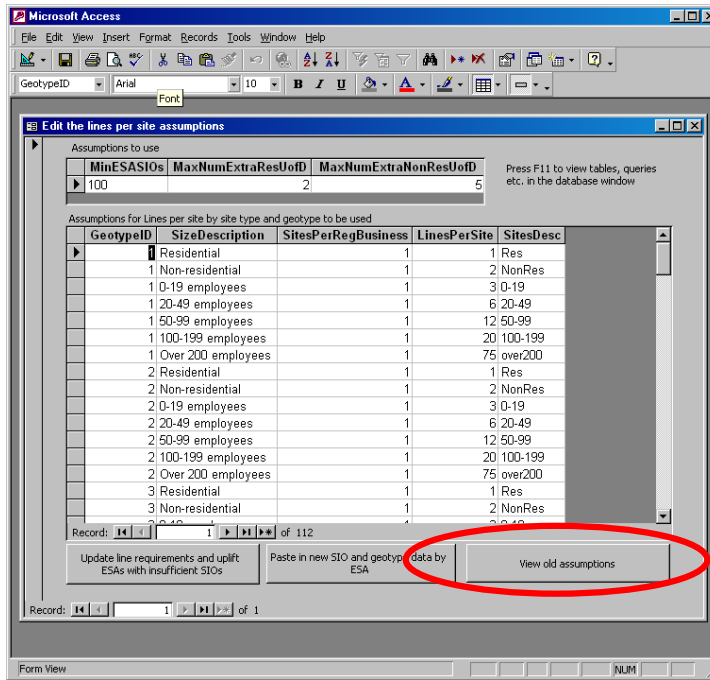
Figure 3.6:

Viewing old assumptions

[Source: Analysys]

Double-clicking this button will allow the user to view the high-level outputs of running sets of assumptions for units of demand on the database. The form is displayed below in Figure 3.7.
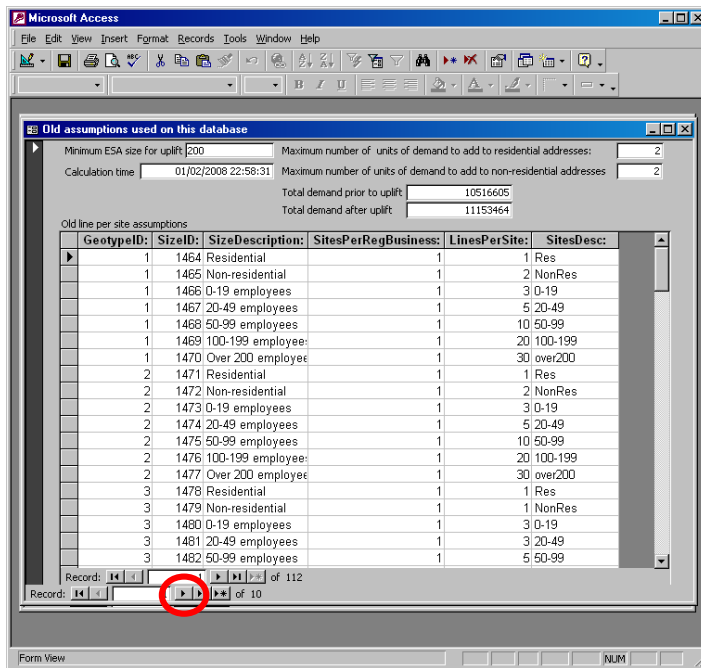
Figure 3.7:
Old assumptions used on
this database [Source:
Analysys]

The window displays the outputs of a single previous run in the LDD. However, all previous runs are stored and can be scrolled through using the button circled in Figure 3.7. For each run, the following information is stored:

- date that the run was completed
- values of all the inputs described in section 3.2.2 (units of demand per site assumption used, by geotype and site type, MaxNumExtraNonResUofD, MaxNumExtraResUofD and MinESASIOs)
- total demand after the basic mapping
- total demand following the uplift process.

This data can be deleted as described previously, but requires little storage space and is useful since it can allow the user to identify sets of assumptions that most adequately model actual demand.

3.2.5 Updating the demand mapping of the whole database

As can be seen in Figure 3.8, the left button on the main form is labelled "Update line requirements and uplift ESAs with insufficient SIOs."
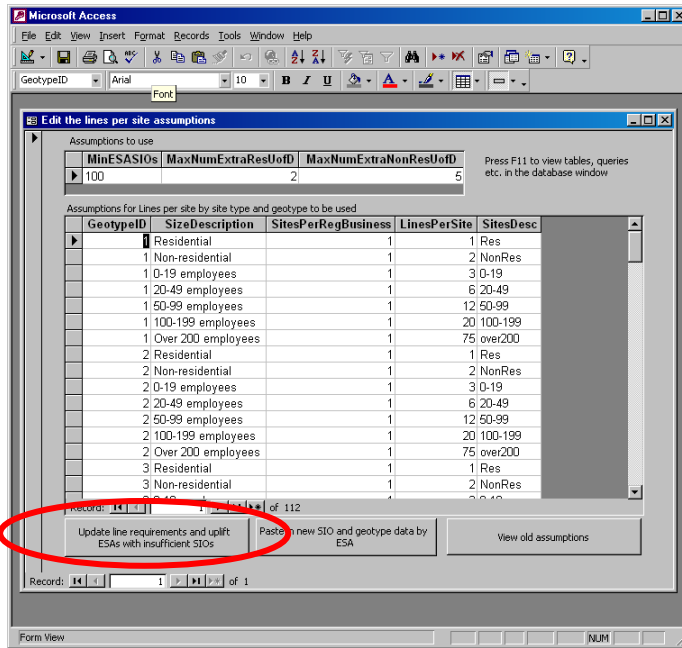
Figure 3.8:

Update line requirements and uplift ESAs with insufficient SIOs [Source: Analysys]

Double-clicking this button will result in the database taking the assumptions currently displayed on the form and updating the demand in the LDD, as summarised in Figure 3.9. In particular, it will assign demand to each address based on both its parent ESA / assigned site type and then uplift SIOs for ESAs which have demand below what exists in reality. This process is described in more detail in the *Fixed LRIC cost model documentation*. The assumptions and the final output will also be stored in the LDD.

An Excel file will also be created and saved, showing demand and addresses by ESA, compared with actual demand.
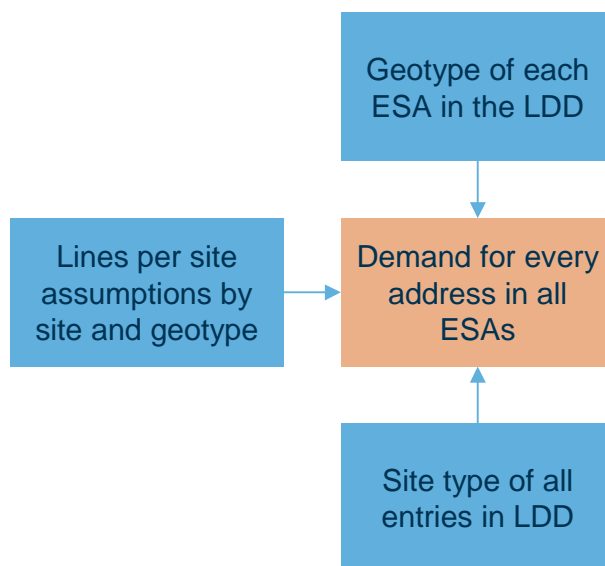
Figure 3.9:

Process used in updating the LDD [Source: Analysys]

This process will take approximately half an hour to run.

