EXata 5.1
Urban Propagation Model Library

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1 Overview of Model Library

1.1 List of Models in the Library

The models described in the Urban Propagation Model Library are listed in Table 1-1.

TABLE 1-1. Urban Propagation Library Models

Model Name	Model Type	Section Number
Automatic Model Selection	Propagation	Section 2.1
COST 231-Hata Propagation Model	Propagation	Section 2.2
COST 231-Walfish-Ikegami (COST-WI) Propagation Model	Propagation	Section 2.3
Okumura-Hata Propagation Model	Propagation	Section 2.4
Street Microcell Propagation Model	Propagation	Section 2.5
Street Mobile-to-mobile Propagation Model	Propagation	Section 2.6
Suburban Propagation Model	Propagation	Section 2.7

1.2 Conventions Used

1.2.1 Format for Command Line Configuration

This section describes the general format for specifying parameters in input files, the precedence rules for parameters, and the conventions used in the description of command line configuration for each model.

1.2.1.1 General Format of Parameter Declaration

The general format for specifying a parameter in an input file is:

```
[<Qualifier>] <Parameter Name> [<Index>] <Parameter Value>
```

where

`<Qualifier>` The qualifier is optional and defines the scope of the parameter declaration. The scope can be one of the following: Global, Node, Subnet, and Interface. Multiple instances of a parameter with different qualifiers can be included in an input file. Precedence rules (see Section 1.2.1.2) determine the parameter value for a node or interface.

Global: The parameter declaration is applicable to the entire scenario (to all nodes and interfaces), subject to precedence rules. The scope of a parameter declaration is global if the qualifier is not included in the declaration.

Example:

```
MAC-PROTOCOL            MACDOT11
```

Node: The parameter declaration is applicable to specified nodes, subject to precedence rules. The qualifier for a node-level declaration is a list of space-separated node IDs or a range of node IDs (specified by using the keyword `thru`) enclosed in square brackets.

Example:

```
[5 thru 10] MAC-PROTOCOL            MACDOT11
```

Subnet: The parameter declaration is applicable to all interfaces in specified subnets, subject to precedence rules. The qualifier for a subnet-level declaration is a space-separated list of subnet addresses enclosed in square brackets. A subnet address can be specified in the IP dot notation or in the EXata N syntax.

Example:

```
[N8-1.0 N2-1.0] MAC-PROTOCOL      MACDOT11
```

Interface: The parameter declaration is applicable to specified interfaces. The qualifier for an interface-level declaration is a space-separated list of subnet addresses enclosed in square brackets.

Example:

```
[192.168.2.1 192.168.2.4] MAC-PROTOCOL MACDOT11
```

`<Parameter Name>`	Name of the parameter.
`<Index>`	Instance of the parameter to which this parameter declaration is applicable, enclosed in square brackets. This should be in the range 0 to *n* -1, where *n* is the number of instances of the parameter. The instance specification is optional in a parameter declaration. If an instance is not included, then the parameter declaration is applicable to all instances of the parameter, unless otherwise specified.
`<Parameter Value>`	Value of the parameter.

Note: There should not be any spaces between the parameter name and the index.

Examples of parameter declarations in input files are:

```
PHY-MODEL                                         PHY802.11b
[1] PHY-MODEL                                     PHY802.11a
[N8-1.0] PHY-RX-MODEL                             BER-BASED
[8 thru 10] ROUTING-PROTOCOL                      RIP
[192.168.2.1 192.168.2.4] MAC-PROTOCOL            GENERICMAC
NODE-POSITION-FILE                                ./default.nodes
PROPAGATION-CHANNEL-FREQUENCY[0]                  2.4e9
[1 2] QUEUE-WEIGHT[1]                             0.3
```

Note In the rest of this document, we will not use the qualifier or the index in a parameter's description. Users should use a qualifier and/or index to restrict the scope of a parameter, as appropriate.

1.2.1.2 Precedence Rules

Parameters without Instances

If the parameter declarations do not include instances, then the following rules of precedence apply when determining the parameter values for specific nodes and interfaces:

Interface > Subnet > Node > Global

This can be interpreted as follows:

- The value specified for an interface takes precedence over the value specified for a subnet, if any.
- The value specified for a subnet takes precedence over the value specified for a node, if any.
- The value specified for a node takes precedence over the value specified for the scenario (global value), if any.

Parameters with Instances

If the parameter declarations are a combination of declarations with and without instances, then the following precedence rules apply (unless otherwise stated):

Interface[i] > Subnet[i] > Node[i] > Global[i] > Interface > Subnet > Node > Global

This can be interpreted as follows:

- Values specified for a specific instance (at the interface, subnet, node, or global level) take precedence over values specified without the instance.

- For values specified for the same instance at different levels, the following precedence rules apply:
  - The value specified for an interface takes precedence over the value specified for a subnet, if any, if both declarations are for the same instance.
  - The value specified for a subnet takes precedence over the value specified for a node, if any, if both declarations are for the same instance.
  - The value specified for a node takes precedence over the value specified for the scenario (global value), if any, if both declarations are for the same instance.

1.2.1.3 Parameter Description Format

In the Model Library, most parameters are described using a tabular format described below. The parameter description tables have three columns labeled “Parameter”, “Values”, and “Description”. Table 1-2 shows the format of parameter tables. Table 1-4 shows examples of parameter descriptions in this format.

TABLE 1-2. Parameter Table Format

Parameter	Values	Description
<Parameter Name> <Designation> <Scope> [<Instances>]	*<Type>* [<Range>] [<Default Value>] [<Unit>]	*<Description>*

<u>Parameter Column</u>

The first column contains the following entries:

- ***<Parameter Name>*:** The first entry is the parameter name (this is the exact name of the parameter to be used in the input files).

- ***<Designation>:*** This entry can be *Optional* or *Required*. These terms are explained below.
  - ***Optional***: This indicates that the parameter is optional and may be omitted from the configuration file. (If applicable, the default value for this parameter is included in the second column.)
  - ***Required***: This indicates that the parameter is mandatory and must be included in the configuration file.

- ***<Scope>:*** This entry specifies the possible scope of the parameter, i.e., if the parameter can be specified at the global, node, subnet, or interface levels. Any combination of these levels is possible.If the parameter can be specified at all four levels, the keyword “All” is used to indicate that.

  Examples of scope specification are:

  Scope: All

  Scope: Subnet, Interface

  Scope: Global, Node

- ***<Instances>:*** If the parameter can have multiple instances, this entry indicates the type of index. If the parameter can not have multiple instances, then this entry is omitted.

Examples of instance specification are:

Instances: channel number

Instances: interface index

Instances: queue index

Values Column

The second column contains the following information:

- ***<Type>*:** The first entry is the parameter type and can be one of the following: Integer, Real, String, Time, Filename, IP Address, Coordinates, Node-list, or List. If the type is a List, then all possible values in the list are enumerated below the word "List". (In some cases, the values are listed in a separate table and a reference to that table is included in place of the enumeration.)

  Table 1-3 shows the values a parameter can take for each type.

TABLE 1-3. Parameter Types

Type	Description
Integer	Integer value Examples: `2`, `10`
Real	Real value Examples: `15.0`, `-23.5`, `2.0e9`
String	String value Examples: `TEST`, `SWITCH1`
Time	Time value expressed in EXata time syntax (refer to *EXata User's Guide*) Examples: `1.5S`, `200MS`, `10US`
Filename	Name of a file in EXata filename syntax (refer to *EXata User's Guide*) Examples: `../../data/terrain/los-angeles-w` (For Windows and UNIX) `C:\scalable\exata\5.1\scenarios\WF\WF.nodes` (For Windows) `/root/scalable/exata/5.1/scenarios/WF/WF.nodes` (For UNIX)
Path	Path to a directory in EXata path syntax (refer to *EXata User's Guide*) Examples: `../../data/terrain` (For Windows and UNIX) `C:\scalable\exata\5.1\scenarios\default` (For Windows) `/root/scalable/exata/5.1/scenarios/default` (For UNIX)
IP Address	IPv4 or IPv6 address Examples: `192.168.2.1`, `2000:0:0:0::1`

TABLE 1-3. Parameter Types (Continued)

Type	Description
IPv4 Address	IPv4 address Examples: `192.168.2.1`
IPv6 Address	IPv6 address Examples: `2000:0:0:0::1`
Coordinates	Coordinates in Cartesian or Lat-Lon-Alt system. The altitude is optional. Examples: `(100, 200, 2.5)`, `(-25.3478, 25.28976)`
Node-list	List of node IDs separated by commas and enclosed in "{" and "}". Examples: `{2, 5, 10}`, `{1, 3 thru 6}`
List	One of the enumerated values. Example: See the parameter `MOBILITY` in Table 1-4.

Note: If the parameter type is List, then options for the parameter available in EXata and the commonly used model libraries are enumerated. Additional options for the parameter may be available if some other model libraries or addons are installed. These additional options are not listed in this document but are described in the corresponding model library or addon documentation.

- ***<Range>*:** This is an optional entry and is used if the range of values that a parameter can take is restricted. The permissible range is listed after the label "*Range:*" The range can be specified by giving the minimum value, the maximum value, or both. If the range of values is not restricted, then this entry is omitted.

  If both the minimum and maximum values are specified, then the following convention is used to indicate whether the minimum and maximum values are included in the range:

`(min, max)`	`min` < parameter value < `max`
`[min, max)`	`min` ≤ parameter value < `max`
`(min, max]`	`min` < parameter value ≤ `max`
`[min, max]`	`min` ≤ parameter value ≤ `max`

`min` (or `max`) can be a parameter name, in which case it denotes the value of that parameter.

Examples of range specification are:

Range: ≥ `0`

Range: `(0.0, 1.0]`

Range: `[1, MAX-COUNT]`

Range: `[1S, 200S]`

Note: If an upper limit is not specified in the range, then the maximum value that the parameter can take is the largest value of the type (integer, real, time) that can be stored in the system.

- ***<Default>*:** This is an optional entry which specifies the default value of an optional or conditional-optional parameter. The default value is listed after the label "*Default:*"
- ***<Unit>*:** This is an optional entry which specifies the unit for the parameter, if applicable. The unit is listed after the label "*Unit:*". Examples of units are: meters, dBm, slots.

Description Column

The third column contains a description of the parameter. The significance of different parameter values is explained here, where applicable. In some cases, references to notes, other tables, sections in the User's Guide, or to other model libraries may be included here.

Table 1-4 shows examples of parameter descriptions using the format described above.

TABLE 1-4. Example Parameter Table

Parameter	Values	Description
`MOBILITY` Optional *Scope:* Global, Node	List: • `NONE` • `FILE` • `GROUP-MOBILITY` • `RANDOM-WAYPOINT` Default: `NONE`	Mobility model used for the node. If `MOBILITY` is set to `NONE`, then the nodes remain fixed in one place for the duration of the simulation. See Table 7-11 for a description of mobility models.
`BACKOFF-LIMIT` Required *Scope:* Subnet, Interface	Integer *Range:* `[4,10)` *Unit:* slots	Upper limit of backoff interval after collision. A backoff interval is randomly chosen between 1 and this number following a collision.
`IP-QUEUE-PRIORITY-QUEUE-SIZE` Required *Scope:* All *Instances:* queue index	Integer *Range:* `[1, 65535]` *Unit:* bytes	Size of the output priority queue.
`MAC-DOT11-DIRECTIONAL-ANTENNA-MODE` Optional *Scope:* All	List • `YES` • `NO` *Default:* `NO`	Indicates whether the radio is to use a directional antenna for transmission and reception.

1.2.2 Format for GUI Configuration

The GUI configuration section for a model outlines the steps to configure the model using the GUI. The following conventions are used in the GUI configuration sections:

Path to a Parameter Group

As a shorthand, the location of a parameter group in a properties editor is represented as a path consisting of the name of the properties editor, name of the tab within the properties editor, name of the parameter group within the tab (if applicable), name of the parameter sub-group (if applicable), and so on.

Example

The following statement:

Go to **Default Device Properties Editor > Interfaces > Interface # > MAC Layer**

is equivalent to the following sequence of steps:

1. Open the Default Device Properties Editor for the node.
2. Click the **Interfaces** tab.
3. Expand the applicable Interface group.
4. Click the **MAC Layer** parameter group.

