

38 WiMAX (802.16e) Model User Guide

The WiMAX model suite includes a discrete event simulation model that lets you analyze network performance in wireless metropolitan area networks. The WiMAX model suite includes the features of the IEEE 802.16e standard. Note that the Wireless Module and a license for the WiMAX specialized model are needed to run simulations. The WiMAX license is also required for viewing or modifying WiMAX process models. This document describes the WiMAX model suite.

Model Features

The model implements the following 802.16e features.

Table 38-1 WiMAX Model Features

Model Feature	Description
MAC Messages	The following MAC-layer messages are modeled: • 802.16e MAC PDU • 802.16e management messages (DSA messages, bandwidth requests, and MAPs) • ARQ messages (feedback, discard, and reset) • Mobility messages (neighbor advertisements, scanning, and handover) • Ranging messages (CDMA codes and ranging setup)
Radio link control	The model lets you configure a static burst profile for each connection.
Scheduling service	The following scheduling services are supported: • UGS • ertPS • rtPS • nrtPS • BE
Automatic Retransmission Request (ARQ)	The model includes the following support for ARQ, a retransmission mechanism that resides in the WiMAX MAC layer: • Per-connection support for rtPS, nrtPS and BE connections • Ability to enable ARQ for individual service flows at subscriber station nodes • Ability to enable in-order delivery of SDUs • Ability to enable CRC-32 overhead for individual service flows. CRC-32 is enforced whenever ARQ is modeled in a service flow.

Table 38-1 WiMAX Model Features (Continued)

Model Feature	Description
Packet loss modeling	Two methods are available for modeling packet loss: • When physical layer modeling is enabled, the model accounts for packet losses that are caused by physical layer effects. • When the framing module is enabled, you can configure subscriber station nodes to drop a certain percentage of the PDUs for a given flow or connection. Only one of these methods is used during a simulation. The WiMAX Efficiency Mode attribute determines which method is used.
Bandwidth allocation and request mechanisms	Stand-alone bandwidth request using direct delivery and GPSS mode for bandwidth grant are implemented.
Initial SS and BS association	You can specify the base station to which a subscriber station is connected. By default, subscriber stations are associated with the closest base station. As the subscriber station moves, initial ranging is used for BS association.
Mobility	The following mobility features are modeled: • Neighbor advertisements • Dynamic selection of predefined scanning interval configurations based on measurement levels • Scanning, which can be initiated by the mobile subscriber or the base station • Hard handover when initiated by the mobile subscriber
Ranging	The model supports CDMA-based ranging. The initial and periodic phases of ranging are modeled.
Quality of service (QoS)	The following QoS features are implemented: • Service flows (admitted and active) • Service class name parameters • Per-connection queuing/buffering • Global service class name and global service flows • Dynamic service flow creation

Table 38-1 WiMAX Model Features (Continued)

Model Feature	Description
PHY modeling	The model includes the following physical (PHY) layer effects • PHY-layer overheads • PHY profiles for OFDM, OFDMA, and SC • Co-channel interference for OFDMA and SC • Pathloss for OFDMA and SC • Multipath fading for OFDMA channels. Multipath fading is not modeled for SC channels, since it is assumed that the equalization is done by the SC receiver.
Convergence sub-layer (CS)	The IP CS classifier is implemented.
Broadcast and multicast traffic	The model supports broadcast and multicast traffic when physical layer modeling is enabled. WiMAX treats broadcast and multicast traffic from upper layers as broadcast traffic.
End of Table 38-1	

Model Limitations

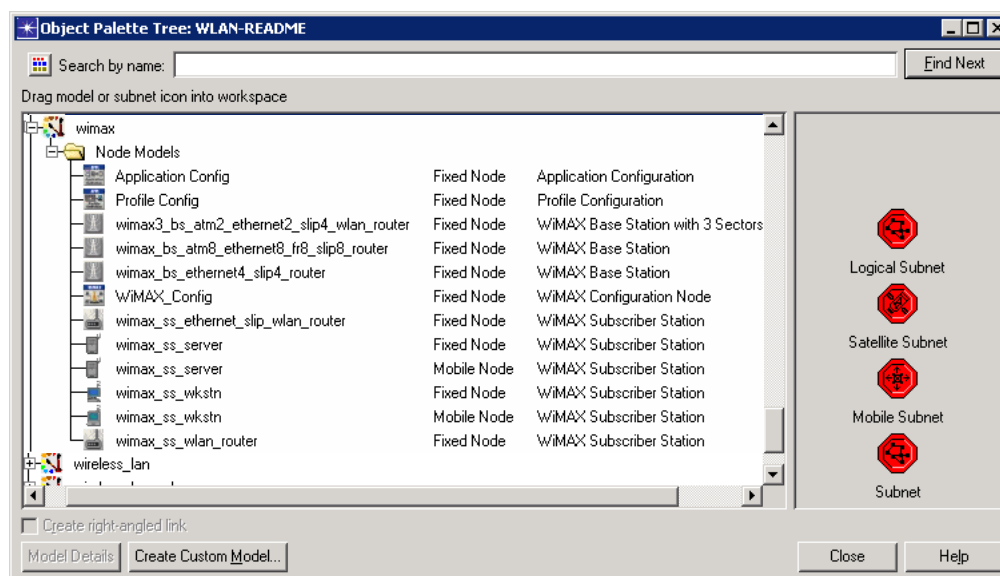
The following features have not been implemented.

