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Prepared for the Australian Competition and Consumer Commission

WIK Mobile Network and Cost Model

Version 1.2

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Contents

List of Abbreviations and Terms

ACCC	Australian Competition and Consumer Commission
AN	Aggregation Network
Annualised CAPEX	Annualised Capital Expenditure
ANSI	American National Standards Institute
ATM	Asynchronous Transfer Mode
AuC	Authentication Centre
B_Data	Basic Data
BCLASIG	BSC Classification and Assignation/Assignment
BH	Busy Hour
BHCA	Busy Hour Call Attempts
BN	Backhaul Network
BSC	Base Station Controller
BSCTREE	Base Station Controller Tree
BSC-BSC link	Link between one BSC and another BSC
BSC-BTS link	Link between a BSC and a BTS
BSC-MSC link	Link between a BSC and a MSC
BSS	Base Station Subsystem
BTS	Base Transmission Station
BTS hub	Centrally located BTS in a district with the largest traffic flow
BTS hub-BSC link	Link between a BTS hub and a BSC
BTS-BTS hub link	Link between a BTS and a BTS hub
Busy Hour	The period in a day experiencing peak network traffic volume
bw	Bandwidth
CAPEX	Capital Expenditure
CDMA	Code Division Multiple Access
CN	Core Network
CORE-DESIGN	A component of the 'GSM CONNECT Core Network' module. The CORE-DESIGN task is divided into two parts: the first one is the logical design which ends with determining the required number of STM-1 DSG which connects the different MSC locations. The second part, named physical design, involves the determination of the corresponding physical topology, which connects the MSC locations, the routing of the STM-1 DSG demand on this topology and finally the determination of the transmission systems and medias.
CP	Central Processor
cpm	Cent Per Minute
CPU	Central Processing Unit
CSPDN	Circuit Switched Public Data Network
CWDM	Coarse Wave Division Multiplex

dB	Decibel
DC	Direct Cost
DEM	Digital Elevation Model
DI	Investment in Productive Network Asset (Direct Investment)
DiLeL	Digital Leased Lines
District	Aggregated postal areas based on population and physical size. Districts are the basic geographical unit used for calculating cell deployment.
DLL	Dynamic Link Library
DS1	ANSI framing specification for the transmission of 24 64 Kbps data streams
DSG	Digital Signal Groups
DWDM	Dense Wave Division Multiplex
E1	ETSI framing specification for the transmission of 32 64 Kbps data streams
EDGE	Enhanced Data Rates for GSM Evolution
EPMU	Equi-Proportionate Mark-Up
ETSI	European Telecommunications Standards Institute
FWC	Fixed Wired Digital Circuits
GHz	Gigahertz
GIS	Geographical Information System
GMSC	Gateway Mobile Switching Centre
GPRS	General Packet Radio Service
GSM	Global System for Mobile Communications
GWU	Gateway Unit
HLR	Home Location Register
HS_Data	High Speed Data
HSCSD	High Speed Circuit Switched Data
HSCSDS	High Speed Circuit Switched Data Service
Hw	Hardware
IC	Interconnection
II	Investment in Network Support Assets (Indirect Investment)
ISDN	Integrated Services Digital Network
IT	Information Technology
Kbps	Kilobits Per Second
Km	Kilometres
Mbps	Megabits Per Second
M-CLASIG	MSC Classification and Assignation/Assignment
mErl	Milli Erlang
MHz	Megahertz

MMS	Multimedia Message Service
MNO	Mobile Network Operator
MS	Mobile Stations
MSC	Mobile Switching Centre
MST	Minimal Spanning Tree
MTAS	Mobile Terminating Access Service
N1	Number of BTS Sites in a Urban Zone
N2	Number of BTS Sites in a Suburban Zone
N3	Number of BTS Sites in a Rural Zone
NSS	Network Switching Subsystem
OC	Operating Cost
OMC	Operations and Maintenance Centre
OPEX	Operating Expenditure
POA	Postal Area
PSPDN	Packet-Switched Public Data Network
PSTN	Public Switched Telephone Network
PTP	Point to Point
PTPRAL	Point to Point Radio Links
RL	Radio Link
RNC	Radio Network Controller
Ro&RAL_ASIG	Route and Radio link assignment
SDH	Synchronous Digital Hierarchy
SLA	Statistical Local Areas
SMS	Short Message Service
SMSC	Short Message Service Centre
SNPT	Strategic Network Planning Tool
SP	Signalling Processor
STM-1	Synchronous Transport Module -1
Sw	Software
TRAU	Transcoder and Rate Adaptation Unit
TRFBHDIF	Traffic Reduction Factor due to Business Hour Differences
TRX	Transceivers
TSLRIC	Total Service Long Run Incremental Cost
TSLRIC+	Total Service Long Run Incremental Cost Plus, where the Plus represents an equi-proportionate mark-up on TSLRIC as a contribution to common organisational-level costs
ULLS	Unconditioned Local Loop Service
USL	Universal Service Levy
USO	Universal Service Obligation

UTM	Universal Transverse Mercator
V_On	Voice On-Network
V_Off_In	Voice Off-Network (Incoming)
V_Off_Out	Voice Off-Network (Outgoing)
VLR	Visitor Location Register
W	Watts
W-CDMA	Wideband Code Division Multiple Access
WDM	Wavelength Division Multiplexing
WIK	WIK-Consult
WIK-MNCM	WIK Mobile Network and Cost Model

1 Introduction

The following sections outline the installation procedure for the WIK Mobile Network and Cost Model (the WIK-MNCM or 'the model') and provide a guide for carrying out cost calculations. The WIK-MNCM includes a database of Australian data (such as population data) that allows the user to calculate estimates of the efficient cost of providing the mobile terminating access service (MTAS) in Australia. The WIK-MNCM has a specific regulatory application to Australia and should not be applied for any other purpose than intended.

2 System requirements

The cost model software has the following minimum system requirements:

- Pentium 4 Processor or AMD equivalent
- at least 512 MB cache of RAM
- 1 GB free HD space
- Windows XP Professional (with full administration rights)
- CD-ROM
- HTML reader (e.g. internet explorer or similar)
- Microsoft Excel XP (recommended for output files)

3 Installation

The cost model software is comprised of a file set. Model installation procedure:

Step 1: Create a folder on your hard-disk. The folder name should not exceed 256 characters.

Step 2: Copy all program files (.txt, .dll, .html etc.) from the CD-ROM or download the ZIP file to the user folder.

Step 3: If you have copied the zipped program files to the designated folder, double-click on the .zip file and the model software will install automatically.

NOTE: It is recommended that the user retains a separate copy of the basic data files provided with the WIK-MNCM. When naming any folders to be used in the WIK-MNCM they **must not contain spaces** otherwise the model will be unable to make calculations. Moreover, the path length must not exceed the number of 256 characters.

4 Overview

The cost model software consists of several modules which **must** be **run in sequence** when creating a **new scenario**:

- Basic geographical and demand related input data ('**GSM CONNECT Scenario Creator'** module);
- Cell deployment ('**GSM CONNECT Cell Deployment**' module);
- Deployment of the aggregation network between BTSs and BSCs ('**GSM CONNECT Aggregation Network**' module);
- Deployment of the backhaul network between BSCs and MSCs ('**GSM CONNECT Backhaul Network**' module);
- Deployment of the core network between MSCs ('**GSM CONNECT Core Network**' module), and
- The investment and cost calculation ('**GSM CONNECT Cost Module**').

These modules may be run individually, however, it is recommended that the user operates the model through the Shell program. The user starts the Shell program by selecting the executable file ***c:\[user folder] \gsmconnect_shell.exe***

The Shell program is shown below:

Each module of the WIK-MNCM software is contained in the Shell program. To run a scenario the user must select the data file that will be used by the 'GSM CONNECT Scenario Creator' module. Once the 'GSM CONNECT Scenario Creator' module has been run the data files required as an input for the next module are automatically generated. The modules must be run **in sequence** to ensure that the necessary data files are generated or updated for each proceeding module. For example, the 'GSM CONNECT Cell Deployment' module will not activate until the 'GSM CONNECT Scenario Creator' module has been executed.

NOTE: The user can change a parameter in a module, but must sequentially re-run the modules. For example, if a parameter is changed in the 'GSM Backhaul Network' module the user must then execute this module and all subsequent modules which in this example are the 'GSM CONNECT Core Network' and the 'GSM CONNECT Cost Module' to derive a cost estimate incorporating the changed parameter(s) in the 'GSM Backhaul Network' module.

The steps for the general operation of the cost model software are as follows:

Step 1: Click on 'gsmconnect_shell.exe' in the relevant user folder.

Step 2: Click on the square button to the left of the 'Go To Scen Creator' button in the Shell program. This will open the folder in which the user has installed the model.

Step 3: Select the file 'Australia.txt' to open the relevant data file for the WIK-MNCM.

Step 4: To run a new scenario using different parameters leave the '**Run Old Scenario**' box unchecked.

NOTE: Checking the '**Run Old Scenario**' box is only recommended if an existing and already calculated scenario is to be re-run.

Step 5: Step through the modules sequentially by clicking on 'Go To …', beginning with the 'GSM CONNECT Scenario Creator' module and finishing with the 'GSM CONNECT Cost Module'.

NOTE: The Shell program remains open in the background when each module is selected. **Switching between the WIK-MNCM's windows is not recommended.**

Step 6: Every completed module calculation produces output files which are stored in the folder where the WIK-MNCM is installed.

NOTE: Since re-running the model with different parameters will change the output files, it is recommended that the user retains a copy of the original data files provided with the model in a separate folder or as a subfolder. To avoid unnecessary confusion it is also recommended that each new scenario that is created has its own folder or subfolder.

5 The main modules of the software

5.1 GSM CONNECT Scenario creator

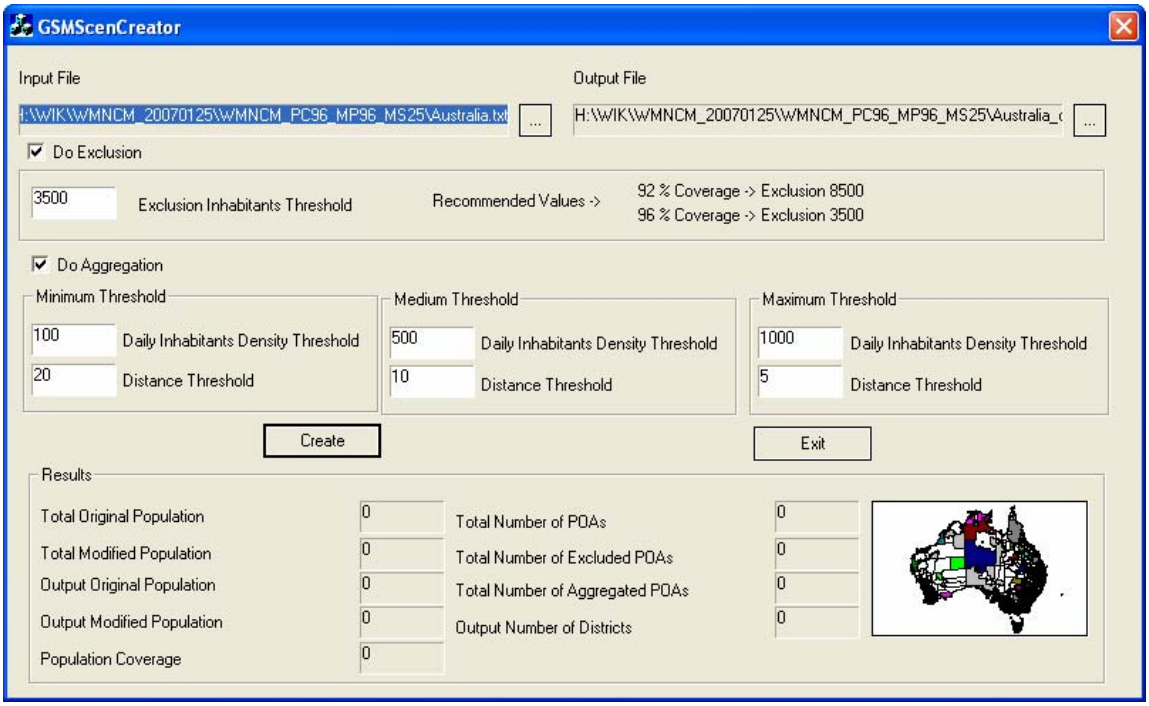
The first module of the model is the 'GSM CONNECT Scenario Creator'. The objective of this module is to set up the basic data required for the model. The module utilises postal code areas to create districts comprised of one or more Postal Areas (POAs). The POAs provide information on the number of mobile users, geography and topography. They are aggregated into districts in order to enable the calculation of the cell deployment in the 'GSM CONNECT Cell Deployment' module. For further information on the POAs refer to section 5.1.1. of the report titled '*Mobile Termination Cost Model for Australia*, January 2007' (the Report).

The 'GSM CONNECT Scenario Creator' module controls:

- The included POAs for the desired population **coverage**,
- The excluded POAs on the basis of (the small number of) **mobile users (subscribers)** within a particular POA,[1] and
- The aggregation of POAs to form a single **district**.

The main window of the 'GSM CONNECT Scenario Creator' module is shown in the following screenshot:

1 A POA is marked for exclusion if the 'Do Exclusion' option in the main window has been selected and the POA is not included into a larger district in the aggregation process.



The steps for general operation of the 'GSM CONNECT Scenario Creator' module are as follows:

Step 1: The relevant input file will be shown automatically.

NOTE: The output file from the 'GSM CONNECT Scenario Creator' module is generated automatically when the user selects 'Create'. It is recommended that all the output files are stored in the same folder.

Step 2: **Do Exclusion**

In some scenarios it may be useful to consider excluding certain POAs. A POA may be excluded (and is excluded in the reference case) if its population (i.e. including the employees who may work but not reside in a particular POA) is below a specified threshold defined in the corresponding field in the main window of the 'GSM CONNECT Scenario Creator' module. POAs with a population below this threshold may be excluded from the scenarios modelled with this 'GSM CONNECT Scenario Creator' module basis data and therefore not considered in the network design. In this way the user can specify different population coverage levels for the model (e.g. 96 per cent or 98 per cent) by altering the exclusion threshold.

Step 3: **Do Aggregation**

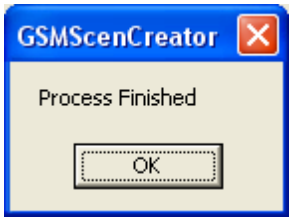
The aggregation procedure converts the POAs into districts. A district may comprise a single or several POAs. The aggregation is performed

on the basis of three POA classifications such that each district may consist of a combination of urban, suburban, and rural POAs. Each POA is classified into a district according to a modified population density threshold[2] and an aggregation distance threshold. If the density of a POA is above the value of the modified population density threshold for an urban area, then the POA is a 'candidate' for a district centre to which the model will aggregate neighbouring POAs. These POAs are then aggregated to form a district if the distance between their district centre and another district centre exceeds the aggregation distance threshold for urban districts.

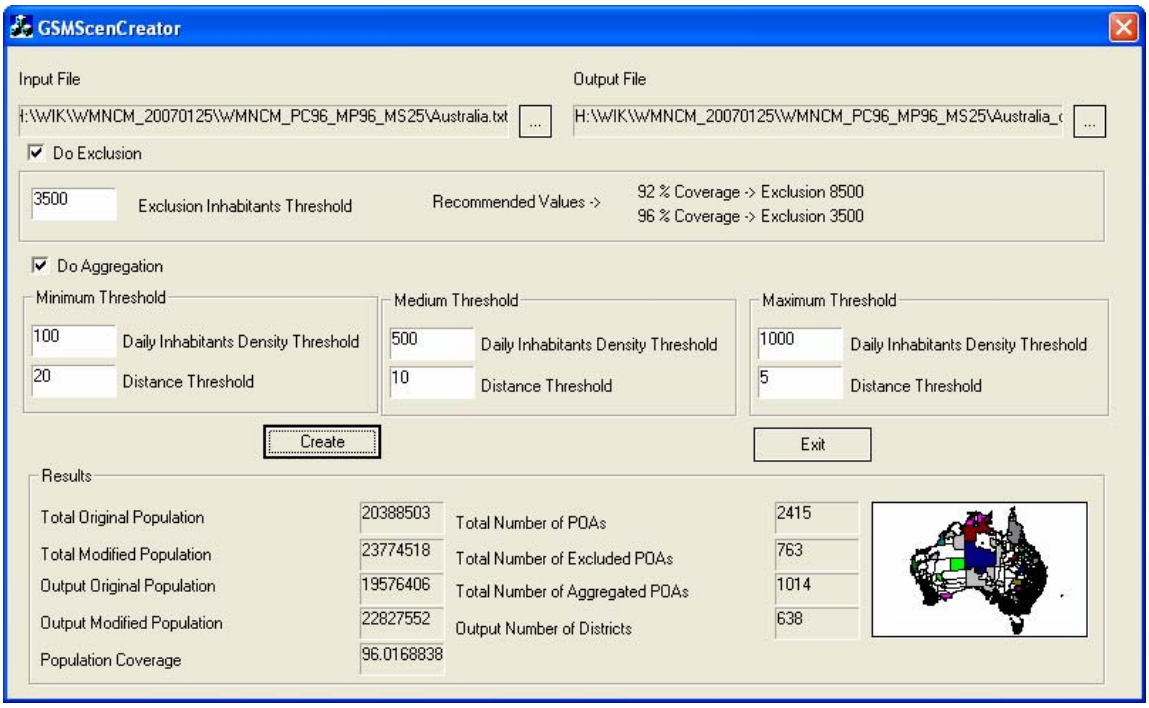
The scenarios included in the Report are based on the aggregation values shown in the screenshot above and it is recommended that these values are not changed. For more details on how the aggregation network is developed the user can consult the Report.

2 The modified population makes allowances for the fact that mobile subscribers, in particular the working population, move between locations and may thus contribute to demand during a typical day in more than one location (i.e. to account for the impact of the working population on covered areas). To address this issue an adjustment to the raw (residential) population for a modified population becomes necessary.

Step 4: The calculations in the 'GSMScenCreator' window are executed by clicking on the '**Create**' button. As soon as the model has completed its calculation the following window appears.



After clicking on 'OK' the results for population, coverage, and POA related information are displayed in the bottom of the 'GSMScenCreator' window.

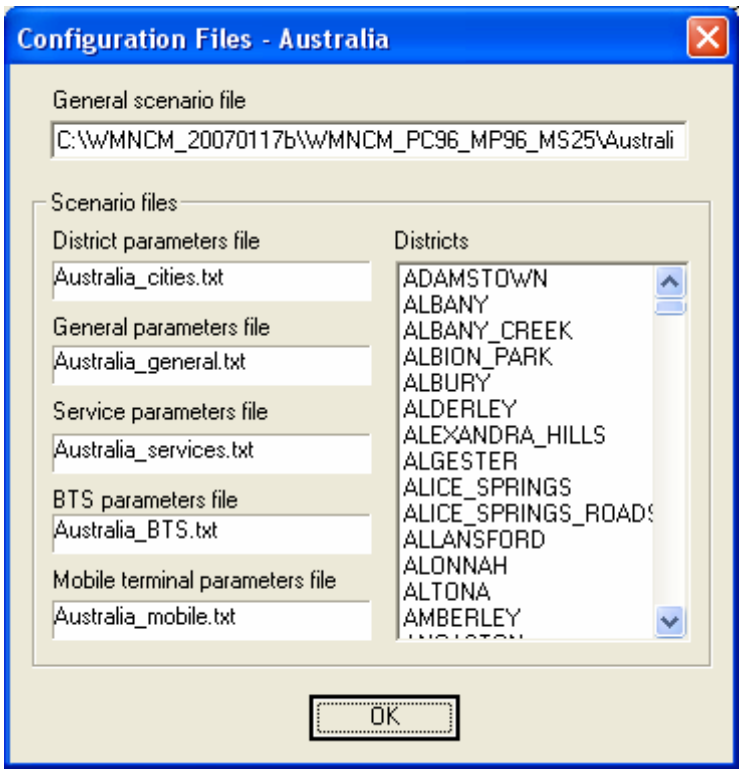


5.2 GSM CONNECT Cell deployment

The ‘GSM CONNECT Cell Deployment’ module provides an estimation of the number of BTS locations in each district for each type of BTS. The ‘GSM CONNECT Cell Deployment’ module determines the area (in square kilometres) of the districts as three concentric rings corresponding to urban, suburban and rural districts.

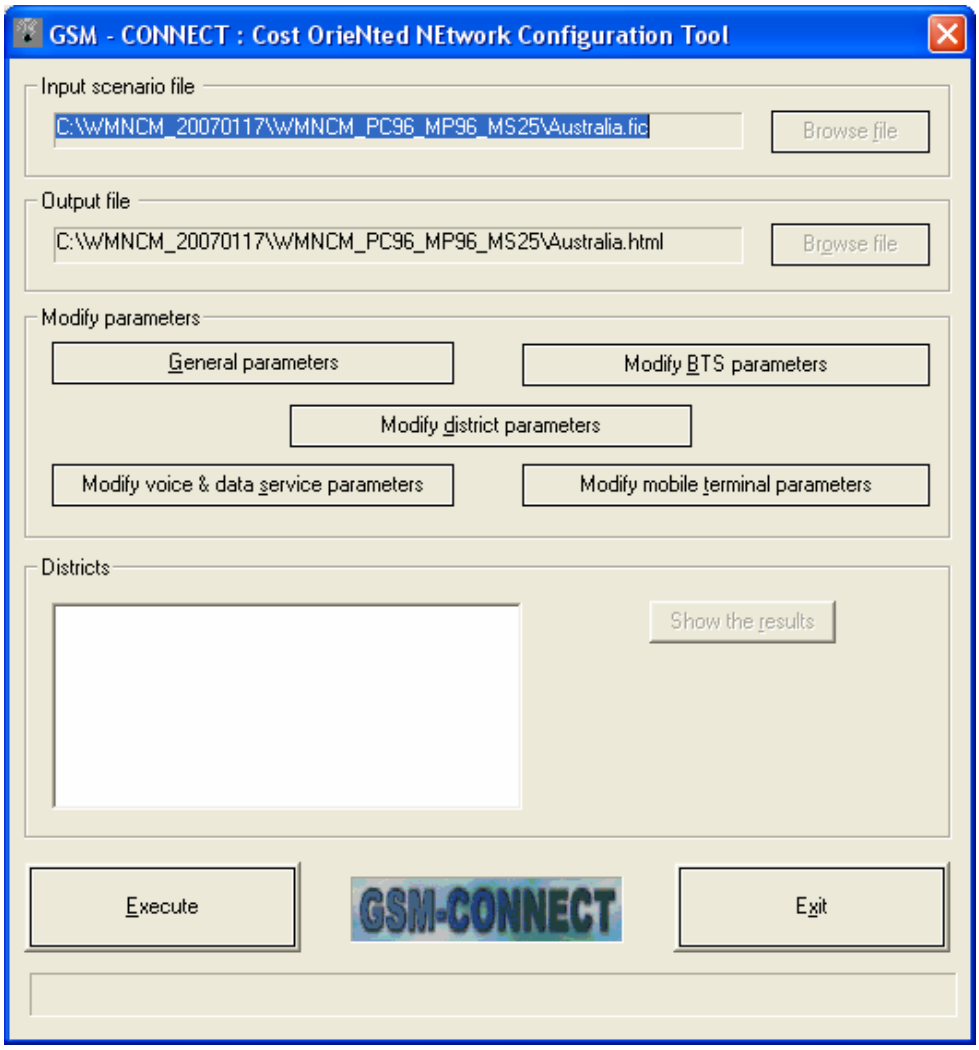
The steps for the general operation of the ‘GSM CONNECT Cell Deployment’ module are as follows:

Step 1: Select the ‘Go to Cell Deployment’ button and the ‘Configuration Files - Australia’ window will appear.



