MQSeries Integrator - Message generator and coverage analysis tools

Version 1.1

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Take Note!

Before using this report be sure to read the general information under "Notices".

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This edition applies to Version 1.1 of *WebSphere MQ Integrator - Automatic Message Generator* and to all subsequent releases and modifications unless otherwise indicated in new editions.

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Summary of Amendments

Date	Changes
08 May 2001	Initial release
10 January 2002	Add support for WebSphere MQ Integrator V2.1.

In the WebSphere MQ Integrator V2.1 release, new constraints can be added to message fields. When generating a new default profile, the Message Generator takes into account several of these constraints, to create a profile that better fits the message characteristics. For example, suppose an Integer type field was assigned *minInclusive* and *maxInclusive* constraints, the Message Generator will assign a *Random* generation function to this field, with the field constraints as the *Lower Bound* and *Upper Bound* limits of the function.

Preface

This SupportPac includes two tools that enhance the testing support given by MQSeries Integrator: an automatic message generator and a coverage analysis tool.

The general purpose of automatic message generation is to give the user the ability to generate a stream of message inputs with some characteristics. The user selects a message type and then defines directives for generation. The directives are given dynamically by choosing a generation function for every message field. Basic generation functions are provided. According to the user directives a message suite is generated automatically. The generated message suite can then be used to test a message flow or the endpoint applications.

Coverage analysis, in general, is used for finding areas of a program that were not exercised by a set of test cases. This leads to creating additional test cases to increase coverage. The quantitative measure of coverage is an indirect measure of quality. A coverage analyzer automates this process. As the percentage of coverage grows, it implies that more areas of the code were exercised, thus increases the probability to encounter bugs and raises the correctness of the program.

The coverage analysis tool enables the user to inspect the coverage achieved in several executions of a message flow. The executions of the message flow can be a result of running the message suite generated automatically by the message generator or using messages created in other way (manually, by an application). The tool analyzes the execution information out of system trace files and presents to the user various visual and textual reports.

Bibliography

- *WebSphere MQ Integrator for Windows NT and Windows 2000 Version 2.1 Installation Guide,* IBM Corporation. GC34-5600-04.

- *WebSphere MQ Integrator Version 2.1 Using the Control Center,* IBM Corporation. SC34-5602-04

Chapter 1. Introduction

Overview

This SupportPac includes two tools that enhance the testing support given by MQSeries Integrator: an automatic message generator and a coverage analysis tool.

The general purpose of automatic message generation is to give the user the ability to generate a stream of message inputs with some characteristics. The user selects a message type and then defines directives for generation. The directives are given dynamically by choosing a generation function for every message field. Basic generation functions are provided. According to the user directives a message suite is generated automatically. The generated message suite can then be used to test a message flow or the endpoint applications.

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The coverage analysis tool enables the user to inspect the coverage achieved in several executions of a message flow. The executions of the message flow can be a result of running the message suite generated automatically by the message generator or using messages created in other way (manually, by an application). The tool analyzes the execution information out of system trace files and presents to the user various visual and textual reports.

Message Generation Process

The message generation process is divided into two main stages:

1. Message generation - data generation for each message field. In this step the user defines the generation functions for each message field and the specific data is generated.

2. Message browsing - in this step the user is able to browse through the generated messages, modify them, save them for a future use or send the to a specified MQ queue as an XML message.

Coverage Analysis Tool

The coverage analysis tool measures the coverage achieved in several executions of a message flow with respect to defined coverage criteria. The following is a list of coverage criteria defined for a message flow:

*   Processing Node Coverage - This measure reports whether each processing node was executed. The model can be refined to report whether each port of the processing node was passed through.

*   Connection Coverage - This measure reports whether each connection in the message flow was passed through.

*   SQL Statement Coverage - This measure reports for every processing node that contains SQL statements whether each of the SQL statements was executed. This model can be calculated for a compound node or the message flow as the accumulation of the measure for its constituents nodes.

- Multiple Condition Coverage - Condition coverage reports for every processing node that contains a boolean sub-expression the true or false outcome of each boolean sub-expression, separated by logical-and and logical-or if they occur. Condition coverage measures the sub-expressions independently of each other. This model can be calculated for a compound node or the message flow as the accumulation of the measure for its constituents nodes.

- n-Node Coverage - For a list of n nodes selected by the user, this measure reports whether these nodes were visited in a single execution of the message flow.

- Exception Coverage - Considering the way runtime exceptions are handled during the execution of a message flow, none of the above coverage criteria reflect the occurrence of runtime exceptions. This measure reports whether a runtime exception occurred in all the relevant processing nodes.

The coverage analysis process is performed in the following stages:

- Select a message flow

- Execute the message flow several times. During the execution of the message flow, information is gathered in the system trace log.

- Load the system trace log to the coverage analysis tool. The format of the system trace file is manipulated and a new coverage file is created, that contains only the information relevant to the coverage analysis. This coverage file can be kept and later loaded to the coverage analysis tool.

- Inspect the coverage achieved in various visual and textual reports.

More trace files can be further loaded to the coverage analysis tool, which accumulates the coverage information from all the trace files loaded.

Chapter 2. Installing the tools

SupportPac contents

The SupportPac includes the message generator code and resources, the coverage analysis tool code and resources, a plug-in node used by the coverage analysis tool and several configuration files of the Control Center that should be replaced. Note that the plug-in node should be installed in the system (instructions follow) but is not meant to be used by the user.

The supplied zip file should be unzipped to the root directory of MQSeries Integrator installation. The following files will be created:

Message Generator code and resources:

<mqsi_root>\classes\generate.jar

<mqsi_root>\Tool\GenFuncsNew.xml

<mqsi_root>\Tool\com\ibm\ivm\mqitool\mgen\MessageGenerationMessages.properties

<mqsi_root>\Tool\com\ibm\ivm\mqitool\mgen\CityTable

<mqsi_root>\Tool\com\ibm\ivm\mqitool\mgen\CompanyNameTable

<mqsi_root>\Tool\com\ibm\ivm\mqitool\mgen\CountryTable

<mqsi_root>\Tool\com\ibm\ivm\mqitool\mgen\FamilyNameTable

<mqsi_root>\Tool\com\ibm\ivm\mqitool\mgen\PrivateNameTable

<mqsi_root>\Tool\com\ibm\ivm\mqitool\mgen\StreetAddressTable

Coverage Analysis Tool code and resources:

<mqsi_root>\classes\coverage.jar

<mqsi_root>\Tool\com\ibm\ivm\mqitool\cov\CoverageAnalysisMessages.properties

<mqsi_root>\Tool\com\ibm\ivm\mqitool\cov\images\redFlag.gif

<mqsi_root>\Tool\com\ibm\ivm\mqitool\cov\images\greenFlag.gif

<mqsi_root>\Tool\images\purple16.gif

<mqsi_root>\Tool\images\pink16.gif

<mqsi_root>\Tool\images\blue16.gif

<mqsi_root>\Tool\images\red16.gif

<mqsi_root>\Tool\images\lightblue16.gif

<mqsi_root>\Tool\images\green16.gif

Plug-in node resources:

<mqsi_root>\Tool\repository\CovTrace

<mqsi_root>\Tool\repository\CovTrace.wdp

<mqsi_root>\Tool\images\CovTrace.gif

<mqsi_root>\Tool\images\CovTrace30.gif

<mqsi_root>\Tool\images\CovTrace42.gif

<mqsi_root>\Tool\images\CovTrace58.gif

<mqsi_root>\Tool\images\CovTrace84.gif

<mqsi_root>\bin\covTrace.lil

Configuration files:

<mqsi_root>\Tool\mqsi.dtd.new

<mqsi_root>\Tool\MQIToolkit.cfg.new

<mqsi_root>\Tool\MQIToolkit.properties.new

<mqsi_root>\Tool\mqsilcc.bat.new

Prerequisites

This SupportPac provides an Automatic Message Generator and a Coverage Analysis Tool to be used with *MQSeries Integrator V2.0.2* and *WebSphere MQ Integrator V2.1*. For normal use, there are no prerequisites other than those required by these products.