- Power Management
- Adaptive burst profile
- Network-assisted handover
- Base station-initiated periodic ranging

Node Models

WiMAX-capable nodes are included in the WiMAX object palette.

Figure 38-1 WiMAX Object Palette



The following table lists the node models capable of WiMAX functionality.

Table 38-2 WiMAX Node Models

Node Model	Description
wimax3_bs_atm2_ethernet2_slip4_wlan_router	Three-sector, fixed base station node model with router functionality. This node has 2 ATM interfaces, 2 Ethernet interfaces, 4 SLIP interfaces, 3 WiMAX interfaces, and one WLAN interface. Each of the WiMAX interfaces represents a sector.
wimax_bs_atm8_ethernet8_fr8_slip8_router	Fixed base station node model with router functionality. This node has 8 ATM interfaces, 8 Ethernet interfaces, 8 Frame Relay interfaces, 8 SLIP interfaces, and one WiMAX interface.
wimax_bs_ethernet4_slip4_router	Fixed base station node model with router functionality. This node has 4 Ethernet interfaces, 4 SLIP interfaces, and one WiMAX interface.
wimax_ss_server	Mobile subscriber station node model with server functionality.

Table 38-2 WiMAX Node Models

Node Model	Description
wimax_ss_workstation	Mobile subscriber station node model with workstation functionality.
wimax_ss_wlan_router	Mobile subscriber station node model with router functionality. This node has one WiMAX interface and one Wireless LAN interface.
WiMAX_Config	Global configuration object used to configure parameters such as service classes and PHY profiles.
End of Table 38-2	

Model Attributes

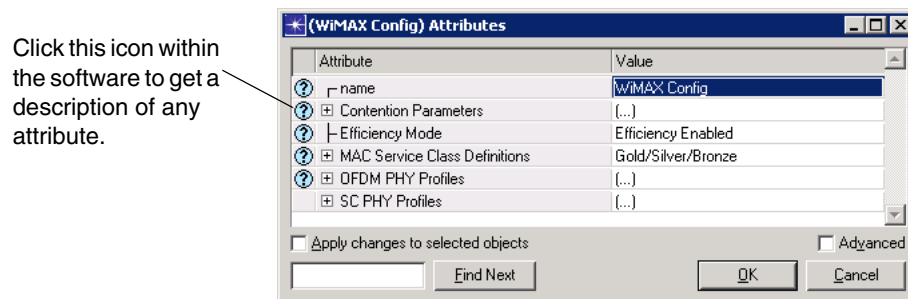
The following attributes are available for configuring WiMAX network models.

WiMAX Configuration Object Attributes

The WiMAX configuration object includes the following attributes.

- Contention Parameters
- Efficiency Mode
- MAC Service Class Definitions
- OFDM(A) PHY Profiles
- SC PHY Profiles

Figure 38-2 WiMAX Configuration Object Attributes



Base and Subscriber Station Attributes

On base station node models and subscriber station node models, all of the parameters needed to specify WiMAX configuration are included in the WiMAX Parameters compound attribute. Figure 38-3 shows the WiMAX Parameters attribute on an subscriber station node. The base station nodes have a similar set of WiMAX parameters that includes attributes for base station (instead of subscriber station) operation. The three-sector base station has three sets of attributes under WiMAX Parameters, one for each sector.

Figure 38-3 WiMAX Parameters Attribute on a Subscriber Station Node

Click this icon within the software to get a description of any attribute.

Attribute	Value
name	ss_BE_9
WiMAX Parameters	
Antenna Gain (dBi)	-1 dBi
Classifier Definitions	(...)
MAC Address	Auto Assigned
PHY Profile	WirelessOFDMA 20 MHz
PHY Profile Type	OFDM
SS Parameters	(...)
BS MAC Address	Distance Based
Downlink Service Flows	(...)
Uplink Service Flows	(...)
Multipath Channel Model	Disabled
Pathloss Parameters	Free Space
Ranging Power Step (mW)	0.25
Timers	Default
Contention Ranging Retries	16
Mobility Parameters	(...)
Transmission Power (W)	0.5
Applications	
CPU	
Client Address	Auto Assigned

Configuring WiMAX

This section describes the ways to configure WiMAX in your network model. The typical configuration steps include:

- Creating the Topology
- Configuring Node Mobility
- Adding Traffic to the WiMAX Network Model
- Configuring WiMAX Parameters

Creating the Topology

Note—WiMAX topologies cannot be created using the import features in the software (such as import from VNE Server or device configuration files). You must create these topologies manually.

When you create the network model, you can specify certain characteristics such as the geographic size of the model. Creating a network topology for WiMAX is similar to creating any other network topology. Be aware that to set geographic size for the model, you must select the following in the Startup Wizard:

- Initial Topology—Choose Create Empty Scenario
- Choose Enterprise, Campus, or Office

You are prompted for dimensions.