The ‘Configuration Files - Australia’ window lists the paths of the input files that are used for the following ‘GSM CONNECT Cell Deployment’ module. Each of these .txt files (‘District parameters file’, ‘General parameters file’, ‘Service parameters file’, ‘BTS parameters file’ and ‘Mobile terminal parameters file’) contain data that will be listed in the input mask of the following ‘GSM CONNECT Cell Deployment’ module. It is not recommended that the path listed in the ‘General scenario file’ field is changed.

The ‘OK’ button activates the main window of the ‘GSM CONNECT Cell Deployment’ module which is shown below.



Step 2: In the main window of the ‘GSM CONNECT Cell Deployment’ module the user may modify relevant input parameters. The parameters are categorised into one of the following:

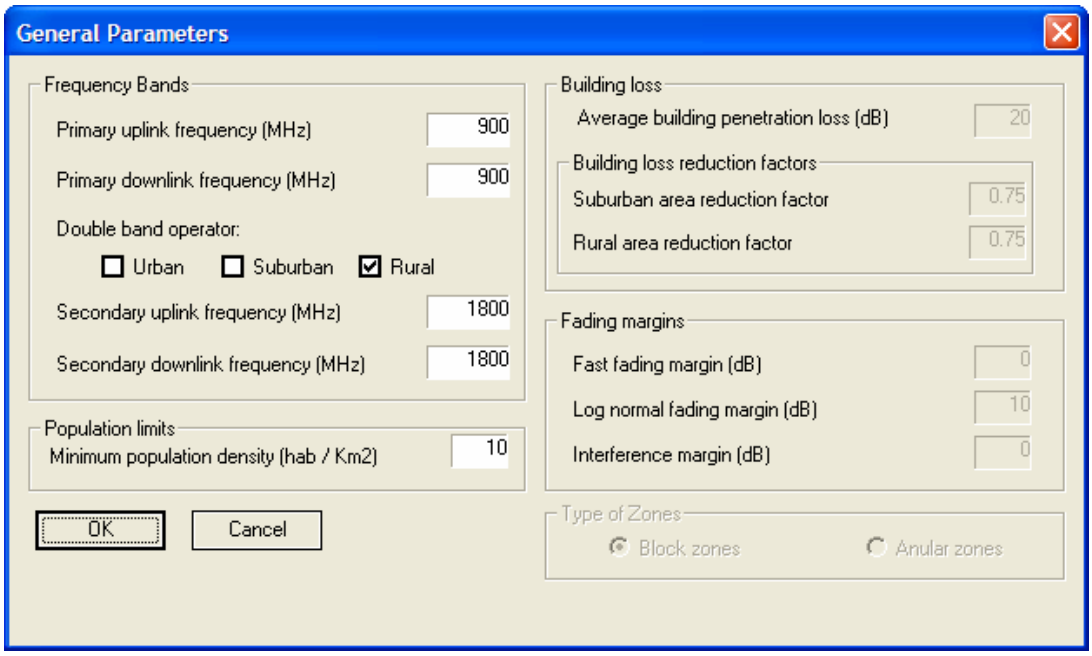
- General parameters,
- Voice & data service parameters,
- District parameters,
- BTS parameters, and
- Mobile terminal parameters.

General parameters

The ‘General Parameters’ window allows the user to change the following parameters:

- The availability of frequencies in the different areas (urban/suburban/rural)
- The values of the used frequencies, and
- The population density.

Grey coloured boxes, such as those listed on the right-hand side of the ‘General Parameters’ window, are fixed in the model and the user is not able to change these parameters.



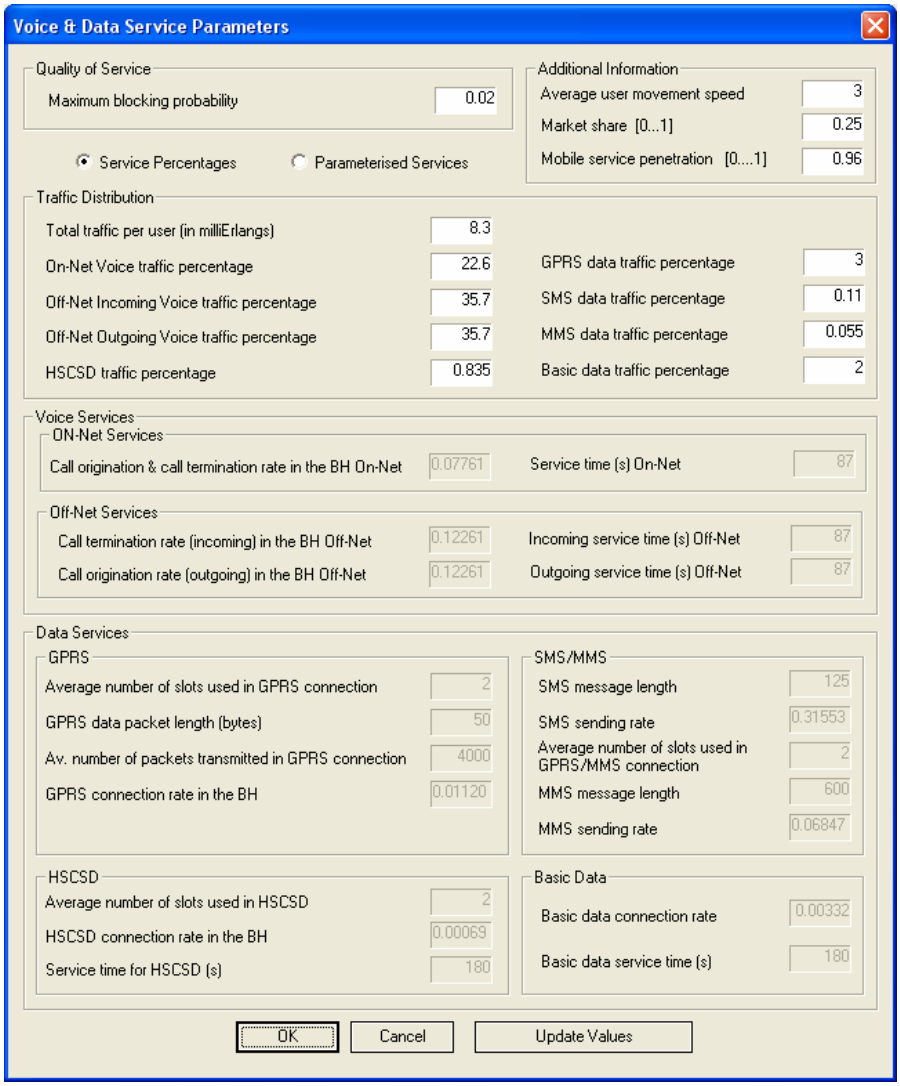
Voice and data service parameters

The 'Voice & Data Service Parameters' window provides an outline of the parameters of all services considered in the WIK-MNCM and their relative contribution to traffic load.[3] This window provides the user with three options:

i) Changing the total traffic per user without changing the distribution to the services,

ii) Changing the share of distribution per service, or

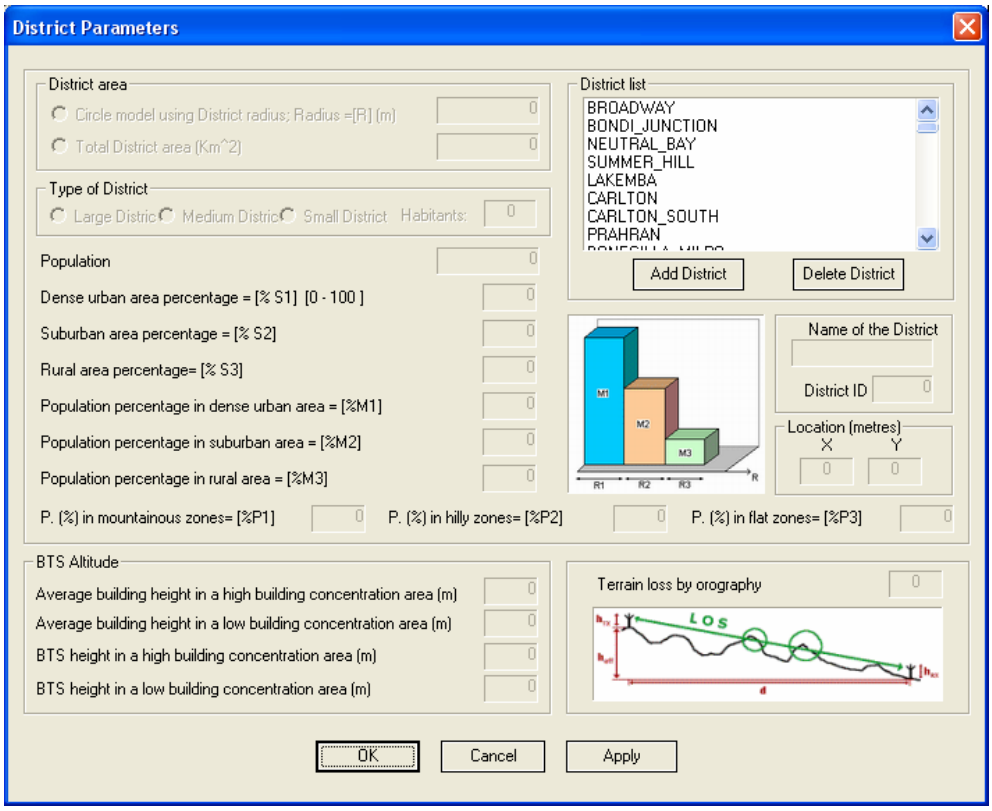
iii) Changing the individual parameter which determines the traffic contributed by a service.



3 Remember that the model identifies the relative proportions of different services in traffic load using the concept of voice equivalent traffic per minute. That is, the traffic flow of each data service is transformed into voice minute equivalents. For further details of the conversion of different types of traffic to voice equivalent minutes users are referred to section 5.2 of the report.

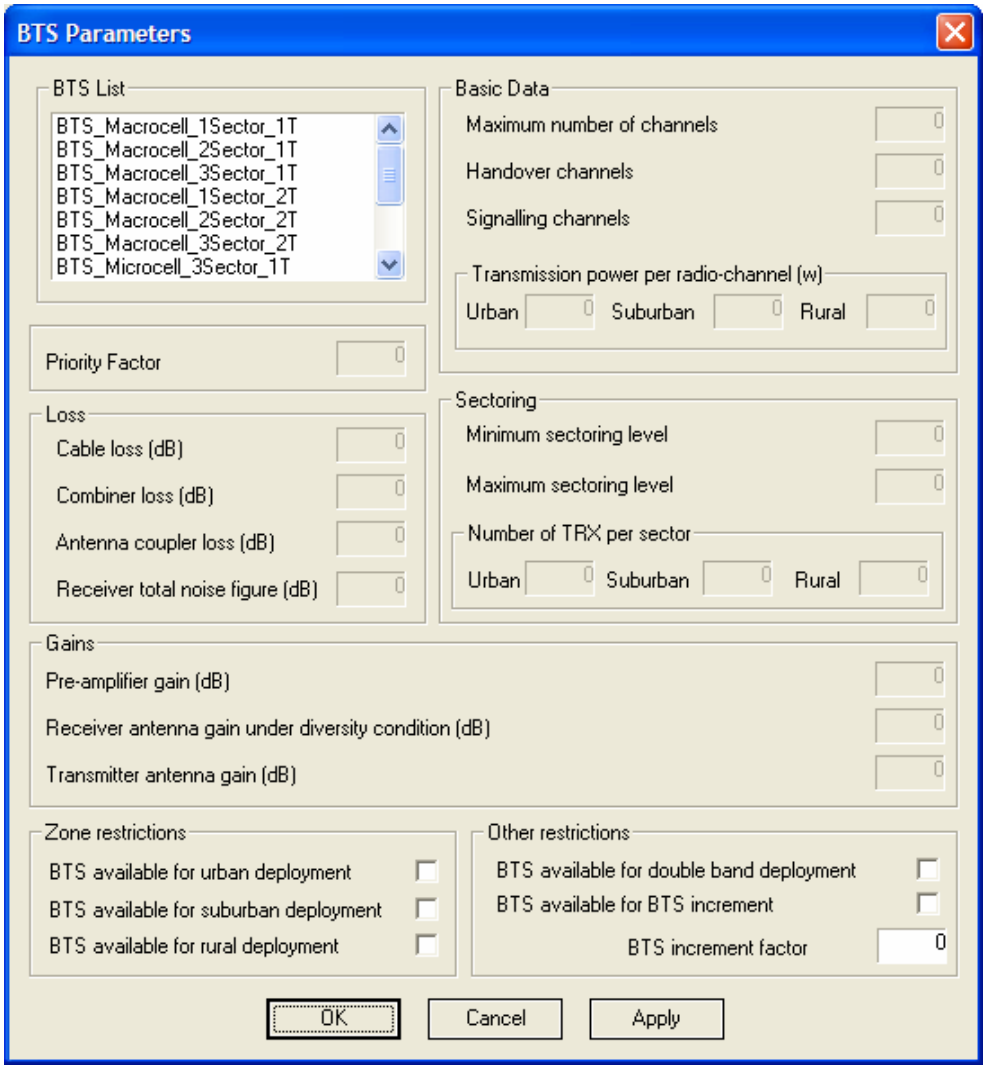
District parameters

The ‘District Parameters’ window provides details about the list of districts generated by the ‘GSM CONNECT Scenario Creator’ module and the districts’ characteristics. Most of the district parameter values are fixed.



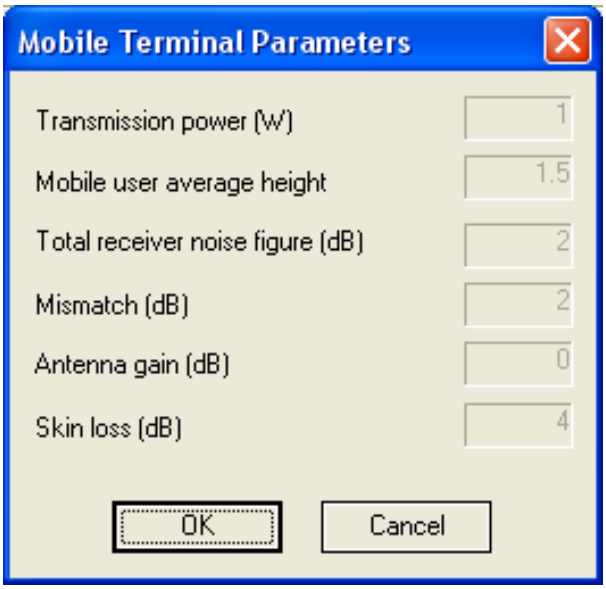
BTS parameters

The ‘BTS Parameters’ window shows the types of BTSs contained in the model. The technical parameter values for each type of BTS are shown when the user selects a type of BTS. While the user may specify the spatial application and a double band use, a number of the technical parameter values are fixed. Once the user has specified the input parameters, click the ‘Apply’ button so that the model reflects these values.

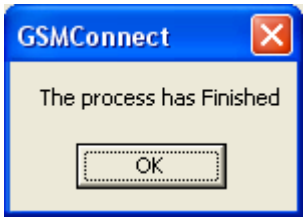


Mobile terminal parameters

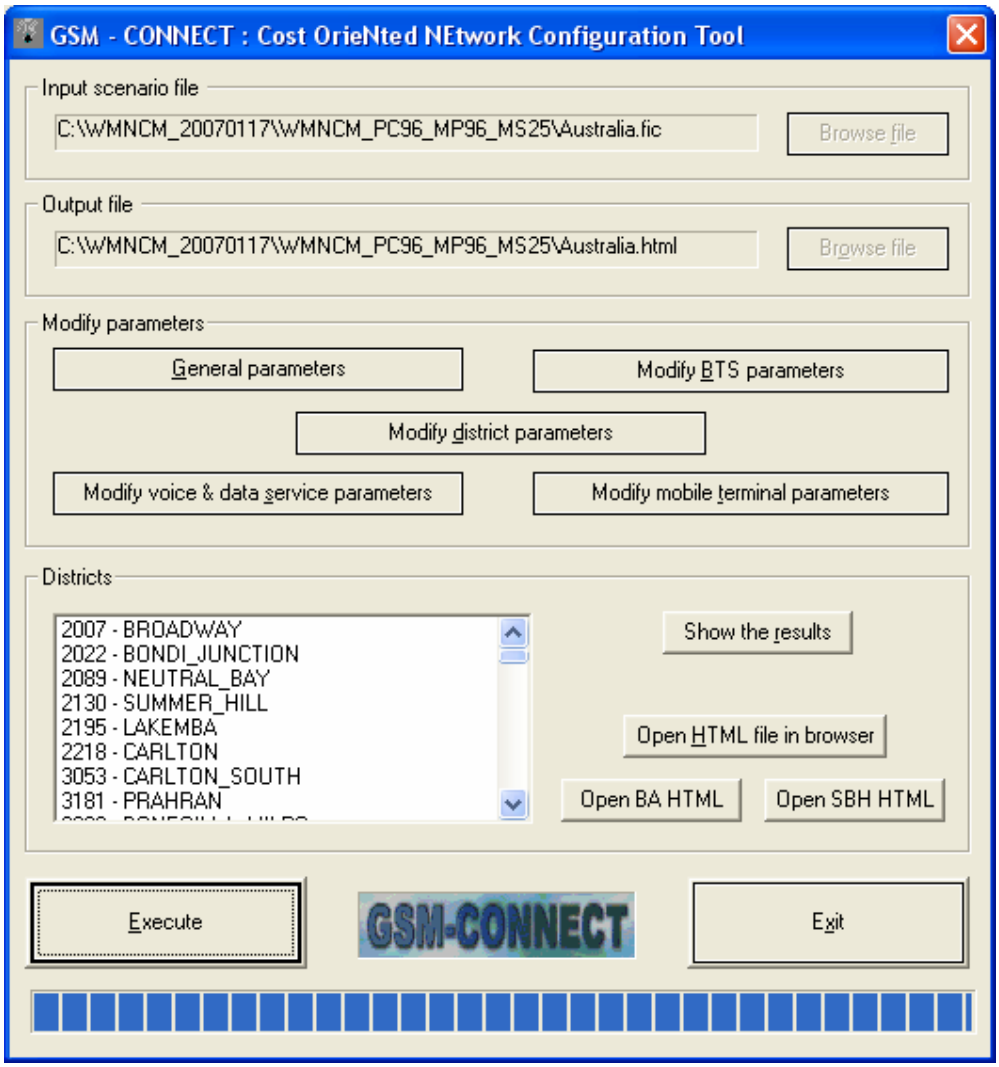
The ‘Mobile Terminal Parameters’ window lists the parameter values of the user terminal and cannot be changed.



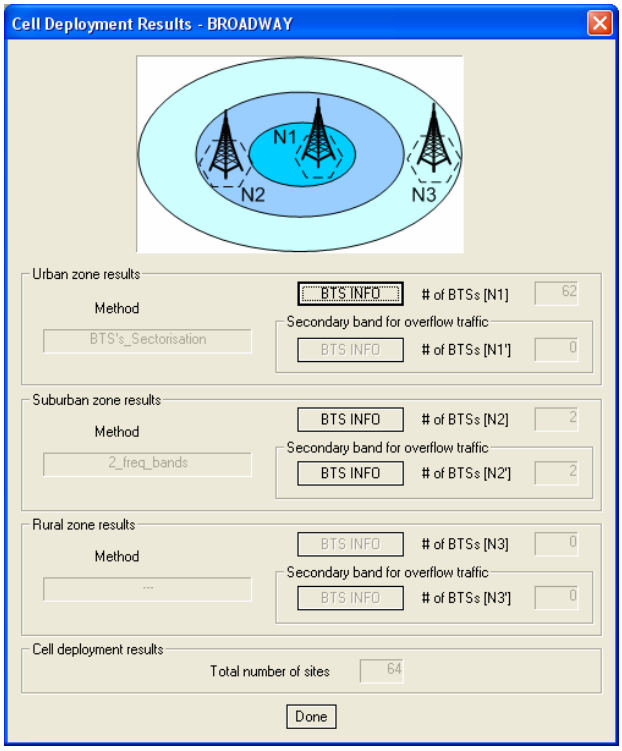
Step 3: Once the user has specified the input parameters in the ‘GSM CONNECT Cell Deployment’ module, the user may proceed with the calculation by clicking the ‘Execute’ button. A confirmation window will appear when the calculations are completed (listed below).



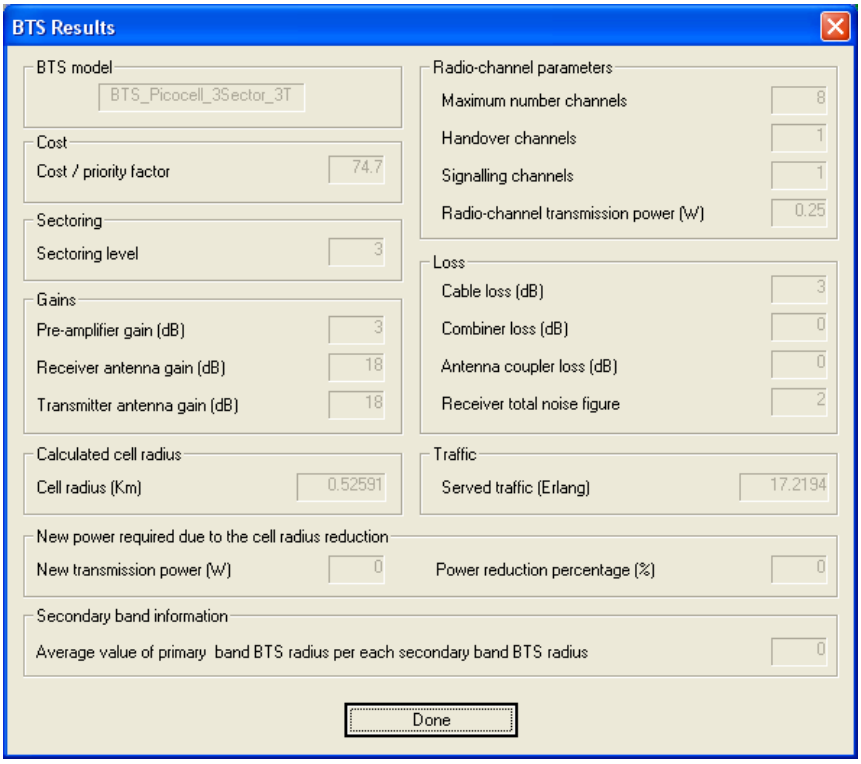
Step 4: Once the 'GSM CONNECT Cell Deployment' module has completed its calculations, the user may view the numerical results. For this purpose the main window of the 'GSM CONNECT Cell Deployment' module provides a list of the districts and provides four additional buttons as shown in the screenshot below. Selecting one district and clicking the 'Show the results' button will provide detailed results for that district. The 'Open HTML file in browser' button opens a complete list of all districts. The 'Open BA HTML' button provides a list of the individual districts with summarised technical information about each district, while the last button labelled 'Open SBH HTML' provides a summary of the selected BTSs over all districts.