Supported Platforms

This SupportPac has been developed and tested in a Microsoft Windows NT environment.

Installing the tools

To Install the Automatic Message Generator and the Coverage Analysis Tool replace the following files with the corresponding files, without the .new extension. For example, replace mqsi.dtd with mqsi.dtd.new and rename it to mqsi.dtd. Be sure to backup the original files.

<mqsi_root>\Tool\mqsi.dtd.new

<mqsi_root>\Tool\MQIToolkit.cfg.new

<mqsi_root>\Tool\MQIToolkit.properties.new

<mqsi_root>\Tool\mqsilcc.bat.new

Installing the plug-in node on broker system

The plug-in 'lil' file is extracted to the following directory:
<mqsi_root>\bin

You must stop and restart the broker to enable it to detect the existence of the new 'lil'.

Integrating the plug-in node into the Windows Control Center

Use the following table to move files to their correct location. These locations should already exist providing you have deployed at least one message flow.

Use the following to replace the placeholders:

<hostname>   -   TCP/IP hostname

<CM QMName>   -   Configuration Manager's queue manager name

Filename	Move from location	Move to location
CovTrace	<mqsi_root>\Tool\repository	<mqsi_root>\Tool\repository\private\<hostname>\ <CMQMName>\MessageProcessingNodeType
CovTrace.wdp	<mqsi_root>\Tool\repository	<mqsi_root>\Tool\repository\private\<hostname>\ <CMQMName>\MessageProcessingNodeType

Defining the node to the configuration repository

When you have installed the files in the appropriate directories, as described in the previous section, you must make these definitions available to the Control Center.

Start the Control Center. The user ID you are using must be a member of the MQSeries Integrator group *mqbrdevt*. You are recommended to use the superuser *IBMMQSI2* to complete this task[1]. This causes your new node to be locked under the same user ID as all the supplied IBM primitive nodes. If you do not use this user ID, the definition files in the configuration repository might be accidentally locked, and therefore open to unauthorized update.

1. Select the Message Flows view.

2. Select an existing Message Flow Category, or create a new one.

3. Right-click the selected category, and select *Add->Message Flow*.

    A list box is displayed showing all existing IBM-supplied primitive nodes and any defined message flows you have installed following the instructions provided.

4. Select the node CovTrace.

    This node now appears within the message flow category you selected in the tree view in the left-hand pane.

5. Select the new node CovTrace, and right-click. Select *Check In*.

Right-click again, and select Lock. Then right-click again and select Check In for a second time. After this check, the interface and *.wdp* definition files disappear from the local directory and go into the shared repository, where they are available to all users of the Control Center. However, user can only use this new node if they have installed the additional files (icons, properties files, and so on) on their own system.

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[1] You must take care if you change logon IDs to complete this task. Changing logon IDs can effect the operation of the Configuration Manager's queue manager if it is on this system, but not running as a Windows NT service. See the *MQSeries Integrator Administration Guide* for more information about queue manager operation (Chapter 2) and the superuser *IBMMQSI2* (Chapter 4).

Chapter 3. Using the Automatic Message Generator

Message Generator

The Message Generator View

The **Message Generator** View enables the user to automatically create messages for a certain message type. To display the **Message Generator** view, click the **Message Generator** tab in the Control Center and then the **Generator** pane. **Figure 1** shows an example of the **Message Generator** view.
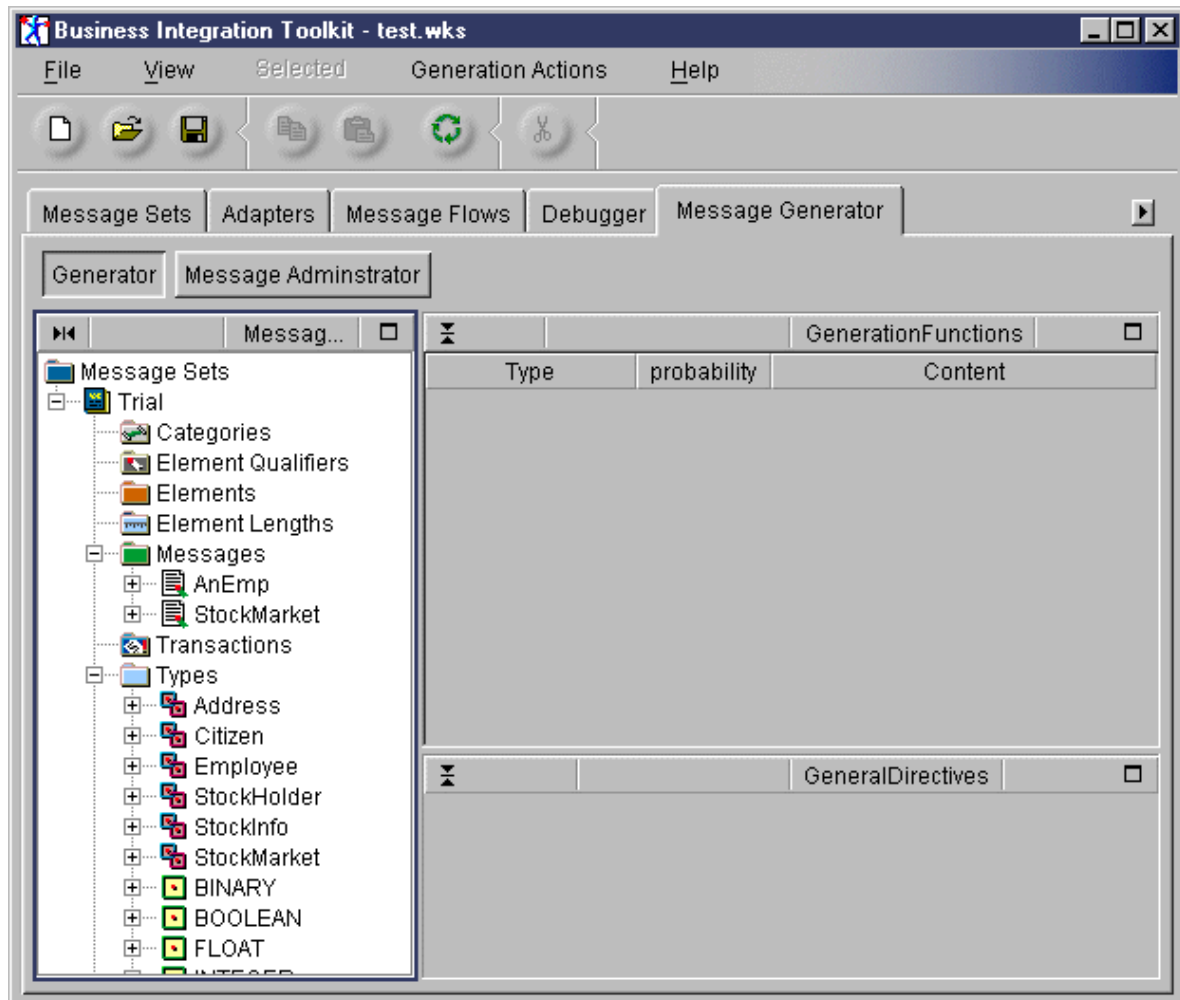

Figure 1: The Message Generator View

The left area of the screen displays the message sets and their elements that currently reside in the workspace, as the **Message Sets** view.