You can add nodes to your network model several ways:

- Manually, by dragging and dropping objects from the object palette into the Project Editor workspace.
- Manually, using the Topology > Rapid Configuration... command from the menu bar to specify and build a complete network topology quickly.
- Programmatically—You can use the OPNET Development Kit to add nodes to a network model. For more information about this option, see `Ets_Obj_Install()` on page AAA-5-74. You can also use External Model Access (EMA) to add a number of nodes to a model. For more information about this option, see External Model Access on page MFA-1-1.
- Modeling the terrain, as described in the Using Terrain Modeling Module on page TMM-2-1. (Currently, the model does not account for the effects of terrain on WiMAX.)

Configuring Node Mobility

Once you have a populated network model, you can configure mobility to some or all of the nodes in the network. You can model mobility by

- Configuring trajectories
- Configuring random mobility
- Programmatically manipulating the position of the nodes

See *Configure Mobility* for information on how to configure WiMAX to support mobile nodes.

Adding Traffic to the WiMAX Network Model

After you have created the WiMAX network topology, you can introduce traffic into the model. You can do this through the use of discrete application traffic (including standard application models such as FTP and E-mail, custom applications, and application demands). The model does not support other forms of traffic modeling, such as traffic flows or raw packet generation.

Application support is included in the subscriber station nodes (workstation and server models).

Configuring WiMAX Parameters

This section describes the basic steps needed to implement WiMAX functionality in a network model.

- 1) Define Service Classes
- 2) Configure Efficiency Mode
- 3) Configure Physical Layer (PHY) Profiles
- 4) Associate Subscriber Stations with Base Stations
- 5) Define Service Flows
- 6) Assign Traffic to Service Classes
- 7) Configuring Physical Layer Parameters
- 8) Configure Mobility

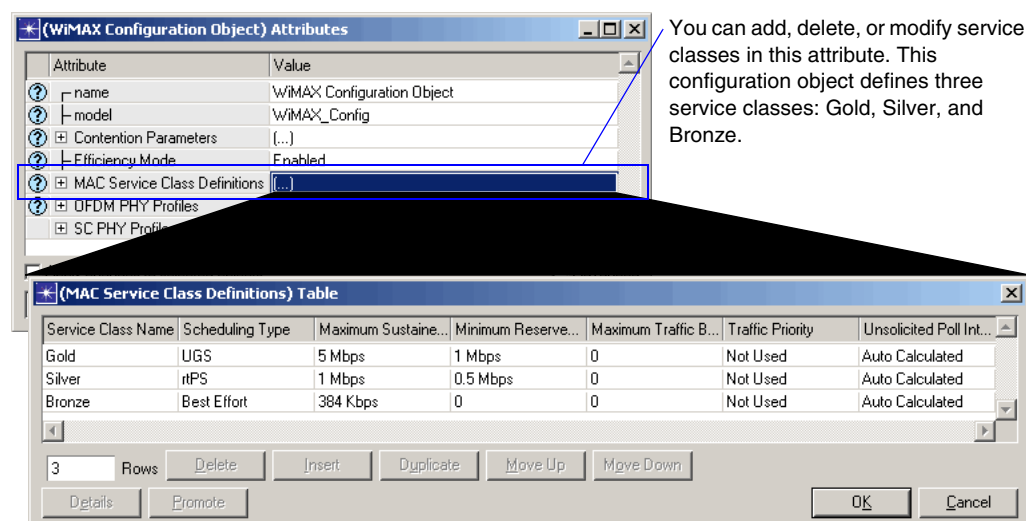
The steps listed above are sufficient for running a simulation with the default parameters. After completing the basic setup, you might want to examine and modify other WiMAX attributes in the WiMAX configuration object and in the WiMAX Parameters attribute on subscriber station and base station nodes. Detailed descriptions of all attributes are included in the Attributes dialog box within the software.

Define Service Classes

A service class groups the QoS requirements of service flows. The service classes must be defined in the MAC Service Class Definitions attribute of the WiMAX configuration object. Each scenario that includes WiMAX must have a WiMAX configuration object. Service classes are associated with service flows on subscriber nodes.

By default, the configuration object defines three service classes: Gold, Silver, and Bronze. You can modify the parameters of each of these service classes or replace the default service classes with your own classes. Although you can configure multiple service classes to use the same scheduling type, each service class must have a unique name.

Figure 38-4 Defining WiMAX Service Classes



Configure Efficiency Mode

Depending on the goals of your WiMAX simulation study, you can configure the model to use a limited set of features. The following table lists the features included in each efficiency mode.

Table 38-3 Features Included in WiMAX Efficiency Modes

Efficiency Mode	Included Features
Mobility and Ranging	All WiMAX model features enabled
Physical Layer Enabled	All WiMAX model features except • Mobility • Ranging
Framing Module Enabled	All WiMAX model features except • Physical layer effects • Mobility • Ranging
Efficiency Enabled	All WiMAX model features except • Physical layer effects • Frame modeling • ARQ • Mobility • Ranging Note: This mode consists only of the features included in the initial WiMAX model release.
End of Table 38-3	

Generally, setting the Efficiency Mode to Physical Layer Enabled or Framing Module Enabled generates more accurate delay statistics due to the increased granularity introduced by the ARQ, framing, and physical layer features.