The above path is shown in Figure 1-1.

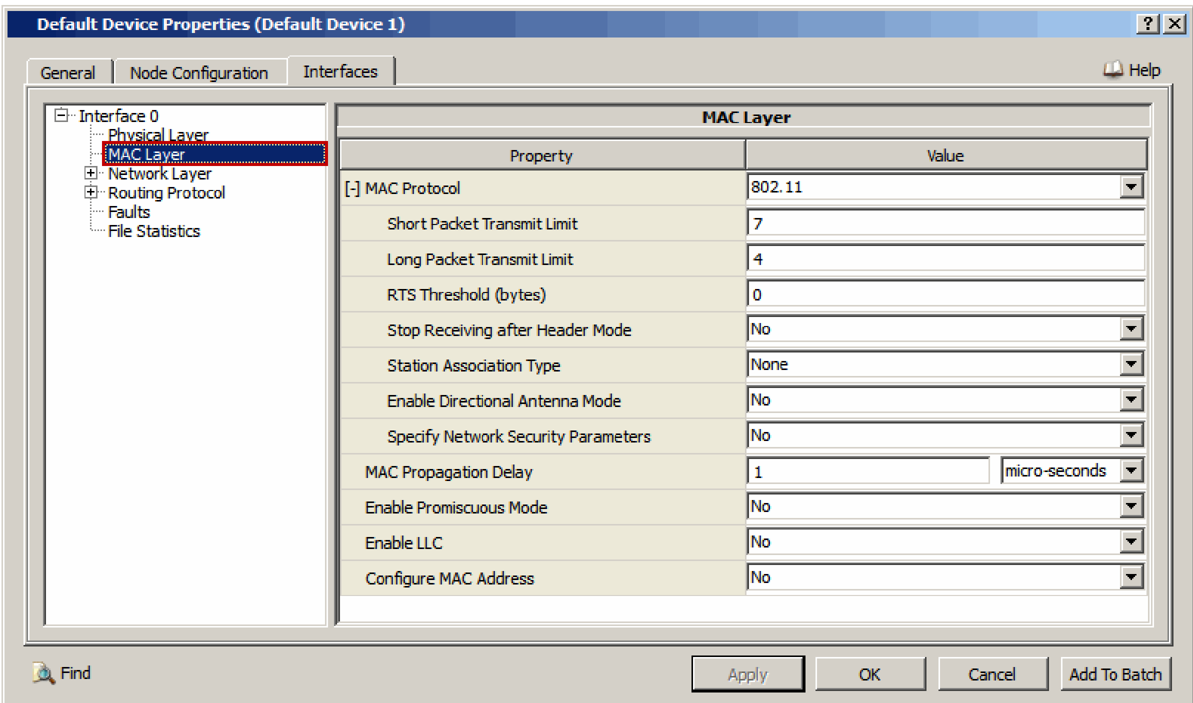


FIGURE 1-1. Path to a Parameter Group

Path to a Specific Parameter

As a shorthand, the location of a specific parameter within a parameter group is represented as a path consisting of all ancestor parameters and their corresponding values starting from the top-level parameter. The value of an ancestor parameter is enclosed in square brackets after the parameter name.

Example

The following statement:

> Set **MAC Protocol** *[= 802.11]* **> Station Association Type** *[= Dynamic]* **> Set Access Point** *[= Yes]* **>** *Enable Power Save Mode* to *Yes*

is equivalent to the following sequence of steps:

1. Set **MAC Protocol** to *802.11*.
2. Set **Station Association Type** to *Dynamic.*
3. Set **Set Access Point** to *Yes*.
4. Set **Enable Power Save Mode** to *Yes*.

The above path is shown in Figure 1-2.

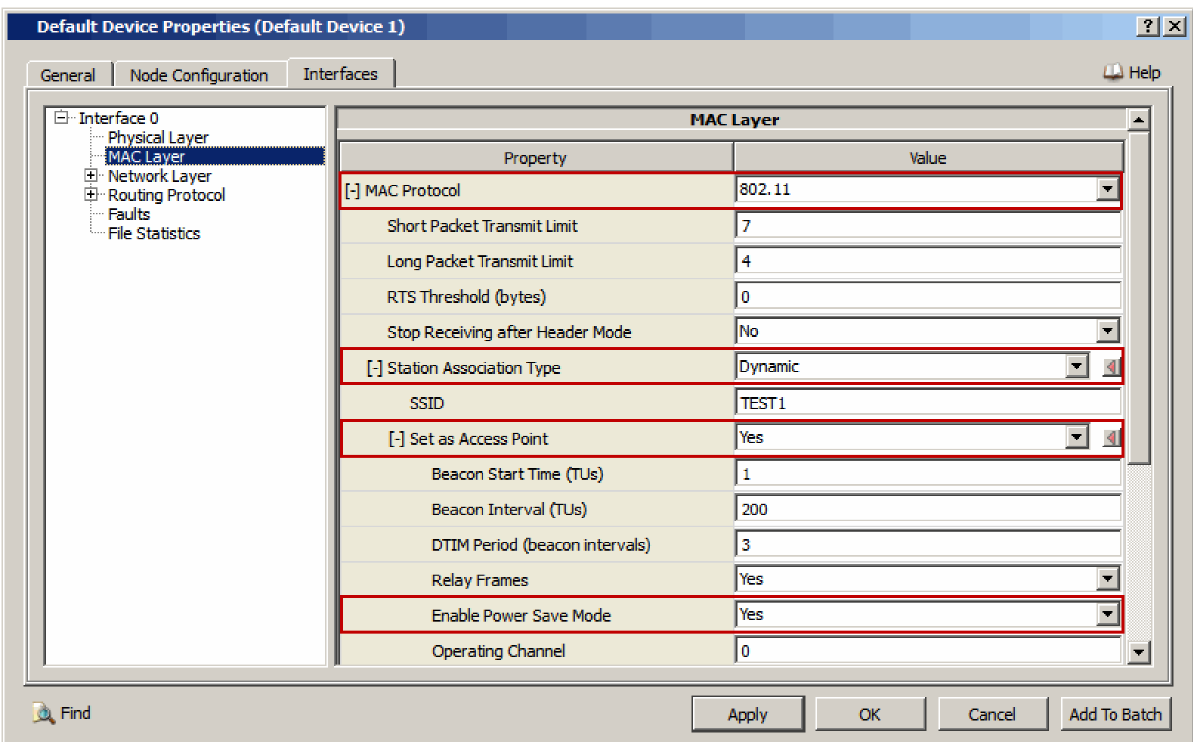


FIGURE 1-2. Path to a Specific Parameter

Parameter Table

GUI configuration of a model is described as a series of a steps. Each step describes how to configure one or more parameters. Since the GUI display name of a parameter may be different from the name in the configuration file, each step also includes a table that shows the mapping between the GUI names and command line names of parameters configured in that step. For a description of a GUI parameter, see the description of the equivalent command line parameter in the command line configuration section.

The format of a parameter mapping table is shown in Table 1-5.

TABLE 1-5. Mapping Table

GUI Parameter	Scope of GUI Parameter	Command Line Parameter
<GUI Display Name>	*<Scope>*	*<Command Line Parameter Name>*

The first column, labeled "GUI Parameter", lists the name of the parameter as it is displayed in the GUI.

The second column, labeled "Scope of GUI Parameter", lists the level(s) at which the parameter can be configured. *<Scope>* can be any combination of: Global, Node, Subnet, Wired Subnet, Wireless Subnet, Point-to-point Link, and Interface.

Table 1-6 lists the Properties Editors where parameters with different scopes can be set.

Notes: **1.** Unless otherwise stated, the "Subnet" scope refers to "Wireless Subnet".

2. The scope column can also refer to Properties Editors for special devices and network components (such as ATM Device Properties Editor) which are not included in Table 1-6.

TABLE 1-6. Properties Editors for Different Scopes

Scope of GUI Parameter	Properties Editor
Global	Scenario Properties Editor
Node	Default Device Properties Editor (General and Node Configuration tabs)
Subnet Wireless Subnet	Wireless Subnet Properties Editor
Wired Subnet	Wired Subnet Properties Editor
Point-to-point Link	Point-to-point Link Properties Editor
Interface	Interface Properties Editor, Default Device Properties Editor (Interfaces tab)

The third column, labeled "Command Line Parameter", lists the equivalent command line parameter.

Note: For some parameters, the scope may be different in command line and GUI configurations (a parameter may be configurable at fewer levels in the GUI than in the command line).

Table 1-7 is an example of a parameter mapping table.

TABLE 1-7. Example Mapping Table

GUI Parameter	Scope of GUI Parameter	Command Line Parameter
Define Area	Node	`OSPFv2-DEFINE-AREA`
OSPFv2 Configuration File	Node	`OSPFv2-CONFIG-FILE`
Specify Autonomous System	Node	N/A

TABLE 1-7. Example Mapping Table (Continued)

GUI Parameter	Scope of GUI Parameter	Command Line Parameter
Configure as Autonomous System Boundary Router	Node	`AS-BOUNDARY-ROUTER`
Inject External Route	Node	N/A
Enable Stagger Start	Node	`OSPFv2-STAGGER-START`

2 Propagation Models

This chapter describes features, configuration requirements and parameters, statistics, and scenarios for Propagation Models in the Urban Propagation Models, and consists of the following sections:

- Automatic Model Selection
- COST 231-Hata Propagation Model
- COST 231-WI Propagation Model
- Okumura-Hata Propagation Model
- Street Microcell Propagation Model
- Street Mobile-to-Mobile Propagation Model
- Suburban Propagation Model

2.1 Automatic Model Selection

The Urban Automatic Model Selection model (Auto-select) is based on the documents listed in Section 2.1.7.

2.1.1 Description

When the Auto-select option for pathloss model is chosen, EXata selects appropriate pathloss models based on the node location and urban terrain features. Different path-loss models are used according to their locations with respect to obstacles in the propagation path. EXata allows selection of different model(s) for each source-destination pair and changes the models dynamically as the node positions change.

Note: Use of the Auto-select option requires that urban terrain features be configured as well. Refer to *EXata User's Guide* and *Wireless Model Library* for details.

The pathloss models selected by the Auto-select feature for different situations are listed in Table 2-1. The Auto-select feature selects the model corresponding to the first situation in the table that matches the source-destination characteristics.

TABLE 2-1. Pathloss Models Selected by Auto-select Feature

Model	Frequency Range	Situation
Free space	All	No obstructions in the path. No multi-path effects.
COST-Walfish-Ikegami LoS	800 MHz-2 GHz	One or both nodes at roof height. Line of sight.
COST-Walfish-Ikegami NLoS	800 MHz-2 GHz	One or both nodes at roof height. No line of sight.
Street Microcell LoS	800 MHz-2 GHz	Both nodes on the ground. One or more buildings separating the nodes. Line of sight.
Street Microcell NLoS	800 MHz-2 GHz	Both nodes on the ground. One building separating the nodes. No line of sight.
Street Mobile-to-Mobile	800 MHz-2 GHz	Both nodes on the ground. More than one building separating the nodes.
COST231 Indoor	800 MHz-2 GHz	Indoor.
ITU-R Indoor	< 800 MHZ > 2 GHz	Indoor.
ITU-R UHFVHF	30 MHz-300 MHz	All outdoor situations.
ITU-R UHF LoS	300 MHz-800 MHz	Outdoor. Line of sight.
ITU-R LoS	< 30 MHZ > 2 GHz	Outdoor. Line of sight.