By selecting a district from the list and clicking the ‘Show the results’ button the user will access data for that particular district, as shown in the following screenshot:

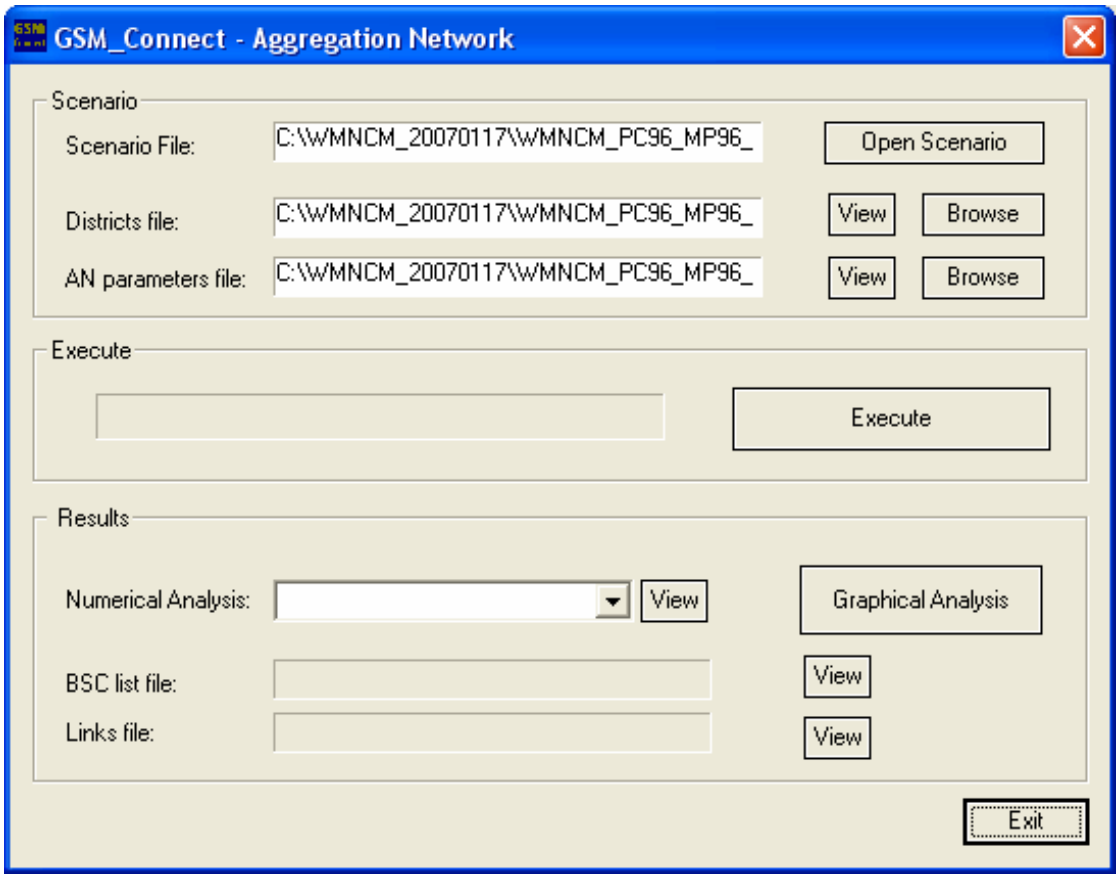


Note that for the three types of districts, the number of BTSs in the frequency bands is displayed. Clicking on the ‘BTS INFO’ button will provide relevant information on the type of BTSs used in each district.


BTS Results
BTS model
BTS_Picocell_3Sector_3T
Cost
Cost / priority factor
74.7
Sectoring
Sectoring level
3
Gains
Pre-amplifier gain (dB)
3
Receiver antenna gain (dB)
18
Transmitter antenna gain (dB)
18
Calculated cell radius
Cell radius (Km)
0.52591
Radio-channel parameters
Maximum number channels
8
Handover channels
1
Signalling channels
1
Radio-channel transmission power (W)
0.25
Loss
Cable loss (dB)
3
Combiner loss (dB)
0
Antenna coupler loss (dB)
0
Receiver total noise figure
2
Traffic
Served traffic (Erlang)
17.2194
New power required due to the cell radius reduction
New transmission power (W)
0
Power reduction percentage (%)
0
Secondary band information
Average value of primary band BTS radius per each secondary band BTS radius
0
Done

5.3 GSM CONNECT Aggregation network

The ‘GSM CONNECT Aggregation Network’ module controls the modelling procedure for the network segment between a BTS and the relevant BSC. The first window in this module is represented by the following screenshot:

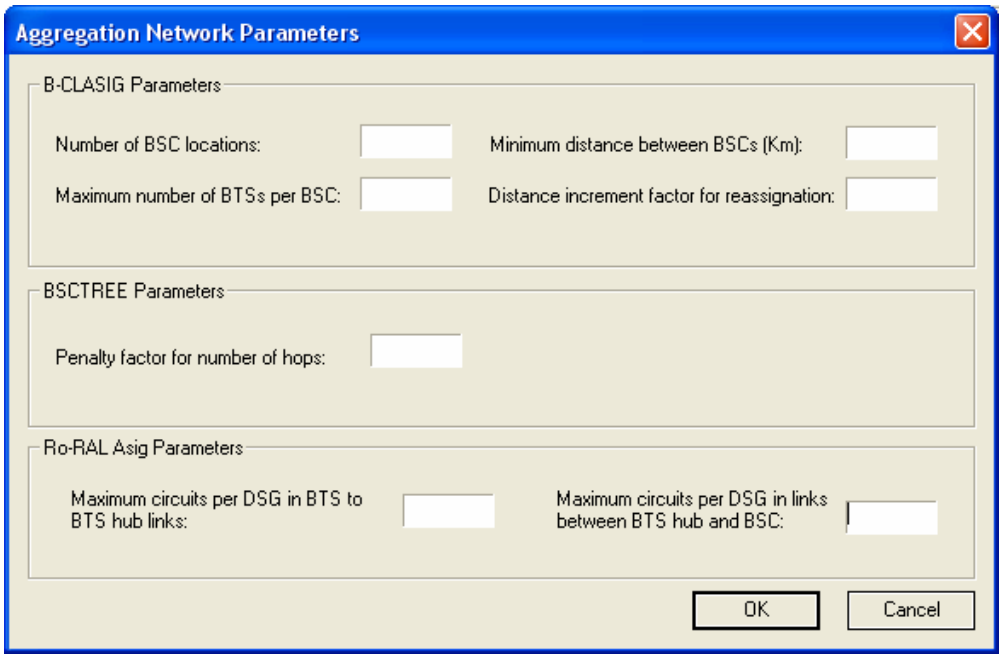


The ‘Scenario File’, the ‘Districts file’, and the ‘AN parameters file’ are generated automatically as outputs derived from the previous modules.

The ‘Districts file’ contains the output from the ‘GSM CONNECT Cell Deployment’ module. The user is only required to specify the parameters which are relevant for designing the aggregation network. These parameters are specified in the ‘AN parameters file’ field.

The steps for the general operation of the 'GSM CONNECT Aggregation Network' module are as follows:

Step 1: The following window 'Aggregation Network Parameters' opens when the user selects 'View' in the 'AN parameters file' field:



The user is required to specify the:

- Number of BSC locations,
- Maximum number of BTSs connectable per BSC location[4],
- Minimum distance between the BSCs (measured in kilometres),
- Distance increment factor for re-assignation,
- Penalty factor, and
- Maximum number of circuits per DSG (E1) for links between the BTS and the BTS hub and links between the BTS hub and the BSC.

4 The cost model considers the possibility that more than one BSC unit may be installed at one BSC location.

Number of BSC locations and the Maximum number of BTSs per BSC

Note that the number of BSC locations and the maximum number of BTSs per BSC location are highly correlated. The number of BTS locations must not exceed the product of the maximum number of BTSs at a BSC location times the number of BSCs in the 'GSM CONNECT Cell Deployment' module. Due to Australia's population distribution, BSCs located in remote and rural districts might be assigned to a small number of BTSs while in densely populated districts higher numbers of BTSs may be assigned to BSCs. The 'minimum distance' or length between BSC locations can be changed by the user to alter the geographical distribution of BSCs.

Minimum distance between BSCs (Km)

The minimum distance between BSC locations is measured in terms of kilometres.

The relevant algorithm defines the BSC location as the BTS hub location in each district with the highest number of BTSs assigned to it that satisfies the minimum distance threshold between the BSC locations. This distance threshold thereby influences the geographical distribution of the BSC locations. A large value will distribute the BSC locations widely over Australia and may lead to a situation where BSC locations do not correspond to the BSCs with the highest number of aggregated BTSs. Given Australia's population distribution, there is a strong concentration of BSC locations (and shorter distances between each BSC) in South-east Australia (where the population is concentrated). However, in remote and rural districts BSC locations tend to be more dispersed and connected over longer distances. A distance value for BSC locations between 50 and 100 kilometres is recommended.

Distance increment factor for reassignation

This parameter influences the reassignment of districts from one BSC location to another when the maximum number of BTSs assigned to a BSC is reached.

NOTE: As a result of relevant studies (as cited in section 5.3.2 of the Report) the value is currently designated as one and it is recommended that this value is not changed.

Penalty factor for the number of hops

A penalty factor is used to develop the design or topology of the aggregation network tree which connects the BTS hubs located in the centre of the districts to the BSC. The value of the penalty parameter controls the topology of the link structure in this network segment, such that every time a BTS hub is connected with the BSC *via another* BTS hub a penalty occurs.

The higher the penalty factor the closer the aggregation network tree will resemble a star topology. As BTSs will avoid hopping through other BTSs (due to the penalty factor) and instead link directly to the BSC.

NOTE: A value of zero establishes a tree structure which minimises the total length of the network. Most studies use a value of one to achieve a stable topology across a wide range of scenarios, particularly when factoring cost impacts on transmission links. It is recommended that the value of one in the model is retained for all scenarios.

Maximum circuits per DSG in BTS to BTS hub links and the Maximum circuits per DSG in links between BTS hub and BSC.

These two parameters allow the user to limit the use of the E1 group and hence increase network resilience.

NOTE: The maximum value is 30, which reflects the maximum use of each E1 group. It is recommended to use a value of 28 as this ensures spare capacity in the event of any unforeseen traffic increase.

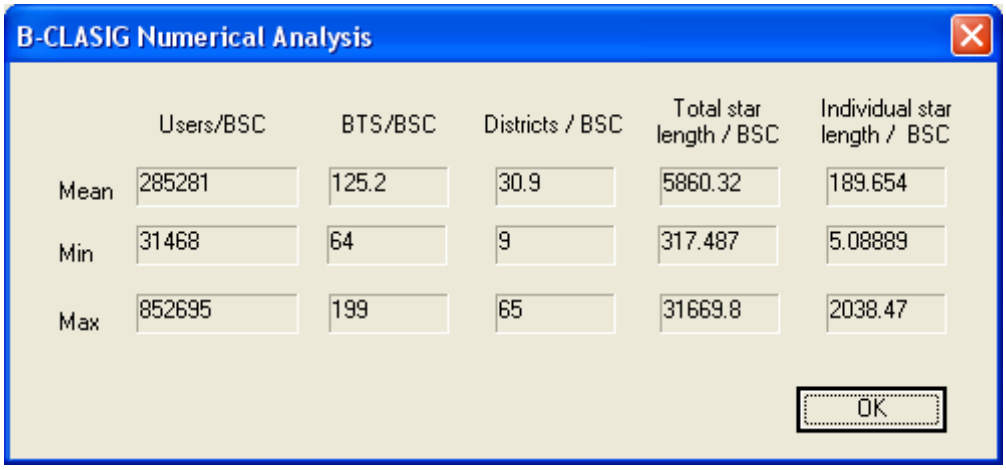
Step 2: Click the 'Execute' button to run the 'GSM CONNECT Aggregation Network' Module. The following message appears on completion:

Step 3: Viewing results (optional)

The 'B-CLASIG Numerical Analysis' window provides the user with a numerical and graphical analysis of the aggregation network calculations.

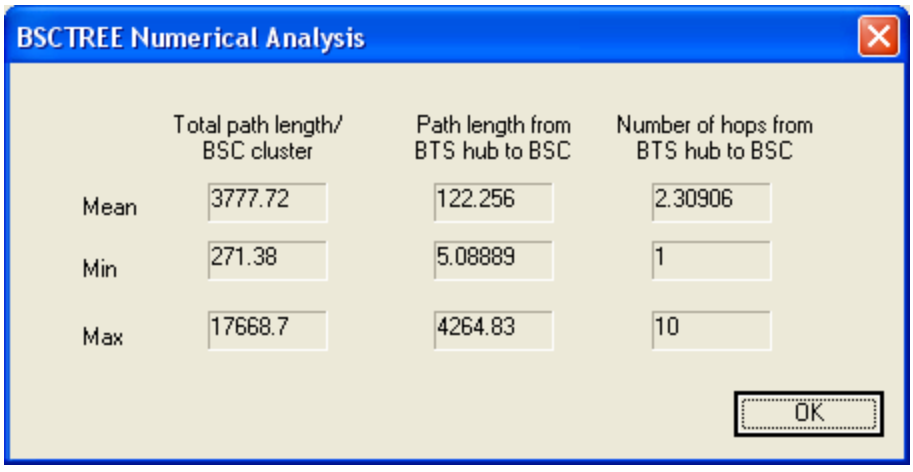
The user has to select in the '**Numerical Analysis**' field the 'BCLASIG' file to view statistical data on the assignation process, including the mean, maximum and minimum results in regard to the:

- Users per BSC,
- Number of BTSs per BSC,
- Number of districts per BSC,
- Total star length per BSC (i.e. length of all BTS links to BSCs, and
- Individual star length per BSC (i.e. length of BTS links to BSCs).



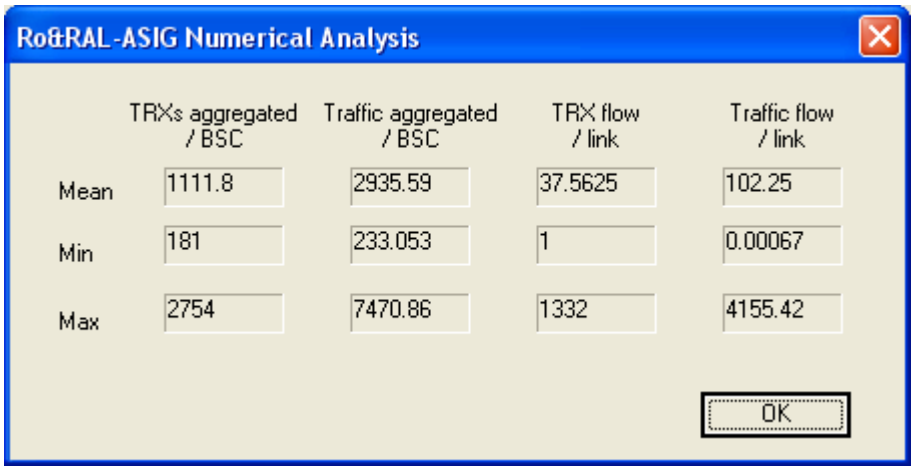
The user may also select information about the BSC links by selecting in the '**Numerical Analysis**' field the 'BSCTREE Numerical Analysis' file. This function provides statistical data on the assignation process, including the mean, maximum and minimum results in regard to the:

- Total path length per BSC cluster,
- Path length from BTS hubs to BSCs, and
- Number of hops from BTS hubs to BSCs.

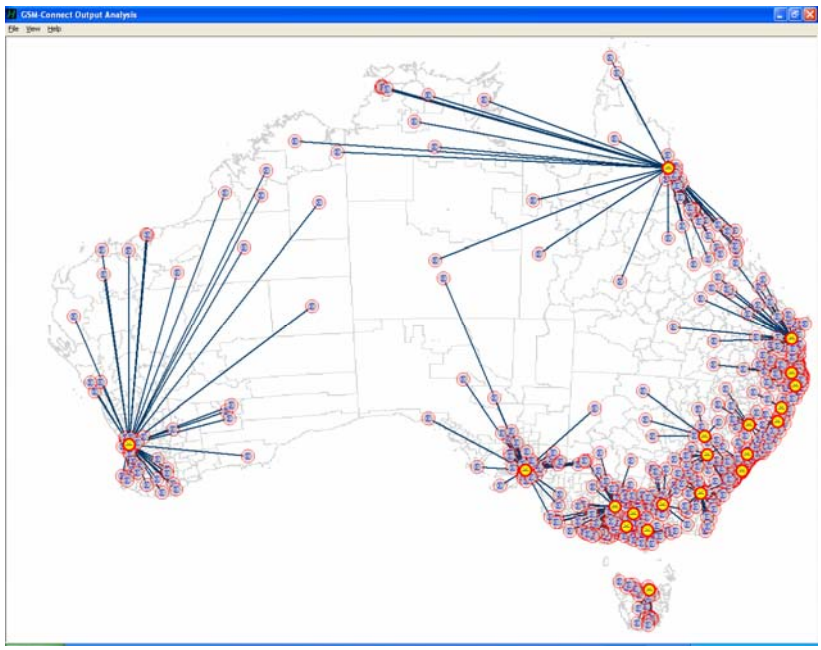


The user may also select information on the routing and radio link systems assignment by selecting in the '**Numerical Analysis**' field the 'Ro&Ral-ASIG Numerical Analysis' file. This function provides statistical data on the assignation process, including the mean, maximum and minimum results in regard to the:

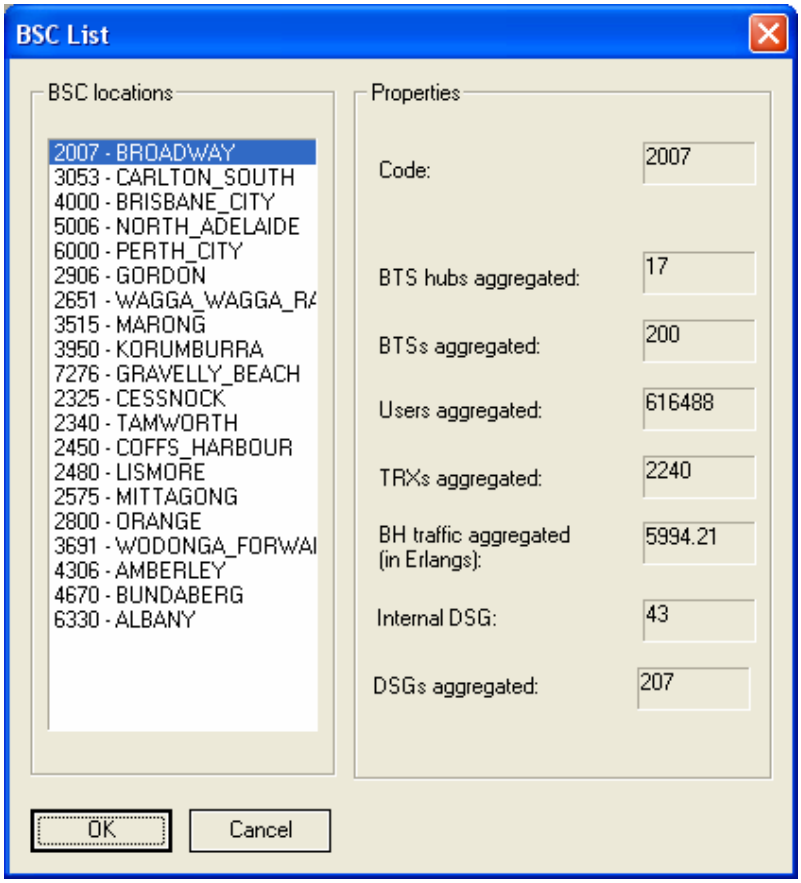
- TRXs aggregated per BSC,
- Traffic aggregated per BSC,
- TRX flow per link, and
- Traffic flow per link.



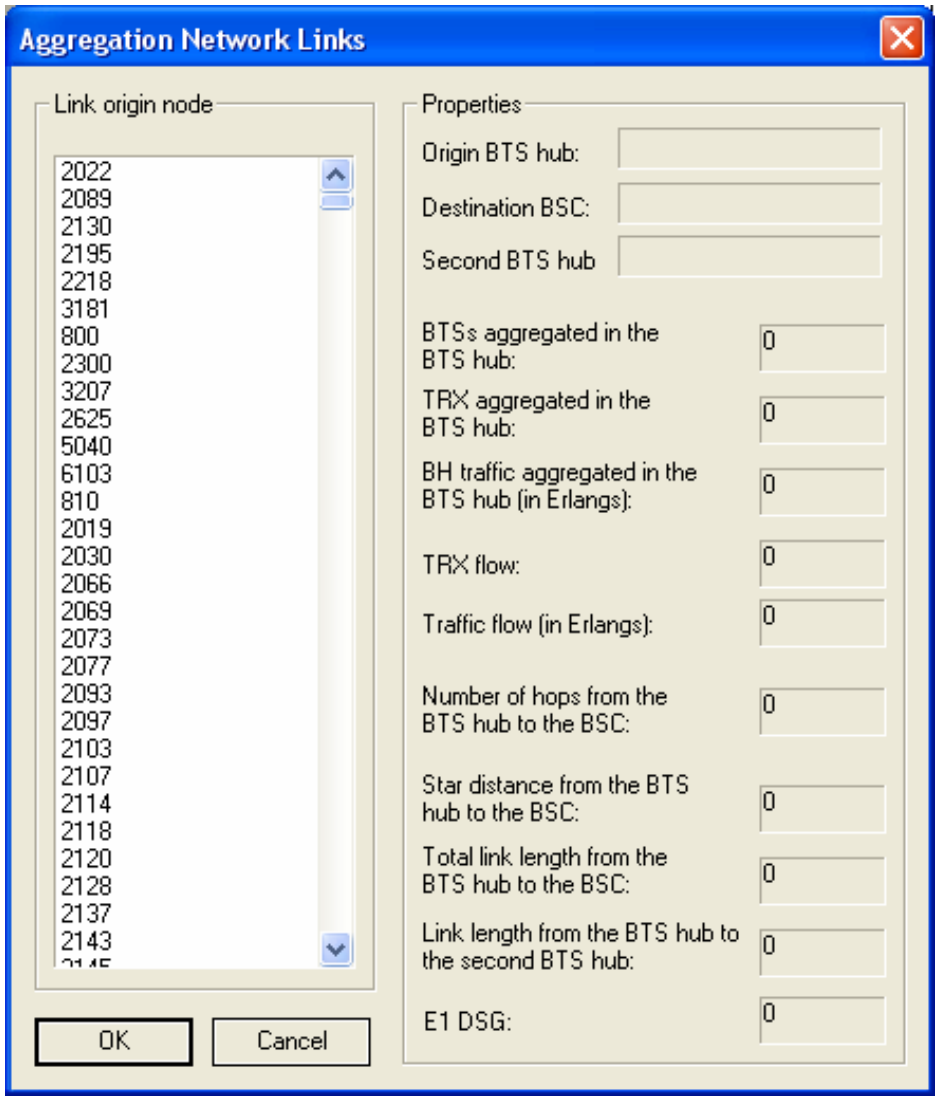
In addition, the 'Graphical Analysis' function provides an Australian map showing the BSC and BTS locations and their corresponding assignation calculated by the model.