Note—Even if you configure mobility, ARQ, framing, or physical layer attributes, their effects are only modeled when using an efficiency mode that supports their features.

Configure Physical Layer (PHY) Profiles

For modeling studies that use the model's framing features, you need to configure the SC PHY Profiles attribute or the OFDM PHY Profiles attribute (or both). As mentioned in Configure Efficiency Mode, you need to set the efficiency mode to Framing Module Enabled or Physical Layer Enabled to model the framing mechanisms in WiMAX connections.

PHY layer profiles are used for the following:

- estimating link capacities during admission control
- determining uplink/downlink boundary information using the configured frame structure information
- determining PHY-layer overheads

Note—Some of the PHY attributes are not used in the Framing Module Enabled mode.

Associate Subscriber Stations with Base Stations

You can use the WiMAX Parameters > SS Parameters > BS MAC Address attribute on the subscriber station to specify the base station to which the subscriber station connects. By default, this attribute is set to Distance Based, which means that the subscriber station connects to the closest base station. This association is permanent when mobility is disabled.

If mobility is enabled, this attribute is used to determine the first BS association only. As a node moves, scanning is used to determine candidate base stations for association, and then initial ranging is performed to complete association.

Define Service Flows

After you have defined the service classes in the WiMAX configuration object, you can assign these service classes to the service flows that you create between subscriber stations and the base station. Uplinks refer to service flows from subscriber station to the base station. Downlinks refer to service flows from the base station to the subscriber station.

Both uplink and downlink service flows are defined and configured at the subscriber node. By default, all subscriber stations have no defined service flows. At runtime, simulation establishes a best effort connection in each direction between the subscriber station and its base station—this best effort connection is in addition to any configured connections.

Note—The best effort connections created when there are no defined service flows are labeled “System Default” in the Results Viewer (View Results dialog box).

You can define multiple uplink and downlink service flows between a subscriber station and base station. Within the set of uplink service flows, no two service flows should have the same service class. Similarly, within the set of downlink service flows, no two service flows should have the same service class. Uplinks are defined in the WiMAX Parameters > SS Parameters > Uplink Service Flows attribute. Downlinks are defined in the WiMAX Parameters > SS Parameters > Downlink Service Flows attribute.

ARQ configuration is included in the service flow definition. By default, ARQ is disabled. To enable ARQ, set the WiMAX Parameters > SS Parameters > Downlink/Uplink Service Flows > ARQ Parameters > Automatic Retransmission Request attribute to Enabled and make sure that the Efficiency Mode attribute (on the WiMAX configuration object) is set to Framing Module Enabled or Physical Layer Enabled. This enables ARQ with the default configuration settings. To customize the configuration, you can modify the other parameters in the ARQ Parameters attribute on the subscriber node. The PDU Dropping Probability attribute can be configured to model PHY-layer losses on a per-connection basis when the efficiency mode is set to Framing Module Enabled. In the Physical Layer Enabled efficiency mode, the packets are dropped based on the physical layer effects. The ARQ module reacts to packet losses by retransmitting the PDUs.

Figure 38-5 Defining Uplinks and Downlinks on Subscriber Stations

Use these attributes to define the service flows between this subscriber station and its base station. In this example, the subscriber station will connect to the closest (Distance Based) base station.

The inset at right shows the sub-attributes of the Downlink Service Flows attribute, including attributes for configuring ARQ.

These attributes are also available for configuring uplink service flows.

Attribute	Value
name	ss_BE_9
WiMAX Parameters	
Antenna Gain (dBi)	-1 dBi
Classifier Definitions	(...)
MAC Address	Auto Assigned
PHY Profile	WirelessOFDMA 20 MHz
PHY Profile Type	OFDM
SS Parameters	(...)
BS MAC Address	Distance Based
Downlink Service Flows	(...)
Uplink Service Flows	(...)
Multipath Channel Model	Disabled
Pathloss Parameters	Free Space
Ranging Power Step (mW)	0.25
Timers	Default
Contention Ranging Retries	16

Attribute	Value
BS MAC Address	Distance Based
Downlink Service Flows	(...)
rows	1
row 0	
Service Class Name	Specify...
Initial Modulation	64-QAM
Initial Coding Rate	3/4
Average SDU Size (bytes)	1500
Activity Idle Timer (seconds)	60
Buffer Size (bytes)	64 KB
ARQ Parameters	(...)
Automatic Retransmission	Disabled
Window Size (ARQ bloc...	512
Block Size (bytes)	256
Retransmission Time Inte...	0.1
Block Lifetime Interval (s...	3
Sync Loss Time Interval ...	Infinite
Purge Time Interval (sec...	Infinite
In-Order SDU Delivery	Disabled
PDU Dropping Probability	Disabled
CRC Overhead	Disabled
Uplink Service Flows	(...)