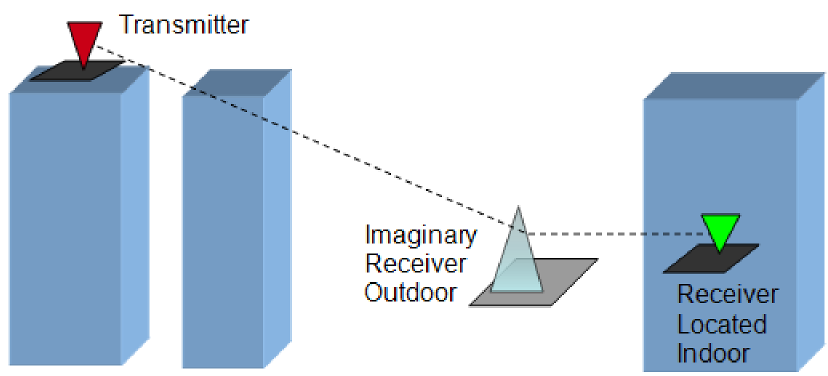
TABLE 2-1. Pathloss Models Selected by Auto-select Feature (Continued)

Model	Frequency Range	Situation
ITU-R UHF NLoS	300 MHz-800 MHz	Outdoor. No line of sight.
ITU-R NLoS-1	< 30 MHZ > 2 GHz	Outdoor. No line of sight. Nodes on parallel streets.
ITU-R NLoS-2	< 30 MHZ >2 GHz	Outdoor. No line of sight. Nodes on perpendicular streets.
Two Ray	All	No obstructions in the path. Some multi-path effects. **Note:** This model is selected if no better match is found.

Pathloss Models for Hybrid Environments

If the two nodes are in different buildings or if one node is indoor and the other is outdoor, then the path between the nodes is considered to be made of multiple segments and a pathloss model is selected for each segment as follows:

- When one node is indoor and the other is outdoor, the path between them has two segments, as shown below:



The COST231 Indoor model is used for the segment between the indoor receiver and the imaginary outdoor receiver. For the outdoor segment, the best-matching model from Table 2-1 is selected.

- When the two nodes are in different buildings, then the path between them has three segments: between the indoor transmitter and an imaginary outdoor transmitter, between the indoor receiver and an imaginary outdoor receiver, and between the imaginary outdoor transmitter and the imaginary outdoor receiver. The COST231 Indoor model is used for the first two segments. For the outdoor segment, the best-matching model from Table 2-1 is selected.

2.1.2 Command Line Configuration

To configure the Auto-select model, include the following parameter in the scenario configuration (.config) file:

```
PROPAGATION-PATHLOSS-MODEL [<Index>]      URBAN-MODEL-AUTOSELECT
```

where

`<Index>` Index of channel to which this parameter declaration is applicable, enclosed in square brackets. This should be in the range 0 to n -1, where n is the number of channels.

The instance specification is optional. If an instance is not included, then the parameter declaration is applicable to all channels.

Auto-select Parameters

Table 2-2 lists the Auto-select model configuration parameters specified in the scenario configuration (.config) file. Table 2-2 describes the parameters for configuring the Auto-select model-specific tables in the statistics database tables (refer to *EXata Statistics Database User's Guide* for details).

See Section 1.2.1.3 for a description of the format used for the parameter tables.

TABLE 2-2. Auto-select Model Parameters

Parameter	Value	Description
PROPAGATION-URBAN-AUTOSELECT-ENVIRONMENT *Optional* *Scope:* Global *Instances:* channel number	List: • URBAN • METROPOLITAN *Default:* METROPOLITAN	Specifies the environment. The model is applicable to urban and metropolitan environments.

Table 2-3 lists the parameters for configuring Auto-select model-specific tables in the statistics database.

TABLE 2-3. Auto-select Model Statistics Database Tables Configuration Parameters

Parameter	Value	Description
STATS-DB-URBAN-PROP-TABLE *Optional* *Scope:* Global	List: • YES • NO *Default:* NO	Indicates whether the Urban Propagation Statistics table is to be generated.

2.1.3 GUI Configuration

This section describes how to configure the Auto-select model in the GUI.

Configuring Auto-select Model

To configure the Auto-select model in the GUI, perform the following steps:

1. Go to **Scenario Properties Editor > Channel Properties**.
2. Set **Number of Channels** to the desired value as shown in Figure 2-1.

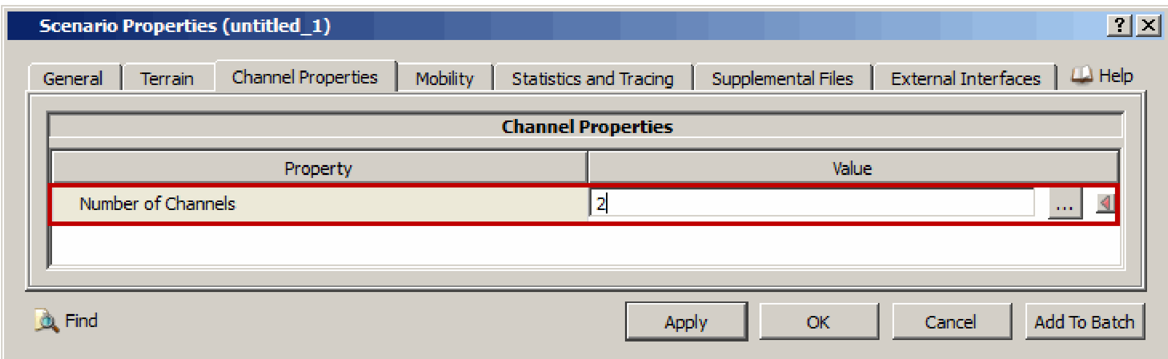


FIGURE 2-1. Setting Number of Channels

3. Click on the **Open Array Editor**  button in the **Value** column. This opens the Array Editor.

4. In the left panel of the Array Editor, select the index of the channel to be configured. In the right panel, set **Pathloss Model** to *Urban Model Autoselect* and set the dependent parameters listed in Table 2-4.

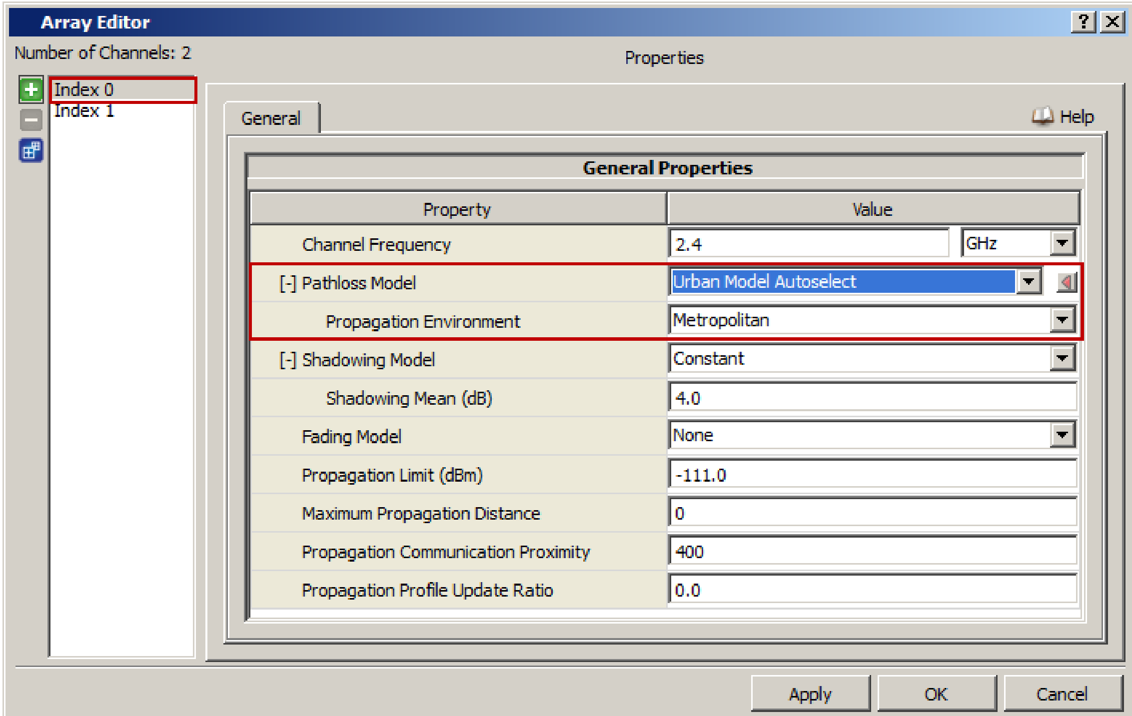


FIGURE 2-2. Configuring Automatic Model Selection Parameters

TABLE 2-4. Command Line Equivalent of Automatic Model Selection Parameters

GUI Parameter	Scope of GUI Parameter	Command Line Parameter
Propagation Environment	Global	PROPAGATION-URBAN-AUTO-SELECT-ENVIRONMENT

Configuring Statistics Database Parameters

To configure the Auto-select Model-specific tables in the statistics database, perform the following steps:

1. Go to **Scenario Properties Editor > Statistics > Statistics Database**.
2. Set **Enable Statistics Database** to *Yes*.
3. Set **Model-specific Tables** set to *Yes* and set the Auto-select Model-specific database table parameters listed in Table 2-5.

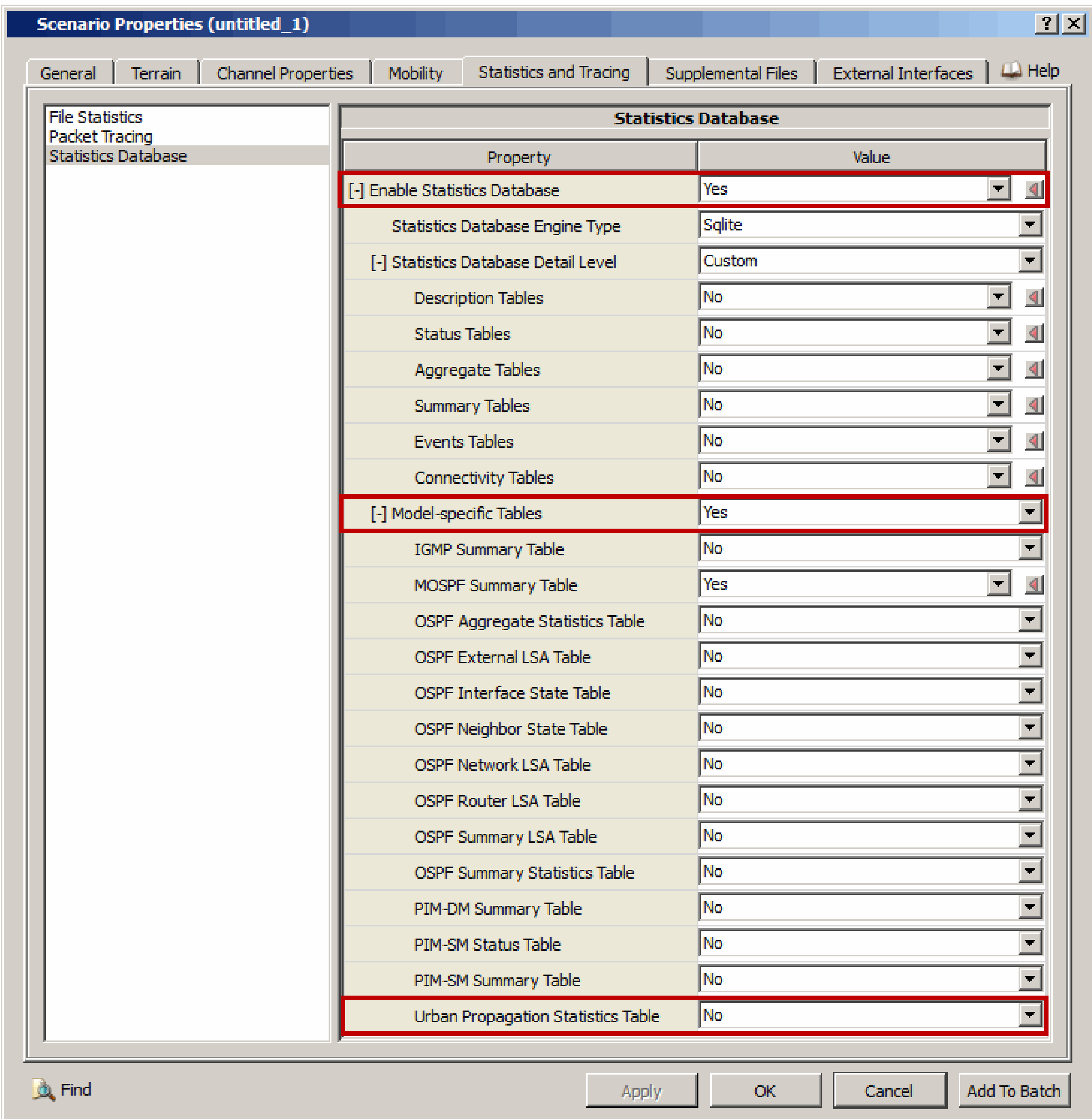


FIGURE 2-3. Configuring Auto-select Model Tables in Statistics Database

TABLE 2-5. Command Line Equivalent of Auto-select Model Statistics Database Table Parameters

GUI Parameter	Scope of GUI Parameter	Command Line Parameter
Urban Propagation Statistics Table	Global	`STATS-DB-URBAN-PROP-TABLE`

2.1.4 Statistics

This section describes the file, database, and dynamic statistics of the Auto-select model.