The ‘BSC List’ file provides relevant information for the BSC location (listed below).



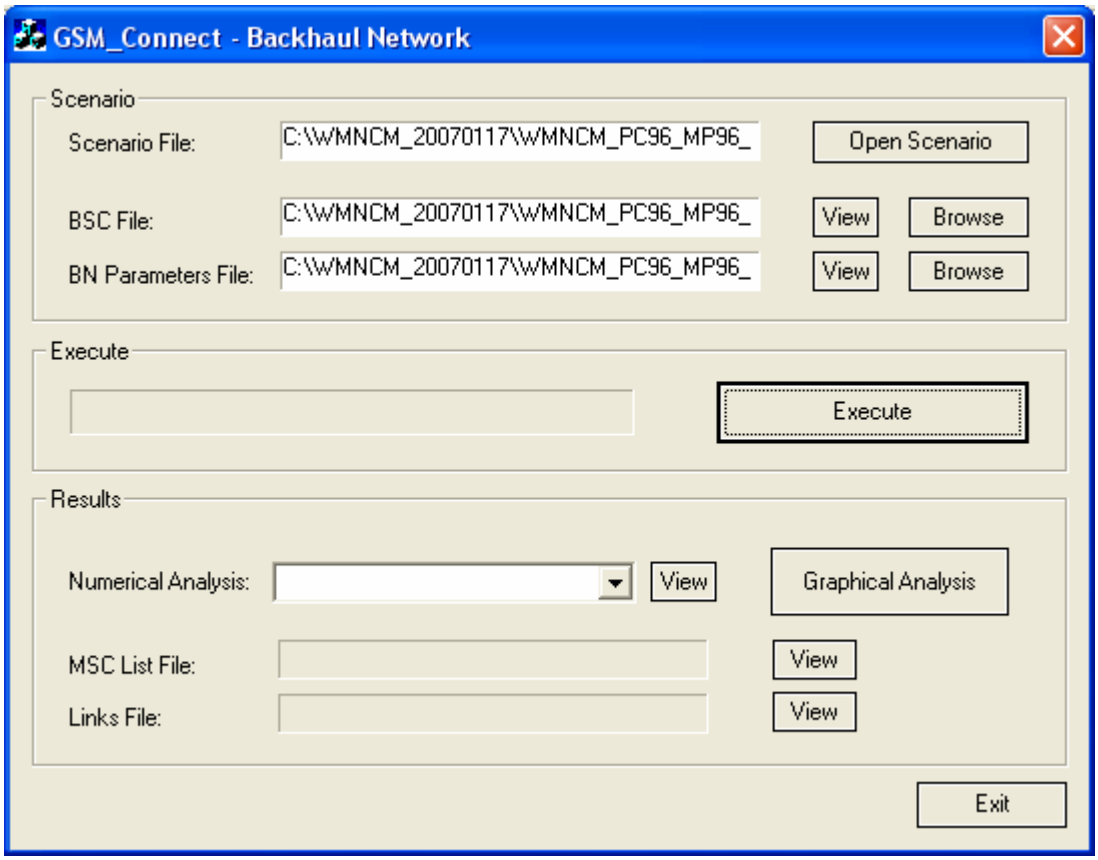
The ‘Aggregation Network Links’ window lists the properties of links connecting a BTS hub to a BSC (listed below). If a link is a direct connection between the origin BTS hub and the BSC, i.e. the connection does not consider a second BTS hub, the values in the ‘Destination BSC’ and ‘Second BTS hub’ fields are the same. If the link, however, is an indirect connection between the origin BTS hub and the BSC which means that the link considers additionally a second BTS hub, the two field values are not the same. The ‘Destination BSC’ field always lists the BSC location while the ‘Second BTS hub’ field always lists the network location to which the origin BTS hub is connected directly.



Step 4: Select ‘Exit’ to return to the Shell program.

5.4 GSM CONNECT Backhaul network

The ‘GSM CONNECT Backhaul Network’ module controls the modelling procedure for the network segment between the BSCs and MSCs. The module starts with the following window:

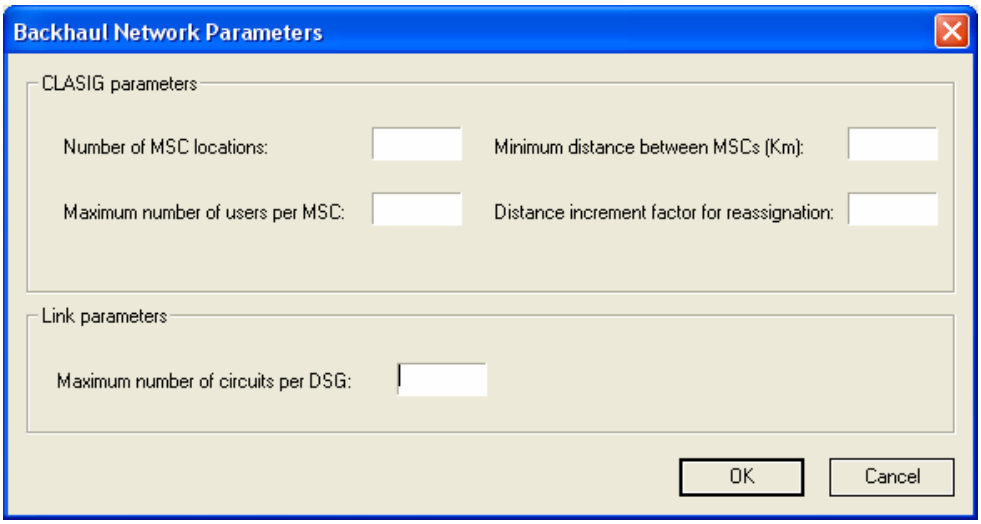


In the scenario file, the ‘BSC File’ and the ‘BN Parameters File’ are already provided.[5] Both input files are ‘*.txt’ files and consist of a number of input parameters which are required for the determination of the backhaul network topology. By clicking ‘View’ the input window appears where the user can take a look at the input parameters or carry out changes on them. A change in the input parameter values will generate a new ‘BSC File’ or ‘BN Parameters File’.

5 If there are no parameter files displayed, the user has to click on the ‘Open Scenario’ button and select the corresponding scenario file. The scenario file is a <*.scnbn> file and should be located in the relevant user programme folder.

The requisite steps for the 'GSM CONNECT Backhaul Network' module are as follows:

Step 1: The following input window opens by clicking on 'View' at the 'BN Parameters File' option:



The user is required to specify the:

- Number of MSC locations,
- Minimum distance between MSCs,
- Maximum number of users per MSC,
- Distance increment factor, and
- Maximum number of circuits per DSG.

Number of MSC locations and the Minimum distance between MSCs (Km)

A typical value for MSC locations ranges from 10 per cent to 25 per cent of the number of BSC locations. The upper value of the range is generally used for a small number of BSC locations and the lower value of the range is generally used for a large number of BSC locations to generate the number of MSC locations.

The 'Minimum distance between MSCs' is a threshold parameter measured in kilometres. It determines the distribution of MSCs using a similar method to that for BSC locations.

NOTE: The 'GSM CONNECT Backhaul Network' module selects the MSC locations from the set of BSC locations. The minimum distance should not be less than the one used in the aggregation network for the BSC locations. Given Australia's geography and population distribution, five MSC locations with a distance threshold of 300 kilometres is recommended.

Maximum number of users per MSC

Capacity limitations are considered by the parameter '**maximum number of users**' to be assigned to a MSC location. This parameter determines how many subscribers can be aggregated at a single MSC location. Hence, the parameter has a similar function to the parameter, which sets the capacity limits for the BSC.

NOTE: Each MSC location is already a BSC location and hence the value selected for the capacity limitation has to be larger than the corresponding maximum number of users connected to a BSC location. The user can find this value in the numerical analysis of the aggregation network (by selecting 'BCLASIG').

In some cases the user might select a combination of parameter values, e.g. a value for the maximum number of users per MSC that is too low, which will result in an error message instructing the user to change the value.

Distance increment factor for reassignation

This parameter has the same function as the one in the aggregation network. It is recommended that this value remains at 1.

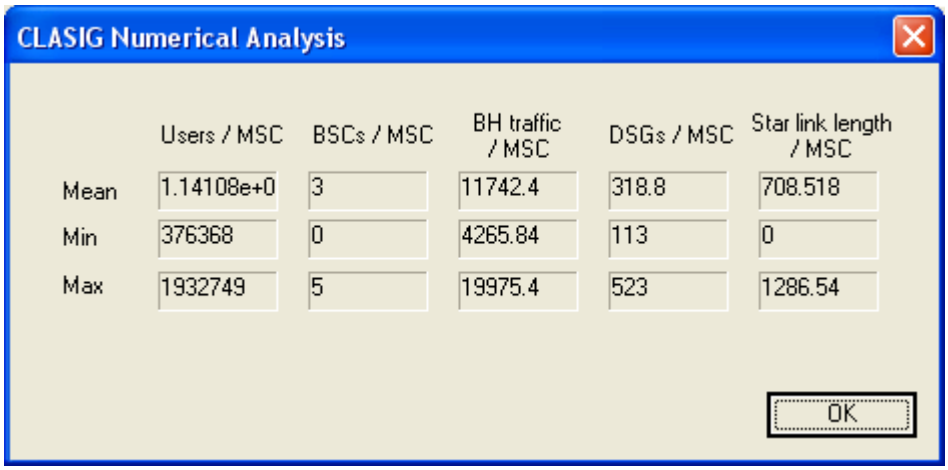
Maximum number of circuits per DSG

This parameter specifies the maximum number of 64 Kbps channels, which are available per E1 in the backhaul network. A value of 28 is recommended in line with studies for call termination in fixed network regulation, as further discussed in section 5.3.3 of the Report.

Step 2: Click the 'Execute' button to generate outputs for this module. After execution of the module, the following message box appears indicating successful execution:

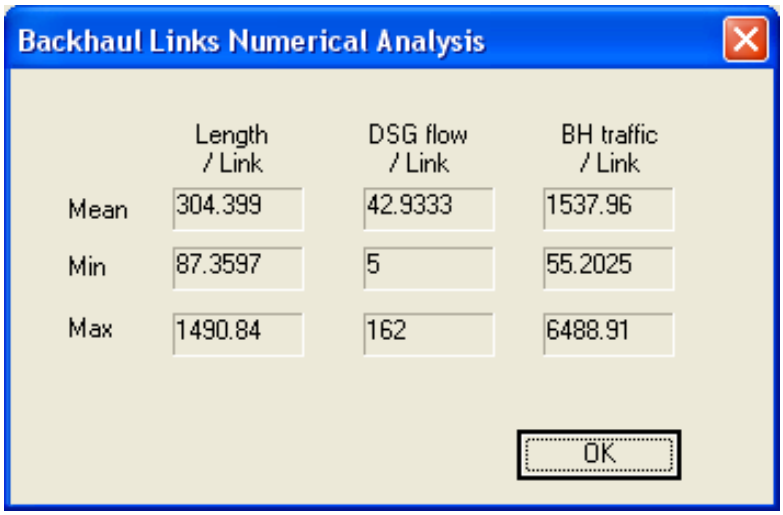
Step 3: Once the module has completed its calculations, a number of quantitative outputs are generated. By selecting 'M-CLASIG' under the '**Numerical Analysis**' field the user can view in the 'CLASIG Numerical Analysis' window statistical data on the assignation process, including the mean, maximum and minimum results for the:

- Users per MSC,
- BSCs per MSCs,
- Busy hour backhaul traffic per MSC,
- DSGs per MSC, and
- Star link lengths per MSC.

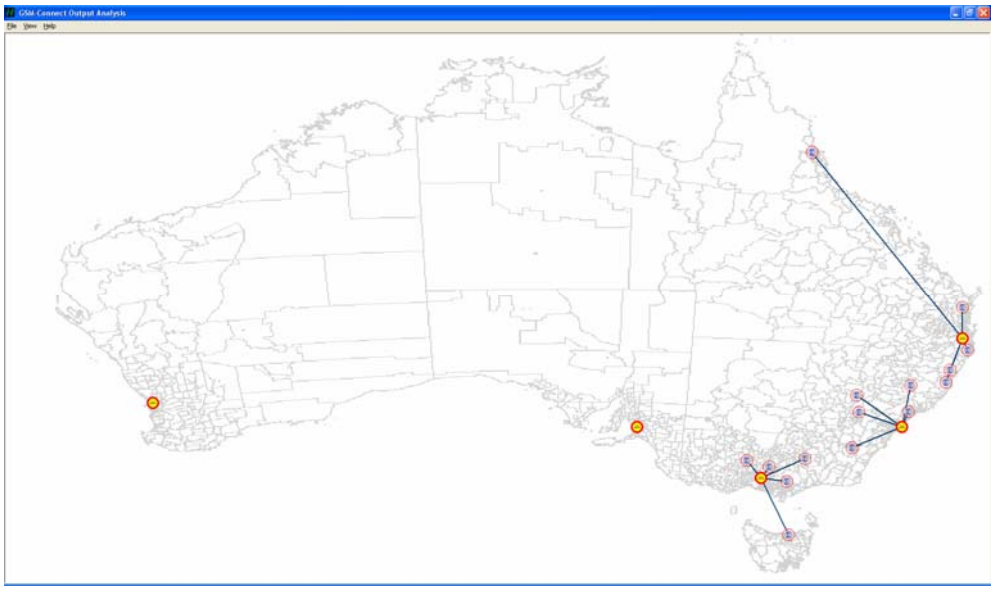


By selecting 'Backhaul Links' under the **'Numerical Analysis**' field the user can view in the 'Backhaul Links Numerical Analysis' window statistical data on the assignation process, including the mean, maximum and minimum results in regard to the:

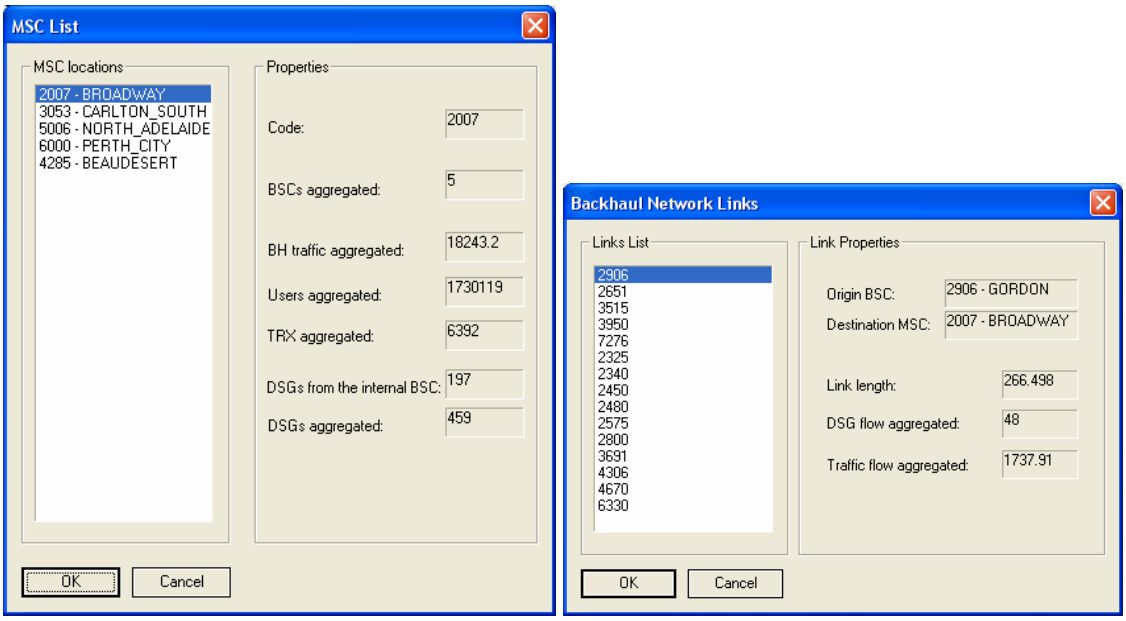
- Length of backhaul links per link,
- DSG flow per link, and
- Busy hour backhaul traffic per link.



The '**Graphical Analysis**' worksheet provides a scheme of the backhaul network. Yellow shaded nodes represent MSC locations. Grey coloured nodes represent BSC locations.



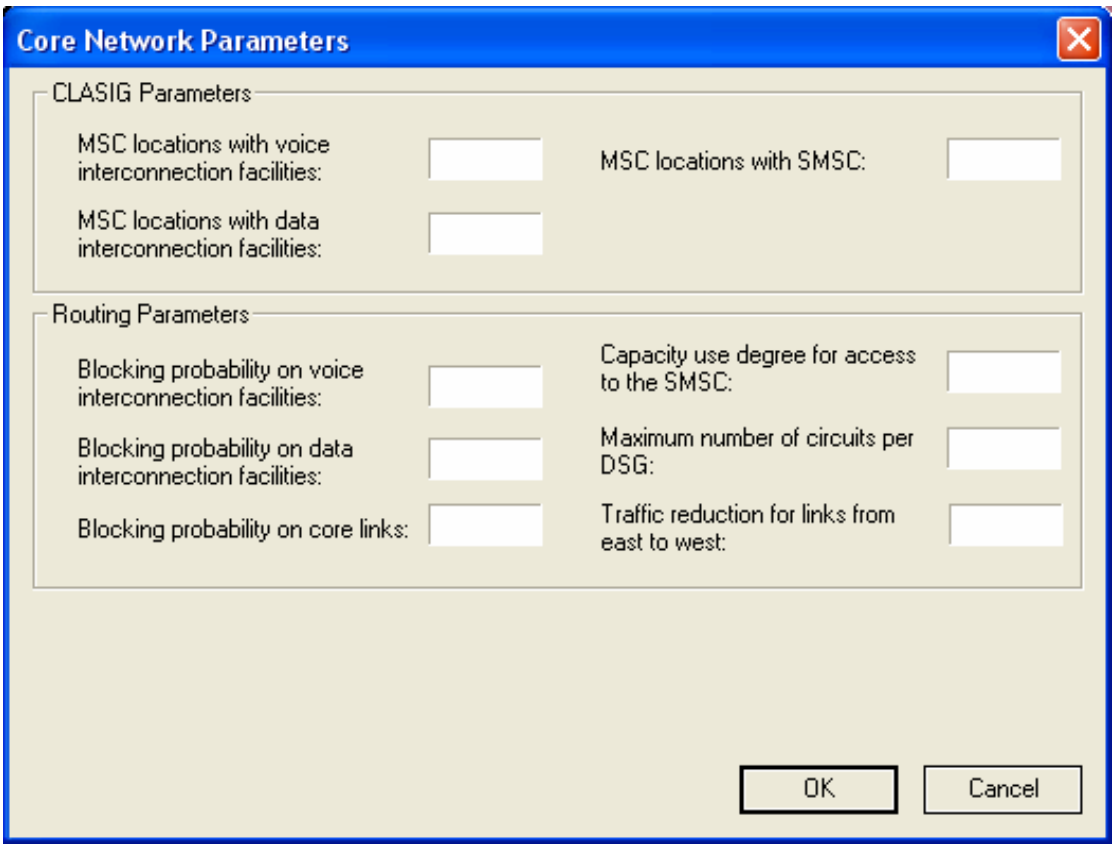
Detailed information about each MSC and each BSC-MSC link is available in the ‘MSC List’ window and the ‘Links List’ window , which can be displayed using the ‘View’ function:



5.5 GSM CONNECT Core network

After modelling the backhaul network the user may proceed to model the core network. The steps are the similar to the 'GSM CONNECT Backhaul Network' module.

First, the user has to determine the parameter values as shown in the following window:

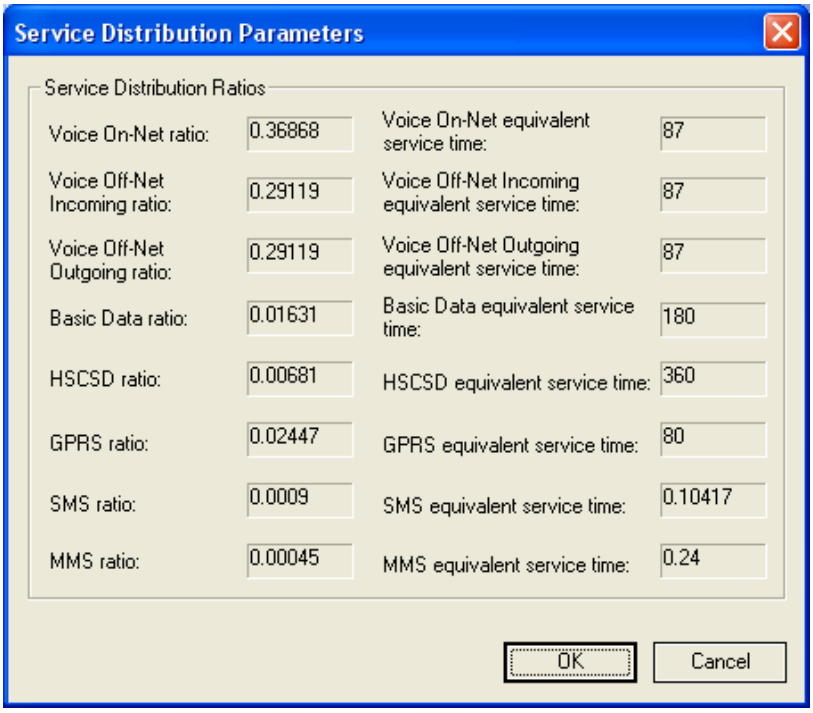


The user has to specify the number of interconnection locations for both voice and data services as well as the number of MSC locations where a service centre for SMS is installed.