Assign Traffic to Service Classes

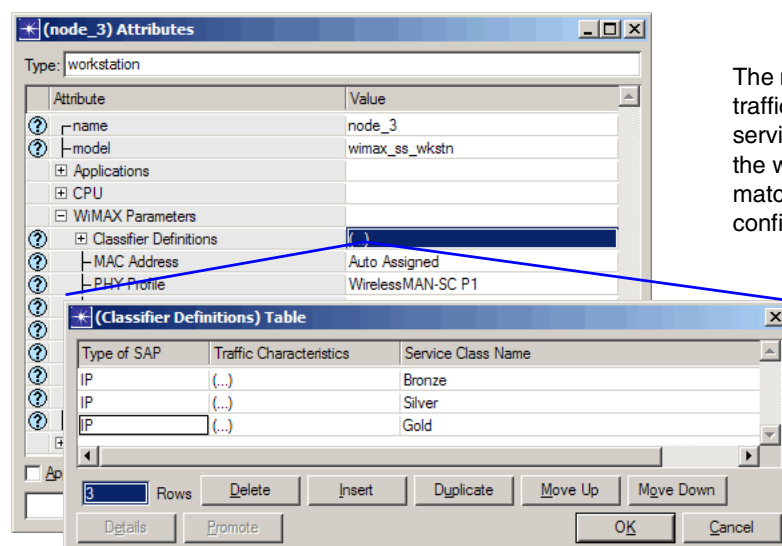
The service flows between subscriber and base station nodes can be configured to use a particular service class.

You can assign traffic to service classes in the WiMAX Parameters > Classifier Definitions attribute on subscriber and base station nodes. The assignments specified in this attribute apply to traffic sent from the station. In other words, the Classifier Definitions attribute on subscriber stations applies to traffic in the uplink direction (to the base station) whereas the Classifier Definitions attribute on base stations applies to traffic in the downlink direction (to the subscriber station).

When configuring classifier definitions, you use a match condition to specify the type of traffic that should be assigned to a particular service class. You can use the following characteristics to classify traffic: type of service, source address, destination address, source port, and destination port. Any traffic that is not explicitly assigned to a service class is sent using Best Effort service.

By default, the WiMAX node models have no classifier definitions configured on them, which means that all traffic would use the default best effort connection (System Default connection).

Figure 38-6 Configuring Traffic to Use a Particular Service Class



Configuring Physical Layer Parameters

If you want to include physical layer effects in the network model, you need to configure the following parameters on subscriber and base station nodes:

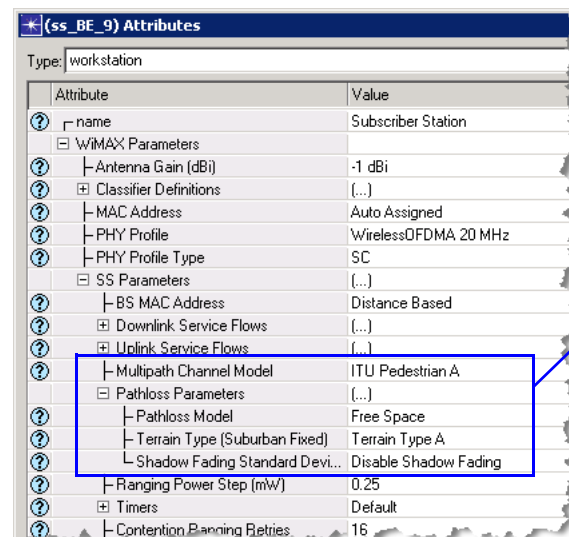
- Transmission Power
- Pathloss Parameters (subscriber stations only)

- Multipath Channel Model (subscriber stations only)
- PermBase (base stations only)

The model assumes that the physical channel from the subscriber station to the base station has the same properties as the reverse channel that goes from the base station to the subscriber station. So, both channels are configured by the Pathloss Parameters and Multipath Channel Model attributes on the subscriber station.

The Pathloss Parameters attribute and Multipath Channel Model attributes are configured and implemented separately. Although the model includes corresponding values for these attributes, you do not have to use corresponding values. This gives you the flexibility to experiment with non-standard pairs of multipath and pathloss models.

Figure 38-7 Configuring Physical Layer Channels



Physical layer channels are configured on subscriber station nodes. The configuration applies to channels in both directions.

Here, the value of the pathloss model (Vehicular Environment) corresponds to the value of multipath channel model (ITU Vehicular A). This is a standard pairing of pathloss and multipath models.

The model also supports non-standard pairs of pathloss and multipath models.

Configure Mobility

To model mobility in WiMAX networks, the following configuration is needed:

- The WiMAX efficiency mode must be set to Mobility and Ranging Enabled.
- Handovers and Scanning related attributes can be configured under the WiMAX Parameters > SS Parameters > Mobility Parameters attribute on subscriber stations and under the WiMAX Parameters > BS Parameters > Mobility Parameters attribute on base station nodes.