Create a Generation Profile

To create a new generation profile:

1. In the Message Sets pane, right click on a message type and click **Create New Profile**. The **Create new Message Generation Profile** dialog is displayed, as shown in **Figure 2**.
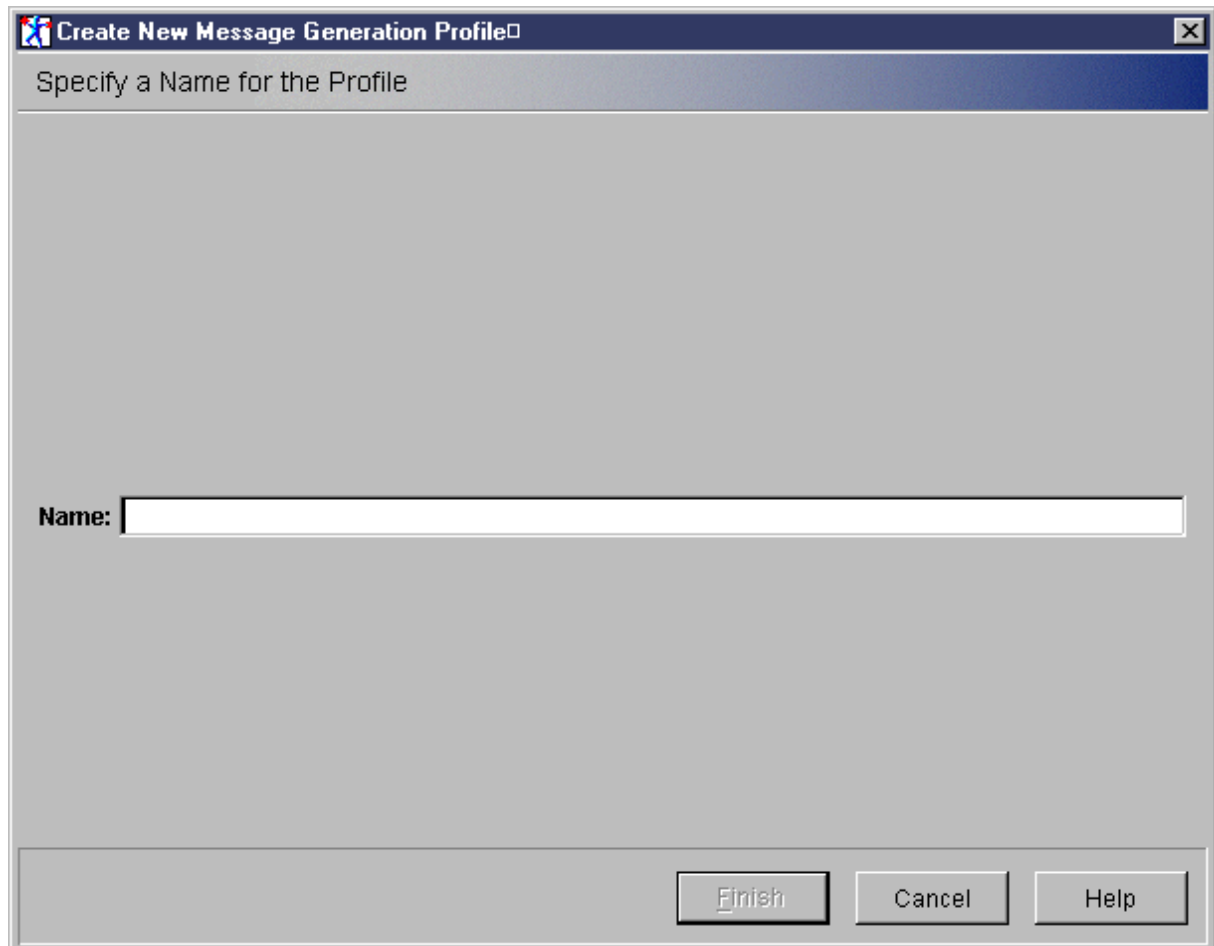
Figure 2: Create New Message Generation Profile Dialog

2. Complete the fields on the dialog: In the **Name** field, type a name for this new message generation profile.

3. Click **Finish** to complete the creation of this generation profile.

The right area of the window contains the details of the default generation profile that was created. The **General Directives** pane contains general profile characteristic. When choosing a message field in the **Message Sets** pane, the list of generation functions defined for it is presented in the **Generation Functions** pane (only one for the default profile). **Figure 3** presents the Message Generator view after a default generation profile was created.
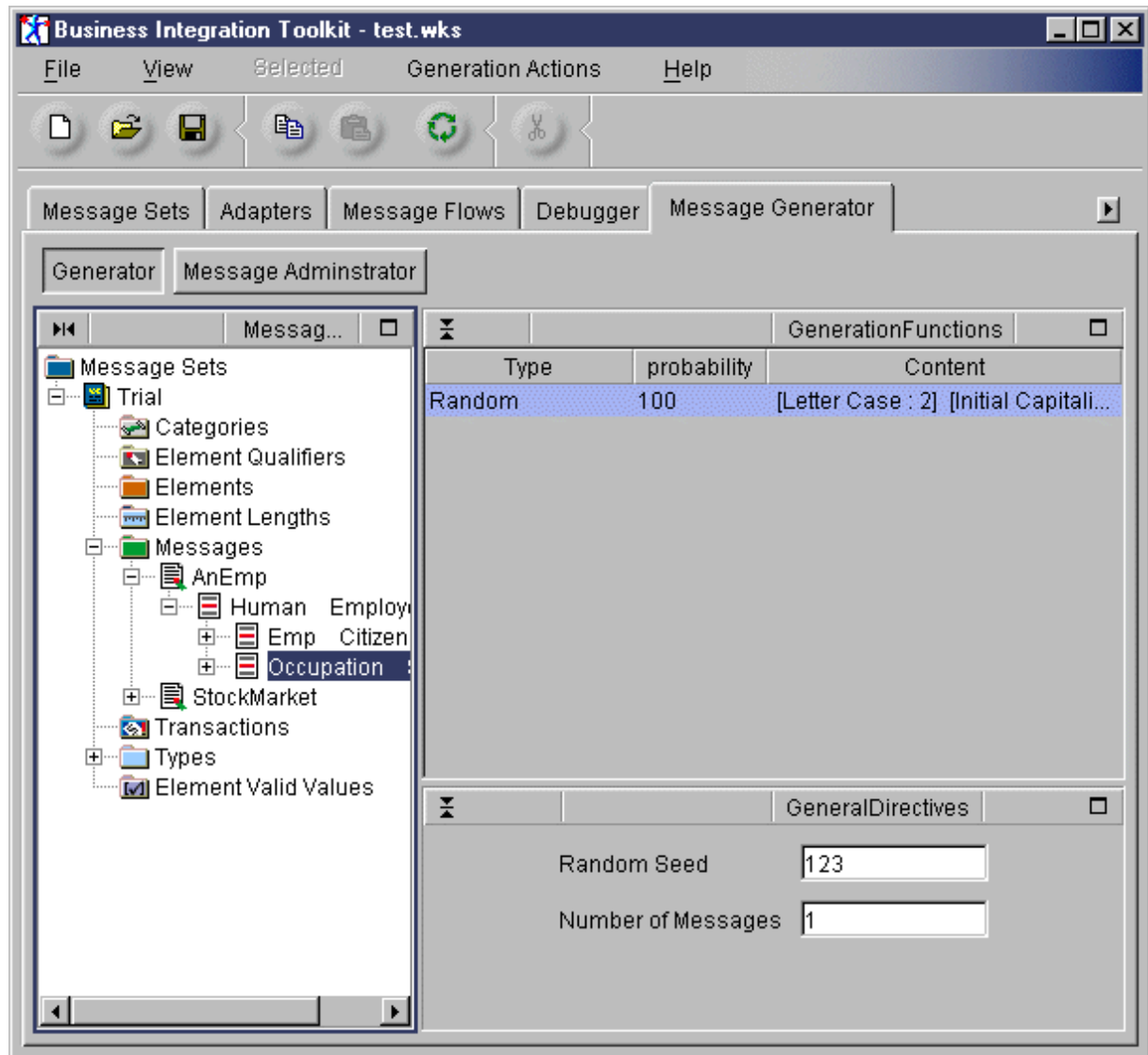
Figure 3: Default Generation Profile

Load a Generation Profile

A previously saved profile can be loaded by right clicking on the message type in the **Message Sets** pane and then clicking **Load Generation Profile**. A new dialog opens with the list of available generation profiles. Select a profile from the list and click **Finish**. The details of the generation profile will appear on the screen. If the list presented is empty, no previous saved profiles exist.

Save a Generation Profile

After a new profile was created/loaded and the desired changes have been made, to save the generation profile, right click on the message type in the **Message Sets** pane and then click **Save Generation Profile**.

Delete a Generation Profile

A previously saved profile can be deleted by right clicking on the message type in the **Message Sets** pane and then clicking **Delete Generation Profile**. A new dialog opens with the list of available generation profiles. Select a profile from the list and click **Finish**. If the list presented is empty, no previous saved profiles exist.