NOTE: If the value specified here is lower than the number of MSC locations the model selects those locations providing the highest aggregated traffic value. If the number specified here is larger than the number of MSC locations, an error message will appear and the user must reduce the input value.

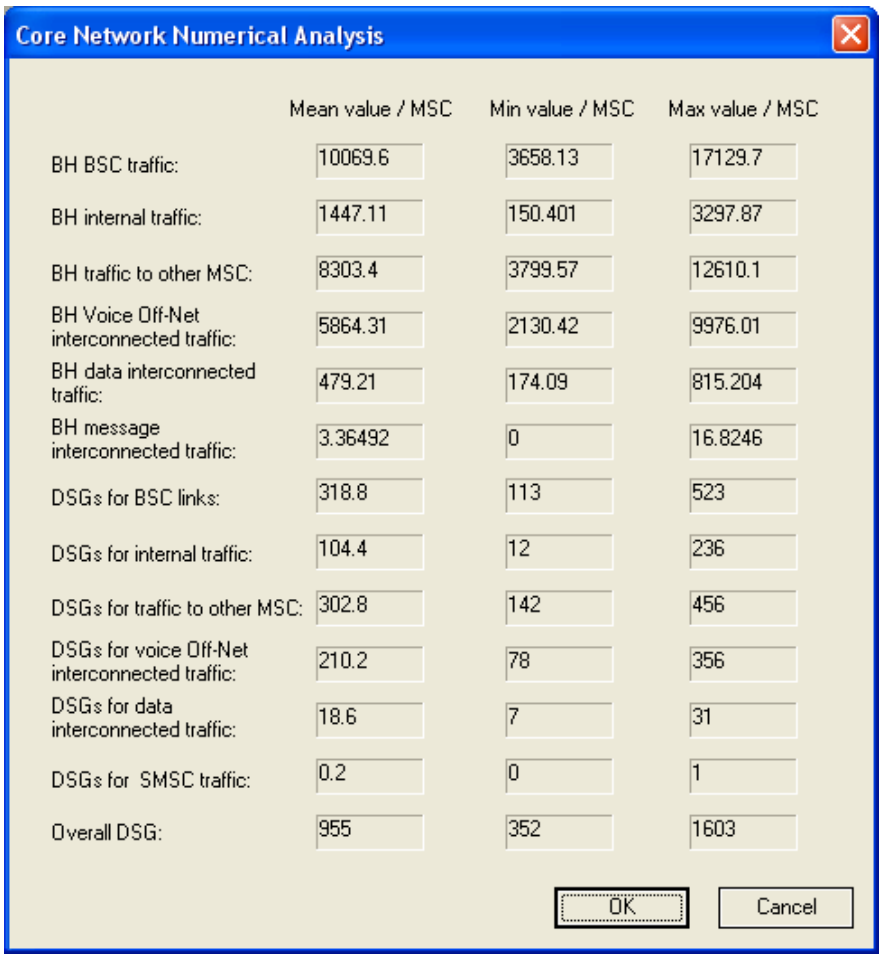
Additionally, the user has to specify different blocking probabilities and the maximum number of 64 Kbps circuits to be aggregated in an E1 group. Additionally, the model provides the capacity to consider the impact of different business hours between MSC locations in eastern and western Australia and the user may specify a traffic reduction factor.

The ‘GSM CONNECT Core Network’ module also includes the ‘Equivalent Traffic File’ which provides information about the service distribution ratios (listed below) in the ‘Service Distribution Parameters’ window. The model user cannot change these values.

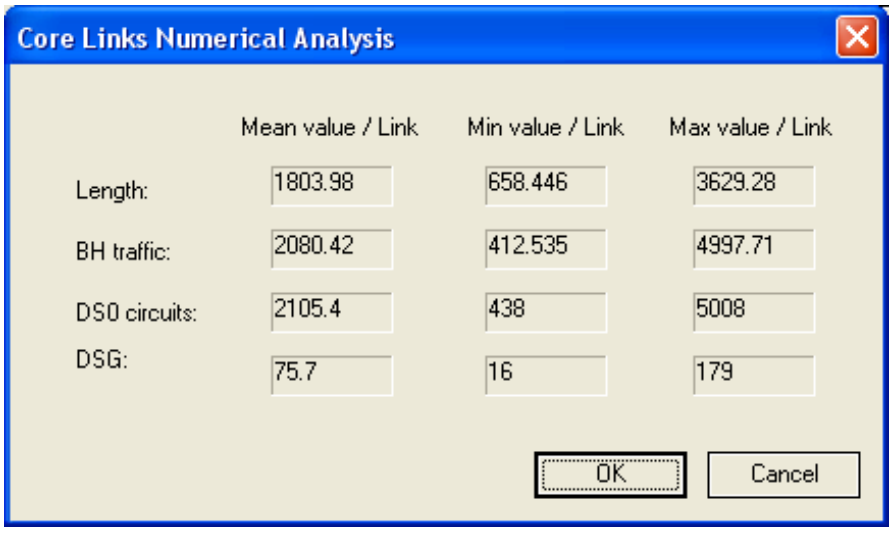


After running the ‘GSM CONNECT Core Network’ module, a message box appears indicating successful execution.

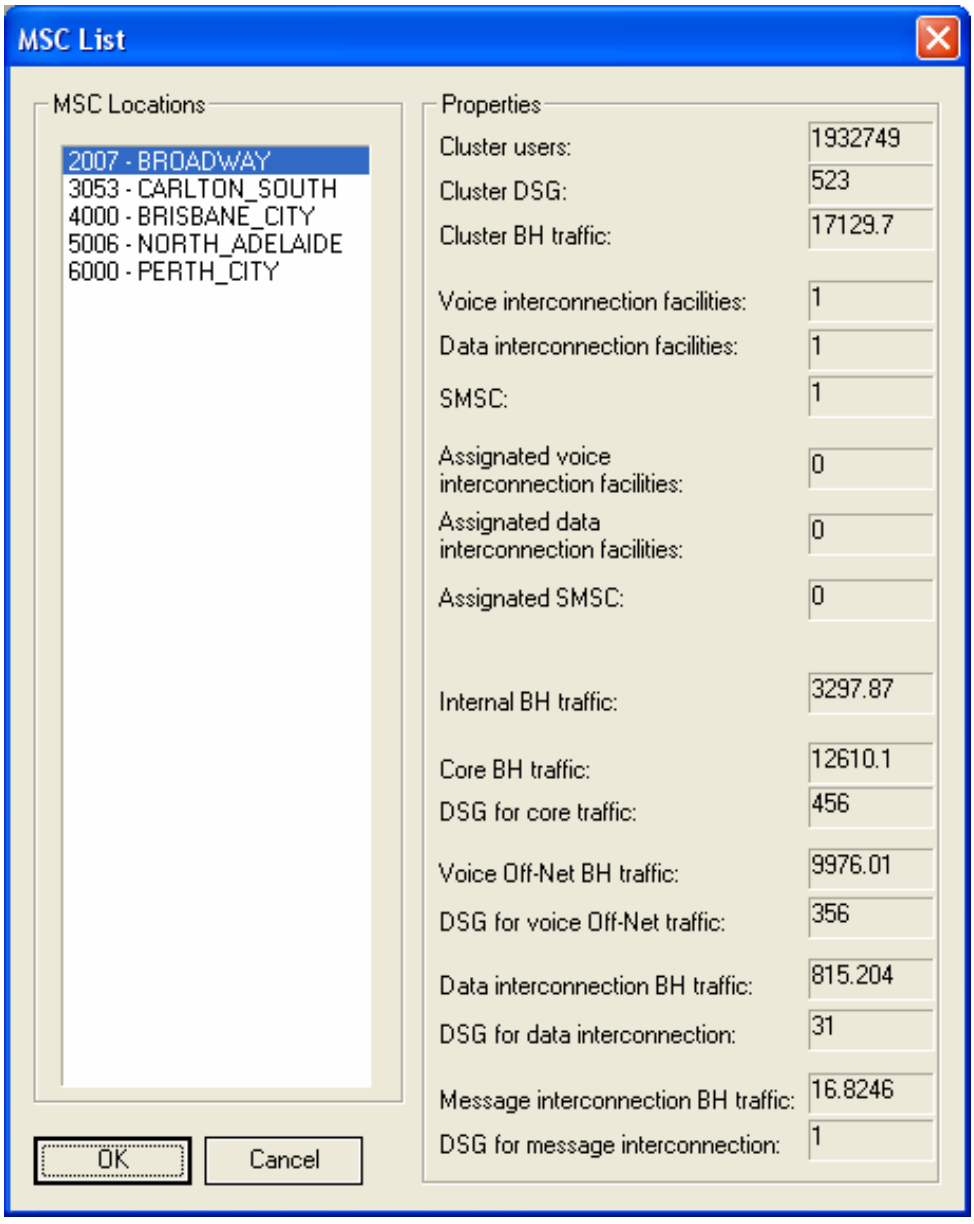
The ‘GSM CONNECT Core Network’ module provides numerical and graphical outputs. The following ‘Core Network Numerical Analysis’ window lists relevant information about the core design:



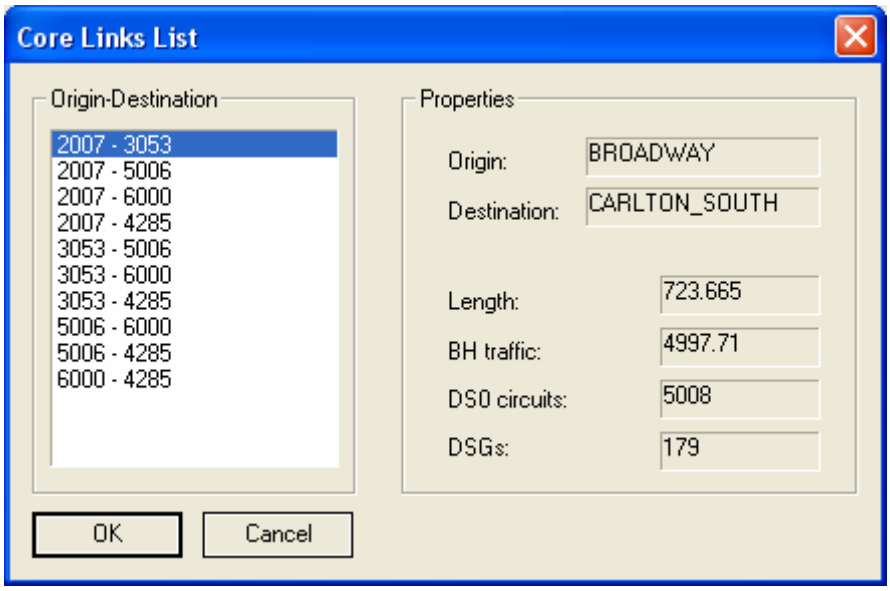
The ‘Core Links Numerical Analysis’ window provides relevant information about the links in the core network (listed below).



The ‘MSC List’ window provides relevant information about the MSCs of the network.

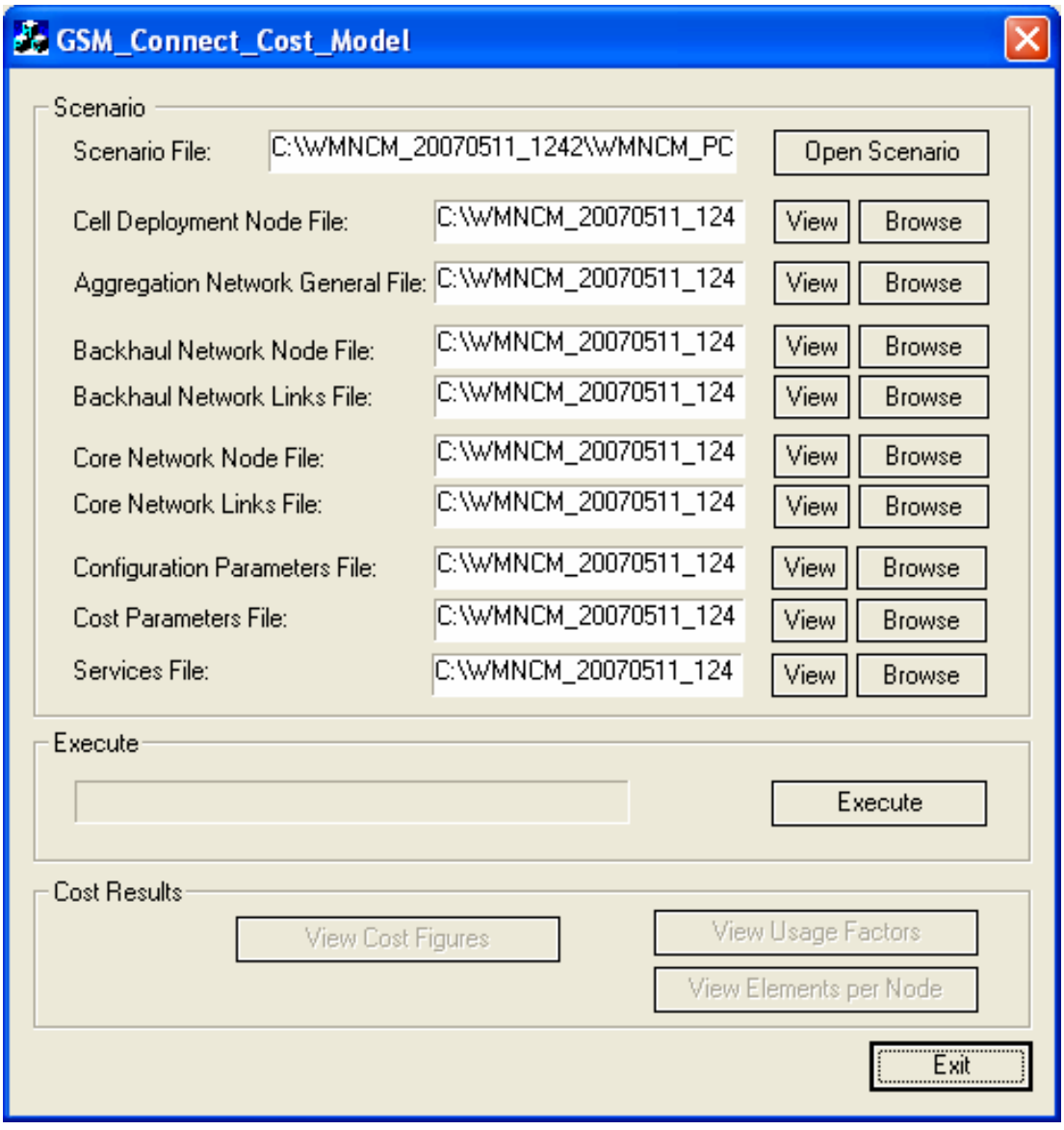


Compared to the backhaul and aggregation networks, the number of outputs relevant to the core network (links and location) are relatively small. The user can view the values of the core link as displayed in the following window ('Core Links List'):



5.6 GSM CONNECT Cost Module

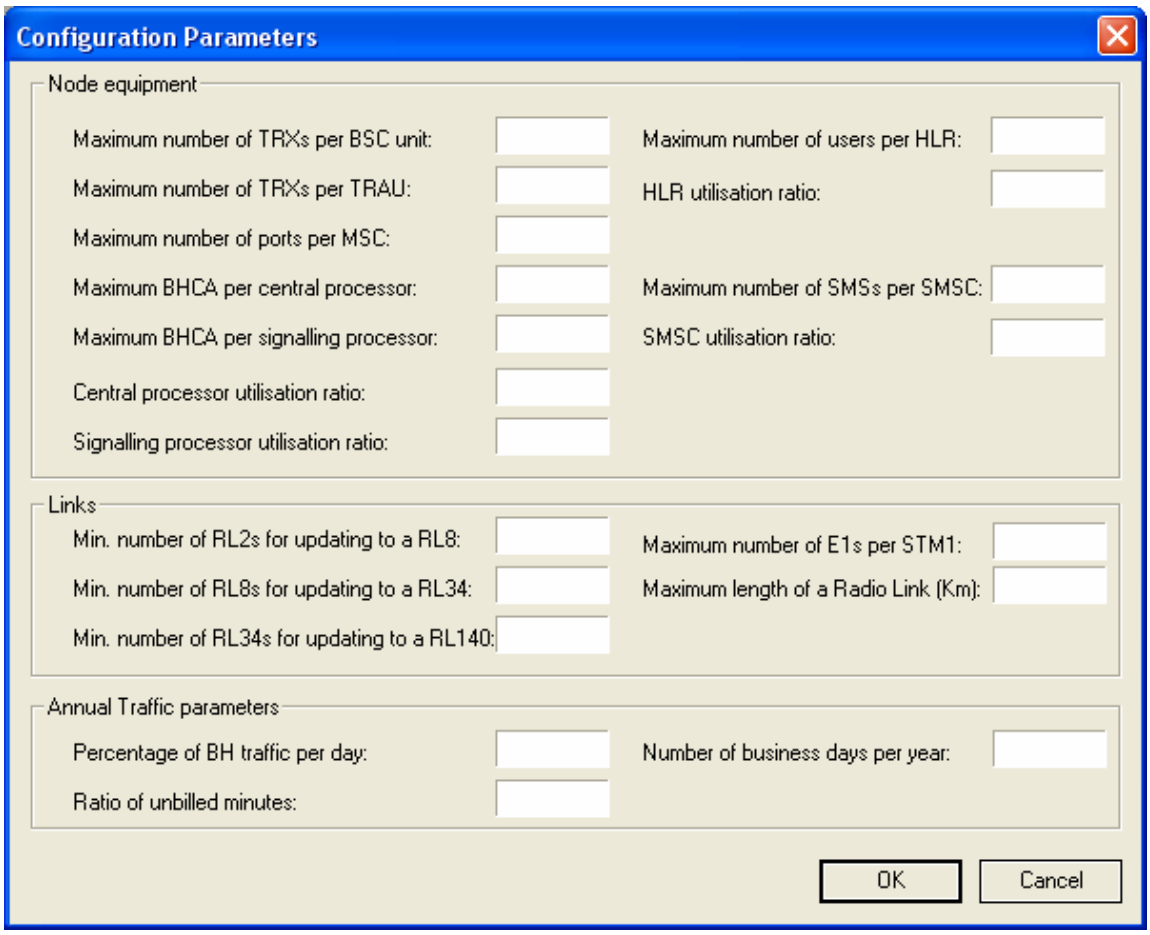
The 'GSM CONNECT Cost Module' is accessed initially through the following window, comprising of the output files from previous modules (GSM CONNECT Cell Deployment, GSM CONNECT Aggregation Network, GSM CONNECT Backhaul Network (nodes and links), GSM CONNECT Core Network (nodes and links) and services):



The window also identifies two additional categories of inputs which the user can change:

- Additional configuration data, and
- Cost parameters.

5.6.1 ‘Configuration Parameters’ window



The ‘Configuration Parameters’ window is subdivided into three different frames containing input fields for information about ‘Node equipment’, ‘Links’ and ‘Annual Traffic parameters’.

Node equipment

The first frame in the window specifies the maximum values for parameters for different network elements, for example the maximum number of Busy Hour Call Attempts (BHCA) per central processor or the maximum number of ports an MSC can manage. Moreover, the user may also set the maximum number of TRXs per BSC or TRAU unit.

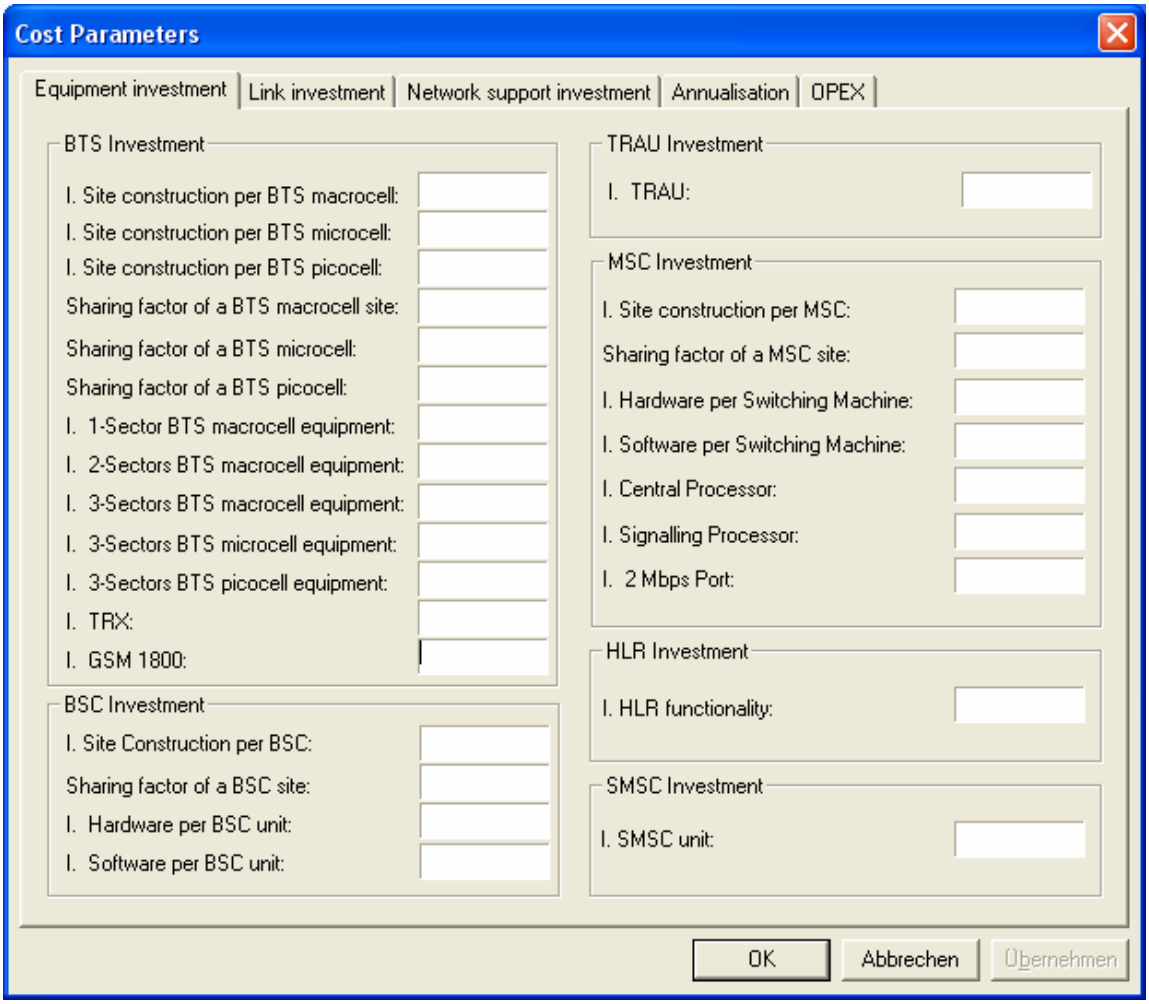
Links

The second frame focuses on the specifications for links, including different types of radio links, physical lines and the maximum length of a radio link which can be bridged without the need for a repeater.

