The Geographic Information System modelling environment for the Unbundled Copper Local Loop and Unbundled Bitstream Access services final pricing principle

Purpose

1. The purpose of this document is to further describe the production environment (datasets, computations, software and processes) used to create the road and building (R&B) network model.

2. The R&B network model generates the base tables for TERA's UCLL Access database to enable dimensioning calculations to be performed.

3. It is assumed the reader has a good understanding of Access databases and geospatial techniques.

The GIS datasets used

4. The following datasets are used to create the R&B network:

    a. Corelogic Road Network (Refer to section 3.2.1 of the June 2015 TERA Model Specification document).

    b. Chorus Exchange Points

    c. Chorus Street Cabinet Points

    d. Corelogic Address Points were used as a proxy for building location points.

5. Details of these datasets are described in other documents (Refer to section 3.1 of the June 2015 TERA Model Specification document).

The computer platform

6. All calculations were undertaken on standard desktop computers running either Windows 7 Professional SP1 (32 bit) or Windows 8.1 Enterprise (64 bit).

The software programmes and tools used

7. The software used for the calculations incorporated open source geospatial toolkits, used widely through-out public and private organisations.

    The following version of software were used:

- *Microsoft Access Version 14.0.7151.5001 (32 bit)*

- *QGIS 2.8.1-Wien*

  Site: *http://www.qgis.org*

QGIS version	2.8.1-Wien	**QGIS code revision**	exported
Compiled against Qt	4.8.5	**Running against Qt**	4.8.5
Compiled against GDAL/OGR	1.11.2	**Running against GDAL/OGR**	1.11.2
Compiled against GEOS	3.4.2-CAPI-1.8.2	**Running against GEOS**	3.4.2-CAPI-1.8.2 r3921
PostgreSQL Client Version	9.2.4	**SpatiaLite Version**	4.1.1
QWT Version	5.2.3	**PROJ.4 Version**	480Q
Scintilla2 Version	2.7.2		

- *Spatialite Version 4.1.1*

Site: http://www.gaia-gis.it/gaia-sins

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SpatiaLite version ..: 4.1.1    Supported Extensions:
    - 'VirtualShape'      [direct Shapefile access]
    - 'VirtualDbf'        [direct DBF access]
    - 'VirtualXL'         [direct XLS access]
    - 'VirtualText'       [direct CSV/TXT access]
    - 'VirtualNetwork'    [Dijkstra shortest path]
    - 'RTree'             [Spatial Index - R*Tree]
    - 'MbrCache'          [Spatial Index - MBR cache]
    - 'VirtualSpatialIndex' [R*Tree metahandler]
    - 'VirtualXPath'      [XML Path Language - XPath]
    - 'VirtualFDO'        [FDO-OGR interoperability]
    - 'SpatiaLite'        [Spatial SQL - OGC]
PROJ.4 version ......: Rel. 4.8.0, 6 March 2012
GEOS version ........: 3.4.0dev-CAPI-1.8.0 r3826
LWGEOM version ......: 2.0.3
SQLite version ......: 3.7.17
SQLite version 3.7.17 2013-05-20 00:56:22
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- *Spatialite network*

  Site: https://www.gaia-gis.it/spatialite-2.3.0/spatialite-network-2.3.0.html

- *spatialite_gui V 1.7.1*

  Site: *http://www.gaia-gis.it/gaia-sins*

Modelling the road and building network

8. The purpose of R&B network modelling is to generate the base tables for the Access database to enable the dimensioning calculations to be performed.

9. The design of the R&B network model and associated derived path required:

    a. In the copper network, each street cabinet to be connected, via the road network, to the nearest exchange avoiding, where practical, private roads and motorways.

b. In the copper network, each road segment to be connected, via the road network, to the nearest street cabinet or exchange avoiding, where practical, private roads and motorways.

c. In the fibre network, each road segment to be connected, via the road network, to an exchange. The exchange a road segment is connected to is the exchange that it would be connected to in the copper network, whether it would be directly connected or via a street cabinet. The shortest path road segment to the exchange is calculated avoiding, where practical, private roads and motorways.

10. The Access model tables that were populated from the road network model are:

- SOURCE_SECTION — Contains the road segment data

- SOURCE_BUILDINGS — Contains the building location including the id of the associated road segment

- SOURCE_MDF_SC_PATHS — Contains a summary of the path from each street cabinet to the nearest exchange point.

- SOURCE_DETAILED_MDF_SC_PATHS — Contains a list of the road segments that make up the path from each street cabinet to the nearest exchange point

- SOURCE_SC_BUILDING_PATHS — Contains a summary of the path from each road segment to the nearest street cabinet.

- SOURCE_DETAILED_SC_BUILDING_PATHS — Contains a list of the road segments that make up the path from each road segment to the nearest street cabinet.

- SOURCE_MDF_BUILDING_PATHS — Contains a summary of the path from each road segment to the associated exchange point being the exchange point associated with the nearest street cabinet to the road segment.