2.1.4.1 File Statistics

The Auto-select model does not generate any statistics for the statistics (.stat) file.

2.1.4.2 Database Statistics

The Auto-select model enters statistics in the following Auto-select model-specific database table:

- Urban Propagation Statistics Table

2.1.4.3 Dynamic Statistics

No dynamic statistics are supported for the Auto-select model.

2.1.5 Sample Scenario

2.1.5.1 Scenario Description

The sample scenario is roughly equivalent to QUALNET_HOME/scenarios/urban/auto-select/cost_wi/cost_wi_los.config. It simulates one ground node and one rooftop node with line of sight, which will cause the COST Walfish Ikegami model to be selected.

Topology

Figure 2-4 shows the topology for the Auto-select propagation sample scenario.

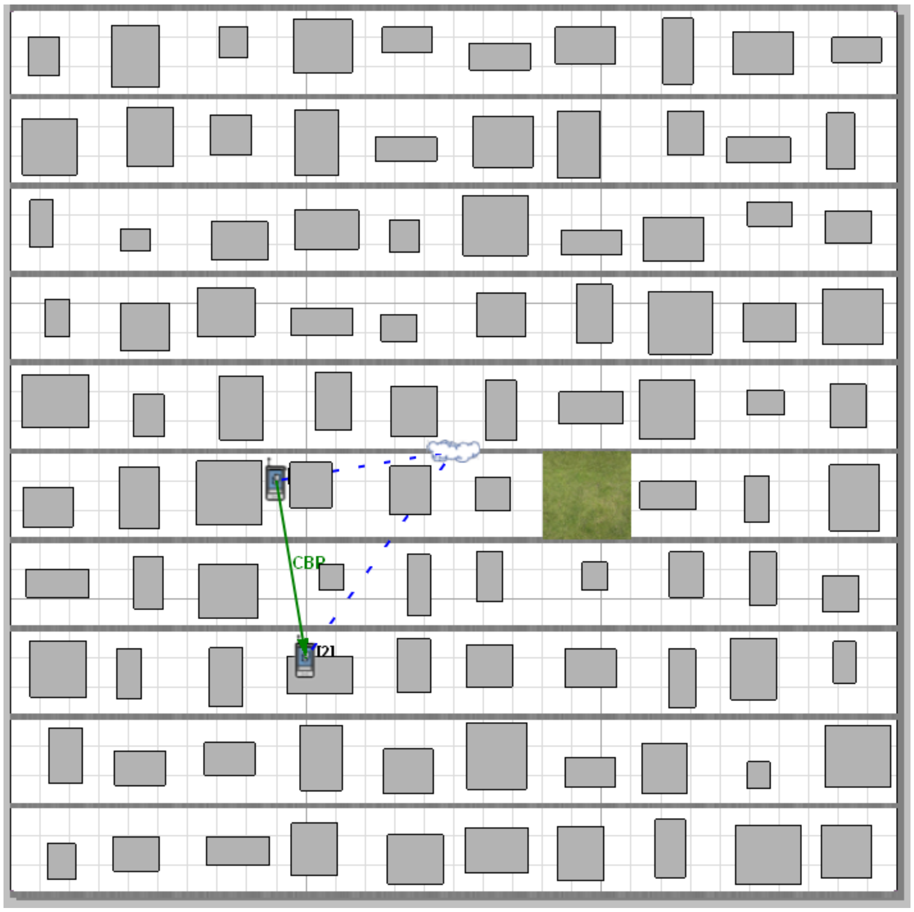


FIGURE 2-4. Sample Scenario Topology

2.1.5.2 Command Line Configuration

To configure the sample scenario in command line, include the following lines in the scenario configuration (.config) file:

```
// Define a wireless subnet with 2 nodes.
SUBNET N8-192.0.1.0 { 1, 2 }
[ N8-192.0.1.0 ] MAC-PROTOCOL CSMA
PHY-MODEL PHY-ABSTRACT
PHY-ABSTRACT-DATA-RATE 2000000
PHY-ABSTRACT-TX-POWER 15
PHY-ABSTRACT-RX-SENSITIVITY -95.0
PHY-ABSTRACT-RX-THRESHOLD -85.0
PHY-RX-MODEL SNR-THRESHOLD-BASED
PHY-RX-SNR-THRESHOLD 10

// Configure Terrain
COORDINATE-SYSTEM CARTESIAN
TERRAIN-DIMENSIONS ( 3000, 3000 )

TERRAIN-DATA-TYPE             NONE
URBAN-TERRAIN-TYPE            QUALNET-URBAN-TERRAIN
TERRAIN-FEATURES-SOURCE       FILE
TERRAIN-FEATURES-FILENAME[0] ../urban/terrain/urban10x10.xml

TERRAIN-FEATURE-SUBTRACT-TERRAIN-ELEVATION NO

// Configure Pathloss Model to Urban-Model-Autoselect
PROPAGATION-PATHLOSS-MODEL[0] URBAN-MODEL-AUTOSELECT
// Configure Routing protocol at subnet level
[190.0.1.0] ROUTING-PROTOCOL BELLMANFORD

// Position the two nodes.
NODE-PLACEMENT FILE
NODE-POSITION-FILE scenario.nodes
```

The file scenario.nodes should contain the following lines:

```
1 0 (  900, 1400, 0 )  # ground node
2 0 ( 1000,  800, 40 ) # rooftop node
```

2.1.5.3 GUI Configuration

To configure the sample scenario in the GUI, perform the steps described below.

1. Go to **Scenario Properties Editor >Terrain**.
2. Set **Scenario Dimension** to *(3000, 3000)*.
3. Set **Urban Terrain Format** to *QualNet Format*.
4. Set **Urban Terrain Features Format** to *QualNet Terrain File*.
5. Set **Number of Terrain Files** to *1*.
6. Set **Urban Terrain Features File [0]** to *C:/exata/5.1/scenarios/urban/terrain/urban10x10.xml*, as shown in Figure 2-5.

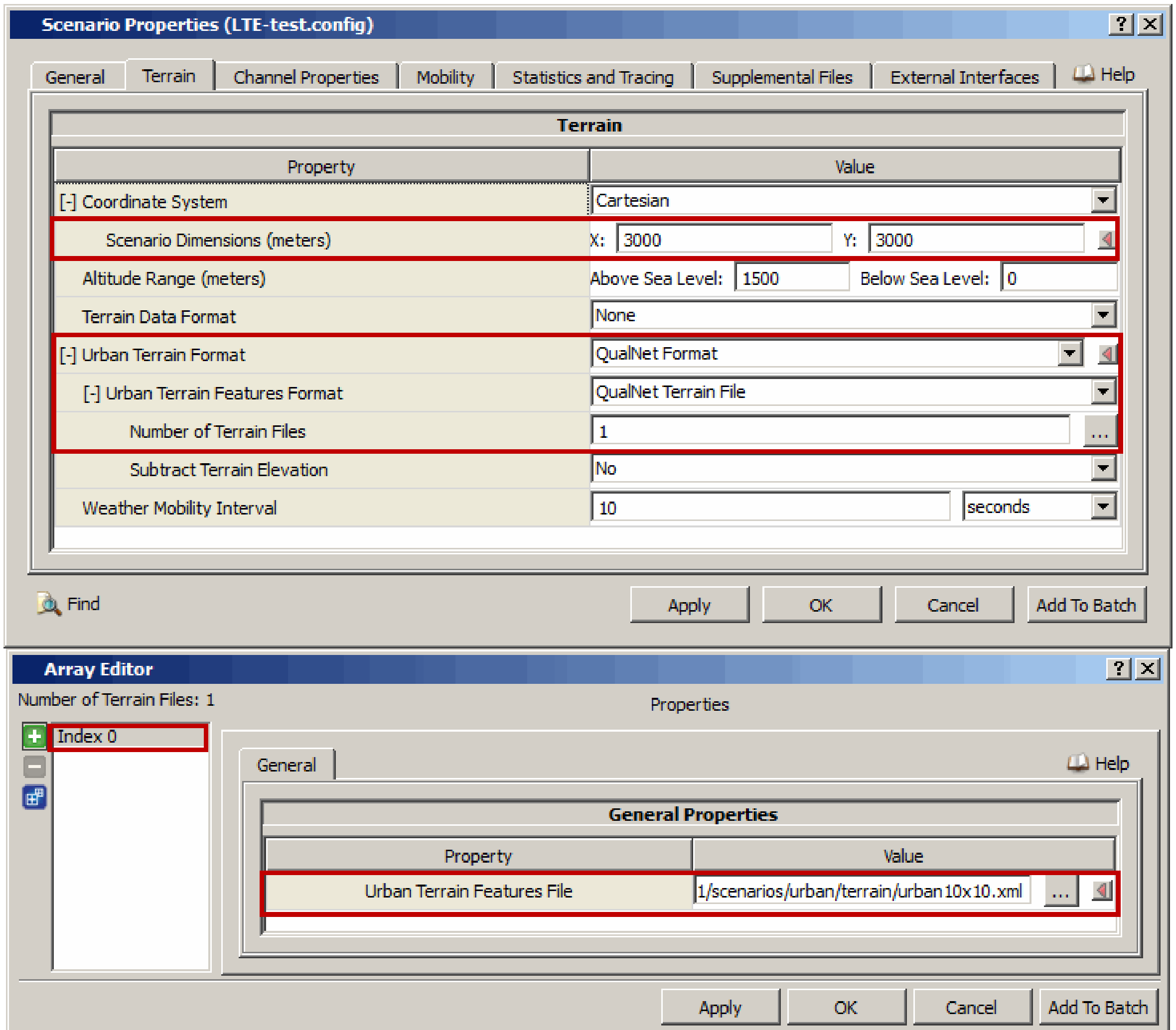


FIGURE 2-5. Configuring Terrain Parameters for Sample Scenario

7. Go to **Scenario Properties Editor > Channel Properties**.
8. Set **Pathloss Model [0]** to *Urban Model Autoselect,* as shown in Figure 2-2.
9. To allow the Auto-select model to choose COST-WI, set **Channel Frequency[0]** to *1.6 GHz*. COST-WI is selected only for frequencies ranging from 800 MHz to 2 GHz.
10. Place 2 nodes and a wireless subnet on canvas. Connect nodes 1 and 2 to the wireless subnet.
11. Select the wireless subnet. Go to **Wireless Subnet Properties Editor > Routing Protocol > General**.
12. Set **Routing Protocol IPv4** to *Bellman Ford.*
13. Configure a CBR application between nodes 1 and 2.
14. Select the CBR application and go to **CBR Properties Editor**.
15. **Set Items to Send** to *1000*, **Interval** to *5 seconds,* **Start Time** to *0 seconds, and* **End Time** to *25 seconds*.

16. Save and run the scenario.

2.1.6 Scenarios Included in EXata

The EXata distribution includes several sample scenarios for the Auto-select model. All scenarios are located in the directory EXATA_HOME/scenarios/urban/auto_select. Table 2-6 lists the sub-directory where each scenario is located.