Figure 38-8 Configuring Mobility Parameters on SS and BS Nodes**Subscriber station parameters**

?	Timers	Default
?	Contention Ranging Retries	16
?	Mobility Parameters	(...)
?	Scanning Parameters	(...)
?	Handover Parameters	(...)
?	Applications	

Base station parameters

?	WiMAX Parameters	
?	Antenna Gain (dBi)	15 dBi
?	BS Parameters	(...)
?	Maximum Number of SS Nodes	100
?	Received Power Tolerance	(...)
?	CDMA Codes	(...)
?	Backoff Parameters	(...)
?	Mobility Parameters	(...)
?	Neighbor Advertisement Parameters	Advertise every 10 frames
?	Scanning Parameters	(...)
?	Handover Parameters	(...)

- On base station node models, each WiMAX interface belongs to a unique IP subnet. To facilitate Layer-3 handoff between base station interfaces, mobile IPv4 must be configured on the base stations (BS) and mobile stations (MS).

Procedure 38-1 Configuring Mobile IPv4 for WiMAX Mobility Support

- Configure the base station nodes to support mobile IPv4.
 - Manually assign IP addresses to the WiMAX interfaces of all base stations that need to support mobility (and hence mobile IPv4). The IP interface for WiMAX usually has an MTU of 1500, which can be useful when trying to identify WiMAX interfaces on a BS node.
 - Specify the IP interface name (that runs WiMAX). To do this, configure the IP > Mobile IP Router Parameters > Mobile IPv4 > Interface Information > Interface Name attribute. For example, in wimax_bs_router_adv the interface name is "IF32".
 - Specify the mobile IPv4 agent type for the WiMAX IP interfaces. To do this configure the IP > Mobile IP Router Parameters > Mobile IPv4 > Interface Information > Agent Type attribute. The recommended value of this attribute is Home Agent/Foreign Agent.
- Configure the subscriber station nodes to support mobile IPv4.
 - Specify the home agent. To do this, set the Home Agent IP Address attribute (IP > Mobile IP Host Parameters > Home Agent IP Address) on the mobile station to the IP address of one of the base stations configured in step 1.1.
 - If the mobile station will start the simulation in a network other than its home network, give the mobile station an IP address that matches the IP subnet of its home agent.

End of Procedure 38-1

Analyzing WiMAX Networks

To analyze WiMAX performance, you can collect several statistics and analyze reports about WiMAX behavior in a scenario.

Available Statistics

WiMAX statistics can be collected on a global, per-node, or a per-connection basis.

Figure 38-9 WiMAX Global Statistics

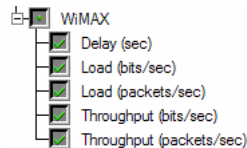
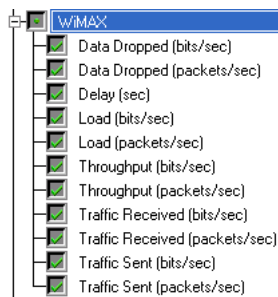
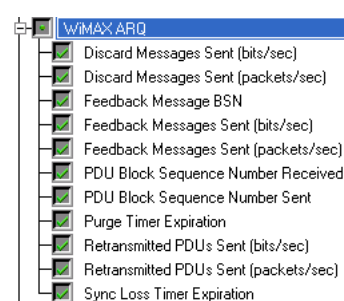


Figure 38-10 WiMAX Node Statistics

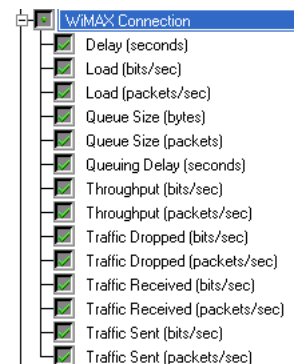
Statistics for general WiMAX traffic at the MAC layer



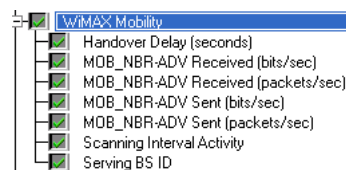
Statistics on ARQ performance



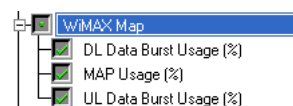
Statistics on performance of uplink and downlink connections