Annual Traffic parameters

The third frame on 'Annual Traffic parameters' considers information inputs required for the calculation of the annual busy hour traffic. In this window the user may specify the share of busy hour traffic per day and the number of business days. The ratio of busy hour traffic per day and the number of business days per year are the parameters used to convert traffic in the busy hour to annual traffic. In addition, in this window the model provides an input field for the ratio of unbilled minutes to total annual minutes which reduces the total annual minutes relevant for the cost estimation.

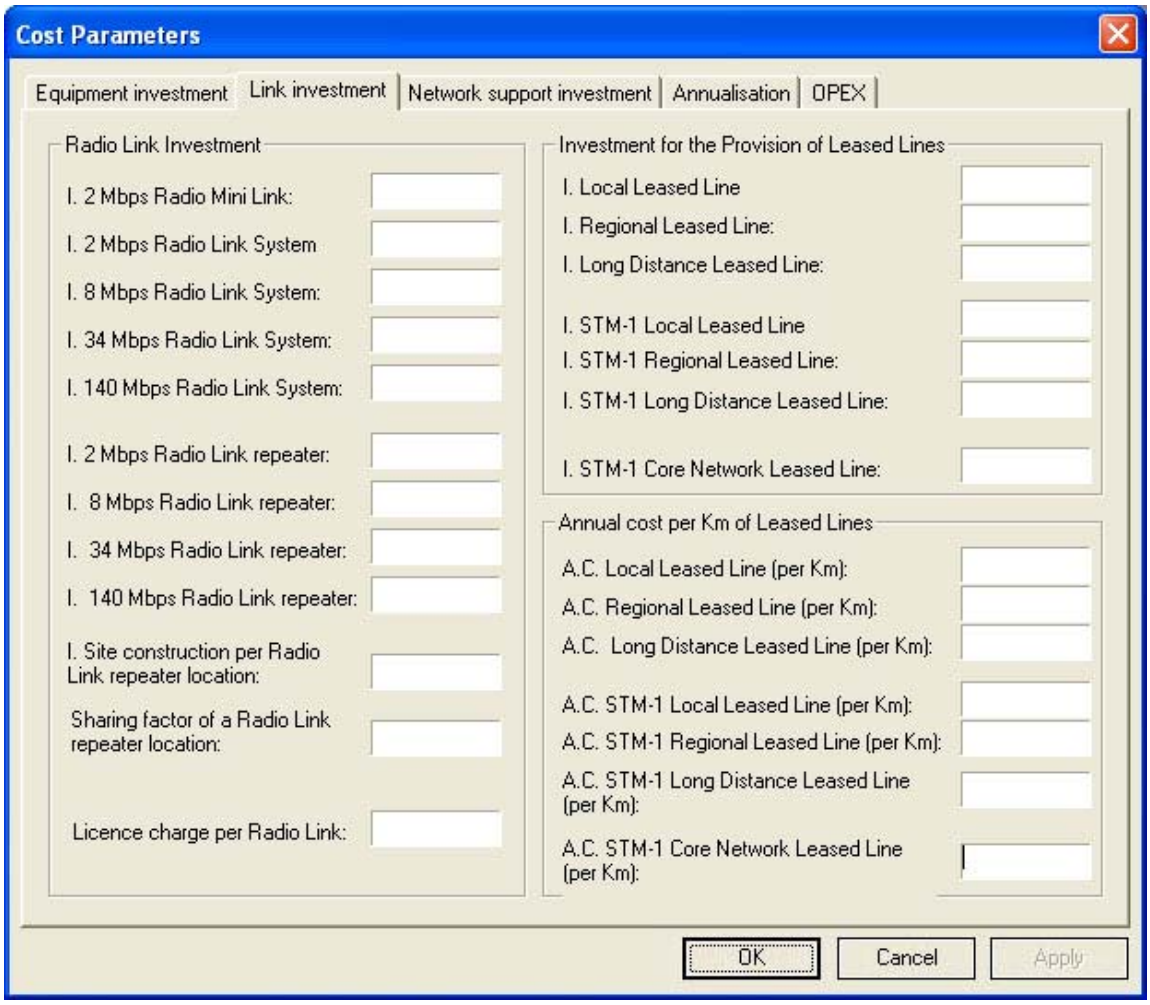
5.6.2 'Cost Parameters' window



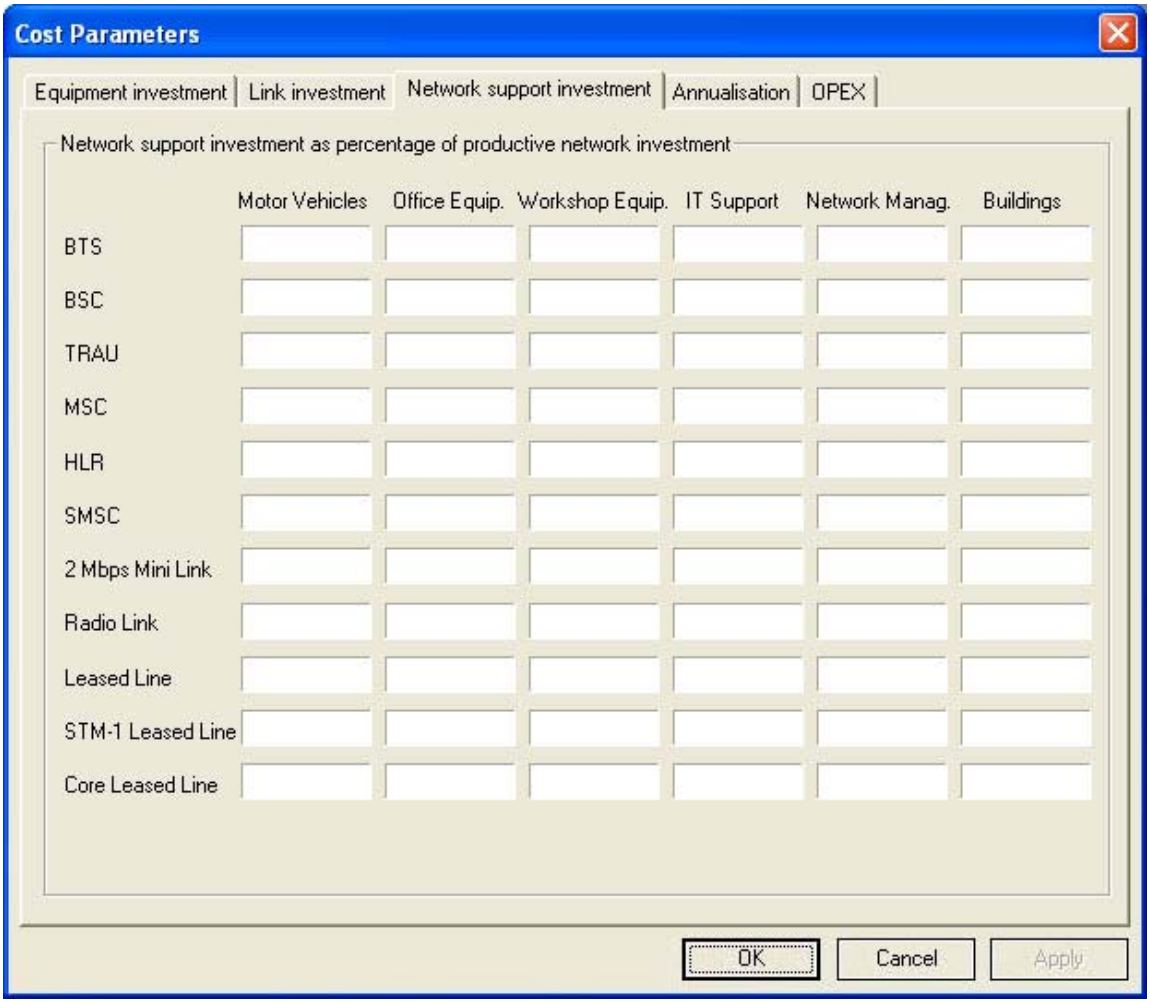
The 'Cost Parameters' windows contains data about the value of investment used in the model.

Equipment investment mainly refers to investment in productive network assets.

'BTS Investment' contains information about the value of investment in BTSs, site equipment and the sharing factors for these sites. A sharing factor is given for BTSs, BSCs and MSCs. This specifies the share of site investment that is borne by the mobile network operator. For additional information on the site sharing factor refer to section 5.3.4 of the Report.



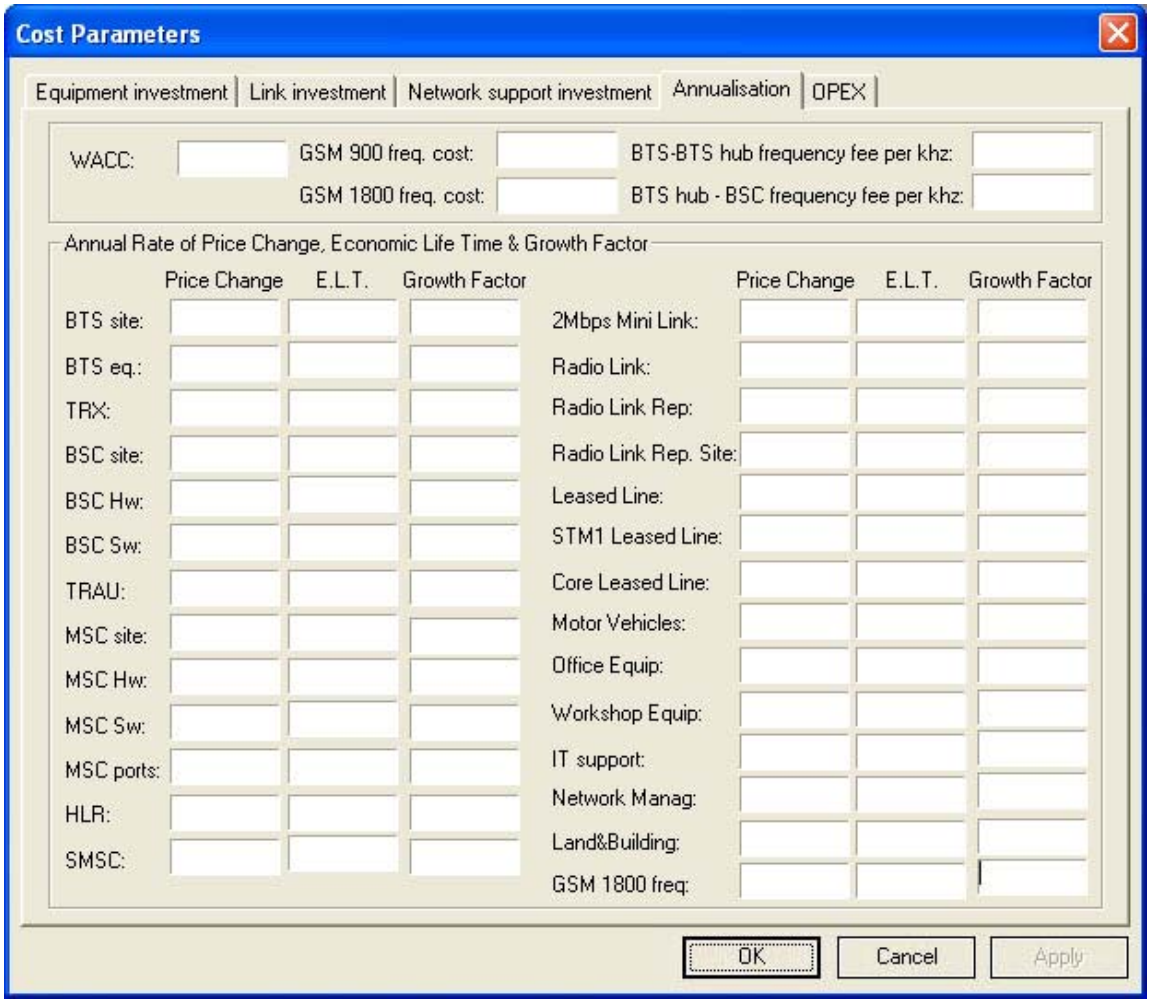
The 'Link investment' window provides information about the investment figures for radio links, repeaters and leased lines. Moreover, the window lists the sharing factor for repeater sites. Additionally, this window contains parameters for the annual costs per kilometre for different types of leased lines. In this module the leased lines are classified according to their length as local (0-10 kilometres), regional (10-150 kilometres) and long distance (more than 150 kilometres) leased lines and by the type of transmission system.



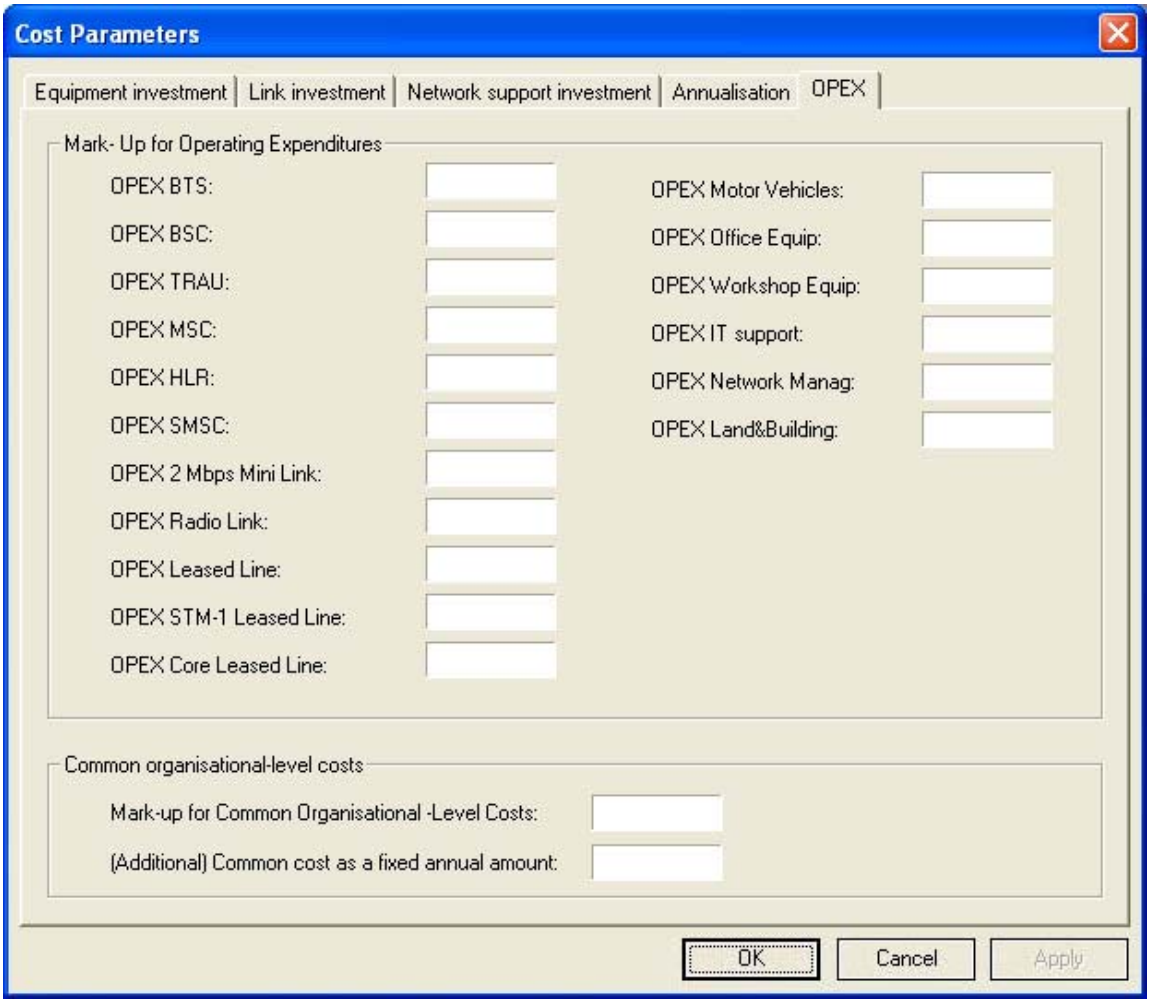
The ‘Network support investment’ window contains parameters in the form of mark-ups on the network support assets for the following:

- Motor vehicles,
- Office equipment,
- Workshop equipment,
- IT support,
- Network management, and
- Buildings.

The input values are applied as a mark-up on the investment value of the specific network element.



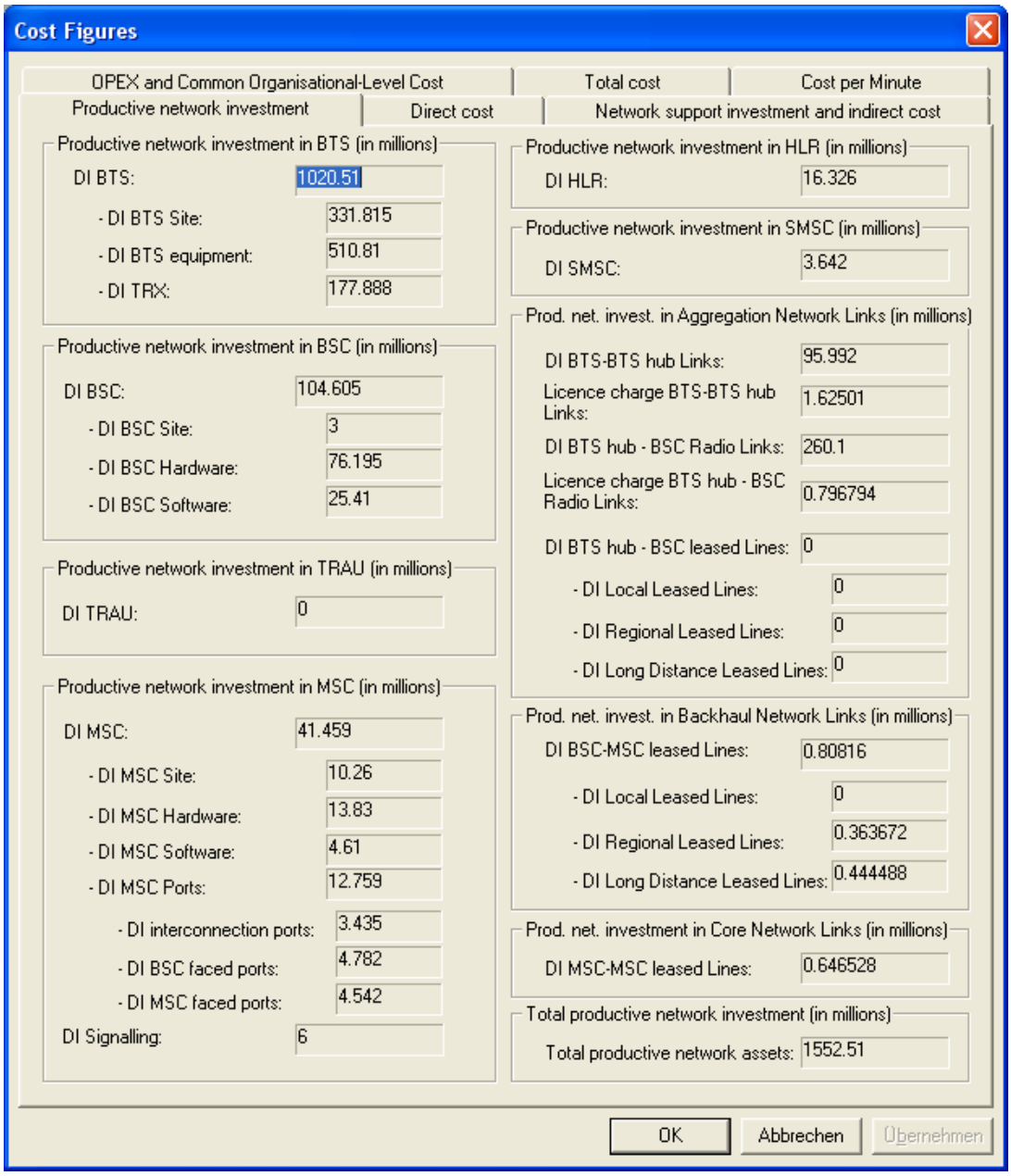
The ‘Annualisation’ window contains parameters about expected average annual price changes, economic lifetimes and growth factors specified by network elements. The parameters are commonly applied to transform investment values into annual cost values.



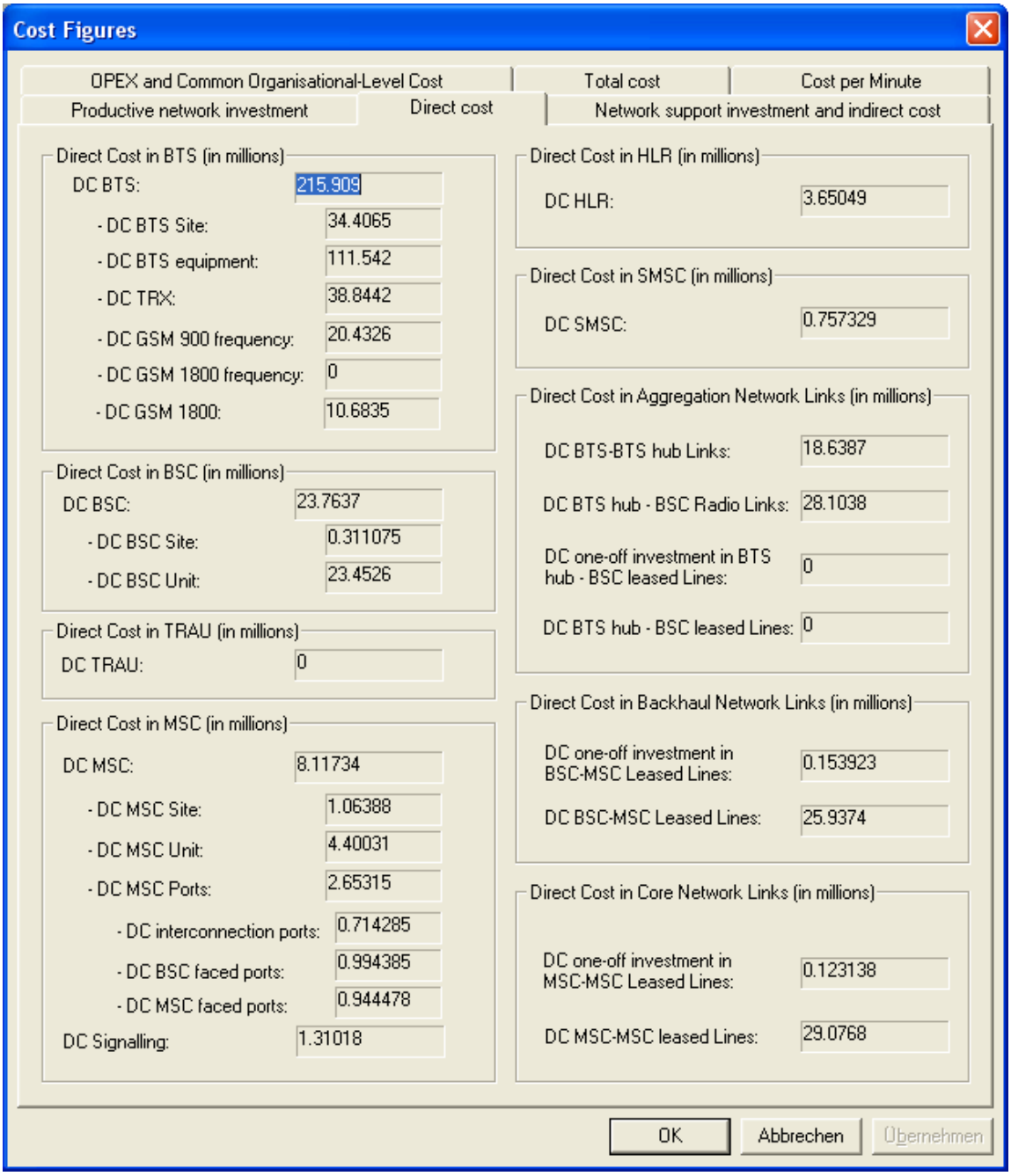
The ‘OPEX’ window includes mark-ups that are applied on the investment values of specific network assets (which include the investment in the productive network assets and the network support assets).