3.2.6 Obtain all G–NAF entries for any given ESA

When the LDD has a satisfactory distribution of demand, location data can be extracted. This can be done using a simple query on the tables *TaGNAFDemand* and *TaGNAFMesh*, which is linked in from *GNAF.mdb*. To illustrate how such a query would be set up, let us assume that we are attempting to extract the co-ordinates for the Waymouth ESA (WAYM):

- Open the LDD and press F11 to view the database window

- Make sure that *TaGNAFMesh* is correctly linked to the LDD, by:

  − clicking on 'Tools' → 'Database Utilities' → 'Linked Table Manager'
  − ticking both the check box next to TaGNAFMesh and next to "Always prompt for a new location" and clicking 'OK'
  − selecting the path of *GNAF.mdb* , clicking 'Open' and then closing the window once the link has been refreshed

- Click on the Queries tab on the Objects bar, circled in red and then click on 'New,' circled in green in Figure 3.10 below.
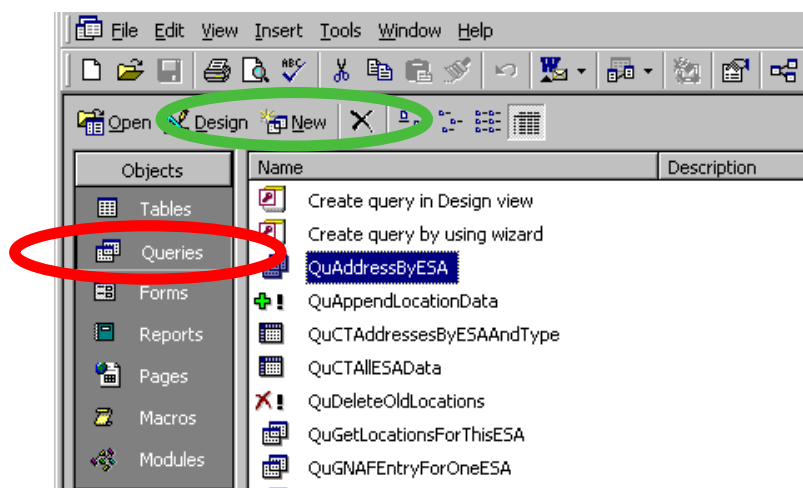
Figure 3.10:
Opening a query [Source: Analysys]

- Select 'Design View' and then 'OK' on the dialog box

- Select both TaGNAFDemand and TaGNAFMesh and click 'Add'

- Set up the query as show below in Figure 3.11 for the case of WAYM:
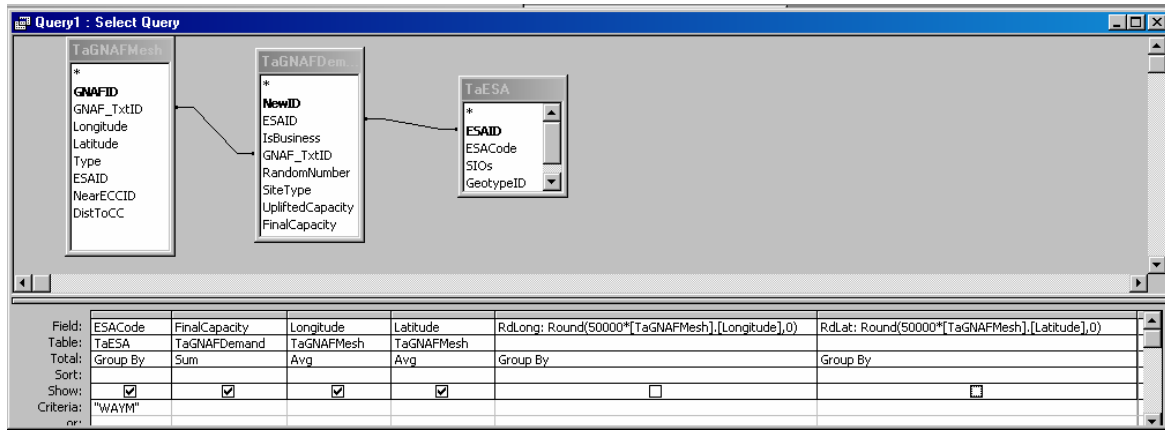
Analysys

Figure 3.11:   Query to obtain the locations for WAYM [Source: Analysys]

Click on the button marked with a red exclamation mark to run the query. This query groups the addresses using the methodology described in the *Fixed LRIC cost model documentation* and may take a long time to do for large ESAs or batches of ESAs. This could be broken down into several steps, e.g.

- run a make-table query to get addresses and co-ordinates within WAYM and place into a table

- add in two extra columns (data type Long) to the table and use an update query to populate them with the rounded multiples of the longitudes and latitudes

- Run a final group by query to group by the rounded longitudes / latitudes to obtain the aggregated capacity and average longitudes / latitudes for each location.

The query shown in Figure 3.11 results in output like that shown in Figure 3.12 below.

Figure 3.12:

Locations and demand for

the WAYM ESA [Source:

Analysys]

This data can then be copied by clicking 'Edit' → 'Select All' and then 'Edit' → 'Copy,' before pasting into Excel.

For the simpler case of obtaining merely the entries in the LDD relevant to an ESA, a simpler Select Query can be used, as shown below in Figure 3.13.

Figure 3.13:

Obtaining the entries in

the LDD that lie in the

WAYM ESA [Source:

Analysys]

This will simply provide the GNAF_PID, capacity and co-ordinates of each entry lying in WAYM.

4 Processing the location data for an ESA

This chapter describes the process required in order to process the locations for a single Exchange Service Area (ESA), from raw data, for the purposes of the geoanalysis and access network module. An analogous process can be run for completing batches of ESAs in this manner, although the calculation time will increase. This is particularly true for the mapping of locations onto the street network.

4.1 Data set requirements

The following data sets are required:

- Location and Demand Database (LDD), saved in Microsoft Access
- The complete set of G–NAF locations in the Microsoft Access database *GNAF.mdb*
- The tables AUS_ESA and AUS_EXCH from ExchangeInfo
- The table XXX_ST from StreetPro, for the street network of the state containing the ESA

The zone of the Map Grid of Australia co-ordinate system that the ESA lies in is also required (ESAs have all been identified as lying in zones 49-56).

4.2 Process

This section outlines the steps in the process required to generate a list of locations, with associated demand, using these data sources. The steps are summarised in below:
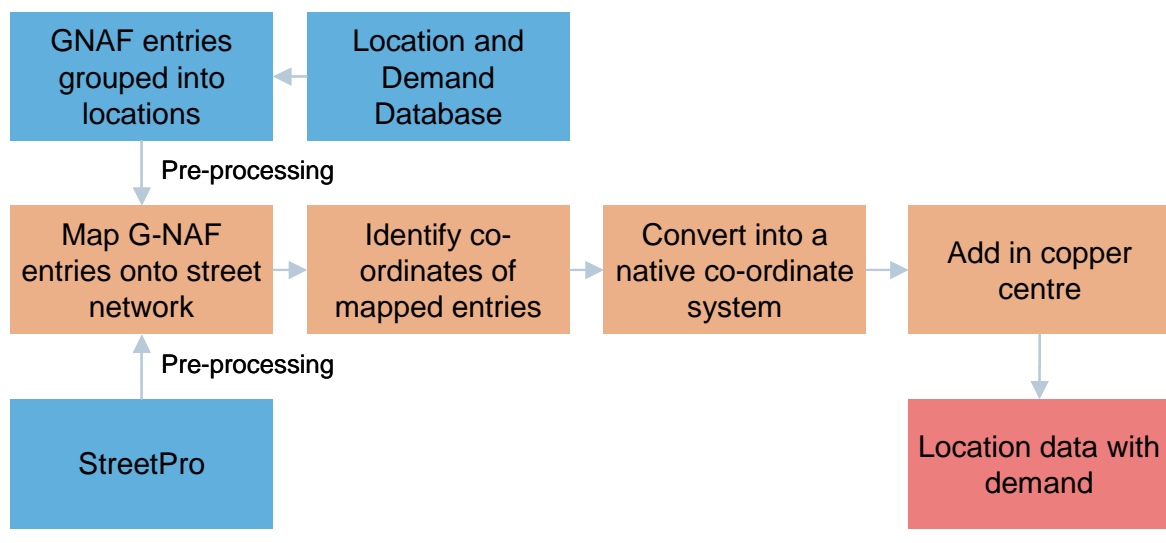
Figure 4.1:   Generating the location data [Source: Analysys]

The steps are as follows:

- preparing the G–NAF entries, as explained in section 4.2.1
- preparing the streets, as explained in section 4.2.2
- mapping the G–NAF entries onto the streets, as explained in section 4.2.3
- identifying the co-ordinates of the mapped points, as explained in section 4.2.4
- converting the co-ordinates into MapGrid of Australia, as explained in section 4.2.5
- adding in the copper centre location, as explained in section 4.2.6.

To demonstrate the process, we will go through the processes needed to generate the locations for the Waymouth ESA, the first ESA in our sample.

4.2.1 Preparation of G–NAF entries for the ESA

- Use a Select query within the LDD, as shown in Figure 3.11, to export the GNAF_PID, latitude, longitude and units of demand at each G–NAF entry which has been mapped to WAYM into an Excel workbook. This will aggregate G–NAF entries within ~3m of each other into a single location

- Open the Excel workbook and in MapInfo and save as a new table e.g. WAYMPt.