Modify a Generation Profile

Modify General Directives

To modify any of the general directives parameters just override the value in the text field next to the parameter.

Modify Generation Functions

For a selected message field the list of currently defined generation functions for it is presented in the **Generation Functions** pane. The following operations are possible:

- Edit the properties of a generation function - right click on the generation function and select **Edit Generation Function**. A new dialog opens with the properties of the generation function. Change the values as desired and click **Finish**. Any changes made can be undone if you click **Cancel** instead. **Figure 4** presents an example for a specific generation function properties dialog.

Figure 4: Random Generation Function Dialog

- Delete a generation function - right click on the generation function and select **Delete Generation Function**. The generation function will disappear from the view.

- Add a generation function - right click on the message field and select **Add Generation Function** and then the specific type of generation function. A new dialog opens with the properties of the generation function. Insert the values as desired and click **Finish**. The generation function will be added to the view. Any changes made can be undone if you click **Cancel** instead. Alternatively you can choose to add a generation function from the menu - when a message field is selected select **Generation Actions -> Add Generation Function**, and continue as above.

- Modify the probability of a generation function - select the probability value of a generation function and modify its value.

Generate Messages

After a generation profile was created or loaded, the message suite can be created by selecting **Generation Actions -> Start Generation**. Before generation starts, the profile is checked for inconsistencies (such as: lower bound larger than upper bound). If any error or warning is found, a dialog opens with the details. Message generation does not proceed before the user fixes the errors. If no errors found a message will appear on the screen when the generation process is complete.

Save Generated Messages

After messages were generated, the message suite can be saved as an XML file or a binary file. The binary file can be later reloaded to the **Message Browser** application. To save generated messages click **Generation Actions -> Save Messages -> to XML File / to Binary File**.

Message Browser

Message Administrator View

The **Message Administrator** View enables the user to manipulate the message suite that was created by the message generator. To display the **Message Administrator** view, click the **Message Generator** tab in the Control Center and then the **Message Administrator** pane. **Figure 5** presents an example of the **Message Administrator** view.
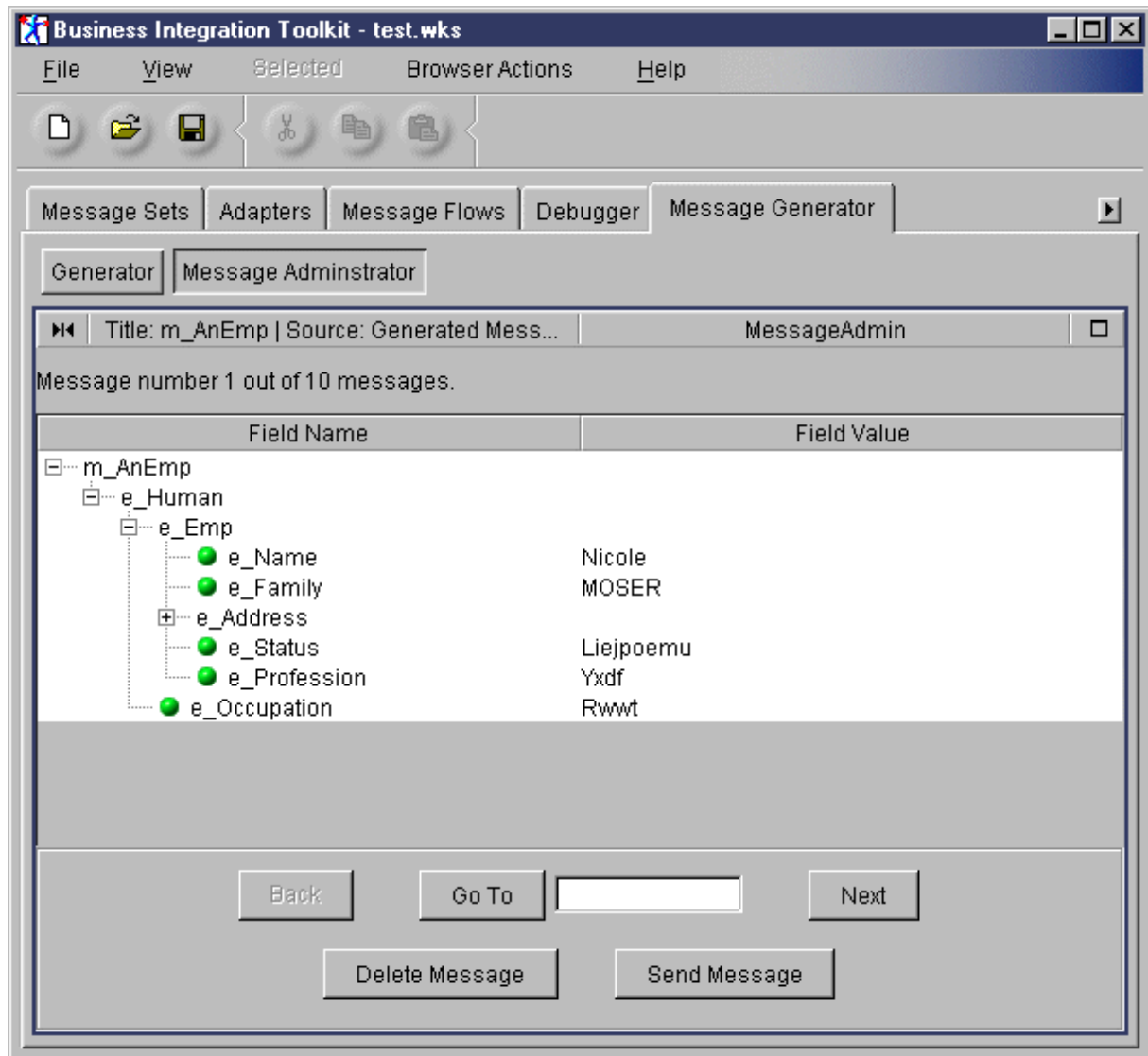

Figure 5: Message Administrator View

The first message in the suite is presented on the screen. The user can manipulate the message suite in several ways.

Browse the Messages

Use the **Next**, **Back** and **Go To** buttons to browse through the generated messages. When a message is presented on the screen, its contents can be modified by simply changing the value of a field.

Delete a Message

Use the **Delete Message** button to delete the currently displayed message from the suite.

Send a Message

Use the **Send Message** button to send the currently displayed message to an MQ queue. A new dialog is opened, where the queue properties are listed. Enter the correct values and click **Finish**. An XML message in the format of the message type, containing the specific message contents is delivered to the specified queue. After the message is delivered successfully a notification message is displayed.

Send the Message Suite

The whole message suite can be sent to a specified MQ queue. Select **Browser Actions -> Send Messages**. The same dialog as for a single message send is opened. Instead of delivering a single message, all the messages is the suite are sent. After a successful delivery a notification message is displayed.

Save Messages

If any changes have been made to the message suite, or the messages generated were not saved before, the message suite can be saved as an XML file or a binary file. To save the message suite click **Generation Actions -> Save Messages -> to XML File / to Binary File**.

Load Messages

A message suite that was previously saved to a binary file can be loaded to the Message Browser application. To do so select **Browser Actions -> Load Messages From Binary File**. A file dialog will be opened. Select a file and click **Open**. The first message in the loaded message suite will appear on the screen. The user is now able to perform all the above manipulations on the loaded suite.

Field Generation Functions

Following is a list of available generation functions for each field basic type, with their properties.

Integer Generation Functions

1. **Random**
   Integer random function generates random values out of a specified domain. The user should specify the following parameters:
   Null Probability - the probability to generate an empty number
   Unique - should the values generated for this field be unique over the specified domain
   Lower Bound - lower bound of the domain
   Upper Bound - upper bound of the domain

2. **Constant**
   Integer constant value function assigns the field the same *constant*.

3. **Sequential**
   Integer sequential function assigns sequential values to the field, starting with an *Initial Value* using an *Increment Value*.

4. **From File**
   This function reads the integer values from a file given by the user.