The common organisational-level cost is a percentage mark-up on annualised CAPEX (direct and indirect cost), and OPEX (as outlined in section 4.3.2.2 of the Report).

The results of the 'GSM CONNECT Cost Module' are contained in a series of worksheets:

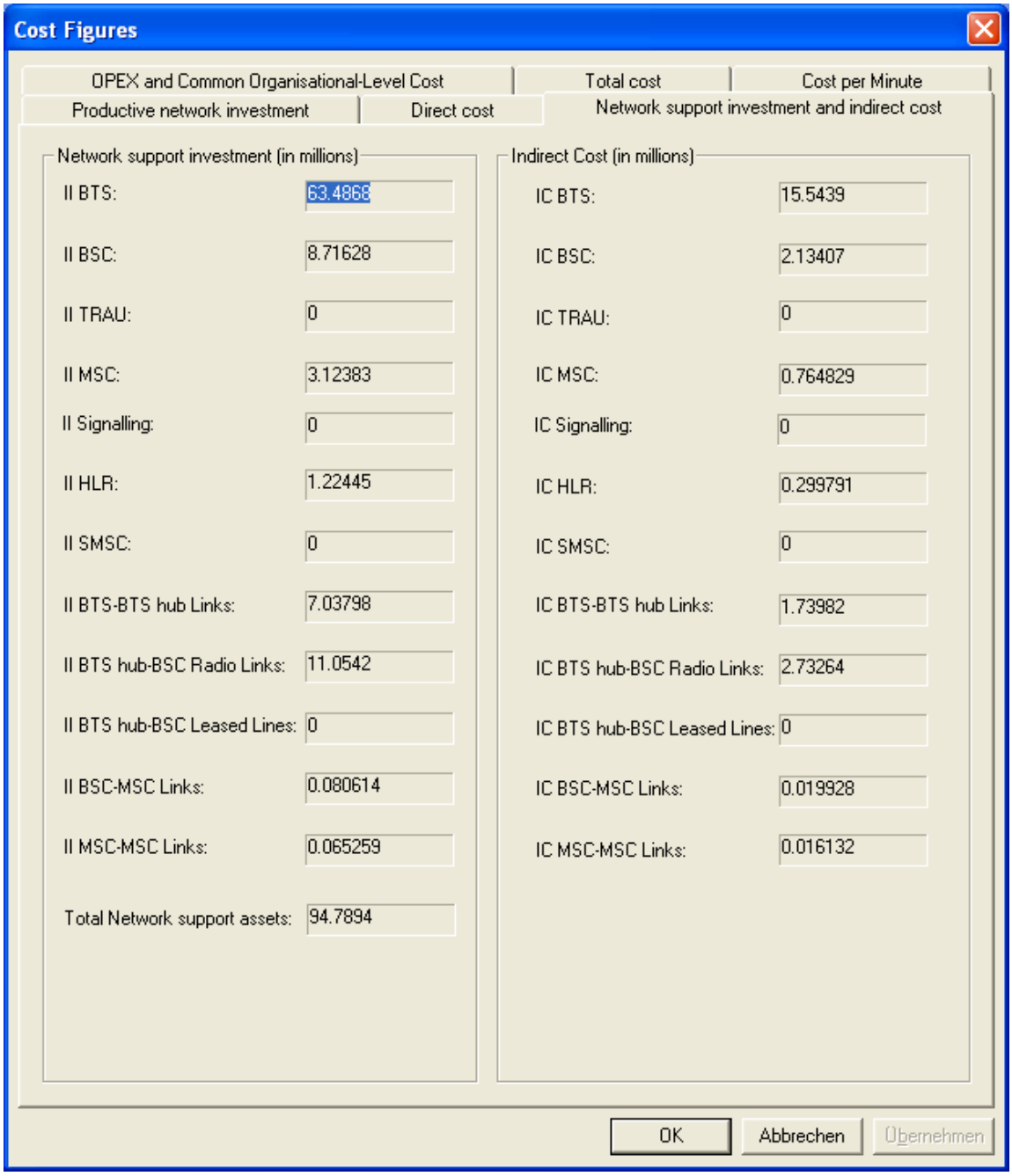


When all the input parameters are specified in the 'GSM CONNECT Cost Module' and the module is executed, the resulting costs can be seen by clicking the 'View Cost Figures' button. The 'Productive network investment' window contains a list of the investment value of productive network assets and links.

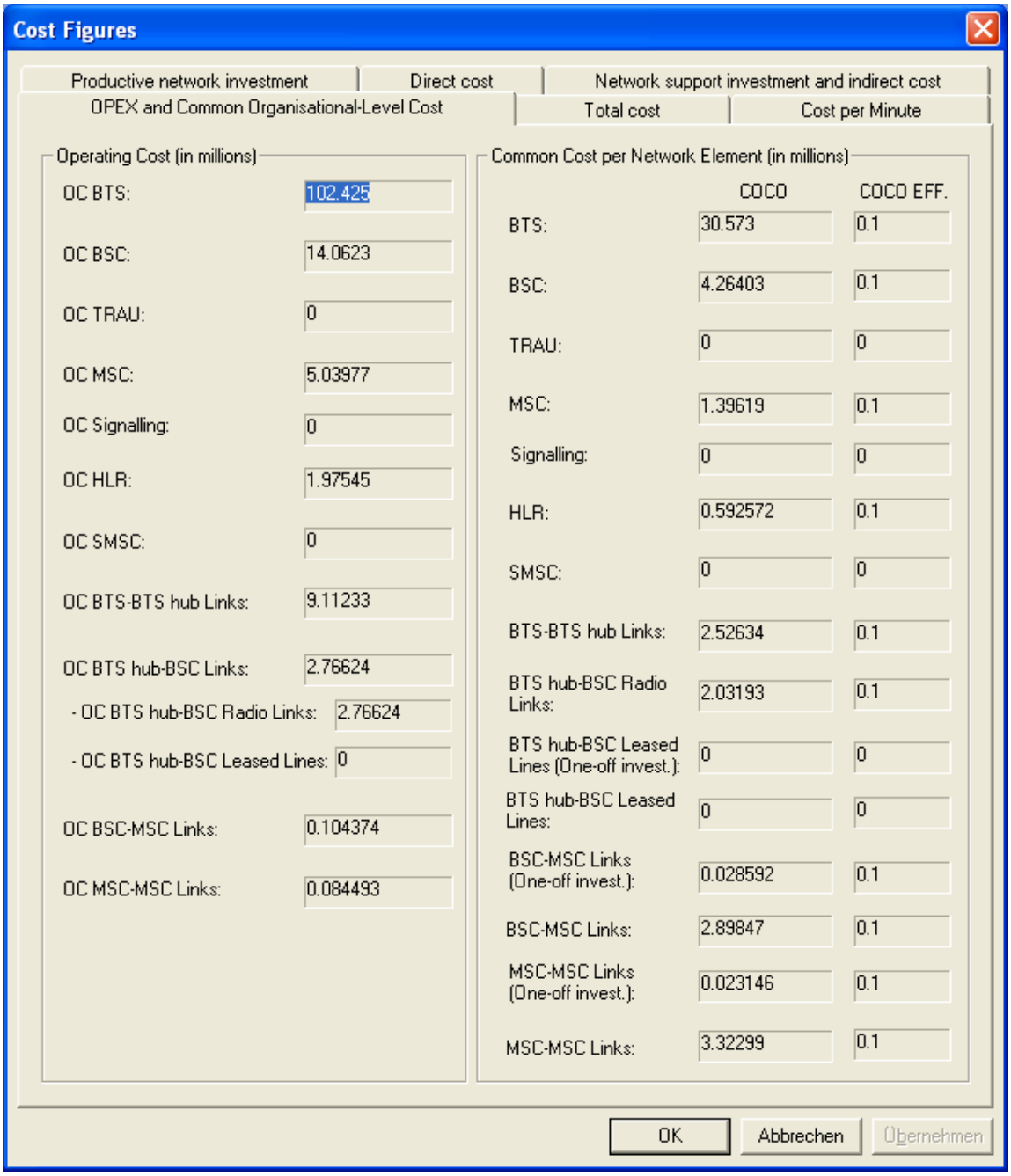


The relevant costs for the productive network assets are presented in the 'Direct cost' window. Among others this window includes annual licence costs for 900 MHz and 1,800 MHz and annual leased line costs.[6]

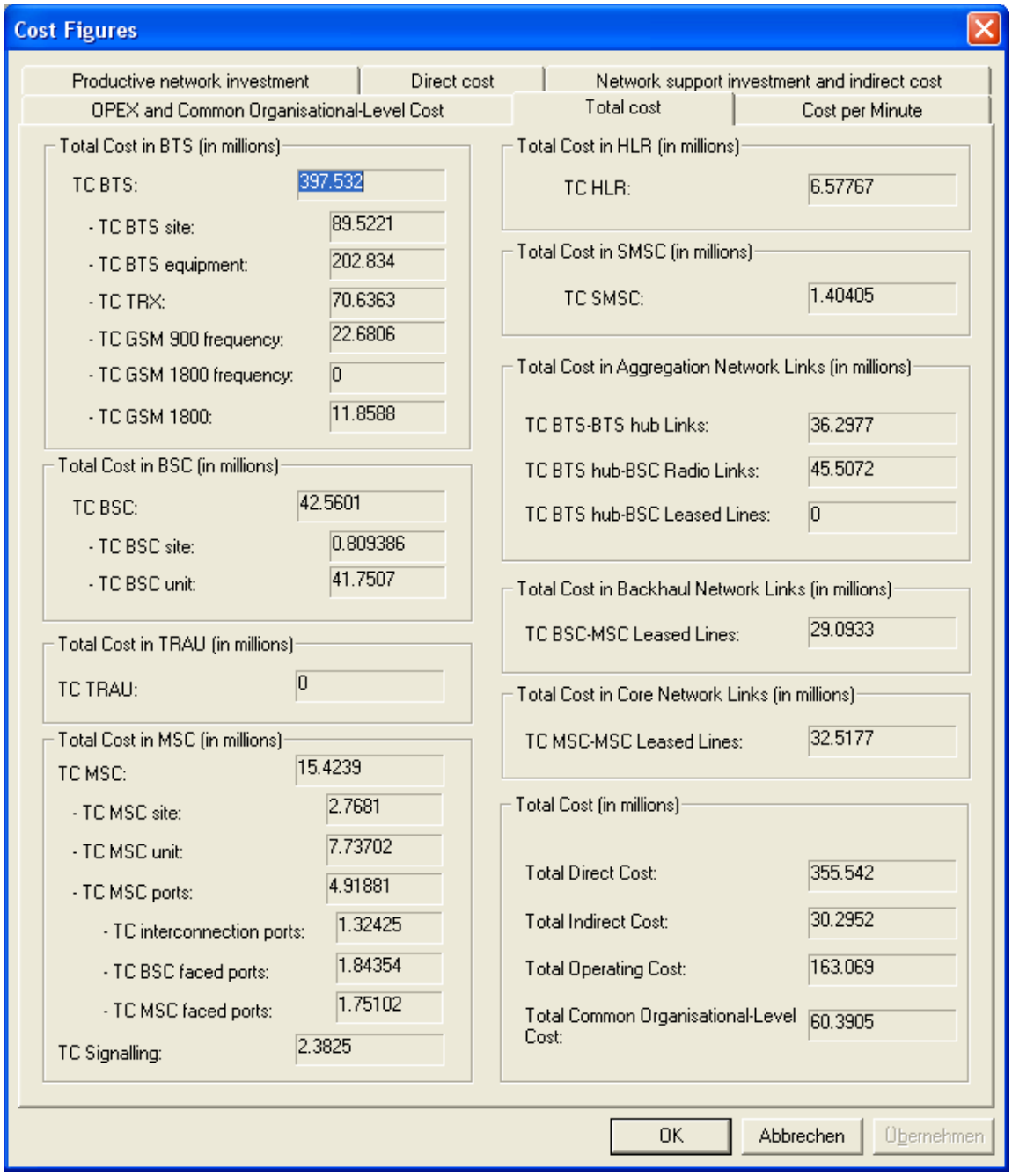
6 Regarding the aggregation network the annual leased line costs can be found in the 'DC BTS-BTS hub Links', 'DC one-off investment in BTS hub – BSC leased Lines', and 'DC BTS hub – BSC leased Lines' fields. The 'Direct Cost in Backhaul Network Links (in millions)', and 'Direct Cost in Core Network Links (in millions)' frames provide the same information for the backhaul network and the core network.



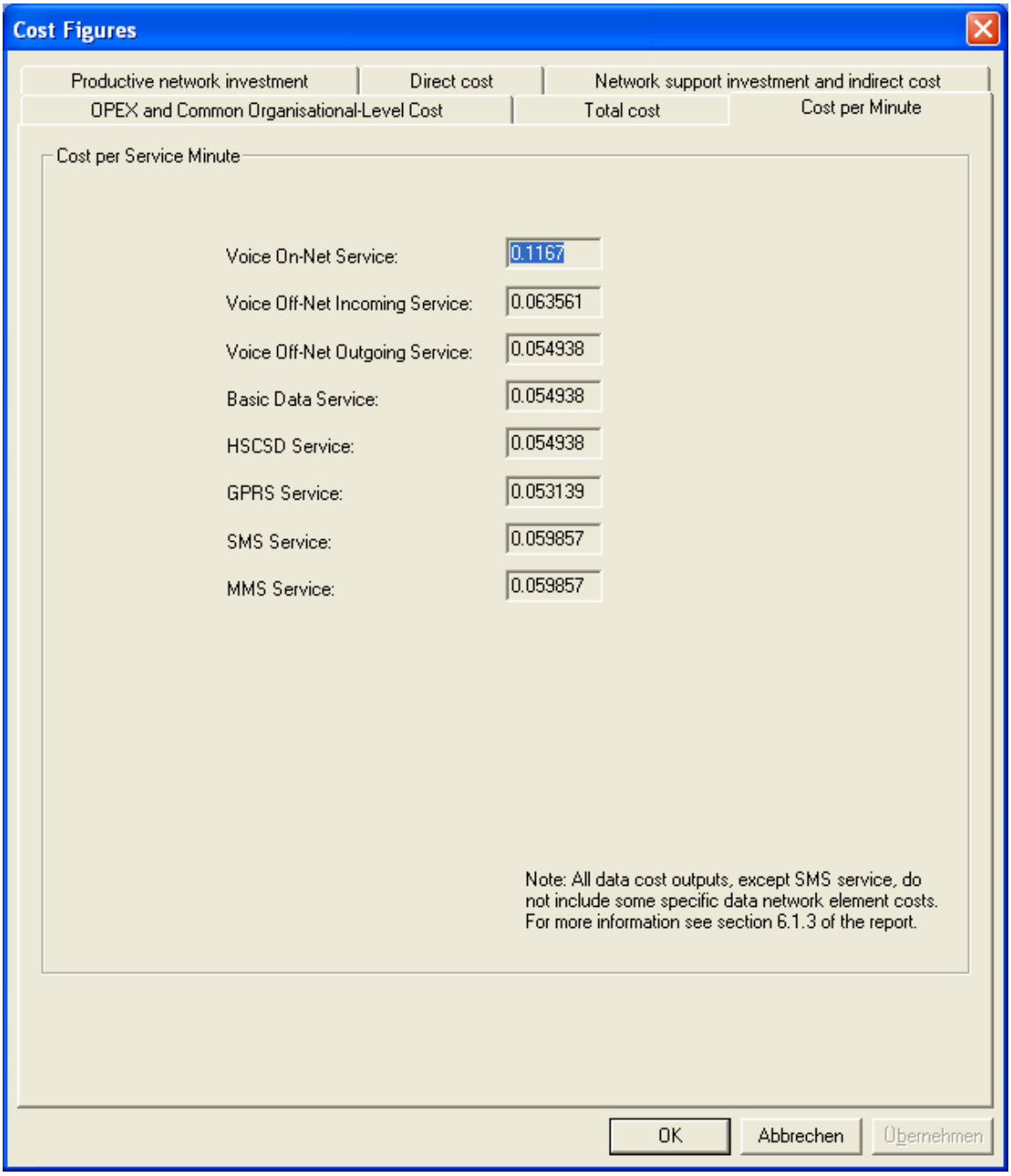
The ‘Network support investment and indirect cost’ window summarises the investment values for network support assets and the associated annual (indirect) costs.



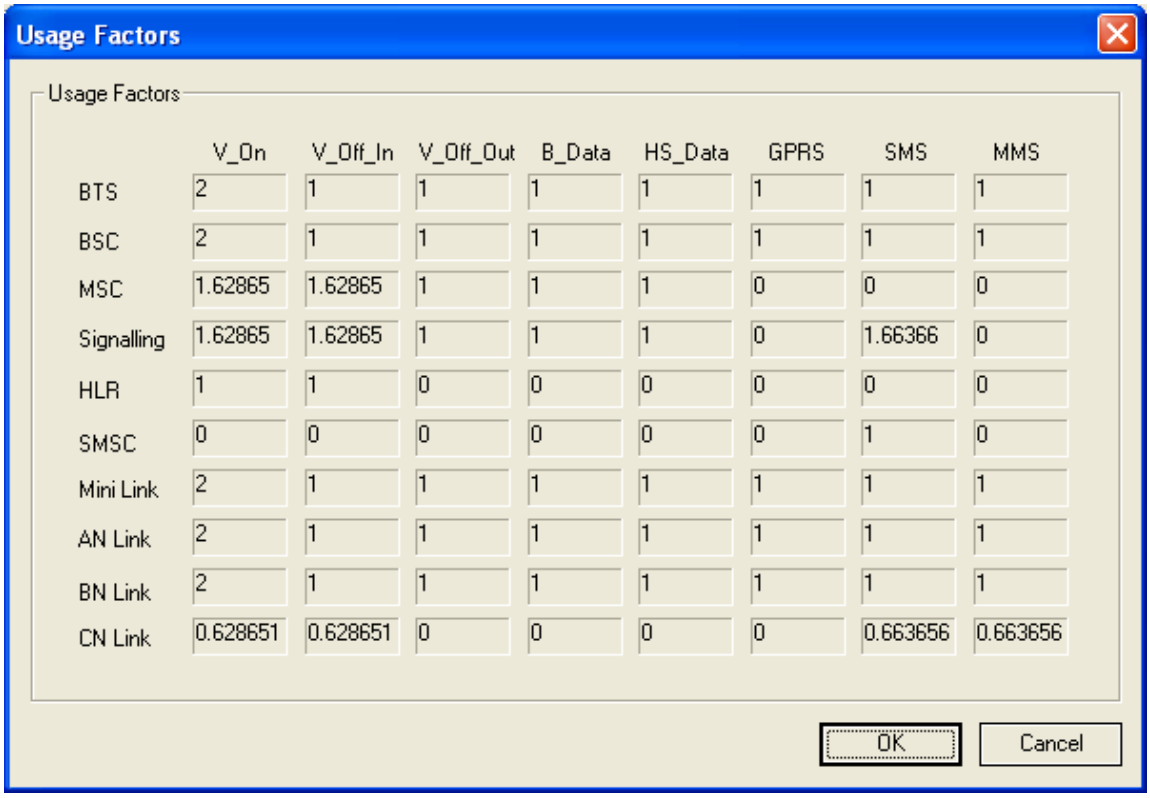
The ‘OPEX and Common Organisational-Level Cost’ window includes the outputs for OPEX and common organisational-level costs. This window identifies the common organisational-level costs per network element (which could be found in the column ‘COCO’) and an effective mark-up per network element which reflects the common organisational-level cost mark-up and a fixed amount of annual common organisational-level costs. The column ‘COCO EFF’ includes these effective common organisational-level cost mark-ups.



The ‘Total cost’ window in the ‘GSM CONNECT Cost Module’ provides the total cost (annualised CAPEX (direct and indirect costs), OPEX and common organisational-level costs) classified by network element as well as the total costs of the whole network that are commonly regarded as relevant.