- Make the table mappable (with the 'Latitude/Longitude' co-ordinate system) and plot the G–NAF entries in this co-ordinate system.

4.2.2 Preparation of streets for the ESA

- Draw a 50m buffer around the ESA boundary for Waymouth contained in AUS_ESA from ExchangeInfo. Use this buffer object to ensure that all the necessary street is captured.

- Use an intersect query on the street network for the state containing the ESA (SA_ST for Waymouth) and the buffered ESA to identify the streets that intersect Waymouth.

- Save these streets in a separate table (e.g. WAYMSt), add a column and create a unique index (called, for example, StreetID) e.g. by updating the column using 'Tools' → 'Update Column' with *rowed*.

- Use the 'Split' function or ('Erase Outside' function) to identify the street segments that lie *within* the buffered ESA. The difference in street networks is shown below in Figure 4.2 for Waymouth.

Analysys

Figure 4.2:   Street line segments from StreetPro Display that (a) intersect WAYM and (b) actually lie within Waymouth [Source: Analysys]

4.2.3 Mapping the G–NAF points onto streets in the ESA

- Load the Distance Calculator on MapInfo and click 'Tools' → 'Distance Calculator' → 'Run Distance Calculator.' The screen that appears is shown in Figure 4.3.
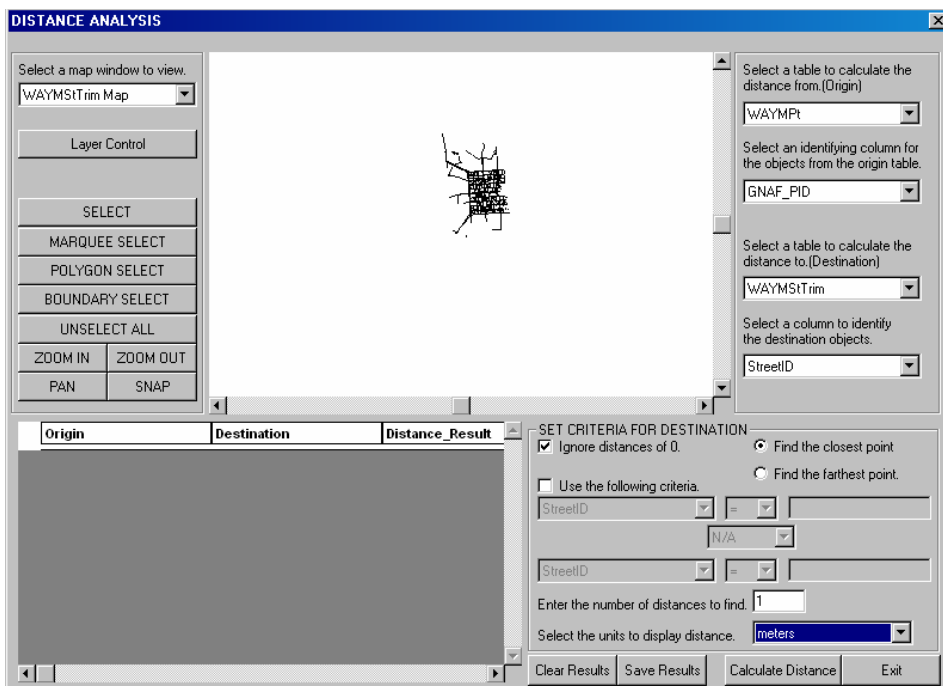
Figure 4.3:   Distance Calculator [Source: Analysys]

- Set the origin table to be the list of points (WAYMPt) and use 'GNAF_PID' as the identifier.

- Set the destination table to be the street file (WAYMSt) and use 'StreetID' as the identifier.

- Set the units to be metres and click 'Calculate Distance.' This will identify the nearest street edge in WAYMSt to each point in WAYMPt and join the two objects with the shortest edge possible. Save the file as a separate table: this new table must be called *Streeted*. This is required for the MapBasic file in section 4.2.4 (and transcribed in annex A) to work, although it can be saved as another name later.

4.2.4 Identifying the co-ordinates of the equivalent street point for each G–NAF entry

- Open the blank MapInfo table template SL.

- Use the MapBasic in Annex A: to identify the co-ordinates of the endpoints of each line: the first node is the original point and the second node is its street counterpart. These pairs of co-ordinates in the table SL. The format of SL must not be changed, or else the MapBasic file will not work.

- Save the table SL as a new file e.g. WAYMSL.

- Set the table as mappable (Latitude/Longiutde) and plot the street points.

- Add a new column (Integer data type) to the new table and use WAYMPt to update with the capacity of each entry.

4.2.5 Converting co-ordinates into Map Grid of Australia

- Add four new columns to the new table with the Float data type (called say GNAF_AMG_x, GNAF_AMG_y, St_AMG_x and St_AMG_y).

- Load the Co-ordinate Extractor tool and click 'Tools' → 'Co-ordinate Extractor' → 'Extract Co-ordinates': the following dialog box appears. For the case of WAYM, we would populate it as shown in Figure 4.4.
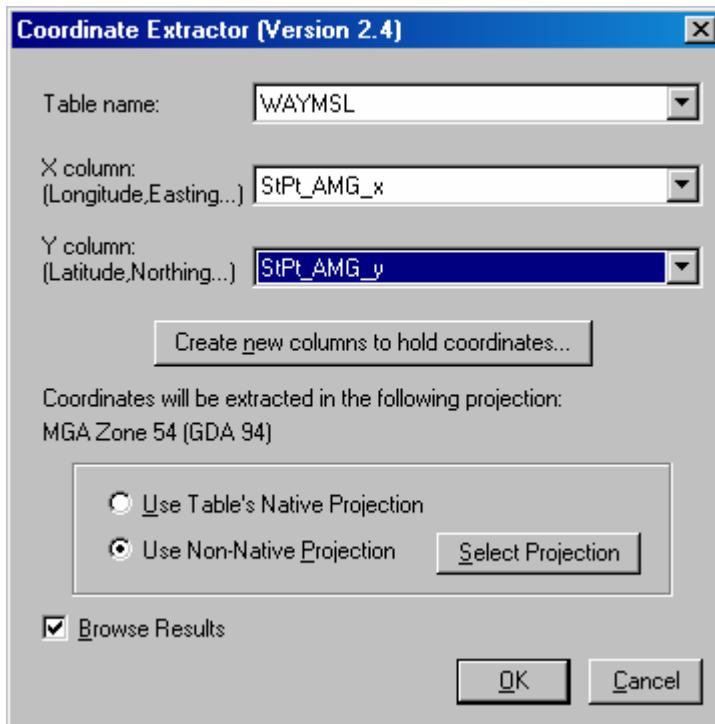
Analysys

Figure 4.4:
Co-ordinate Extractor
dialog box [Source:
Analysys]

- Select the X column and Y column to be StPt_AMG_x and StPt_AMG_y respectively.

- Select 'Use Non-Native Projection' and then click on 'Select Projection'.

- Select the relevant zone of the Map Grid of Australia (54 for WAYM).

- Click 'OK' and the tool will write the co-ordinates of the street points into StPt_AMG_x and StPt_AMG_y.

- This can be repeated for the G–NAF co-ordinates, by:

  – dropping the map
  – making the table mappable, again as the 'Latitude/Longitude' co-ordinate system and plotting the G–NAF points
  – clicking 'Tools' → 'Co-ordinate Extractor' → 'Extract Co-ordinates' again
  – selecting the X column and Y column to be GNAF_AMG_x and GNAF_AMG_y respectively
  – selecting the use of the same non-native projection as before and clicking 'OK'
  – the tool will write the co-ordinates of the original G–NAF points into GNAF_AMG_x and GNAF_AMG_y.

4.2.6 Adding in the copper centre

The one point not included is the copper centre for the ESA. This is copied in separately from a pre-calculated file which contains all copper centres mapped in all Map Grid of Australia zones.

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This means that the co-ordinates for the relevant zone can then be easily derived. We do not map this point on to the street: the G–NAF point and street point are assumed to be coincident.

4.3 Additional calculations

A by-product of mapping the locations onto the streets is that each has an associated line, with its endpoints defined by the averaged co-ordinates of the GNAF entries and the corresponding street point or final drop point (FDP). For each ESA in the sample, the data workbooks contain these endpoint co-ordinates in the Map Grid of Australia.