String Generation Functions

1. **Random**
   Integer random function generates random values out of a specified domain. The user should specify the following parameters:
   Letter Case - should the value generated be all upper case, all lower case or according to value generated.
   Initial Capitalization - should the first letter be capitalized.
   Null Probability - the probability to generate an empty number
   Choose from ABC Domain - declare the domain of characters to choose from.
   Format - specify a format for the string.
   String Length - specify whether the string length should be fixed or random.
   Length Lower Bound - length lower bound to be used for random length string.
   Length Upper Bound - length upper bound to be used for random length string*.*
   Length - string length to be used for a fixed length string

2. **Constant**
   String constant value function assigns the field the same *constant*.

3. **From Data Table**
   This function assigns a value to the field out of data tables that are shipped with the tool. Each table covers a certain topic, such as: Cities, Street Addresses, etc.

4. **From File**
   This function reads the string values from a file given by the user.

Float Generation Functions

1. **Random**
   Float random function generates random values out of a specified domain. The user should specify the following parameters:
   Null Probability - the probability to generate an empty number
   Unique - should the values generated for this field be unique over the specified domain
   Lower Bound - lower bound of the domain
   Upper Bound - upper bound of the domain
   Decimal Points - number of decimal points

2. **Constant**
   Float constant value function assigns the field the same *constant*.

3. **Sequential**
   Float sequential function assigns sequential values to the field, starting with an *Initial Value* using an *Increment Value*.

4. **From File**
   This function reads the float values from a file given by the user.

Boolean Generation Functions

1. **Random**
   Boolean random function generates either True or False randomly. The user should specify the following parameters:
   Null Probability - the probability to generate an empty number

2. **Constant**
   Boolean constant value function assigns the field the same *constant*.

3. **From File**
    This function reads the boolean values from a file given by the user.

Binary Generation Functions

1. **Random**
    Binary random function generates random values out of a specified domain. The user should specify the following parameters:
    Null Probability - the probability to generate an empty number
    Unique - should the values generated for this field be unique over the specified domain
    Lower Bound - lower bound of the domain
    Upper Bound - upper bound of the domain

2. **Constant**
    Binary constant value function assigns the field the same *constant*.

3. **Sequential**
    Binary sequential function assigns sequential values to the field, starting with an *Initial Value* using an *Increment Value*.

4. **From File**
    This function reads the binary values from a file given by the user.

Chapter 4. Using the Coverage Analysis Tool

Coverage Analysis Start

Coverage Analysis Tool View

The **Coverage Analysis Tool** View enables the user to launch the coverage analysis process and inspect the coverage results. To display the **Coverage Analysis Tool** view, click the **Coverage Analysis** tab in the Control Center. **Figure 6** shows an example of the **Coverage Analysis Tool** view.
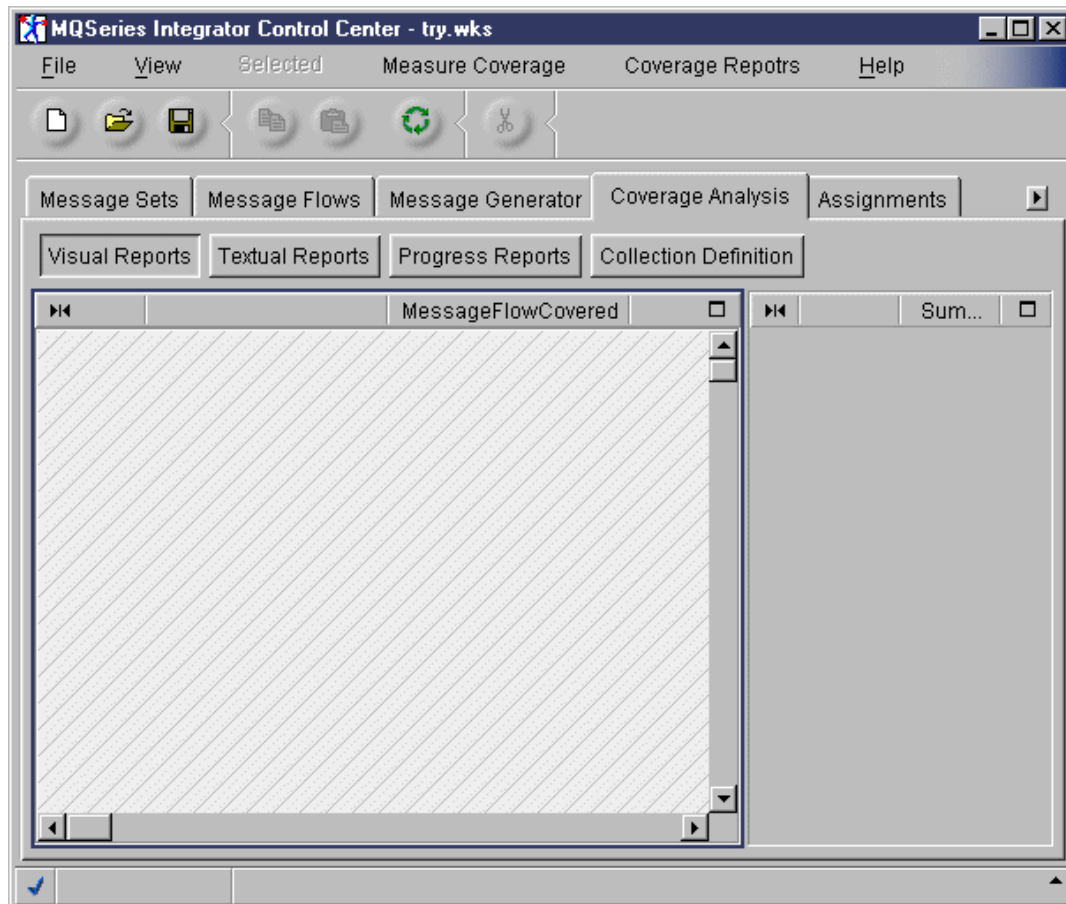
Figure 6: Coverage Analysis Tool View