- SOURCE_DETAILED_MDF_BUILD_PATHS — Contains a list of the road segments that make up the path from each road segment to the associated exchange point being the exchange point associated with the nearest street cabinet to the road segment.

Building the road segments from Corelogic data

11. The Corelogic Road Network data formed the basis of the R&B network model. Road segments not relevant to the actual road network, eg waterways, tracks, were removed from the core database.

12. To reduce the number records in the Access model sequential Corelogic road segments were merged such that each merged segment started and terminated at an intersection or the terminus of the road. Roads with an attribute of Private or Motorway were only merged with roads of the same characteristic.

13. In order to give preference to a network that avoided motorways and privately owner roads, where practical, a weighting was applied to each road segment as follows:

    a. If road segment is motorway then 5 times the road segment length.

    b. If road segment is private then 3 times the road segment length

    c. Otherwise 1 times the road segment length.

14. These weightings were used to calculate the weighted distance. For example this means if the path between points A and B can traverse entirely along private roads and there is an alternative path that can traverse entirely along a public road that is less than 3 times the actual length of the private road path then the public path is used otherwise the private road path is used.

Chorus exchange and street cabinets

15. The location of the existing exchange and street cabinets were used to define the terminal points for the shortest path calculations.

16. To enable the R&B network to include the connections to the exchange and street cabinet points, the exchange and street cabinets were connected to the R&B network by determining the nearest road segment to each cabinet and exchange point. A virtual connection (segment) between the point and the nearest road segment was created and the road segment split into two segments.

Shortest path calculations

17. All the road network and data manipulation undertaken used Spatialite tools.

    a. Refer to http://www.gaia-gis.it/gaia-sins/libspatialite-4.1.0-RC1/spatialite-sql-4.1.0.html for description of all Spatialite functions.

    b. QGIS was used to visually validate the processes and resulting datasets.

18. First a   Spatialite VirtualNetwork was created from the road segments data using the spatialite-network application (https://www.gaia-gis.it/spatialite-2.3.0/spatialite-network-2.3.0.html). The VirtualNetwork connects each road segment, exchange and

cabinet. This is equivalent to a graph in which Dijkstra's Shortest Path algorithm[1] can be run. This is the R&B network.

19. The VirtualNetwork was used for each least cost (ie shortest path weighted distance) calculation irrespective of whether a road segment had associated buildings.

20. The nearest exchange to each street cabinet was determined by calculating the cost (weighted distance) from each cabinet to each adjacent exchange.

    a. For each street cabinet the path from the exchange to the cabinet was extracted from the R&B network.

    b. The summary for each of these paths is recorded in the SOURCE_MDF_SC_PATHS table of the Access database and the sequence and road segment id information is recorded in the SOURCE_DETAILED_MDF_SC_PATHS

21. In a similar manner the location of the nearest street cabinet (or exchange which is modelled in the same manner as a street cabinet) to each road segment was determined. However, due to the volume of calculations that would be required the following iterative approach was taken.

    a. Find the nearest cabinet or exchange (based on a straight line point-to-point calculation) to each road segment.

    b. Determine the actual road network distance and the cost (weighted distance) to the nearest street cabinet or exchange.

    c. Multiply the actual road network distance in 21.b. above by a factor of 5 (being the maximum weighting used for the motorway road segments).

    d. Determine the nearest street cabinet or exchange within the straight line distance of the road segment determined in 3 above.

22. Each road segment is therefore assigned to the nearest (lowest weighted distance cost) street cabinet or exchange.

23. The path and sequence information from the street cabinet to the road segment was extracted and recorded in SOURCE_SC_BUILDING_PATHS and SOURCE_DETAILED_SC_BUILDING_PATHS.

24. As the road segments were now assigned to a street cabinet and the street cabinet were assigned to exchange point each road segment was assigned the associated exchange point.

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[1]   (https://en.wikipedia.org/wiki/Dijkstra%27s_algorithm)

25. The nearest (lowest weighted distance cost) path from each exchange to the road segment was then extracted and stored in the SOURCE_MDF_BUILDING_PATHS and SOURCE_DETAILED_MDF_BUILD_PATHS tables.

Modelling buildings - CoreLogic address points

26. The CoreLogic address data contains an attribute, road_id, for the road segment associated to the address point. This attribute, along with the coordinate of the address point was used to determine how far along a merged R&B road segment (ie what percentage) the address point was. For this operation the SpatialLite functions ST_Line_Locate_Point and ST_Line_Interpolate_Point were used.

27. This percentage was used to determine the HORIZONTAL_LENGTH value stored in the BUILDINGS table. The HORIZONTAL_LENGTH is the distance from the end of the road segment nearest to the exchange point to the point on the road segment nearest to the address point. This distance was derived by multiplying road segment length by the percentage the address point is located along the segment.