These lines allow us to define two additional quantities related to the final drop:

- average distance between the GNAF and FDP, by geotype
- average distance between the property boundary and the FDP, by geotype.

Their derivations are explained in more detail below.

4.3.1 Average distance between the GNAF and FDP

Doing a simple average of this distance across all the locations in our sample in a geotype is likely to lead to an over-estimate of this distance in geotypes using the rural deployment algorithm. This is because of the extremely remote locations served by wireless and satellite. Therefore, we have calculated the average using only those locations that are served by copper / fibre when the sample is calculated using crow-flies (also known as Euclidean) distance as the p-function.

4.3.2 Average distance between the property boundary and the FDP

In order to calculate these distances for each geotype, we use the same set of links from our sampled ESAs as used for deriving the average distance between the GNAF and the FDP.

In addition, we require the land parcels that lie within the boundaries of our sampled ESAs from CadastralPlus 2007. These land parcels are then used to isolate only those portions of the line segments that lie outside these land parcels, using the 'Object' → 'Erase' function in MapInfo. This is illustrated for a set of links below in Figure 4.5.[3]

---

[3]   Due to inconsistencies in the geographic data contained in the G–NAF, CadastralPlus and StreetPro, this process leads to a proportion of links being fully erased.
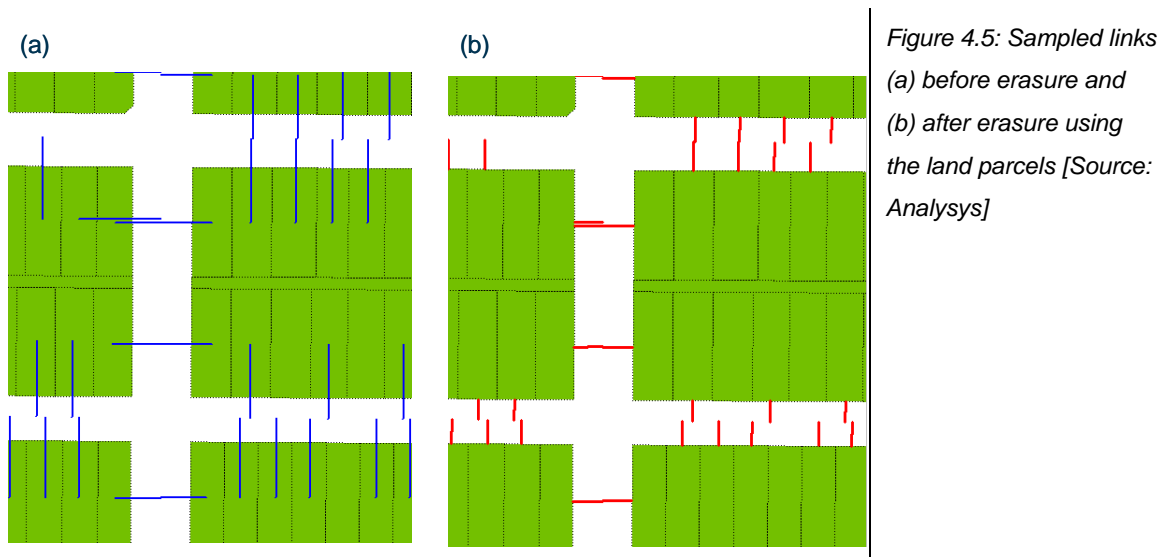
Analysys

Figure 4.5: Sampled links (a) before erasure and (b) after erasure using the land parcels [Source: Analysys]

The average distance between the property boundary and the FDP in a geotype is then estimated by the ratio of the total link length remaining for a geotype after the erasing process and the number of links within the geotype.

Values for Band 1, Band 2 and Band 3/4 and even a single value across all bands can be derived using the total lengths obtained from this methodology.

4.3.3 Using these additional calculations in the model

These two quantities are then used in the customer access network (CAN) module to define the average distances per location from:

- the network termination point (NTP) to the property boundary
- the property boundary to the FDP.

The latter is taken to be the second quantity. We estimate the former using the formula:

*Z * (average distance from GNAF to FDP – average distance from property boundary to FDP)*

where the value of Z is a single proportion calculated for all geotypes using information for Band 2 from the TEA model. Specifically:

- The lead-in cable lengths from the Band 2 model ESAs that we have sampled are used to estimate the average length of the lead-in for Band 2. We assume this average length is equivalent to our distance from the NTP to the FDP.[4]

---

4 ` This is because the Band 2 model deploys trench on one side of the street. Since properties are usually on both sides of the street, the average lead-in cable deployed would, on average, be equivalent to that deployed from our modelled trench network, which is deployed down the centre of the street.

![Analysys logo]

- We estimate the distance from the NTP to the property boundary for Band 2 by two methods:

(1) taking the difference of the distance derived from the Band 2 model and our average distance between the property boundary and the FDP derived in Band 2

(2) taking the difference of our average distance from G–NAF to FDP in Band 2 and our average distance between the property boundary and the FDP derived in Band 2

- We derive Z as the ratio of (1) divided by (2).

We do not think that it is reasonable to use Z=1, as this implies that the NTP lies at the G–NAF co-ordinates. These co-ordinates are normally placed at the centre of the land parcel, whereas in reality it is likely that the building (and hence NTP) would favour being closer to the property boundary adjacent to the street. The quantities used in our calculation of Z are summarised below in Figure 4.6.
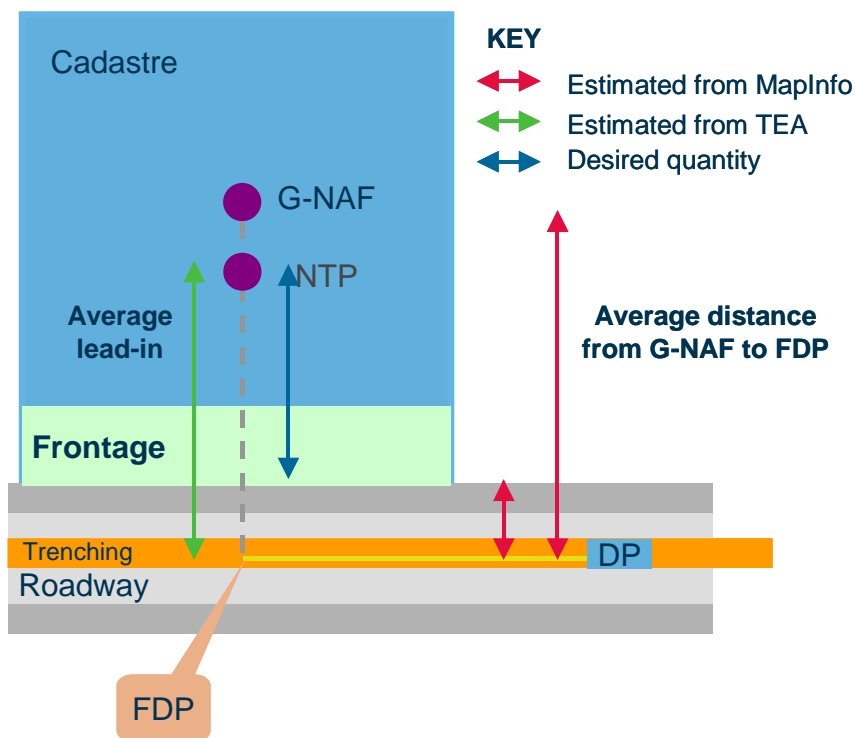
Figure 4.6: Quantities estimated using the Band 2 model and MapInfo [Source: Analysys]

5   Updating the sample of ESAs

As is discussed in the *Fixed LRIC cost model documentation*, a sample of 200 out of the 5070 ESAs have been processed and the network elements required to serve the locations have been calculated within the geoanalysis and access network module. It may be that the sample is revised in the future. New ESAs may be sampled, or the sample size may be increased.

This section goes through the steps required to include another ESA within the sample. This process is extendable to batches of ESAs. Let us assume that the geotyping has not been revised but the sample size has been increased and we need to add a fifth ESA to the second geotype (geotype 1 is already a census).

There are basically four steps:

- Identify the ESA using *Sampling workbook.xls*, as described in section 5.1.

- Process the location data, as described in section 4 and 5.2.