Load a Message Flow

The first step needed to launch the coverage analysis process is selection of a message flow. To load a message flow to the coverage analysis tool select **Measure Coverage->Select Message Flow** from the menu bar. A dialog that contains a list of all the message flows in the workspace is shown. Select a message flow from the list and click **Finish**. To cancel this operation select **Cancel** instead. The message flow chosen is now displayed in the main area of the screen, colored red to indicate that no coverage information is yet gathered. **Figure 7** presents an example of the tool view after loading a message flow.
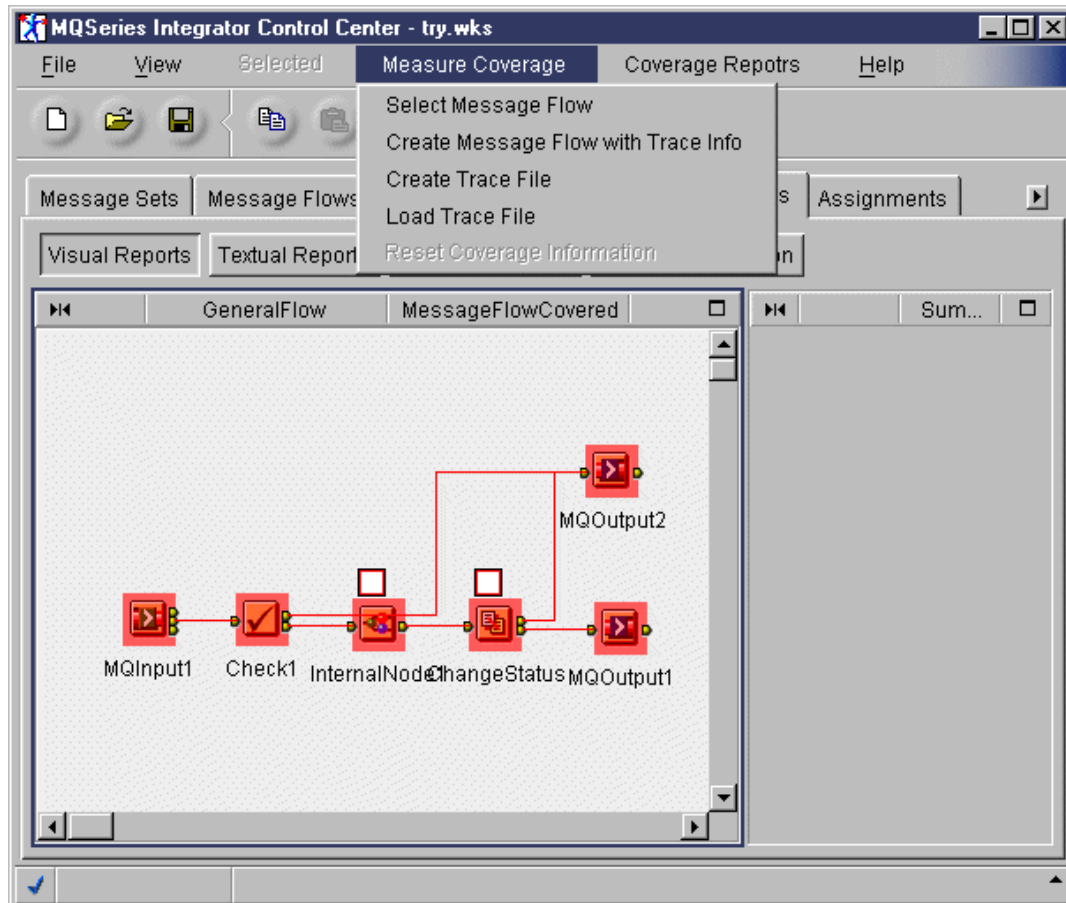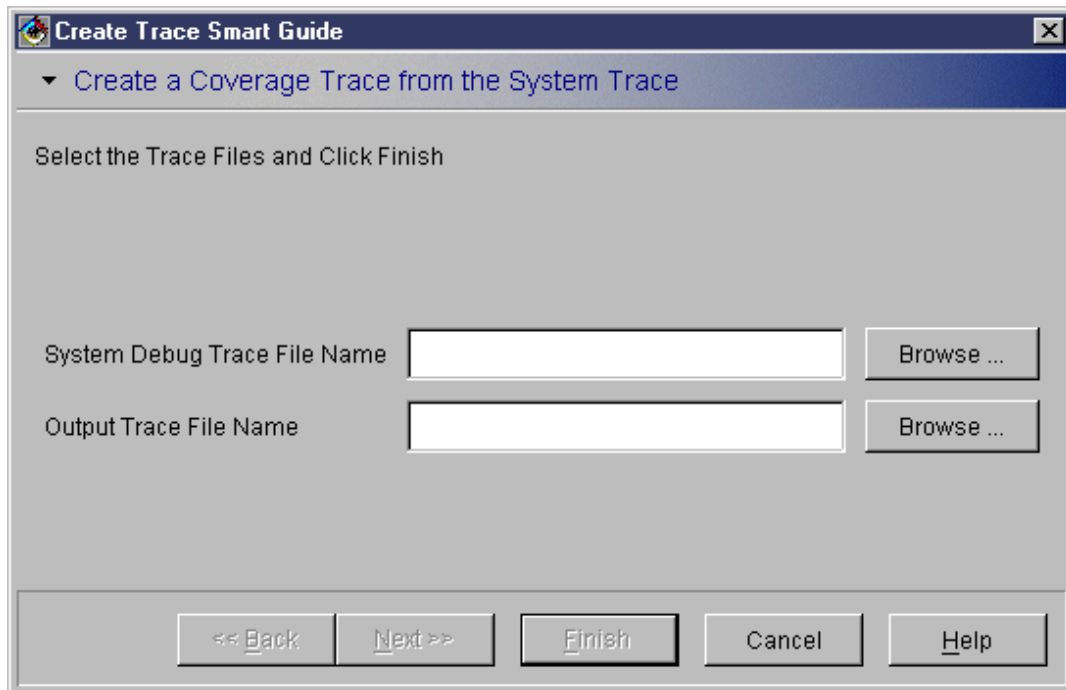

Figure 7: A Message Flow Loaded

Create a Message Flow with Trace Information

The next step in the coverage analysis process is execution of the message flow. The user is responsible for this operation. Instead of executing the original message flow, a new message flow should be created that gathers supplemental information to the system trace file, needed for the coverage analysis process. To create this new message flow select **Measure Coverage->Create Message Flow with Trace Info** from the menu bar. A new message flow will be created and checked in to the repository. The user is notified when this process ends.

It is now the responsibility of the user to execute this message flow and turn the system trace option on. This can be done using MQSeries Integrator command: **mqsichangetrace *Broker Name* -u -e *Execution Group Name* -l debug**.

Load a System Trace File

After the user has completed executing the message flow, the system trace file should be loaded to the coverage analysis tool.   First, the system trace file should be created using the following MQSeries Integrator command: **mqsireadlog *Broker Name* -u -e *Execution Group Name* -f -o *File Name***.   To load the system trace file to the coverage analysis tool select **Measure Coverage->Create Trace File** from the menu bar. The following dialog opens.

Enter the name of the system trace file created in the first field. Enter a name for a coverage file in the second field. The information in the system trace file is gathered and a coverage file is created. The coverage file contains only the information relevant to the coverage analysis process. This coverage file can be kept by the user for a future use, as it can be loaded to the coverage analysis tool using the option of loading a trace file.

When this operation is done, the tool completed analyzing the coverage information and ready to present the coverage results in various reports.

Load a Coverage File

To load a coverage file, that was previously created from a system trace file, select **Measure Coverage->Load Trace File** from the menu bar.   Several coverage files can be loaded to the coverage analysis tool, which accumulates the coverage information gathered in all files.

When this operation is done, the tool completed analyzing the coverage information and ready to present the coverage results in various reports.

Reset Coverage Information

After loading a trace file or several trace files to the coverage analysis tool, the user is able to reset the coverage information gathered so far by selecting **Measure Coverage->Reset Coverage Information** from the menu bar. After this operation, the tool is back to the state as after a message flow was loaded.

n-Node Collection Definition

This is a supplemental tool inside the coverage analysis tool, to allow the user to define n-Node collections, for the n-Node coverage criteria.

Collection Definition View

The **Collection Definition Tool** View enables the user to define new n-Node collections or to update the existing ones. To display the **Collection Definition Tool** view, click the **Coverage Analysis** tab in the Control Center and then choose **Collection Definition**. **Figure 8** shows an example of the **Collection Definition Tool** view, after a message flow was loaded.
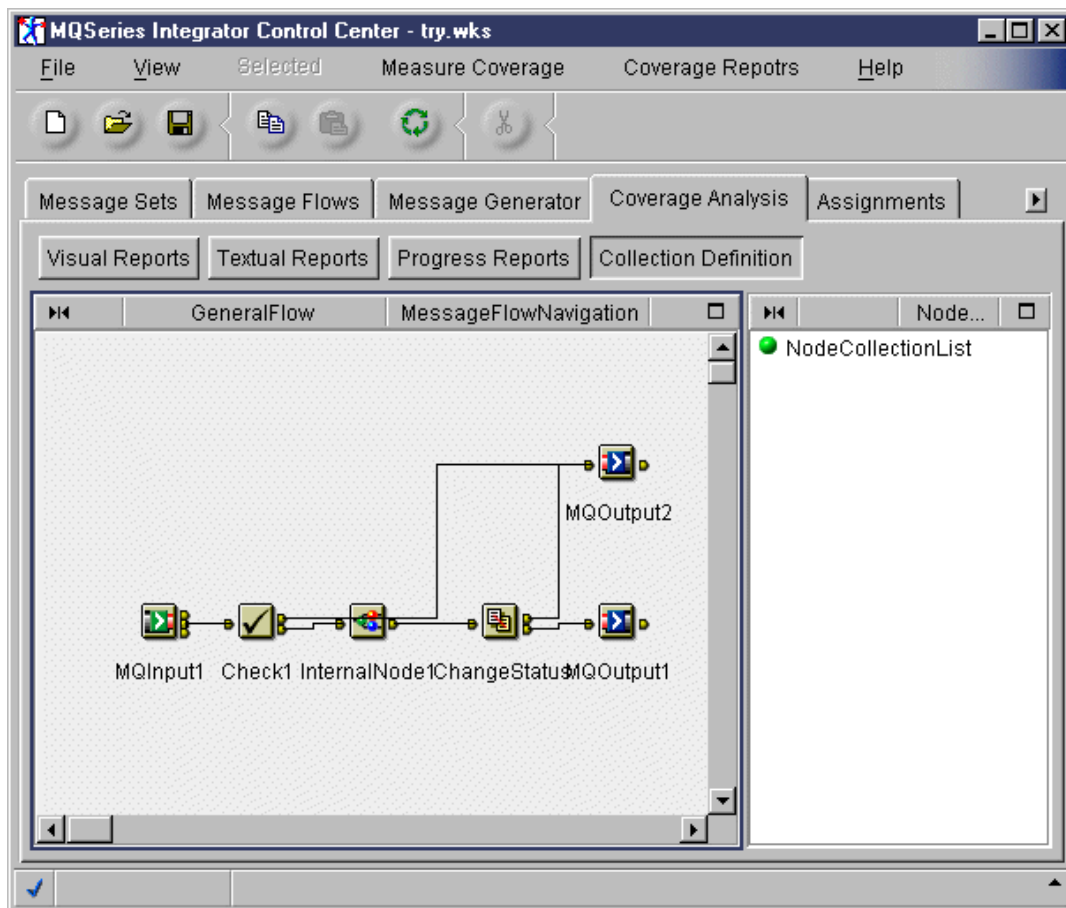