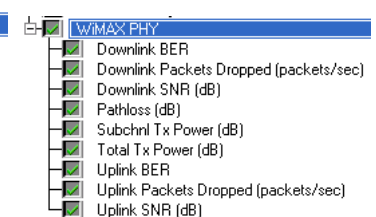
Statistics for mobility performance



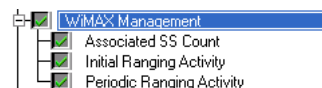
Statistics on MAP usage in BS nodes



Statistics on performance at the physical layer



Statistics for ranging performance

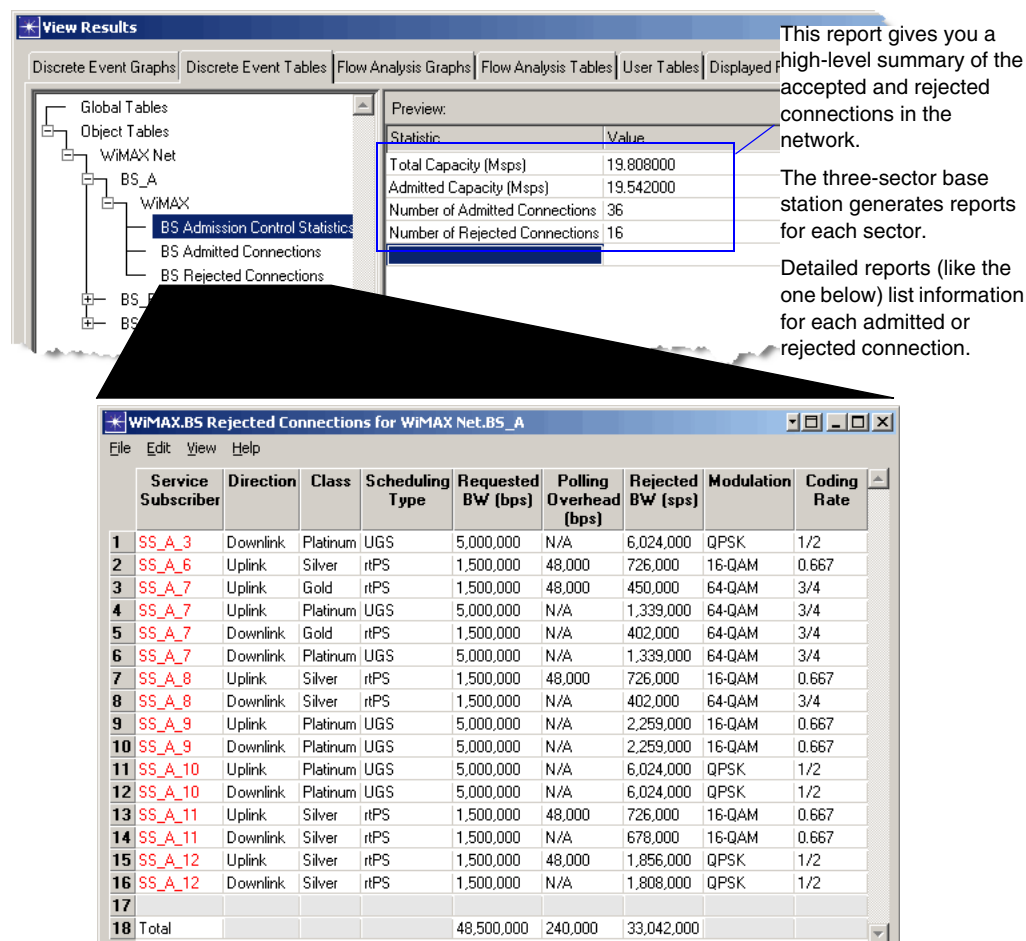


Note—Collecting BER and SNR PHY statistics can significantly increase simulation run times and the size of the output vector file.

Available Reports

The WiMAX model suite includes reports that let you view details about the admitted and rejected connections for each base station. These reports are available from the Discrete Event Tables tab in the View Results dialog box—they are automatically generated for all scenarios that use WiMAX so you do not need to choose these reports before running a simulation.

Figure 38-11 WiMAX Admission Control Report



Model Architecture

The following sections describe the underlying architecture of the WiMAX model.

- Node Architecture on page SPM-38-19
- Process Models on page SPM-38-21
- Pipeline Stages on page SPM-38-22

All model files are included in the following directory, unless otherwise indicated.

```
<opnet_dir>/models/std/wimax
```

Node Architecture

Figure 38-12 depicts the node model architecture for WiMAX subscriber station node models.

Figure 38-12 Subscriber Station Node Models (Server and Workstation)

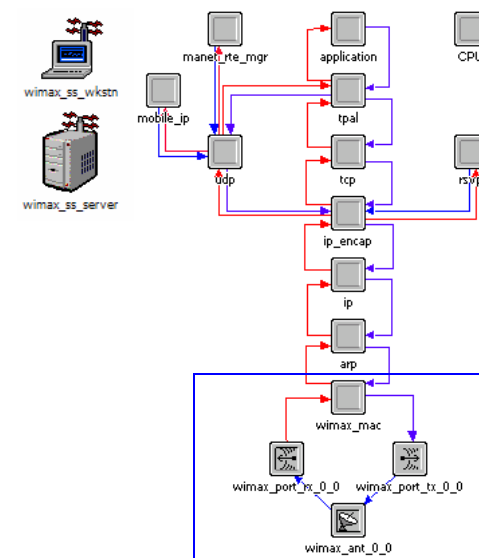
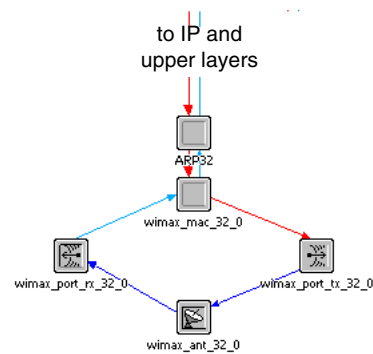