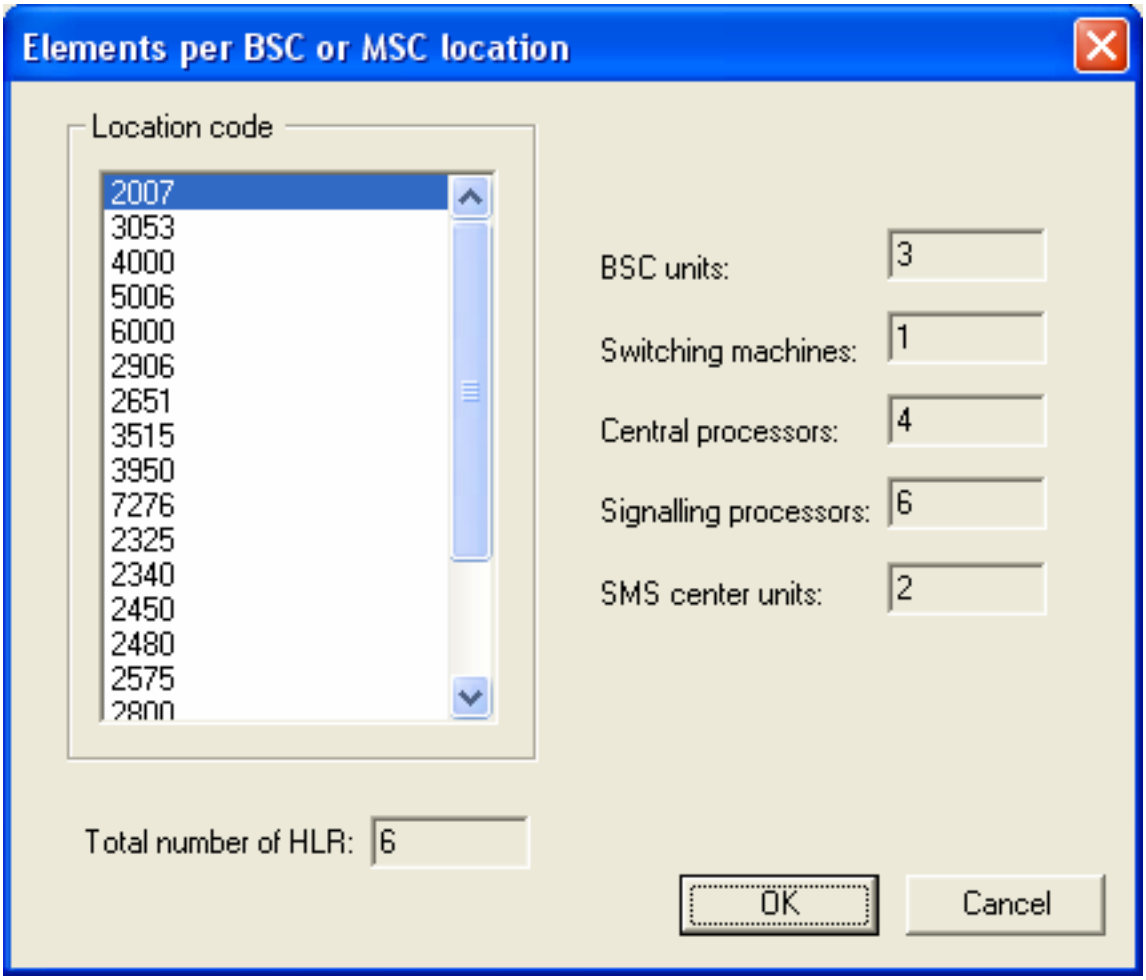


The ‘Cost per Service Minute’ window provides information on the cost per minute differentiated by services. The model lists these results for the voice services Voice On-Net, Voice Off-Net Incoming and Voice Off-Net Outgoing as well as for the data services: Basic Data, HSCSD, GPRS, SMS and MMS.



The ‘GSM CONNECT Cost Module’ also includes a ‘View Usage Factors’ function which provides a ‘Usage Factors’ window listing both voice service usage minutes and data service usage minutes differentiated by network elements. Generally, the usage factors may lie in a feasible range of between 0 and 2 (and can include several decimal places).

Additionally, the ‘GSM CONNECT Cost Module’ provides information about the equipment installed at BSC and MSC locations which the user can access by clicking the button ‘View Elements per Node’. If the user selects this option, the window ‘Elements per BSC or MSC location’ appears. The user can select a location code in order to identify the corresponding network equipment per location code. For each node the window outlines the number of BSC units, switching machines, central processors, signalling processors and SMSC units. Moreover, in this window the model provides information about the number of HLRs required for operating the network.


Elements per BSC or MSC location
Location code
2007
3053
4000
5006
6000
2906
2651
3515
3950
7276
2325
2340
2450
2480
2575
2800
BSC units:
3
Switching machines:
1
Central processors:
4
Signalling processors:
6
SMS center units:
2
Total number of HLR:
6
OK
Cancel

6 Output file

This section provides the specification of the output file provided by the 'GSM CONNECT Cost Module'.

Variable	Explanation
di_bts	Productive network investment in BTS
di_bts_site	Productive network investment in BTS sites
di_bts_eq	Productive network investment in BTS equipment
di_trx	Productive network investment in TRX
di_bsc	Productive network investment in BSC
di_bsc_site	Productive network investment in BSC sites
di_bsc_unit_hw	Productive network investment in BSC hardware
di_bsc_unit_sw	Productive network investment in BSC software
di_trau	Productive network investment in TRAU
di_msc	Productive network investment in MSC
di_msc_site	Productive network investment in MSC sites
di_msc_hw	Productive network investment in MSC hardware
di_msc_sw	Productive network investment in MSC software
di_msc_ports	Productive network investment in MSC ports
di_msc_icports	Productive network investment in MSC ports (facing IC)
di_msc_bscports	Productive network investment in MSC ports (facing BSC)
di_msc_mscports	Productive network investment in MSC ports (facing MSC)
di_HLR	Productive network investment in HLR
di_smsc	Productive network investment in SMSC
di_rl2_bts_btsh	Productive network investment in radio links between BTS and BTS hub
di_rlx_btsh_bsc	Productive network investment in radio links between BTS hub and BSC
di_ll2f_btsh_bsc	Upfront (one off) investment in leased lines (2 Mbps) between BTS hub and BSC
di_ll2f_loc_btsh_bsc	Upfront (one off) investment in leased lines (2Mbps) between BTS hub and BSC (local)
di_ll2f_reg_btsh_bsc	Upfront (one off) investment in leased lines (2Mbps) between BTS hub and BSC (regional)
di_ll2f_ld_btsh_bsc	Upfront (one off) investment in leased lines (2Mbps) between BTS hub and BSC (long distance)
di_ll155f_bsc_msc	Upfront (one off) investment in leased lines (155 Mbps) between BSC and MSC
di_ll155f_loc_bsc_msc	Upfront (one off) investment in leased lines (155 Mbps) between BSC and MSC (local)
di_ll155f_reg_bsc_msc	Upfront (one off) investment in leased lines (155 Mbps) between BSC and MSC (regional)
di_ll155f_ld_bsc_msc	Upfront (one off) investment in leased lines (155 Mbps) between BSC and MSC (long distance)
di_ll155f_core	Upfront (one off) investment in leased lines (155 Mbps) between MSC and MSC
ii_bts	Investment in network support assets for BTS

Variable	Explanation
ii_bsc	Investment in network support assets for BSC
ii_trau	Investment in network support assets for TRAU
ii_msc	Investment in network support assets for MSC
ii_hlr	Investment in network support assets for HLR
ii_smsc	Investment in network support assets for SMSC
ii_bts_btsh	Investment in network support assets for BTS – BTS hub links
ii_rlx_btsh_bsc	Investment in network support assets for BTS hub – BSC radio links
ii_ll2f_btsh_bsc	Investment in network support assets for BTS hub – BSC leased lines (2Mbps)
ii_ll155f_bsc_msc	Investment in network support assets for BCS – MSC leased lines (155Mbps)
ii_ll155f_core	Investment in network support assets for MCS – MSC leased lines (155Mbps)
dc_bts	Direct cost for BTS
dc_bts_site	Direct cost for BTS sites
dc_bts_eq	Direct cost for BTS equipment
dc_trx	Direct cost for TRX
lic_GSM900	Licence cost for GSM 900
lic_GSM1800	Licence cost for GSM 1,800
dc_bsc	Direct cost for BSC
dc_bsc_site	Direct cost for BSC sites
dc_bsc_unit	Direct cost for BSC hardware and software
dc_trau	Direct cost for TRAU
dc_msc	Direct cost for MSC
dc_msc_site	Direct cost for MSC sites
dc_msc_unit	Direct cost for MSC hardware and software
dc_msc_ports	Direct cost for MSC ports
dc_msc_icports	Direct cost for MSC ports (facing IC)
dc_msc_bscports	Direct cost for MSC ports (facing BSC)
dc_msc_mscports	Direct cost for MSC ports (facing MSC)
dc_hlr	Direct cost for HLR
dc_smsc	Direct cost for SMSC
dc_rl2_bts_btsh	Direct cost for radio links between BTS and BTS hub
dc_rl_btsh_bsc	Direct cost for radio link systems between BTS hub and BSC
dc_ll2f_btsh_bsc	Direct cost (one off) for leased lines (2 Mbps) between BTS hub and BSC
dc_ll2_btsh_bsc	Direct cost for leased lines (2 Mbps) between BTS hub and BSC
dc_ll155f_bsc_msc	Direct cost (one off) for leased lines (155 Mbps) between BSC and MSC
dc_ll155_bsc_msc	Direct cost for leased lines (155 Mbps) between BSC and MSC
dc_l1155f_core	Direct cost (one off) for leased lines (155 Mbps) between MSC and MSC
dc_ll155_core	Direct cost for leased lines (155 Mbps) between MSC and MSC
ic_bts	Indirect cost for BTS
ic_bsc	Indirect cost for BSC

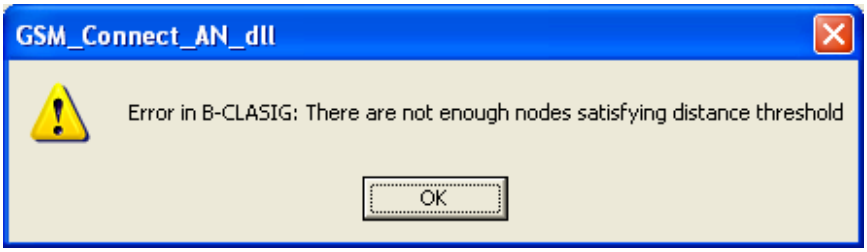
Variable	Explanation
ic_trau	Indirect cost for TRAU
ic_msc	Indirect cost for MSC
ic_hlr	Indirect cost for HLR
ic_smsc	Indirect cost for SMSC
ic_rl2_bts_btsh	Indirect cost for BTS – BTS hub radio links
ic_rl_btsh_bsc	Indirect cost for BTS hub – BSC radio links
ic_ll2f_btsh_bsc	Indirect cost for BTS hub – BSC leased lines (2Mbps)
ic_ll155f_bsc_msc	Indirect cost for BCS – MSC leased lines (155Mbps)
ic_ll155f_core	Indirect cost for MCS – MSC leased lines (155Mbps)
oc_bts	Operating cost for BTS
oc_bsc	Operating cost for BSC
oc_trau	Operating cost for TRAU
oc_msc	Operating cost for MSC
oc_hlr	Operating cost for HLR
oc_smsc	Operating cost for SMSC
oc_bts_btsh	Operating cost for BTS – BTS hub links
oc_btsh_bsc	Operating cost for BTS hub – BSC links
oc_rl_btsh_bsc	Operating cost for BTS hub – BSC radio links
oc_ll2f_btsh_bsc	Operating cost for BTS hub – BSC leased lines (2Mbps)
oc_ll155f_bsc_msc	Operating cost for BCS – MSC leased lines (155Mbps)
oc_ll155f_core	Operating cost for MCS – MSC leased lines (155Mbps)
totdc	Total direct cost
totic	Total indirect cost
totoc	Total operating cost
totcoco	Total common cost
coco_bts	Common organisational-level cost for BTS
coco_bsc	Common organisational-level cost for BSC
coco_trau	Common organisational-level cost for TRAU
coco_msc	Common organisational-level cost for MSC
coco_hlr	Common organisational-level cost for HLR
coco_smsc	Common organisational-level cost for SMSC
coco_rl2_bts_btsh	Common organisational-level cost for BTS – BTS hub radio links
coco_rl_btsh_bsc	Common organisational-level cost for BTS hub – BSC radio links
coco_ll2f_btsh_bsc	Common organisational-level cost for BTS hub – BSC leased lines (2Mbps)
coco_ll155f_bsc_msc	Common organisational-level cost for BCS – MSC leased lines (155Mbps)
coco_ll155f_core	Common organisational-level cost for MCS – MSC leased lines (155Mbps)
tot_bts	Total cost for BTS
tot_bsc	Total cost for BSC
tot_trau	Total cost for TRAU

Variable	Explanation
tot_msc	Total cost for MSC
Tot_sig	Total cost for the processor (Signalling and Central processor)
tot_hlr	Total cost for HLR
tot_smsc	Total cost for SMSC
tot_rl2_bts_btsh	Total cost for BTS – BTS hub radio links
tot_rl_btsh_bsc	Total cost for BTS hub – BSC radio links
tot_ll2f_btsh_bsc	Total cost for BTS hub – BSC leased lines (2Mbps)
tot_ll155f_bsc_msc	Total cost for BCS – MSC leased lines (155Mbps)
tot_ll155f_core	Total cost for MCS – MSC leased lines (155Mbps)
Nserv	Number of services
Costmin_i	Cost per minute for each service considered in the model - Float * Nserv
Di	Total investment in productive network assets
Ii	Total investment in network support assets
dcgsm1800frec	Direct cost in GSM 1,800 frequency
diminil2fee	Total investment in radio link fee
dirlfee	Total investment in license fee per kHz
cocoll2	Common organisational-level cost for leased lines (2Mbps)
cocoll155bn	Common organisational-level cost for leased lines in the backhaul network (155Mbps)
cocoll155cn	Common organisational-level cost for MCS – MSC leased lines (155Mbps) in the core network
coco_bts_eff	Effective common organisational-level cost for BTS
coco_bsc_eff	Effective common organisational-level cost for BSC
coco_trau_eff	Effective common organisational-level cost for TRAU
coco_msc_eff	Effective common organisational-level cost for MSC
coco_sig_eff	Effective common organisational-level cost for processing
coco_hlr_eff	Effective common organisational-level cost for HLR
coco_smsc_eff	Effective common organisational-level cost for SMSC
coco_rl2_bts_btsh_eff	Effective common organisational-level cost for BTS – BTS hub radio links
coco_rl_btsh_bsc_eff	Effective common organisational-level cost for BTS hub – BSC radio links
coco_ll2f_btsh_bsc_eff	Effective common organisational-level cost for BTS hub – BSC leased lines (one off) (2Mbps)
coco_ll155f_bsc_msc_eff	Effective common organisational-level cost for BCS – MSC leased lines (one off) (155Mbps)
coco_ll155f_core_eff	Effective common organisational-level cost for MCS – MSC leased lines (one off) (155Mbps)
coco_ll2_btsh_bsc_eff	Effective common organisational-level cost for BTS hub – BSC leased lines (2Mbps)
coco_ll155_bsc_msc_eff	Effective common organisational-level cost for BCS – MSC leased lines (155Mbps)
coco_ll155_core_eff	Effective common organisational-level cost for MCS – MSC leased lines (155Mbps)

Variable	Explanation
tot_bts_site	Total cost for BTS sites
tot_bts_eq	Total cost for BTS equipment
tot_trx	Total cost for TRX
tot_lic_GSM900	Total cost for GSM 900 frequency
tot_lic_GSM1800	Total cost for GSM 1,800 frequency
tot_GSM1800freq	Total cost for GSM 1,800 (derived from investment figure)
tot_bsc_site	Total cost for BSC sites
tot_bsc_unit	Total cost for BSC equipment (hardware and software)
tot_msc_site	Total cost for MSC sites
tot_msc_unit	Total cost for MSC equipment (hardware and software)
tot_msc_ports	Total cost for MSC ports
tot_msc_icports	Total cost for MSC interconnection ports
tot_msc_bscports	Total cost for BSC faced ports
tot_msc_mscports	Total cost for MSC faced ports
n_hlr	Total number of HLR units in the network
n_BSC_unit_i	Number of BSC units in site i
n_mach_i	Number of switching units in site i
n_cpu_i	Number of switching units in site i
n_sp_i	Number of signalling processor units in site i
n_smsc_i	Number of SMSC units in site i

7 Troubleshooting

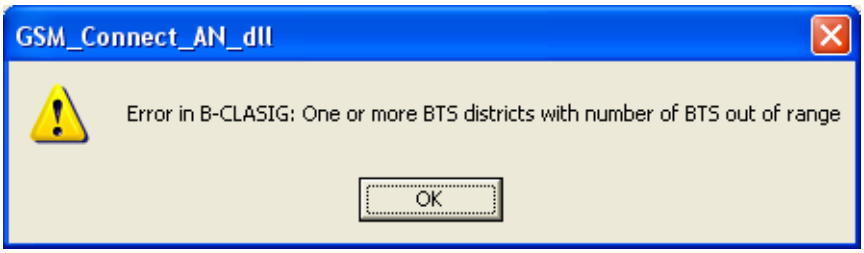
- Error message:



Possible reason: The cost model software could not find enough nodes to locate a BSC.

Possible solution(s): Reduce the number of BSC sites or, alternatively, reduce the minimum distance between the BSC locations.

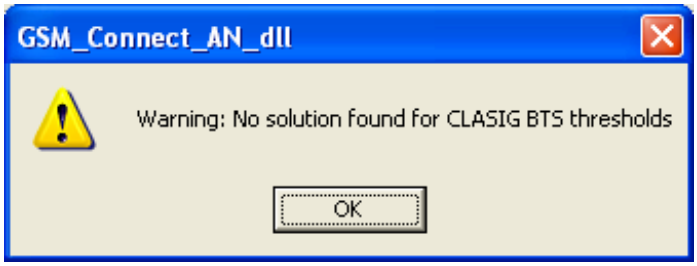
- Error message:



Possible reason: One or more BTS districts contain more BTSs than the maximum number of BTSs allowed for a BSC.

Possible solution(s): Increase the number of BSCs or, alternatively, increase the maximum number of BTSs per BSC.

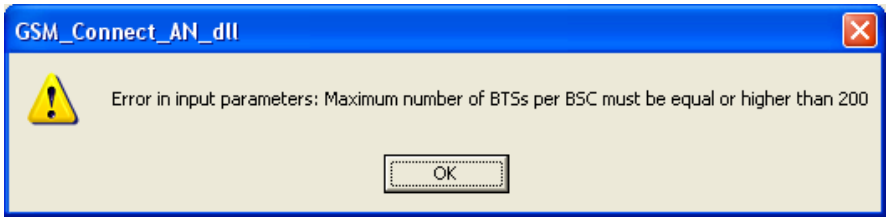
- Error message:



Possible reason: The model could not solve for the maximum number of BTSs per BSC specified by the user.

Possible solution(s): Increase the number of BSCs in the network or, alternatively, to increase the maximum number of BTSs per BSC.

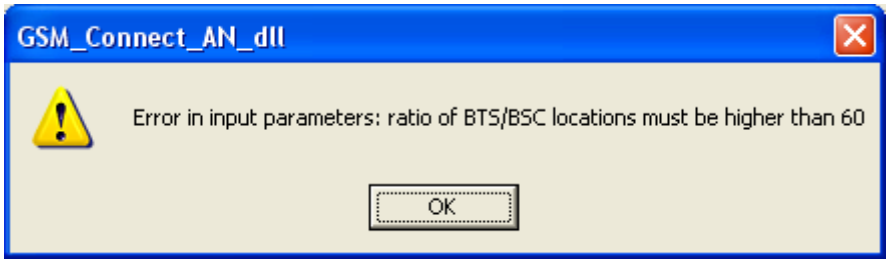
- Error message:



Possible reason: The maximum number of BTSs per BSC is lower than 200.

Possible solution(s): Increase the maximum number of BTSs per BSC to a value that is equal or higher than 200.

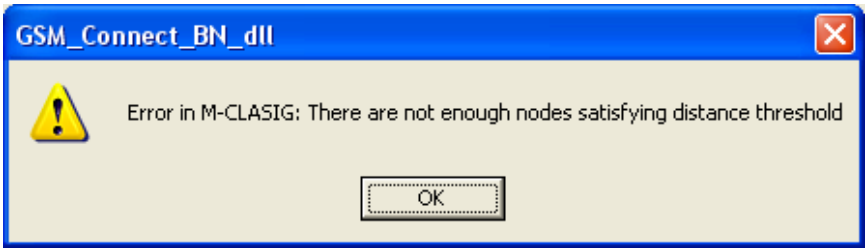
- Error message:



Possible reason: The number of BSC locations is too high.

Possible solution(s): Lower the number of BSC locations.

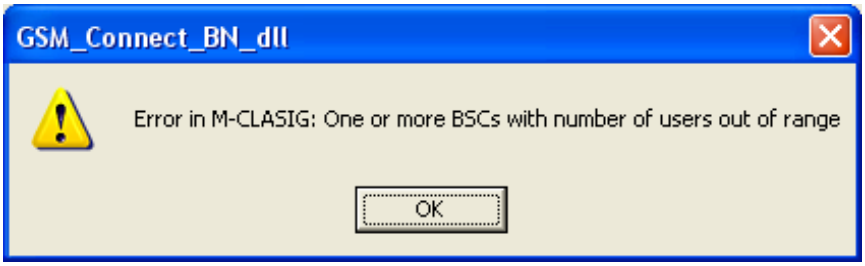
- Error message:



Possible reason: The model could not find enough nodes to locate a MSC.

Possible solution(s): Reduce the number of MSC sites in the network or, alternatively, reduce the minimum distance between MSCs.

- Error message:



Possible reason: The number of assigned users exceeds the maximum number of users allowed in a BSC at one or more BSC locations.

Possible solution(s): Increase the number of BSCs or alternatively increase the maximum number of users per BSC.

- Error message:

Possible reason: The model could not satisfy the maximum number of users per MSC.

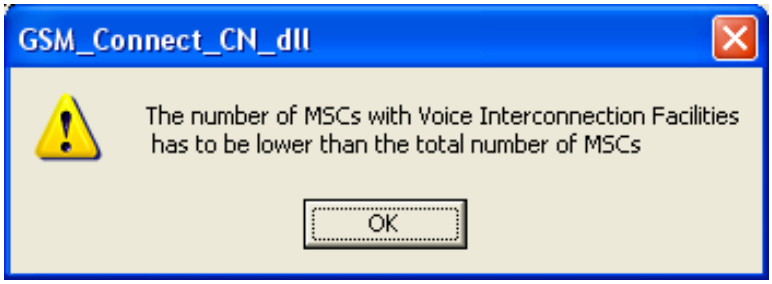
Possible solution(s): Increase the number of MSC sites in the network or, alternatively, increase the maximum number of users per MSC.

- Error message:

Possible reason: The number of MSC locations is higher than 10.

Possible solution(s): Lower the number of MSC locations in the network.

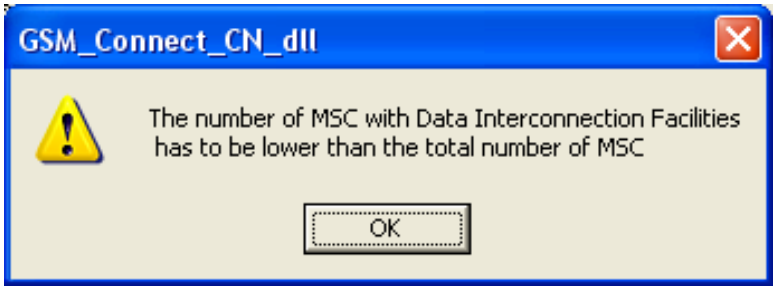
- Error message:



Possible reason: The number of MSCs with voice interconnection facilities is higher than the number of MSCs.

Possible solution(s): Reduce the number of MSCs with voice interconnection facilities.

- Error message:



Possible reason: The number of MSCs with data interconnection facilities is higher than the number of MSCs.

Possible solution(s): Reduce the number of MSCs with data interconnection facilities.

- Error message:

Possible reason: The number of MSCs with Message Service Centres is higher than the number of MSCs.

Possible solution(s): Reduce the number of MSCs with Message Service Centres.