Figure 8: The Collection Definition Tool View

The original message flow is displayed in the left hand side of the window. A tree root named **Node Collection List** is displayed in the right hand side of the window. The list is currently empty since no n-Node collections were loaded nor created.

Create a Collection

To create a new n-Node collection, right click with the mouse on the **Node Collection List** root and select **Create a New n-Node Collection**. A dialog opens where you need to specify a unique name for the collection. Enter the collection name and click **Finish**. To cancel any changes, click **Cancel** instead. The new collection name appears in the tree under the **Node Collection List**.

Add a Node to a Collection

To add a node to a collection, first select the collection in the list at the right hand side of the window. Now right click with the mouse on the node you wish to add to the collection in the message flow view and select **Add Node to Collection**. The name of the node appears in the list under the name of the collection. **Figure 9** displays an example for adding a node to a collection.
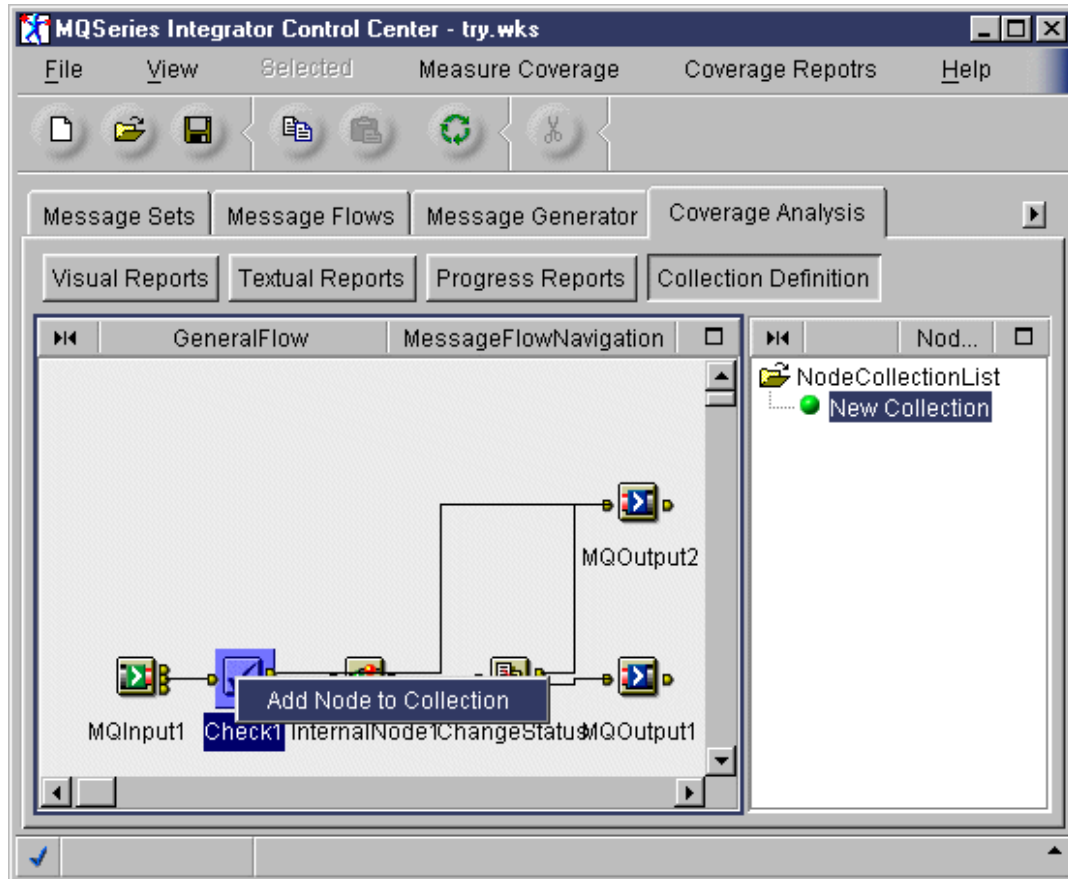

Figure 9: Add a Node to a Collection

Remove a Node from a Collection

To remove a node from a collection, right click with the mouse on the node name that appears in the collection list and select **Remove Node from Collection**.

Save a Collection

To save an n-Node collection to the tool, after creating a new collection and adding nodes to it, right click with the mouse on the collection name in the collections list and select **Save n-Node Collection**. The collection will be added to the tool only if there is no other conflicting collection (i.e. another collection with the same name).

Delete a Collection

To delete a previously saved collection, right click with the mouse on the collection name in the collections list and select **Delete n-Node Collection**.

Rename a Collection

To rename a previously saved collection, right click with the mouse on the collection name in the collections list and select **Rename the Collection**. A dialog opens for the insertion of the new name. It will be checked that no other collection already exists with the same name.

Save Collections to a File

After some collections were created and saved, the user is able to save the collections to a file for future use. The save the collection to a file select **Coverage Reports->Save n-Node Collections to File** from the menu bar. A file dialog opens where you should specify the file name. The collections are saved in the file in XML format.

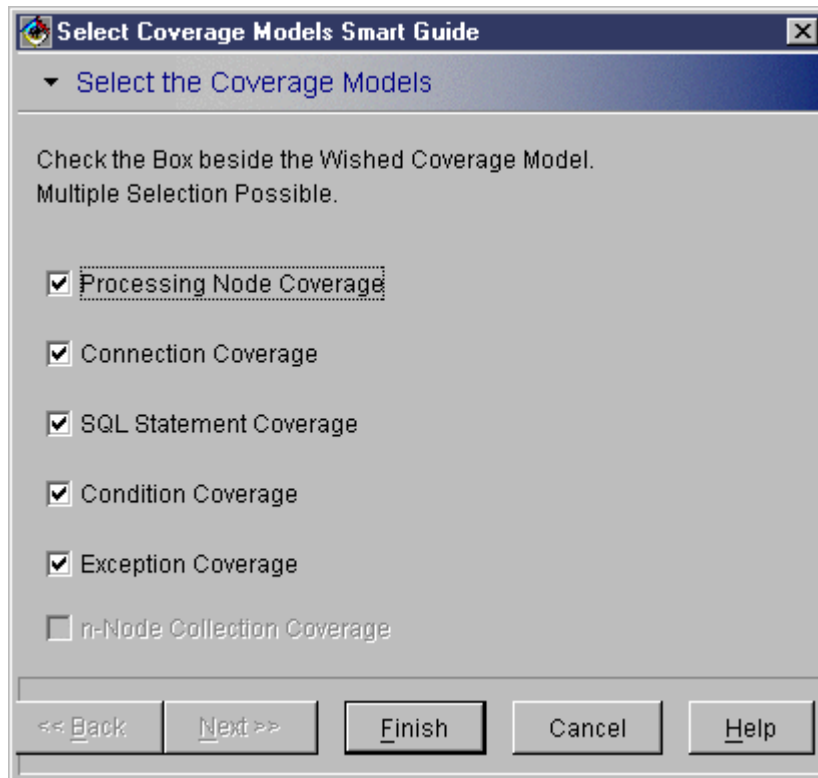## Load Collections from a File

To load n-Node collections from a file, select **Coverage Reports->Load n-Node Collections from File** from the menu bar. A file dialog opens where you need to choose a collections file, that was previously created by the Save to File option. For every collection in the file it is checked that it does not conflict with other existing collections (i.e. another collection with the same name) and that it is a legal collection (i.e. all nodes in the collection are nodes of the message flow). Only after a collection passed all the checks it is loaded to the tool. The collection is added to the collections list.