TABLE 2-6. Auto-select Model Scenarios

Scenario Subdirectory	Description
cost_wi/cost_wi_los	Shows the selection of the COST-WI model with line of sight. COST WI is selected when one node is at roof height and the other is on the ground, in an urban area, with frequency between 800 MHz and 2.0 GHz.
cost_wi/cost_wi_nlos	Same as the last, but without line of sight.
itu_r/los_15GHz	Line of sight link at 15 GHz shows selection of the ITU-R LoS model.
itu_r/los_5GHz	Line of sight link at 5 GHz shows selection of the ITU-R LoS model.
itu_r/mobility	Demonstrates selection of the ITU-R VHFUHF model for all non-freespace urban situations at 200 MHz.
itu_r/nlos	Demonstrates selection of the ITU-R UHF NLoS model.
itu_r/nlos1_5GHz	Demonstrates selection of the ITU-R NLoS1 model, for when the two radios are on parallel streets.
itu_r/nlos2_5GHz	Demonstrates selection of the ITU-R NLoS2 model, for when the two radios are on perpendicular streets.
itu_r/uhf_los_780MHz	Demonstrates the selection of the ITU-R UHF LoS model.
itu_r/uhf_nlos_780MHz	Demonstrates the selection of the ITU-R UHF NLoS model.
itu_r/vhf_los_200MHz	Demonstrates the selection of the ITU-R VHFUHF model regardless of LoS determination.
itu_r/vhf_nlos_200MHz	Demonstrates the selection of the ITU-R VHFUHF model regardless of LoS determination.
m_to_m	Shows the example of AUTOSELECT propagation model where the scenario simulate two ground nodes by keeping the antenna heights below the urban skyline.
street_microcell/los	Demonstrates the selection of the Street Microcell model by placing two nodes at a distance on a narrow street.
street_microcell/nlos	Demonstrates the selection of the Street Microcell model in the NLoS case by placing two nodes around a corner from each other.

2.1.7 References

1. T. Rappaport, *Wireless Communications: Principles and Practice*, Prentice Hall, 2002
2. Gordon L. Stüber, *Principles of Mobile Communication*, Second Edition, 2002 Kluwer Academic Publishers
3. *Digital mobile radio towards future generation systems COST 231*, Final Report
4. ITU-R Recommendation P.453-6
5. ITU-R Recommendation P.530-8
6. ITU-R Recommendation P.453-7
7. ITU-R Recommendation P.676-4
8. ITU-R Recommendation P.838-1
9. ITU-R Recommendation P.1411
10. ITU-R Recommendation P.1546.3
11. Digital Mobile Radio Towards Future Generation Systems COST 231 Final Report
12. "Short distance attenuation measurements at 900 MHz and 1.8 GHz using low antenna heights for microcells", P.Harley, IEEE JSAC, vol.7, pp.5-11, Jan 1989.

2.2 COST 231-Hata Propagation Model

The EXata COST 231-Hata propagation model is based on the documents listed in Section 2.2.6.

2.2.1 Description

The COST 231-Hata propagation model is an empirical model that extends the Hata model to higher frequencies (1500-2000 MHz). It is a outdoor propagation model that is applicable to urban and suburban areas. The model is based on extensive measurement campaigns, and it is valid for flat terrain. The application of the COST-Hata-Model is restricted to situations where node's antenna height is above roof-top levels adjacent to the node.

The COST 231-Hata propagating model is accurate within 1 dB for distances ranging from 1 to 20 km. This model can be used with reasonable accuracy when the following conditions apply:

- Environment is urban, suburban, or open area
- Frequency is in the range 150-2000 MHz (recommended)
- Antenna height of the base station is in the range 30-200 meters (recommended)
- Antenna height of the mobile station is in the range 1-10 meters (recommended)
- Distance between the base station and mobile station is in the range 1-20 km (recommended)

The model is capable of distinguishing between man-made structures and provides different formulation for small, medium, or large cities and urban, suburban, or open areas.

Note: The COST 231-Hata propagation model can be used without any specific terrain information. Since no specific terrain features are considered in the model, the results may not be as accurate as those obtained from the COST 231-Walfish-Ikegami model.

2.2.2 Command Line Configuration

To specify COST 231-Hata model as the Propagation pathloss model, include the following parameter in the scenario configuration (.config) file:

```
PROPAGATION-PATHLOSS-MODEL [<Index>]      COST231-HATA
```

where

`<Index>`	Index of channel to which this parameter declaration is applicable, enclosed in square brackets. This should be in the range 0 to n -1, where n is the number of channels. The instance specification is optional. If an instance is not included, then the parameter declaration is applicable to all channels.

COST 231-Hata Model Parameters

Table 2-7 lists the COST 231-Hata configuration parameters specified in the scenario configuration (.config) file. See Section 1.2.1.3 for a description of the format used for the parameter table.

TABLE 2-7. COST 231-Hata Model Parameters

Parameter	Value	Description
`PROPAGATION-COST231-HATA-ENVIRONMENT` *Optional* *Scope:* Global *Instances:* channel number	List: • `SUBURBAN` • `URBAN` *Default:* `URBAN`	Specifies the environment. The model is applicable to urban and suburban environments.

2.2.3 GUI Configuration

To configure COST 231-Hata model in the GUI, perform the following steps:

1. Go to **Scenario Properties Editor > Channel Properties**.
2. Set **Number of Channels** to the desired value as shown in Figure 2-6.

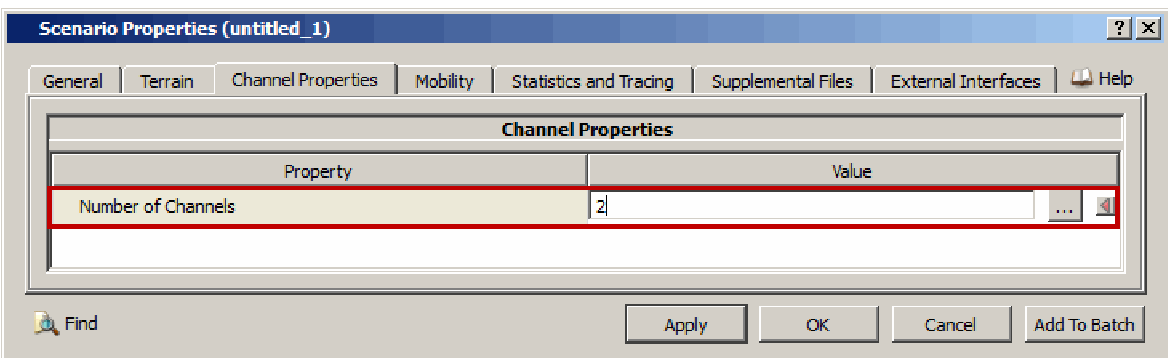


FIGURE 2-6. Setting Number of Channels

3. Click on the **Open Array Editor** ... button in the **Value** column. This opens the Array Editor.
4. In the left panel of the Array Editor, select the index of the channel to be configured. In the right panel, set **Pathloss Model** to *COST231-HATA* as shown in Figure 2-7 and set the dependent parameters listed in Table 2-8.

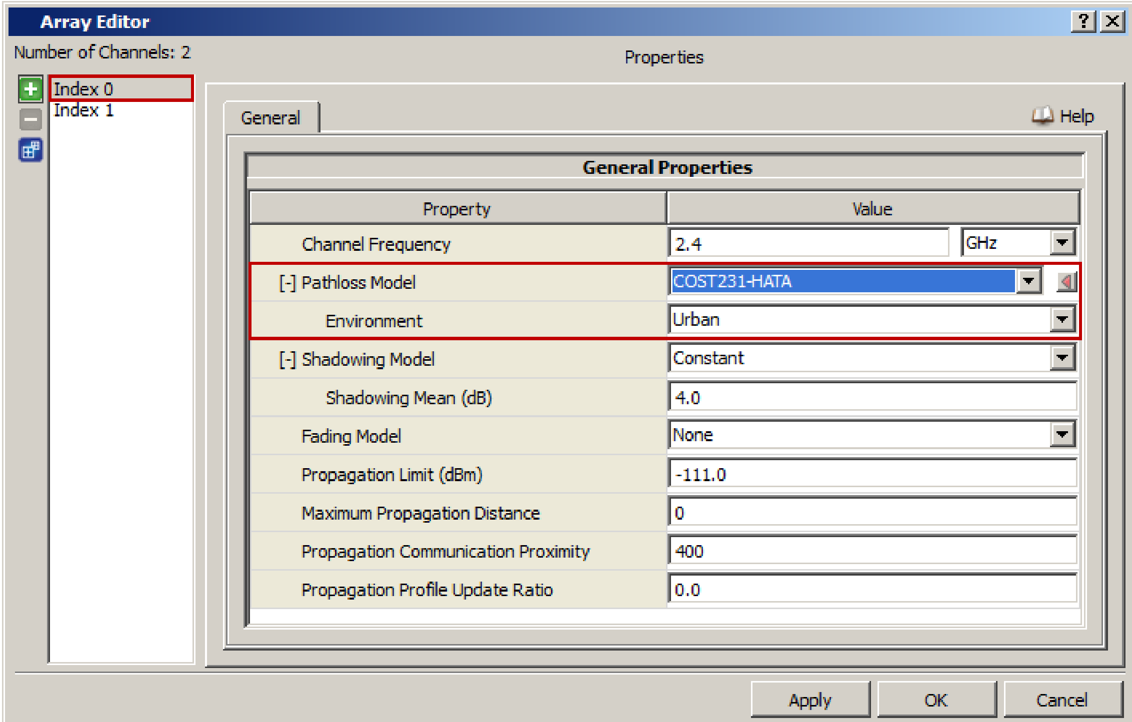


FIGURE 2-7. Configuring COST 231-Hata Pathloss Model

TABLE 2-8. Command Line Equivalent of COST 231-Hata Parameters

GUI Parameter	Scope of GUI Parameter	Command Line Parameter
Environment	Global	PROPAGATION-COST231-HATA-ENVIRONMENT

2.2.4 Statistics

There are no statistics generated for this model.

2.2.5 Scenarios Included in EXata

The EXata distribution includes several sample scenarios for the COST 231-Hata model. All scenarios are located in the directory EXATA_HOME/scenarios/urban. Table 2-9 lists the sub-directory where each scenario is located.

TABLE 2-9. COST 231-Hata Model Scenarios

Scenario Sub-directory	Description
Multiple-Channels	Shows the example of COST231-HATA propagation model

2.2.6 References

1. *Digital mobile radio towards future generation systems COST 231*, Final Report

2.3 COST 231-WI Propagation Model

The EXata COST 231-WI Propagation model is based on the documents listed in Section 2.3.6.

2.3.1 Description

The COST 231-WI propagation model is a combination of the Walfisch and Ikegami models. It is an empirical model that is based on different contributions from members of the "COST 231 Subgroup on Propagation Models". The model allows for improved path-loss estimation by consideration of more data to describe the character of the urban environment and it is applicable to metropolitan centres and urban areas. This model is statistical as no topographical data base of the buildings is considered.

COST 231-Walfish-Ikegami (COST-WI) is a propagation model that can be used with reasonable accuracy when the following conditions apply:

- Environment is urban or metropolitan
- Frequency is in the range 900-1800 MHz
- Antenna height of the base station is in the range 4-70 meters
- Antenna height of the mobile station is in the range 1-3 meters
- Distance between the base station and mobile station is in the range 1-5 km

The COST-WI model provides an empirical formula for line-of-sight (LoS) propagation. To include losses due to non-LoS propagation, path-loss is modeled as a sum of the following:

- Free-space-loss
- Roof-top to street loss due to diffraction and scattering
- Multi-screen losses due to diffraction.

The model works best when base station antenna is above the building roof-top and the variance in building heights is small. The predicted path attenuation agrees in general with the measurements for base station heights less than 70 meters. Large prediction errors are observed when building and antenna heights are the same or when base station antenna is well below the roof-top. The model is known to agree well with the measurement data for propagation path length greater than the *settled field distance*. The settled field distance is a function of wavelength, mean value of relative building heights, and the height of the base station.

The model uses the following variables: roof height, street width, building separation distance, and road orientation with respect to the direction of radio path. These can be specified by the user as parameters in the configuration file (see Table 2-10). If the user does not specify these parameters and a terrain file is available, these variables can be extracted from the terrain file; otherwise, default values listed in Table 2-10 are used.

Note: Use of the COST-WI propagation model requires that urban terrain features be configured as well. Refer to *EXata User's Guide* and *Wireless Model Library* for details.