- Add in a worksheet (called ESA.G2.5) of the same format as those for all other ESAs into workbook *Access – DATA G2.xls*, which is the relevant workbook in the data sub-module, as described in section 5.3.

- Insert a row below that for ESA 2.7 on the *Summary* worksheet in the workbook *Access – CODE.xls*, which is the code sub-module, and update the indices, as described in section 5.4.

5.1   Identification of the ESA

In order to update the sample of ESAs, the workbooks for the geotyping (*Geotyping road per GNAF location.xls*) and sampling (*Sampling workbook.xls*) should usually need to both be open. However, in this case this is not necessary, since the geotyping has not been revised.

On the *2ESA.to.sample* sheet in *Sampling workbook.xls*, you can click on the button "*Copy and paste ESAs by geotype and then generate sample*". This will update the sample. Again, this is not really necessary in this case since the geotypes have not been revised. If the sample size has been explicitly edited in *Sampling workbook.xls* to have geotype 2 needing five ESAs, then the identity of the fifth ESA will be in the summary table.

5.2   Processing location data

This is described in section 4. Refer to section 6 for how to handle the ESA if it has multiple copper centres. For now, we will assume that it has one. Obtain the co-ordinates of the copper centre as well.

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5.3 Updating the DATA sub-module

- In *Access – DATA G2.xls*, take a copy of one of the worksheets (e.g. *ESA.G2.4*) that all sampled ESAs are based on. Rename it as *ESA.G2.5*. Delete any named ranges local to this new worksheet.

- Replace the suffix on all named ranges to be 'ESA.G2.5' and revise all of these named ranges: this can be automated by a macro.

- Add in the ESA index (2.5) ESA code, geotype ULLS Band, AMG Zone, and state into the relevant cells in the range C7:C12.

- Copy the location data for the copper centre into cells C37:F37 and set C11 to be 1 (i.e. the first location is that of the RAU). Assign a nominal capacity of 1 in G37 for the purposes of the deployment algorithms.

- Copy the data for the remaining locations into columns C-G, starting in row 38.

- Copy the formula in cell B38 to the bottom of the list in order to give the list an index. Do the same for the formula in cell I37, which enables the pillar index to be calculated after the network deployments have been derived.

5.4 Updating the CODE sub-module

- Open the workbook *Access-CODE.xls*. On the *Summary* sheet, insert a row between ESAs 2.4 and 3.1.

- Copy the external links for ESA 2.4 from cells F27:H27 and M27:DO27 and paste into the new row: replace the suffixes G2.4 with G2.5 in each case.

- Renumber the ESAs 1-220 rather than 1-219 in column B, so the 8th ESA is now 2.5 rather than 3.1.

- N.B. Provided the indices are renumbered in column B, the row for an ESA can be equivalently removed from this list as well.

6   Handling ESAs with multiple copper centres

If an ESA contains multiple copper centres, then we currently use a Voronoi construction in MapInfo to split the ESA into sub-areas each served by exactly one copper centre. This construction must be done for one ESA at a time, so that it does not self-interfere. Using AUS_ESA and AUS_EXCH from ExchangeInfo, two small tables should be saved; one containing just the ESA and the other just containing the copper centres lying within the ESA.

The Voronoi construction does not work with only two points, so for the case of two copper centres in one ESA, the approach is to add in extra points in a large square around the two copper centres. This has the effect of allowing the Voronoi to be built without destroying the construction around the two original copper centres, as shown below in Figure 6.1.
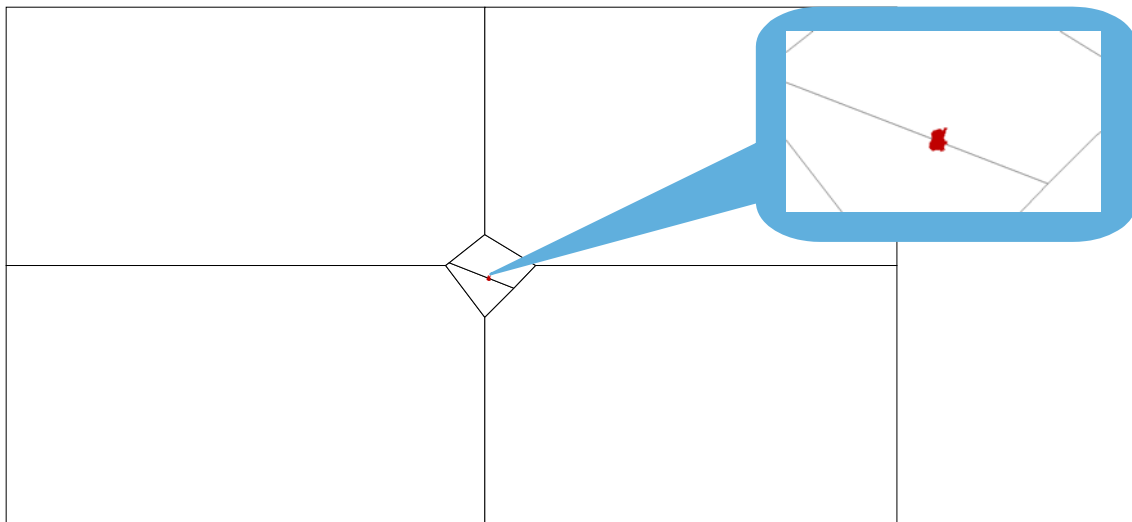
Figure 6.1:   Illustration of a large Voronoi around the ADLE ESA [Source: Analysys]

Having split the copper centre using the Voronoi construction, the locations for the ESA (processed as described in section 4) are then allocated to the sub-ESA that they lie in. This is illustrated by the final allocation of locations for the two subdivisions of the ADLE ESA, as shown below in Figure 6.2.
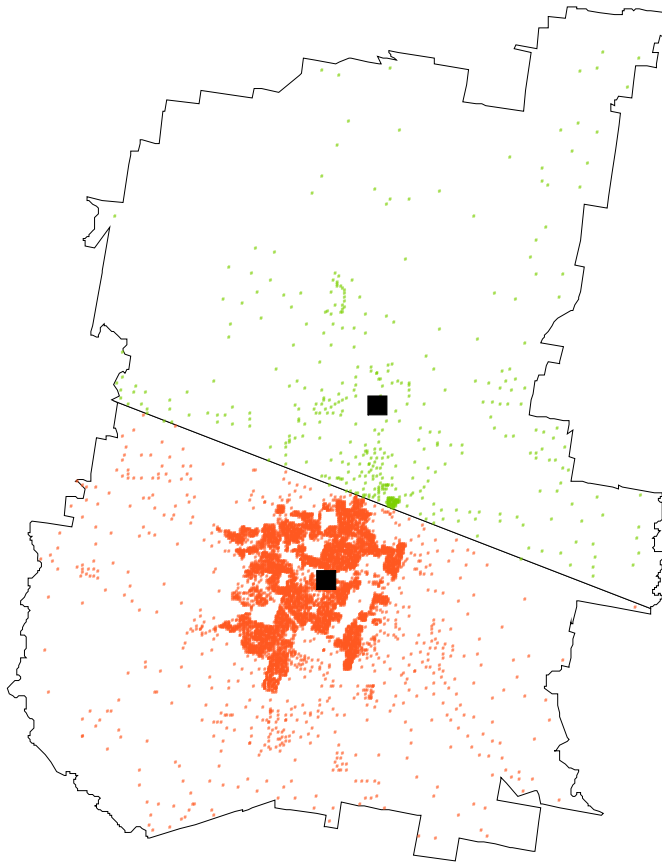
Figure 6.2:

Locations within the two ADLE sub-ESAs: the black squares are the two copper centres [Source: Analysys]

It is possible to automate this process using MapBasic in order to do batches of ESAs in this way.

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7 Calculating cable gauge distributions

The LRIC model captures the deployment of multiple copper cable gauges (0.4mm, 0.64mm and 0.9mm) in the access network in order to satisfy line performance requirements. As stated in the *Fixed LRIC model documentation*, we have used the outputs of the geoanalysis and access network module to calculate the distribution of gauges that can be used in order to satisfy the constraints of ADSL and/or voice where appropriate.

We have calculated the distributions separately for cable deployed between:

- locations and their node (the Distribution network)
- pillars and their parent RAU (the Main network).