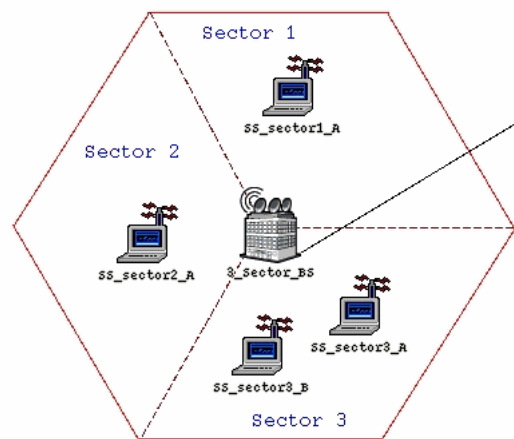
Figure 38-13 depicts the architecture surrounding the WiMAX interface(s) on base station node model.

Figure 38-13 WiMAX Architecture on Base Stations (One Interface Shown)



The three-sector base station has three WiMAX interfaces, which are arranged as shown in Figure 38-14.

Figure 38-14 Sector Coverage for Three-Sector Base Stations



The antenna in each sector covers 160 degrees. This creates an overlap of 40 degrees with each neighboring sector.

Process Models

The WiMAX model uses the following process models.

Table 38-4 WiMAX Process Models

Process	Description
wimax_mac	This is the root process for WiMAX functionality and is responsible for data plane control (MAC layer), including the following: • Data forwarding • Classifying higher-layer traffic to service flows • Encapsulation/Decapsulation of higher-layer packets in MAC frames • Bandwidth request/grant mechanism • ARQ • Packet delivery Depending on whether the interface is on a base station or subscriber station, this process spawns the wimax_bs_control (base stations) or wimax_ss_control (subscriber station) process.
wimax_bs_control	This child process of wimax_mac implements WiMAX functionality on base stations, including: • Admission control • Bandwidth grant scheduler • MAP generation • Activation of admitted service flows • Sending neighbor advertisements • Commanding the SS to enter scanning mode • Responding to ranging messages • Releasing SS resources after handover
wimax_ss_control	This child process of wimax_mac implements WiMAX functionality on subscriber stations, including: • Admission control initiation • Activation of service flows • MAP decoder • Handover initiation • Starting the scanning mode, scanning neighbor base stations • Ranging (initial and periodic) • Selecting the serving base station
End of Table 38-4	

Pipeline Stages

The WiMAX model uses the following pipeline stages.

Table 38-5 WiMAX Pipeline Stages

Module	Pipeline Stage
WiMAX Receiver	wimax_ber
	wimax_bkgnoise
	wimax_ecc
	wimax_error
	wimax_inoise
	wimax_power
	wimax_snr
WiMAX Transmitter	wimax_chanmatch
	wimax_propdel
	wimax_rxgroup
	wimax_txdel
End of Table 38-5	

The support functions for the pipeline stages are included in two external files:

- wimax_phy_support.ex.c
- wimax_phy_mpath_support.ex.c

Each external file has a corresponding header file in the following directory:

```
<opnet_dir>/models/std/include
```

Label Traces

The following table lists the various label traces that can be used while understanding the behavior of the TCP models.

Table 38-6 WiMAX Label Traces

Trace	Description
wimax_admission_control	Prints details about the admission control decision
wimax_broadcast	Prints details about broadcast connections
wimax_connections_out	Prints all the outgoing connections from a particular instance of wimax_mac process
wimax_data	Follows a data packet journey thorough the WiMAX MAC dataplane

Table 38-6 WiMAX Label Traces (Continued)

Trace	Description
wimax_dsa	Follows DSA requests/responses
wimax_map	Prints details about the map creation. (wimax_map_brief provides a more concise description whereas wimax_map_detailed provides more detailed information)
wimax_polling	Prints details about polling for rtPS, nrtPS connections
wimax_ps	Prints details about the pipeline stages
wimax_ho	Prints details about handovers
wimax_scan	Prints details about scanning
wimax_rng	Prints details about ranging
End of Table 38-6	

Reference Documents

WiMAX models are implemented based on information available from the following sources.

Table 38-7 Reference Documents

Reference	Document
V. Erceg, K.V.S. Hari, M.S. Smith, D.S. Baum et al	Channel Models for Fixed Wireless Applications, Contribution IEEE 802.16a-03/01, Jun. 2003
IEEE Std 802.16-2004 (Revision of IEEE Std 802.16-2001)	IEEE Standard for Local and metropolitan area networks—Part 16: Air Interface for Fixed Broadband Wireless Access Systems
IEEE Std 802.16.2™-2004	IEEE Recommended Practice for Local and metropolitan area networks—Coexistence of Fixed Broadband Wireless Access Systems
IEEE P802.16e-2005	Air Interface for Fixed and Mobile Broadband Wireless Access Systems
Recommendation ITU-R M.1225	Guidelines for evaluation of Radio Transmission Technologies for IMT-2000
End of Table 38-7	

For additional information on the WiMAX model suite, search for WiMAX in the Frequently Asked Questions section of the Support Center. Go to the OPNET Support Center and click on FAQs.