2.3.2 Command Line Configuration

To specify COST 231-WI model as the Propagation pathloss model, include the following parameter in the scenario configuration (.config) file:

```
PROPAGATION-PATHLOSS-MODEL [<Index>]      COST231-WALFISH-IKEGAMI
```

where

`<Index>`	Index of channel to which this parameter declaration is applicable, enclosed in square brackets. This should be in the range 0 to n -1, where n is the number of channels. The instance specification is optional. If an instance is not included, then the parameter declaration is applicable to all channels.

COST 231-WI Model Parameters

Table 2-10 lists the COST 231-WI configuration parameters specified in the scenario configuration (.config) file. See Section 1.2.1.3 for a description of the format used for the parameter table.

TABLE 2-10. COST 231-WI Model Parameters

Parameter	Value	Description
`PROPAGATION-COST231-WALFISH-IKEGAMI-ENVIRONMENT` *Optional* *Scope:* Global *Instances:* channel number	List: • `URBAN` • `METROPOLITAN` *Default:* `METROPOLITAN`	Specifies the environment. The model is applicable to urban and metropolitan environments.
`PROPAGATION-ROOF-HEIGHT` *Optional* *Scope:* Global *Instances:* channel number	Real *Range:* ≥ `0` *Unit:* meters *Default:* `21`	Specifies the average roof height in the propagation path.
`PROPAGATION-STREET-WIDTH` *Optional* *Scope:* Global *Instances:* channel number	Real *Range:* ≥ `0` *Unit:* meters *Default:* `20`	Specifies the average street width.
`PROPAGATION-BUILDING-SEPARATION` *Optional* *Scope:* Global *Instances:* channel number	Real *Range:* ≥ `0` *Unit:* meters *Default:* `40.0`	Specifies the average separation between buildings.

2.3.3 GUI Configuration

To configure the COST 231-WI model in the GUI, perform the following steps:

1. Go to *Scenario* **Properties Editor > Channel Properties**.
2. Set **Number of Channels** to the desired value as shown in Section 2-8.

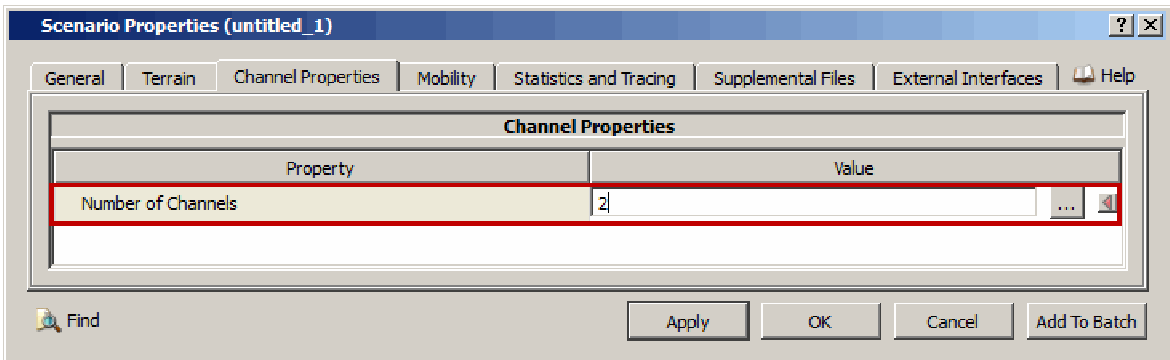


FIGURE 2-8. Setting Number of Channels

3. Click on the **Open Array Editor** ... button in the **Value** column. This opens the Array Editor.
4. In the left panel of the Array Editor, select the index of the channel to be configured. In the right panel, set **Pathloss Model** to *COST231-WALFISH-IKEGAMI* as shown in Figure 2-9 and set the dependent parameters listed in Table 2-11.

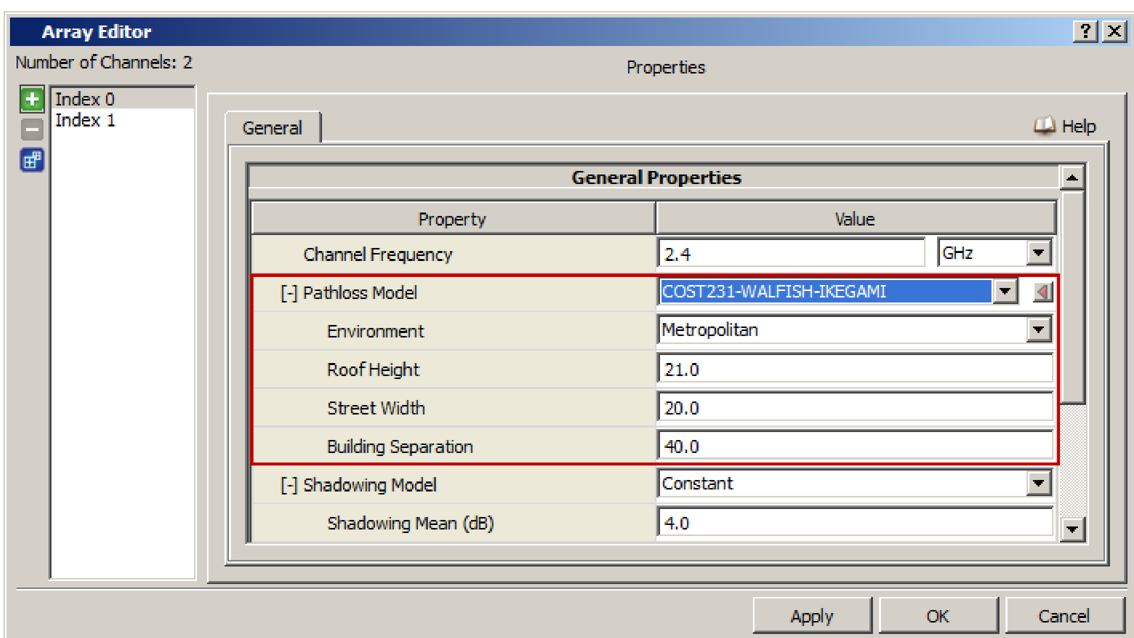


FIGURE 2-9. Configuring COST 231-WI Model

TABLE 2-11. Command Line Equivalent of COST 231-WI Parameters

GUI Parameter	Scope of GUI Parameter	Command Line Parameter
Environment	Global	`PROPAGATION-COST231-WALFISH-IKEGAMI-ENVIRONMENT`
Roof Height	Global	`PROPAGATION-ROOF-HEIGHT`
Street Width	Global	`PROPAGATION-STREET-WIDTH`
Building Separation	Global	`PROPAGATION-BUILDING-SEPARATION`

2.3.4 Statistics

There are no statistics generated for this model.

2.3.5 Scenarios Included in EXata

The EXata distribution includes several sample scenarios for the COST 231-WI model. All scenarios are located in the directory EXATA_HOME/scenarios/urban. Table 2-12 lists the sub-directory where each scenario is located.

TABLE 2-12. COST 231-WI Model Scenarios

Scenario Sub-directory	Description
Multiple-Channels	Shows the example of COST 231-WI propagation model

2.3.6 References

1. *Digital mobile radio towards future generation systems COST 231*, Final Report.

2.4 Okumura-Hata Propagation Model

The EXata Okumura-Hata propagation model is based on the documents listed in Section 2.4.5.

2.4.1 Description

Okumura-Hata propagation model is a statistic model which is derived from the extensive measurements. The correction factors for different types of environments are introduced to provide accurate pathloss predictions.

The Okumura-Hata propagation model is useful for macro-cellular systems and is primarily obtained by fitting the curves to empirical data.

Note: Since the Okumura-Hata model is based upon the data collected by Okumura in the city of Tokyo, it may not accurately provide pathloss values for North-American suburban terrain.

The Okumura-Hata model is valid for the following conditions:

- Environment is urban, suburban or open area
- Frequency is in the range 150-1000 MHz (recommended)
- Antenna height of the base station is in the range 30-200 meters (recommended)
- Antenna height of the mobile station is in the range 1-10 meters (recommended)
- Distance between the base station and mobile station is in the range 1-20 km (recommended)

The pathloss is expressed as the sum *A* + *B log10(d)* + *C*, where the constant coefficients *A*, *B*, and *C* are dependent upon the propagation terrain, and *d* is the distance between the transmitter and receiver.

2.4.2 Command Line Configuration

To specify Okumura-Hata model as the propagation pathloss model, include the following parameter in the scenario configuration (.config) file:

```
PROPAGATION-PATHLOSS-MODEL [<Index>]OKUMURA-HATA
```

where

`<Index>`	Index of channel to which this parameter declaration is applicable, enclosed in square brackets. This should be in the range 0 to n -1, where n is the number of channels. The instance specification is optional. If an instance is not included, then the parameter declaration is applicable to all channels.

Okumura-Hata Model Parameters

Table 2-13 lists the Okumura-Hata configuration parameters specified in the scenario configuration (.config) file. See Section 1.2.1.3 for a description of the format used for the parameter table.

TABLE 2-13. Okumura-Hata Model Parameters

Parameter	Value	Description
`PROPAGATION-OKUMURA-HATA-ENVIRONMENT` *Optional* *Scope:* Global *Instances:* channel number	List: • `SUBURBAN` • `URBAN` • `METROPOLITAN` • `OPEN-RURAL` • `QUASI-OPEN-RURAL` *Default:* `URBAN`	Specifies the environment. The model is applicable to urban, suburban, metropolitan, open rural, and quasi-open rural environments.

2.4.3 GUI Configuration

To configure Okumura-Hata model in the GUI, perform the following steps:

1. Go to **Scenario Properties Editor > Channel Properties**.
2. Set **Number of Channels** to the desired value as shown in Figure 2-10.

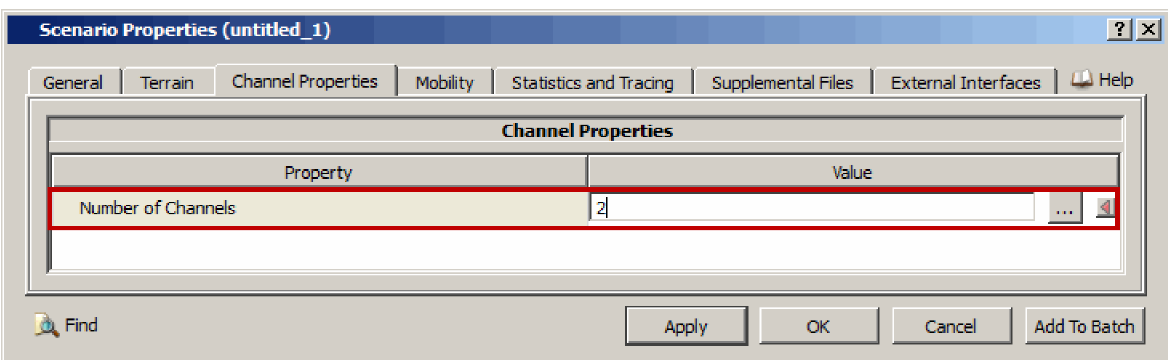


FIGURE 2-10. Setting Number of Channels

3. Click on the **Open Array Editor** ... button in the **Value** column. This opens the Array Editor.

4. In the left panel of the Array Editor, select the index of the channel to be configured. In the right panel, set **Pathloss Model** to *OKUMURA-HATA* model as shown in Figure 2-11 and set the dependent parameters listed in Table 2-14.