The proportion of each cable gauge deployed is calculated by geotype in the workbook *Cable gauge determination.xls*. This workbook is structured as shown below:
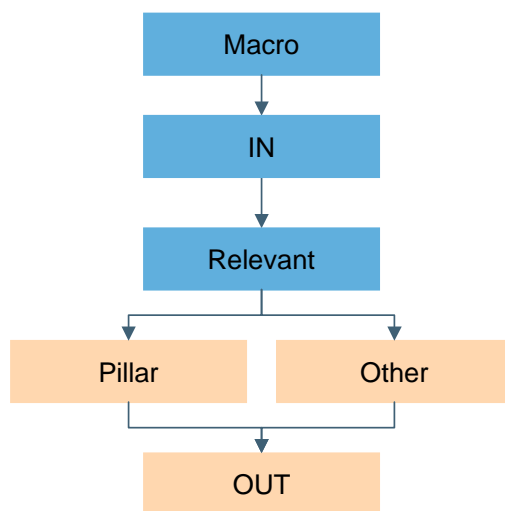
Figure 7.1:
Structure of Cable gauge determination.xls [Source: Analysys]

- The 'Macro' worksheet contains the button which can automatically extract the necessary outputs from the Access DATA workbooks in the geoanalysis and access network module.

- The 'IN' worksheet contains the outputs extracted from the Access DATA workbooks.

- The 'Relevant' worksheet contains the columns required from the table on the 'IN' worksheet.

- The 'Pillar' worksheet calculates the mix of gauges used by copper clusters served by pillars.

- The 'Other' worksheet calculates the mix of gauges used by copper clusters served by RAUs or LPGS

- The 'OUT' worksheet contains the outputs to paste into the Cost module.

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If changes are made to the geoanalysis and access workbooks which lead to different copper cable lengths being calculated, then it is likely that the distribution of cable gauges should be recalculated.

The remainder of this section is set out as follows:

- Section 7.1 outlines how to refresh the 'IN' and 'Relevant' worksheets from the 'Macro' worksheet.
- Section 7.2 outlines how to refresh the data in the 'Pillar' worksheet, as well as the key parameters and calculations.
- Section 7.3 outlines how to refresh the data in the 'Other' worksheet, as well as the key parameters and calculations.
- Section 7.4 describes the key outputs displayed on the 'OUT' worksheet.

7.1 'Macro,' 'IN' and 'Relevant' worksheet

This workbook contains a button entitled "Paste in node data". Pressing this button runs a macro to import all of the output tables entitled "Assets volume by pillar" from the Access - DATA workbooks in the geoanalysis and access network module. This "Assets volume by pillar" tables list asset volumes by access node (pillar, RAU, LPGS, BTS etc.). A selection of columns from these tables are then pasted onto the 'IN' worksheet.

In order to run the macro to completely refresh the data on the 'IN' and 'Relevant' worksheets:

- Open *Cable gauge determination.xls*
- Ensure that the Access CODE and Access DATA workbooks are in the same directory and that the Access CODE workbook is open
- On the 'Macro' worksheet in *Cable gauge determination.xls, s*et F24 to be 1 and set F25 to be 219
- Press the button "Paste in node data".

After pasting in the data from the Access DATA workbooks onto the 'IN' worksheet, the macro then also pastes in the necessary columns of data onto the 'Relevant' worksheet and converts all lengths into kilometres. These columns on the 'Relevant' worksheet contain information on the:

- parent ESA and geotype (columns C and B respectively)
- node type (column D)
- DP-pillar sheath length (column E)
- pillar-RAU sheath length (column F)
- maximum loop length from the FDP to the RAU in the cluster (column G).

In order to update the data in the 'Pillar' and 'Other' worksheets, the entries required from the table on the 'Relevant' worksheet can be identified using a filter. A filter can be activated on this

table by selecting cells B3:G3 on the 'Relevant' worksheet and clicking Data→Filter→Autofilter. The necessary filters are described in sections 7.2 and 7.3 respectively.

7.2 'Pillar' worksheet

The purpose of this worksheet is to test several combinations of gauge for each pillar cluster in the table, from our sampled ESAs, to ascertain which combination can serve the pillar, satisfying line performance requirements for ADSL or voice services.

Having calculated the appropriate combination of gauge for each cluster, we can then estimate distributions of gauge requirements for each geotype based on these sampled pillar clusters. In order to update the data for columns B-G of the 'Pillar' worksheet:

- delete the old data in columns B-G of the 'Pillar' worksheet
- activate the filter on the 'Relevant' worksheet and specify where column D equals "pillar."
- copy the values of these rows
- select cell B11 on the 'Pillar' worksheet and paste values.

For each pillar, we then test several combinations of gauge for main and distribution cable to see whether they could be used to serve the pillar for either ADSL or voice and satisfy line performance requirements. The combinations are tested on the longest loop in the cluster in the following order:

Test	Distribution cable (Copper sheath within pillar cluster)	Main cable (Pillar-RAU copper sheath)	Performance	Column on worksheet
1	0.4mm	0.4mm only	ADSL	Q
2	0.4mm	0.4mm and 0.64mm	ADSL	R
3	0.4mm	0.64mm and 0.9mm	ADSL	S
4	0.64mm	0.64mm and 0.9mm	ADSL	T
5	0.9mm	0.9mm	Voice	U

Figure 7.2: Sequence of combinations of gauges tested [Source: Analysys]

The combination used is the first that, for the longest loop, gives a signal loss below 59.39dB (at 300 KHz) for tests 1–4 (equivalent to being able to provide ADSL), or below 45.45dB (at 40 KHz) for test 5 (equivalent to being able to provide voice). Tests 1-4 are equivalent to testing for the ability of the cable to supply ADSL services whilst 0.4mm or 0.64mm cable can be deployed within the pillar cluster.

For the successful combination, the mix of cable gauges used for the pillar–RAU sheath are then calculated, assuming that the length of the larger gauge in the main cable is minimised.

We assume that the loss per kilometre for the gauges are as follows:

Gauge (mm)	Loss per km for ADSL (dB)	Loss per km for voice (dB)
0.40	13.81	8.25
0.64	8.62	4.03
0.90	6.36	2.48

Figure 7.3: Types of cable deployed [Source: ACIF C559:2006 Unconditioned Local Loop Service (ULLS) Network Deployment]

This calculation is best demonstrated by an example. Suppose a pillar is connected to the RAU with a cable that is 7.49km long, and that the maximum loop length for the cluster is 8.52km. The maximum loop length back to the pillar is then 1.03km. The tests then give the following results:

- **Test 1:** The signal loss assuming only 0.4mm gauge is 117.6dBm, which is too high for ADSL
- **Test 2:** The lowest signal loss assuming 0.4mm gauge within the pillar cluster and 0.4mm/0.64mm gauge back from pillar to RAU is 78.7dBm, which is too high for ADSL
- **Test 3:** The lowest signal loss assuming 0.4mm gauge within the pillar cluster and 0.64mm/0.9mm gauge back from pillar to RAU is 61.8dBm, which is too high for ADSL
- **Test 4:** The lowest signal loss assuming 0.64mm gauge within the pillar cluster and 0.64mm/0.9mm gauge back from pillar to RAU is 56.5dBm, which is sufficiently low for ADSL.

Hence, the longest loop length must be served with 0.64mm gauge within the cluster and a mixture of 0.64mm and 0.9mm gauge back from the pillar. We can then solve the inequality below, for the longest loop, to calculate the smallest length D of 0.9mm cable required back from the pillar:

59.39 ≥ Loop loss from FDP to pillar + loop loss on 0.9mm cable + loop loss on 0.64mm cable

$$59.39 \geq (8.62 \times 1.03) + (6.36 \times D) + (8.62 \times (7.49\text{-}D))$$

which solves to give $D \geq 6.21$km. Therefore, 6.21km of 0.9mm gauge and 1.28km of 0.64mm gauge cable are required for the pillar–RAU sheath in this case.

These sheath lengths by gauge, for both the cable within the pillar clusters and back from the pillar, are calculated for all of the pillar clusters from our sampled ESAs. These lengths are then aggregated by gauge and geotype.

7.3 'Other' worksheet

The purpose of this worksheet is to test several combinations of gauge to be used within each RAU/LPGS cluster in the table, from our sampled ESAs, to ascertain which combination can serve the cluster, satisfying line performance requirements for ADSL or voice services.

Having calculated the combination of gauge for each cluster, we can then estimate distributions of gauge requirements for each geotype based on these sampled clusters.