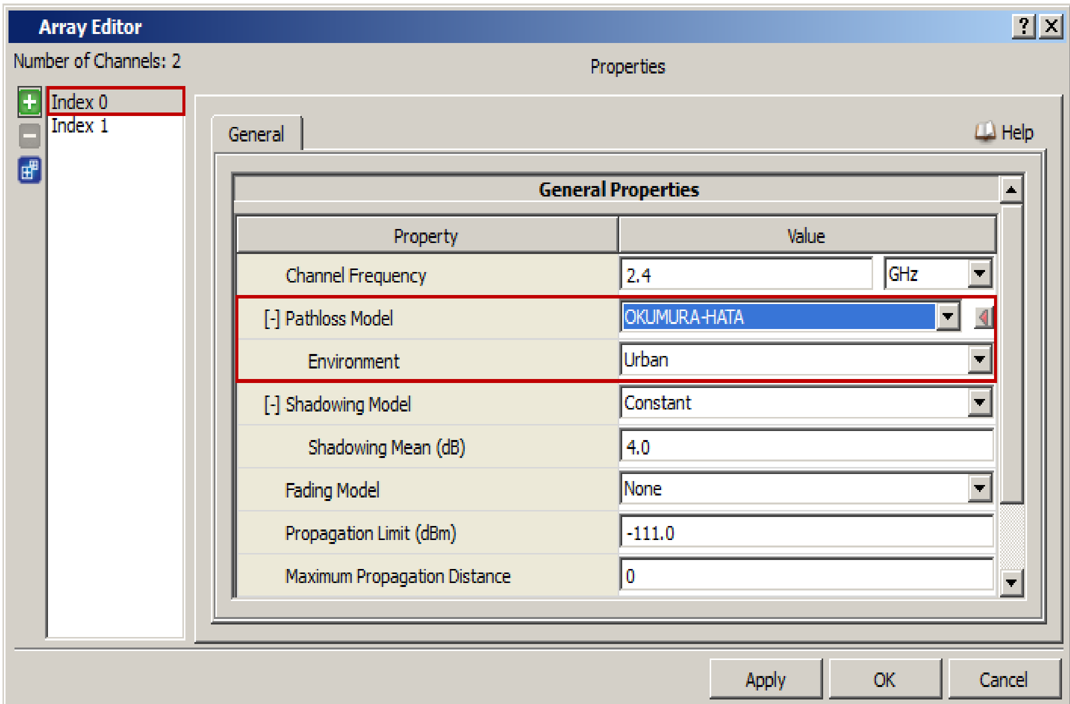


FIGURE 2-11. Configuring Okumura-Hata Model

TABLE 2-14. Command Line Equivalent of Okumura-Hata Parameters

GUI Parameter	Scope of GUI Parameter	Command Line Parameter
Environment	Global	`PROPAGATION-OKUMURA-HATA-ENVIRONMENT`

2.4.4 Statistics

There are no statistics generated for this model.

2.4.5 References

1. M. Hata, “Empirical formula for propagation loss in land mobile radio services,” IEEE Trans. Veh. Technol., vol. VT-29, pp. 317-325, Aug. 1980.
2. Y. Okumura et. al., “Field strength and its variability in VHF and UHF land-mobile radio services,” Rev. Electr. Commun. Lab., vol 16, pp. 825-873, Sept.-Oct. 1968.
3. T. Rappaport, “Wireless Communications: Principles and Practice,” Prentice Hall, 2002

2.5 Street Microcell Propagation Model

The EXata Street Microcell propagation model is based on the documents listed in Section 2.5.6.

2.5.1 Description

The Street Microcell propagation model calculates the pathloss between a transmitter and a receiver located in adjacent streets in an urban canyon. Street Microcell model describes the line-of-sight (LoS) communication as a dual-slope path-loss model. Close to the base station, the signal attenuation follows free-space propagation until the break-point distance is reached. The break-point distance occurs when the Fresnel zone between the two antennas touches the ground, assuming a flat ground surface. After the break-point distance is reached, path-loss decays as inverse-fourth to inverse-eighth power of the distance. Non-LoS propagation occurring due to corner effects in the urban environment is included. At the corner the signal level is assumed to be of the same magnitude as due to the LoS propagation. The signal follows LoS propagation beyond the corner as well where the corner is modeled as an imaginary transmitter.

Note: Use of the Street Microcell propagation model requires that urban terrain features be configured as well. Refer to *EXata User's Guide* and *Wireless Model Library* for details.

2.5.2 Command Line Configuration

To specify Street Microcell model as the propagation pathloss model, include the following parameter in the scenario configuration (.config) file:

```
PROPAGATION-PATHLOSS-MODEL [<Index>]      STREET-MICROCELL
```

where

`<Index>`	Index of channel to which this parameter declaration is applicable, enclosed in square brackets. This should be in the range 0 to n -1, where n is the number of channels. The instance specification is optional. If an instance is not included, then the parameter declaration is applicable to all channels.

Street Microcell Model Parameters

Table 2-15 lists the Street Microcell model configuration parameters specified in the scenario configuration (.config) file. See Section 1.2.1.3 for a description of the format used for the parameter table.

TABLE 2-15. Street Microcell Model Parameters

Parameter	Value	Description
`PROPAGATION-STREET-MICROCELL-ENVIRONMENT` *Optional* *Scope:* Global *Instances:* channel number	List: • `LOS` • `NLOS` *Default:* `LOS`	Specifies the line-of-sight condition. `LOS` : Line-of-sight communication model is to be used. `NLOS` : Non-line-of-sight communication model is to be used.

2.5.3 GUI Configuration

To configure the Street Microcell model in the GUI, perform the following steps:

1. Go to **Scenario Properties Editor > Channel Properties**.
2. Set **Number of Channels** to the desired value as shown in Figure 2-12.

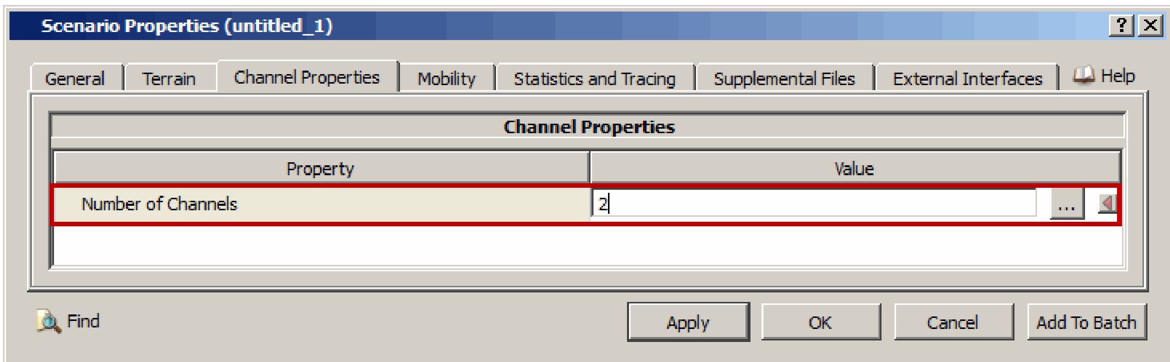


FIGURE 2-12. Setting Number of Channels

3. Click on the **Open Array Editor**  button in the **Value** column. This opens the Array Editor.

4. In the left panel of the Array Editor, select the index of the channel to be configured. In the right panel, set **Pathloss Model** to *Street Microcell* as shown in Figure 2-13 and set the dependent parameters listed in Table 2-16.

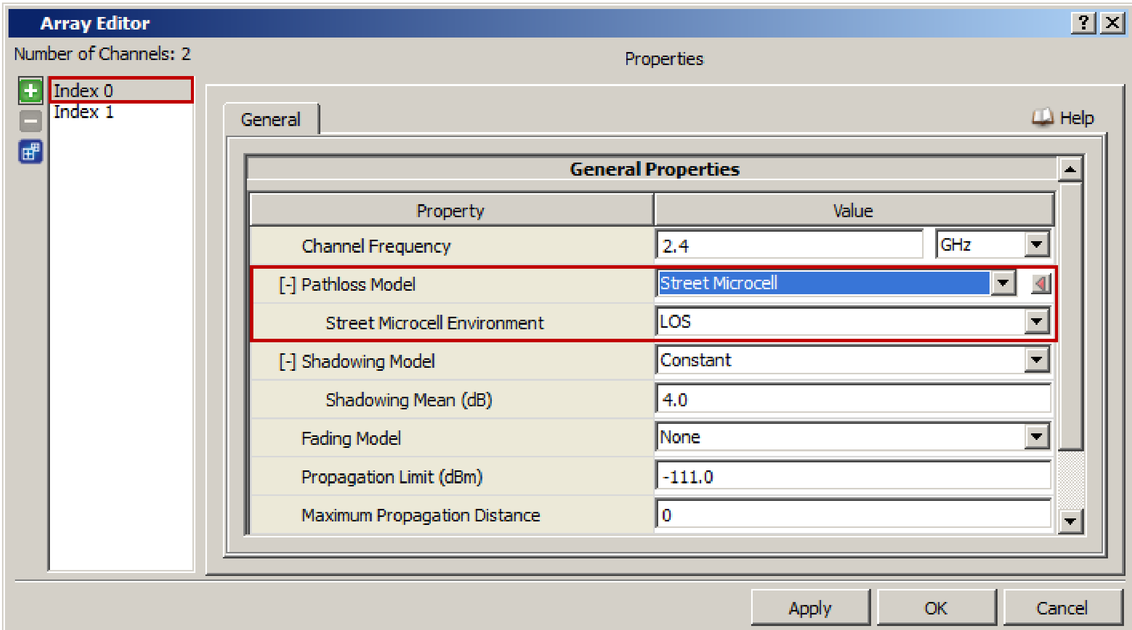


FIGURE 2-13. Configuring Street Microcell Model

TABLE 2-16. Command Line Equivalent of Street Microcell Parameters

GUI Parameter	Scope of GUI Parameter	Command Line Parameter
Street Microcell Environment	Global	PROPAGATION-STREET-MICROCELL-ENVIRONMENT

2.5.4 Statistics

There are no statistics generated for this model.

2.5.5 Scenarios Included in EXata

The EXata distribution includes several sample scenarios for the Street Microcell model. All scenarios are located in the directory EXATA_HOME/scenarios/urban. Table 2-17 lists the sub-directory where each scenario is located.

TABLE 2-17. Street Microcell Model Scenarios

Scenario Sub-directory	Description
Street-Microcell	Shows the example of the STREET-Microcell propagation model

2.5.6 References

1. P.Harley, "Short distance attenuation measurements at 900 MHz and 1.8 gHz using low antenna heights for microcells", IEEE JSAC, vol.7, pp.5-11, Jan 1989.

2. Gordon L. Stüber, "Principles of Mobile Communication", Second Edition, 2002 Kluwer Academic Publishers.

2.6 Street Mobile-to-mobile Propagation Model

The EXata Street Mobile-to-mobile propagation model is based on the documents listed in Section 2.6.6.

2.6.1 Description

The Street Mobile-to-mobile model calculates pathloss between a source and a destination when both are in an urban canyon and are communicating across several building obstacles.

Note: Use of the Street Mobile-to-Mobile propagation model requires that urban terrain features be configured as well. Refer to *EXata User's Guide* and *Wireless Model Library* for details.

2.6.2 Command Line Configuration

To specify Street Mobile-to-mobile model as the Propagation pathloss model, include the following parameter in the scenario configuration (.config) file:

```
PROPAGATION-PATHLOSS-MODEL [<Index>]      STREET-M-TO-M
```

where

`<Index>`	Index of channel to which this parameter declaration is applicable, enclosed in square brackets. This should be in the range 0 to n -1, where n is the number of channels. The instance specification is optional. If an instance is not included, then the parameter declaration is applicable to all channels.

Street Mobile-to-mobile Parameters

Table 2-18 lists the Street Mobile-to-mobile configuration parameters specified in the scenario configuration (.config) file. See Section 1.2.1.3 for a description of the format used for the parameter table.

TABLE 2-18. Street Mobile-to-mobile Parameters

Parameter	Value	Description
`NUM-OF-BUILDINGS-IN-PATH` *Optional* *Scope:* Global *Instances:* channel number	Integer *Default:* `2`	Specifies the average number of buildings in the propagation path.

TABLE 2-18. Street Mobile-to-mobile Parameters (Continued)

Parameter	Value	Description
PROPAGATION-ROOF-HEIGHT *Optional* *Scope:* Global *Instances:* channel number	Real *Default:* 21.0 *Unit:* meters	Specifies the average roof height (in meters) in the propagation path.
PROPAGATION-STREET-WIDTH *Optional* *Scope:* Global *Instances:* channel number	Real *Default:* 20.0 *Unit:* meters	Specifies the average street width (in meters) in the propagation path.

2.6.3 GUI Configuration

To configure the Street Mobile-to-mobile model in the GUI, perform the following steps:

1. Go to **Scenario Properties Editor > Channel Properties**.
2. Set **Number of Channels** to the desired value as shown in Figure 2-14.

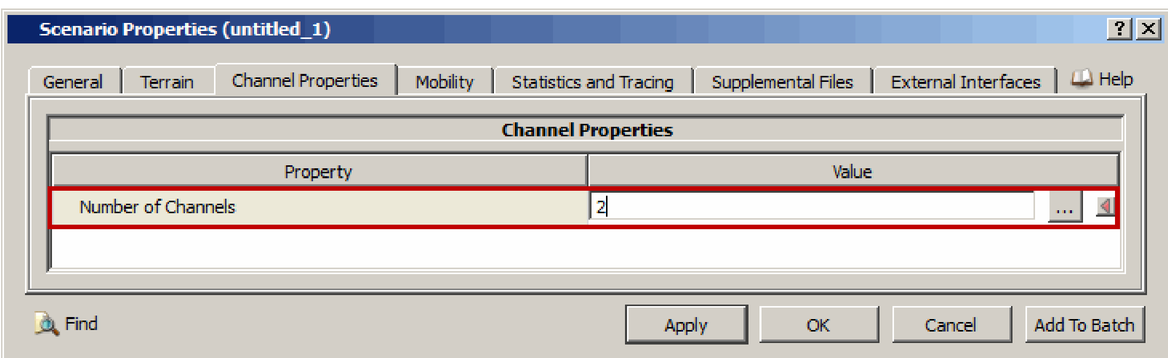


FIGURE 2-14. Setting Number of Channels

3. Click on the **Open Array Editor** [...] button in the **Value** column. This opens the Array Editor.
4. In the left panel of the Array Editor, select the index of the channel to be configured. In the right panel, set **Pathloss Model** to *Street M-To-M* as shown in Figure 2-15 and set the dependent parameters listed in Table 2-19.

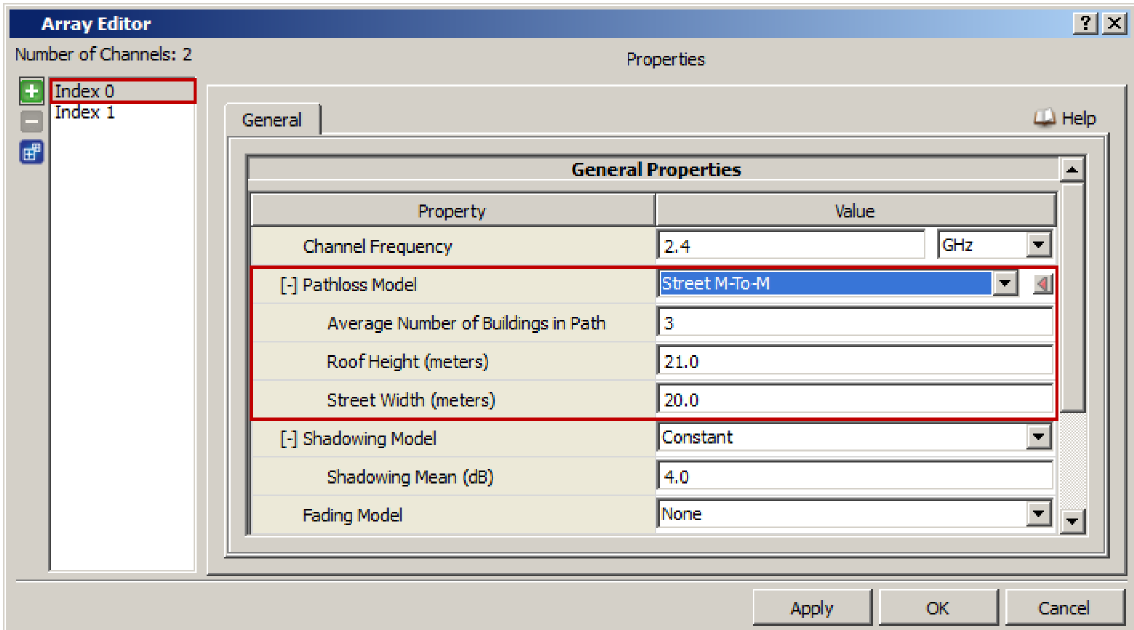


FIGURE 2-15. Configuring Street Mobile-to-mobile Model

TABLE 2-19. Command Line Equivalent of Street Mobile-to-mobile Parameters

GUI Parameter	Scope of GUI Parameter	Command Line Parameter
Average Number of Building in Path	Global	`PROPAGATION-AVG-NUM-OF-BUILDINGS-IN-PATH`
Roof Height	Global	`PROPAGATION-ROOF-HEIGHT`
Street Width	Global	`PROPAGATION-STREET-WIDTH`

2.6.4 Statistics

There are no statistics generated for this model.

2.6.5 Scenarios Included in EXata

The EXata distribution includes several sample scenarios for the Street Mobile-to-mobile model. All scenarios are located in the directory EXATA_HOME/scenarios/urban. Table 2-20 lists the sub-directory where each scenario is located.

TABLE 2-20. Street Mobile-to-mobile Model Scenarios

Scenario Sub-directory	Description
M-to-M	Show example of Street Mobile-to-mobile propagation model.

2.6.6 References

1. Gordon L. Stüber, "Principles of Mobile Communication", Second Edition, 2002 Kluwer Academic Publishers.

2.7 Suburban Propagation Model

2.7.1 Description

The suburban propagation model characterizes propagation in a suburban environment. The model takes into account the effects of terrain and foliage on signals strength.

Note: Use of the Suburban propagation model requires that urban terrain features be configured as well. Refer to *EXata User's Guide* and *Wireless Model Library* for details.

2.7.2 Command Line Configuration

To specify Suburban model as the propagation pathloss model, include the following parameter in the scenario configuration (.config) file:

```
PROPAGATION-PATHLOSS-MODEL [<Index>]  SUBURBAN
```

where

`<Index>` Index of channel to which this parameter declaration is applicable, enclosed in square brackets. This should be in the range 0 to n -1, where n is the number of channels.

The instance specification is optional. If an instance is not included, then the parameter declaration is applicable to all channels.

Suburban Model Parameters

Table 2-21 lists the Suburban model configuration parameters specified in the scenario configuration (.config) file. See Section 1.2.1.3 for a description of the format used for the parameter table.

TABLE 2-21. Suburban Model Parameters

Parameter	Value	Description
PROPAGATION-TERRAIN-TYPE *Optional* (see Note) *Scope:* Global	List: • FLAT • HILLY *Default:* FLAT	Specifies the terrain type based upon the interdecile elevation range obtained after removing the top 10% and the bottom 10%. FLAT : Translated to interdecile elevation range of 0 to 29. HILLY: Translated to interdecile elevation range of 90 or more.
PROPAGATION-PERCENT-AREA-COVERED-BY-VEGETATION *Optional* (see Note) *Scope:* Global	Real *Range:* [0.0 to 100.0] *Unit:* meters *Default:* 65	Specifies the thickness of vegetation. A value of 65 or above indicates a forested area.

Note: If either of the parameters `PROPAGATION-TERRAIN-TYPE` and `PROPAGATION-PERCENT-AREA-COVERED-BY-VEGETATION` is configured, then the other parameter must be configured as well.

2.7.3 GUI Configuration

To configure the Suburban model in the GUI, perform the following steps:

1. Go to **Scenario Properties Editor > Channel Properties**.
2. Set **Number of Channels** to the desired value as shown in Figure 2-16.

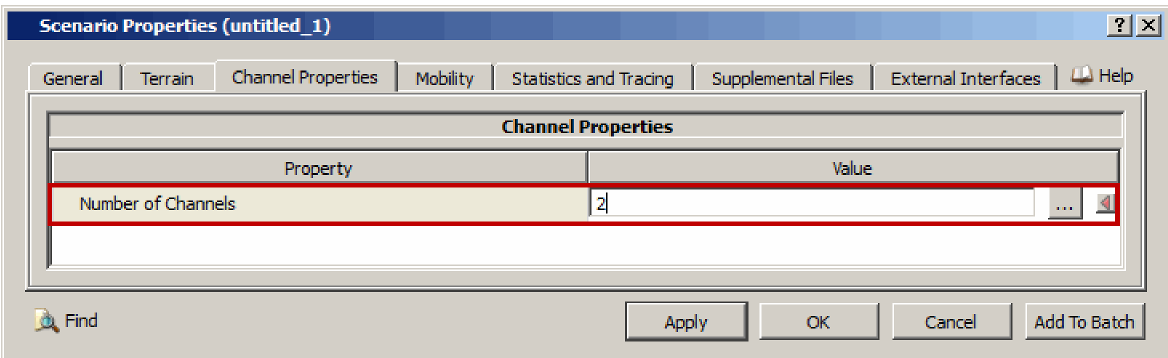


FIGURE 2-16. Setting Number of Channels

3. Click on the **Open Array Editor** ... button in the **Value** column. This opens the Array Editor.
4. In the left panel of the Array Editor, select the index of the channel to be configured. In the right panel, set **Pathloss Model** to *Suburban* as shown in Figure 2-17 and set the dependent parameters listed in Table 2-22.

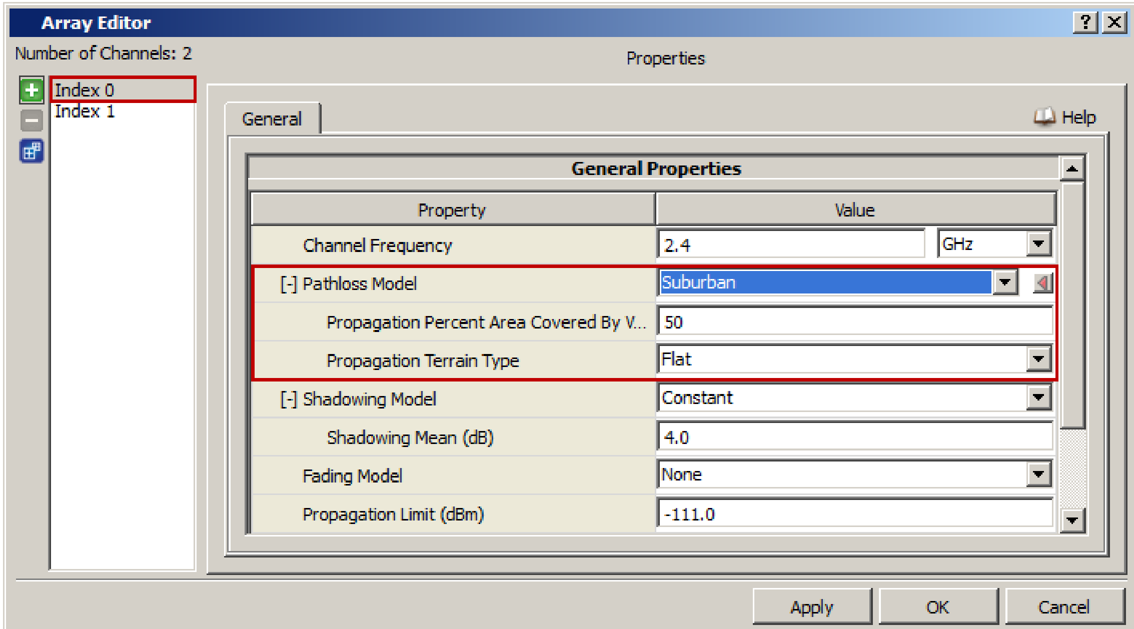


FIGURE 2-17. Configuring Suburban Pathloss Model

TABLE 2-22. Command Line Equivalent of Suburban Parameters

GUI Parameter	Scope of GUI Parameter	Command Line Parameter
Propagation Percent Area Covered By Vegetation	Global	`PROPAGATION-PERCENT-AREA-COVERED-BY-VEGETATION`
Propagation Terrain Type	Global	`PROPAGATION-TERRAIN-TYPE`

2.7.4 Statistics

There are no statistics generated for this model.

2.7.5 Scenarios Included in EXata

The EXata distribution includes several sample scenarios for the Suburban model. All scenarios are located in the directory EXATA_HOME/scenarios/urban. Table 2-23 lists the sub-directory where each scenario is located.

TABLE 2-23. Suburban Model Scenarios

Scenario Sub-directory	Description
Suburban	Shows the example of Suburban propagation model