Analysys

In order to update the data in columns B-G of this worksheet:

- delete the old data in columns B-G of the 'Other' worksheet
- activate the filter on the 'Relevant' worksheet and specify where column D either equals "RAU" or contains the phrase "LPGS".
- copy and paste the values of these rows
- select cell B11 on the 'Other' worksheet and paste values.

For each cluster on this worksheet, we test each type of gauge in ascending order of size as to whether it can be used to serve the longest copper loop in the pillar cluster with sufficiently low signal loss. The smallest gauge that can serve the longest loop is then deployed within the cluster. We test 0.4mm and 0.64mm gauge on the basis of ADSL signal loss constraints and 0.9mm gauge on the basis of voice signal loss constraints.

The total sheath by gauge and geotype is then calculated.

7.4 'OUT' worksheet

The final values of total sheath length by gauge and geotype are linked in from both the 'Pillar' and 'Other' worksheets. This allows the distributions by gauge and geotype to be calculated separately for the distribution sheath within clusters and the main sheath back from the pillar.

The distribution of the main cable sheath back from the pillars should be pasted into cells E87:G100 on the 'UnitCost.Access' worksheet. The distribution of the distribution cable sheath within a cluster should be pasted into cells I87:K100 on the 'UnitCost.Access' worksheet.

8 Evaluation of access and core network overlap

This section outlines the process by which Analysys has determined the level of overlap between the modelled access and core network routes, i.e. the degree to which access and core network routes are deployed in the same trench.

In order to do this, Analysys has mapped the core links between each level in the network (local exchange (LE), point of confluence (PoC), local access switch (LAS), transit network switch (TNS)) using the road and railway network in Australia.

A network analysis tool called RouteFinder[5] has then been used to generate the shortest distances between nodes using actual routes, using the MapInfo StreetPro dataset for roads and railways as the underlying route network. Using this method, the LE–POC minimum spanning trees, PoC rings, LAS rings and TNS rings were plotted.

The remainder of this section describes the processing completed in MapInfo to:

- prepare the street network in StreetPro
- map the core network routes
- define the access network
- complete the overlap analysis itself.

8.1.1 Preparation of the street network

To map the physical trench routes required for the core network, Analysys has used the MapInfo StreetPro Australia network map together with the route plotting software, RouteFinder. In order to ensure that the StreetPro Australia map files were in an appropriate format usable by RouteFinder, pre-processing was required.

The pre-processing comprised two stages:

- Firstly, the StreetPro dataset was filtered in order to reduce the number of routes under consideration in order to enable reasonable computation times

- Secondly, the StreetPro dataset was processed in order to convert it into a format usable by RouteFinder.

---

[5] The standard version of RouteFinder was used (http://www.routeware.dk/routefinder/routefinder.php).

Analysys

Filtering of the StreetPro dataset

Analysys has processed these routes using a subset of the MapInfo StreetPro network data as supplied by MapInfo. This dataset contains road and railway data, classified under a number of different types:

Road type	Road description	Included in analysis
301	Freeways	YES
300	Highways	YES
302	Main roads	YES
303	Local connector roads	YES
304	Sealed roads	YES
305	Unsealed roads	NO (some segments restored)
306	Unsurveyed roads/tracks	NO
307	Restricted access (bus lanes	NO
308	Private roads (permitting public access)	NO
400	Mall/Pathways/Pedestrian Access	NO
9301/9302	Tunnels – Freeway / Main Road	YES
999	Dual carriage crossover	YES
8301 / 8400	Ferry routes – Vehicular / Passenger	NO

Figure 8.1: Road types, description and counts
[Source: Analysys]

Based on the premise that, under a realistic deployment strategy, core network trenches will not be deployed along very small roads (which tend not to be as direct as larger main roads), Analysys filtered the StreetPro dataset to exclude roads smaller than '304' roads).

There have been a couple of exceptions to this filter:

• In the case of the Northern Territories (NT), all road segments within StreetPro that lie within this state have been used in the calculations

• Although unsealed road ('305' roads) has been removed, some of this road has been restored to the road network in order to improve the coverage. This is because in states such as New South Wales, Southern Australia and Western Australia, a significant proportion of the road is unsealed. This unsealed road has been restored based on visual inspection.

The road network has been put together into both a nationwide file and individual files by state.

Analysys

Conversion into a format usable by RouteFinder

In order to use the StreetPro road and railway maps in RouteFinder, the polyline street data needs to be pre-processed. The functions outlined in the table below are used in the stated order:

Function	Purpose	
Snap	Removes duplicate records	
Buffer	Buffers the road network to use as a cutting tool	*Figure 8.2: MapInfo functions used in the pre-processing of the street network [Source: Analysys]*
Split	Split the original road network using the buffered road network	
Disaggregate	Divides up roads into the split-up segments	
Snap	Joins the roads together where they had been split apart	

The purpose of these functions is shown in the diagram below, and is followed by an explanation of how to implement them in MapInfo.

'SNAP' function

(A) Original street network (nodes identified by grey circles). Segments are snapped in order to remove duplicate street segments

'BUFFER' function

(B) 0.5m buffers are generated around the original street network segments

'SPLIT' function

(C) The buffers are used to split the original street network at intersections (where the buffers intersect the original street network) – this generates additional nodes

'DISAGGREGATE' function

(D) Street network is disaggregated generating individual segments between the nodes – this allows intersections to be recognised by RouteFinder

'SNAP' function

(E) The network is subsequently snapped in order to removed the multiple nodes at the street intersections. The intersections in the street network can now be used by RouteFinder
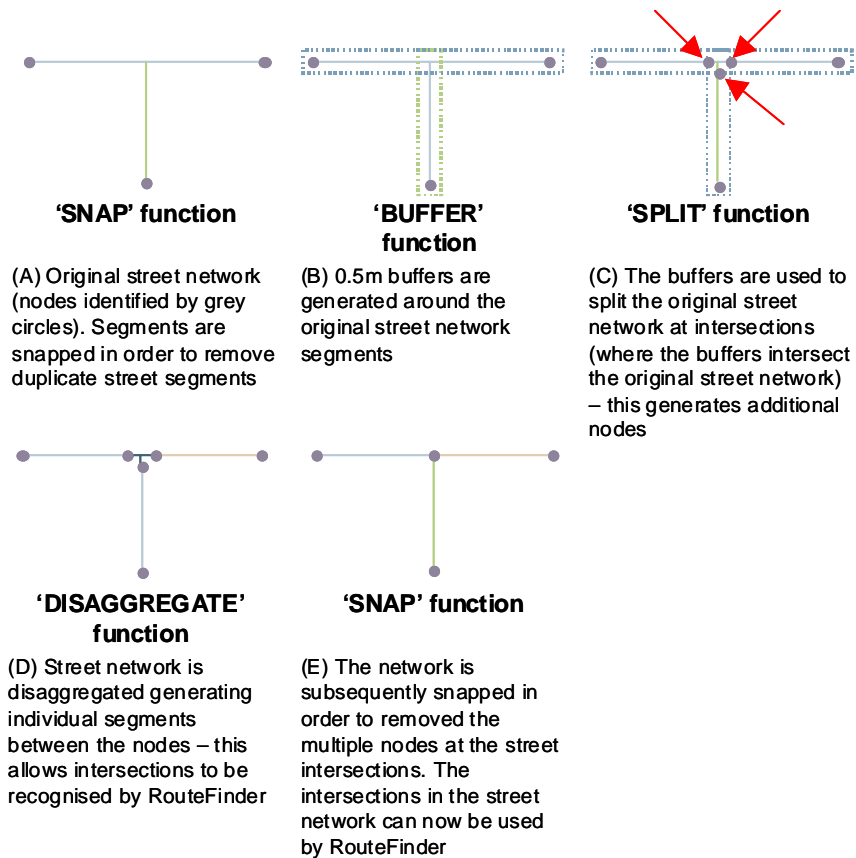
Figure 8.3:   Process used to prepare the StreetPro network for RouteFinder [Source: Analysys]

Having isolated the street network for the state and saved it as a table (named, for example, as *TAS304RdRl.TAB* for the road and railway network, including 304 road segments, for Tasmania), the line segments are pre-processed by the following steps:

- Select *TAS304RdRl.TAB* as editable in the Layer Control window

- Select all the objects in *TAS304RdRl.TAB* and click 'Objects'→ 'Snap/Thin,' check 'Enable Node Snap,' [at 0.1m] and click OK. This function ensures any duplicate records are removed (Figure 8.3 – diagram A)

- Select 'Table'→ 'Buffer' and buffer the individual objects at 0.5m. This generates a second dataset that is the buffered version of the original. This buffered dataset may, for example, be named as *TAS304RdRl_buffered.TAB* and is used to split up the original street network at each of the street intersections (Figure 8.3 – diagram B)

- The buffered street network for certain states will need to be sub-divided into separate sub-regions, otherwise the street network is too complicated for MapInfo to process the subsequent 'Split' command. In order to sub-divide the buffered states, a shape is drawn on the Cosmetic Layer, which is used to divide the street network. This shape generates nodes on either side of the street segments that intersect the shape. An SQL query is used to determine all of the street segments that are located *within* the shape. This first selection is saved, for example as *TAS304RdRl_buffered_1.TAB*. The selection is inverted (to select all those road segments outside of the shape). This second selection is saved, for example as *TAS304RdRl_buffered_2.TAB*. Following this method, the buffered layer is split into multiple sub-selections

- Select all the objects in *TAS304RdRl.TAB* again and click 'Objects'→ 'Set Target'

- Select all the objects in *TAS304RdRl_buffered.TAB* and click 'Objects' → 'Split'. This splits the original street network at each of the street intersections using the buffered street network (Figure 8.3 – diagram C)

- Select all the objects in *TAS304RdRl.TAB* and click 'Objects' → 'Disaggregate.' This breaks up the polylines into multiple lines at each of the splits (Figure 8.3 – diagram D)

- Select all the objects in *TAS304RdRl.TAB* and click 'Objects' → 'Snap/Thin,' check 'Enable Node Snap,' (at 0.6 metres) and click 'OK.' This function ensures any small breaks in the roads at junctions are filled (Figure 8.3 – diagram E)

- Create a new field (as a integer) in *TAS304RdRl.TAB* called 'Speed' and update the field to take the same value everywhere. This information is simply required by RouteFinder[6]

- In order to use the table in RouteFinder, *TAS304RdRl.TAB* is opened in MapInfo and click 'RouteFinder' → 'Create Network' and select *TAS304RdRl.TAB*. When asked to select an attribute field, select the field 'Speed'

The "Exact routes" function needs to be selected in RouteFinder.

---

[6] RouteFinder can bias its analysis based on the relative speed of routes. Setting all values of 'Speed' to the same value means the evaluation of routes is only distance-based.

Analysys

8.1.2 Mapping of the core network routes

Analysys has mapped the physical core network routes onto the actual Australian road and railway network for each of the core network levels.

When mapping the core nodes onto the StreetPro network, RouteFinder translates the nodes to the nearest road segment. This translation means where a node does not exactly sit on a route, a small distance may be missed for each node. This distance can be calculated for each node using the Distance Calculator tool in MapInfo. These additional lengths are accounted for in the overlap analysis.

8.1.3 Definition of the access network

In the geoanalysis and access network module, only a sample of ESAs (200 in total) in Australia were modelled. This overlap analysis requires that consideration be taken of the access network within every ESA. Consequently, Analysys has defined a proxy access network area using two measures:

- The built-up area (BUA) layer shape from the StreetPro Australia dataset – this is MapInfo's generalised representation of areas with a relatively high level of infrastructure

- A 4km-radius buffer around each local exchange copper centre location – this is Analysys's current assumption on what would be a reasonable distance to expect sufficient CAN trench deployment to support inter-exchange network (IEN) network. It equates to a distance where copper easily supports an access network. A sensitivity analysis has been performed on this parameter as it has a significant impact on the trench sharing percentage result

These areas form a shape against which the network routes for the different levels in the core network are assessed.

8.1.4 Overlap analysis

IEN overlap

The overlap of the IEN routes allows the determination of how much core distance is incremental. There are two sets of incremental distances that need to be considered. Trench may be shared at

- an *intra* core network level, for example, parts of the LE–PoC pathways may be deployed along the same route, therefore could share trench

- *inter* core network levels, for example, parts of the PoC–LAS rings may be deployed along the same routes as LE–PoC routes.

Consequently, in order to calculate the total incremental core trench required, the following process was followed:

- Double-counting of trench length within the actual routes for each network level are removed using the 'Snap' MapInfo function. This double-counting is that associated with intra-level trench sharing. The length of the non-overlapping trench can then be calculated using the MapInfo 'ObjectLen()' function

- The LE routes were buffered by 0.5 metres (using the 'Buffer' function in MapInfo). These buffered routes are then used to remove any of the PoC routes that are within the LE-route shape using the 'Erase' function, i.e. it is used to remove the PoC routes that are deployed in the same trench as the LE routes. The length of the incremental PoC trench is subsequently calculated using the MapInfo 'ObjectLen()' function.[7]

  - The incremental PoC file is saved (for subsequent overlay analysis with the access network)

  - The incremental PoC routes are subsequently buffered by 0.5 metres and added to the LE-route file using the 'Append Rows to Table' command

  - This process is repeated for the LAS and TNS routes.

CAN–IEN overlap

In order to determine the overlap of the core network with the access network, each incremental core network level was compared against the proxy access network shape – the shape of the proxy access network was removed from the incremental core network route using the 'Erase' function to determine the distance of the incremental core network outside of the access network.

The level of trench that is shared with the access network is calculated as the difference between the original incremental trench distance and the resultant incremental trench distance.

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[7]   Note: the PoC route table needs to be packed (to remove blank rows), and the Update Column command used to calculate the revised segment distances.

Annex A: MapBasic code for identifying street points

This annex contains the MapBasic code written in order to automate identification of the co-ordinates of the G–NAF entries having been mapped onto streets, as described in section 4.2.4.

The MapBasic file containing this code can be run once the files are open as required by double-clicking on the .MBX file.

A.1 Requirements

The code assumes that the set of lines created by the Distance Calculator has been saved under the name *Streeted.TAB*, which is open. It also assumes that a blank table called *SL.TAB* is also open in MapInfo and contains the fields described in Table 8.1 below:

Field name	Data type
AMG	Integer
ESACode	Character(6)
GNAF_PID	Character(20)
StreetID	Integer
Distance	Float
Unit	Character(6)
GNAFLong	Float
GNAFLat	Float
StPtLong	Float
StPtLat	Float

Table 8.1: List of fields in SL.TAB [Source: Analysys]

A.2 Code transcript

```
Include "MapBasic.DEF"

Dim f1x as float
Dim f1y as float
Dim f2x as float
Dim f2y as float
Dim nodeID as integer
Dim strlinefile as string
Dim strpointfile as string
Dim numnodes as integer
Dim objtype as integer
Dim Objectobj as Object
```

```
Dim strGNAFPID as string
Dim iStreetID as Integer
Dim flDistance as Float
Dim strunit as string
Dim strESAcode as string
Dim lcoordsys as integer

nodeID =0
strESAcode=""
lcoordsys =0
strlinefile = "Streeted"

strpointfile = "SL"
Map from strlinefile
Set CoordSys Earth Projection 1, 33

Fetch First From strlinefile

        Do While Not EOT(strlinefile)

                Objectobj = Streeted.obj
                objtype = ObjectInfo(Objectobj ,OBJ_INFO_TYPE)

                    If objtype=OBJ_PLINE then
                            numnodes = ObjectInfo(Objectobj , OBJ_INFO_NPNTS)

                    If numnodes =2 Then

                            strGNAFPID = Streeted.Origin
                            iStreetID = Streeted.Destination
                            flDistance = Streeted.Distance_Result
                            strunit = Streeted.Distance_Unit

                            nodeID=nodeID+1
                            f1x= ObjectNodeX(Objectobj , 1,1)
                            f1y= ObjectNodeY(Objectobj , 1,1)
                            f2x= ObjectNodeX(Objectobj , 1,2)
                            f2y= ObjectNodeY(Objectobj , 1,2)

                            Insert Into strpointfile
                            Values(lcoordsys,    strESAcode,    strGNAFPID,    iStreetID,
flDistance, strunit, f1x,f1y,f2x,f2y)
```

Analysys

```
                    If nodeID Mod 50000 = 0 Then
                            Commit Table strpointfile Interactive
                    end if
                    end if
            end if
    Fetch Next From strlinefile


    Loop


Close Table strlinefile Interactive
Drop Map strpointfile
Create Map For strpointfile CoordSys Earth Projection 1, 33
Update strpointfile set obj = createpoint (StPtLong, StPtLat)
Map From strpointfile
```