Coverage Reports

The coverage reports are used to display the coverage information gathered from the trace files. The reports display the information for each coverage criteria separately and in various options. The user is able to present the result for a single coverage criteria at a time or for selection of coverage criteria. In all the reports, the default coverage criteria that are displayed are Processing Node Coverage, Connection Coverage and SQL Statement Coverage.

Select Coverage Criteria

To select the coverage criteria that are to be displayed in the coverage reports, select **Coverage Reports->Select Coverage Models** from the menu bar. A dialog opens with the former selected coverage criteria checked. Change your selection and click **Finish**. To cancel this operation click **Cancel** instead. Note that the n-Node coverage criteria cannot be selected with conjunction of any of the other models. The following figure displays the coverage models selection dialog.

Visual Report

The visual report summarizes the coverage results in a graphical way, according to a coverage model chosen, or a combination of a number of coverage models. The report consists of two parts:

- The Message Flow Pane - this pane displays the Message Flow colored according to the chosen coverage models.

- The Information Pane - this pane displays additional information on a chosen node

To see the visual report select the **Visual Reports** tab in the coverage analysis tool view.

The Message Flow Pane

The message flow is presented in this pane colored according to the coverage model chosen and the coverage information gathered. The message flow elements are colored in the following way, according to the coverage criteria chosen:

- Processing Node Coverage - A primitive node is colored green if passed through and colored red otherwise. For compound nodes the same applies, only that covering a compound node means that all it's contained nodes are covered too. If only part of the contained nodes are covered, the compound node is colored in levels of green to red depending on the percentage of the contained nodes covered.

- Connection Coverage - Each connection that was passed through is colored green and red otherwise.

- SQL Statements Coverage - The SQL coverage results are presented by an additional icon above the relevant node. The icon is colored and filled according to the node's coverage in the following way: For a primitive node, containing SQL statements, the icon is colored green if all SQL statements were executed, red if non at all and levels of green to red depending on the percentage of the statements executed. For compound nodes, the number of SQL statements in all the node's contained elements is calculated, and the additional icon is colored according to the percentage of statements that were executed. Note that this icon is not presented at all for nodes that do not contain SQL Statements.

- Multiple Condition Coverage - The condition coverage results are presented in a way similar to the SQL statements coverage, with an icon that is placed next to that of SQL statements. As in the SQL case, for a simple node containing SQL statements the icon is colored according to the percentage of conditions that were covered (received both true and false). For compound nodes, the icon is colored according to the percentage of the conditions covered in all the contained nodes.

- Exception Coverage - A flag is positioned above the failure ports of all the nodes that have such a port. This flag is colored green if an exception occurred in that node, and red otherwise.

- n-Node Coverage - For a selected n-Node collection, all the nodes in the collection are colored green if all of them were passed through in at least one execution and red otherwise.

The user may choose to view the results of more than one coverage model at a time. The only coverage criteria that cannot be presented with the others is the n-Node Coverage criteria.

The Information Pane

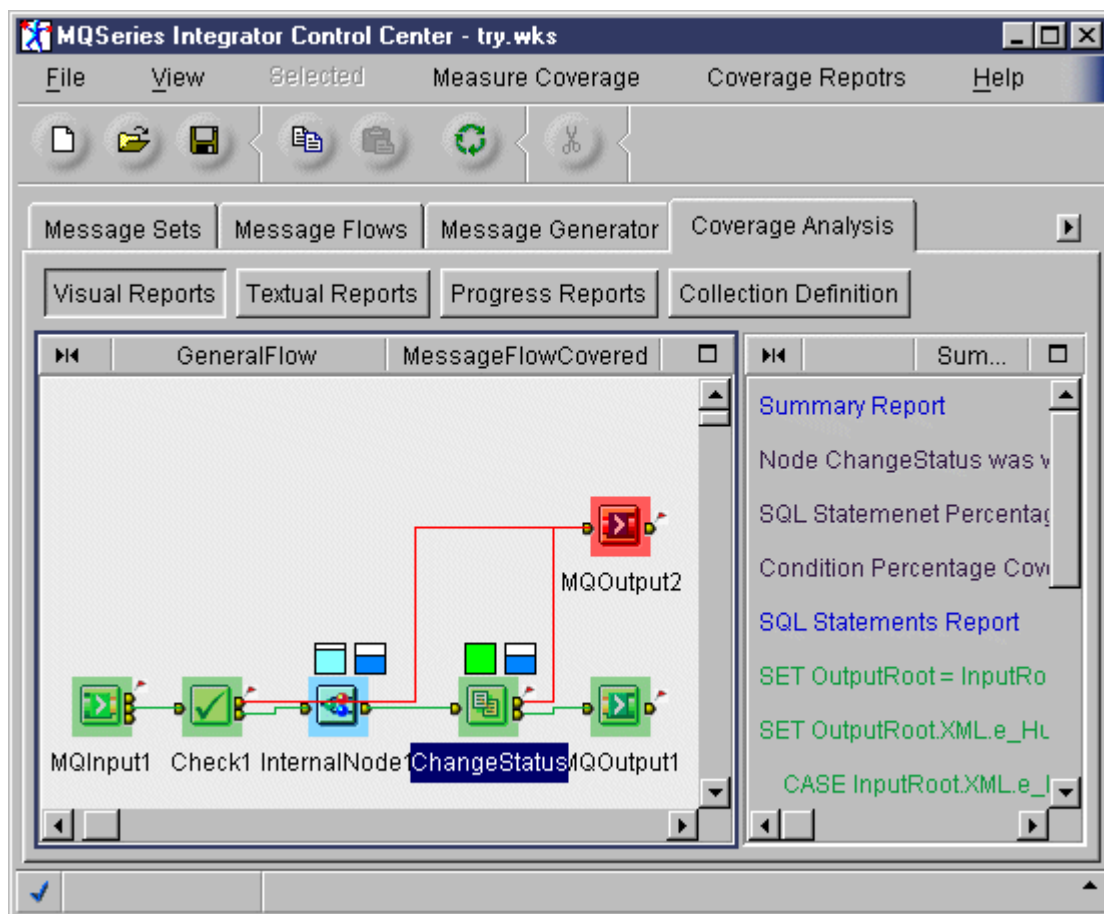This pane has two main functions:

- Displaying additional information on selected nodes.

- Displaying the list of n-Node collections defined by the user allowing the user to choose the collection to be presented in the visual report.

The functionality of the pane alternates between these two functions depending on the coverage criteria that are selected to be displayed. For all the coverage criteria except the n-Node coverage criteria, the pane will display additional information on a selected node in the following way:

- On selection of a primitive processing node that contains SQL Statements - the pane displays the SQL code of the node. All the executed SQL statements and the covered conditions are colored green. A textual summary of the percentage of each of the coverage criteria is displayed.

- On selection of a compound node - the pane displays a textual summary of the percentage of each of the coverage criteria.

When the user selects to view the results of the n-Node coverage, the pane changes it's functionality. The pane will now display a tree list of all the n-Node collections defined/loaded by the user. To view the coverage results of an n-Node collection, select the collection in the list. The nodes contained in the collection are colored as described above.

Figure 10 displays a visual report example. All the coverage criteria except the n-Node coverage criteria are chosen. The information pane displays additional information on the selected node.
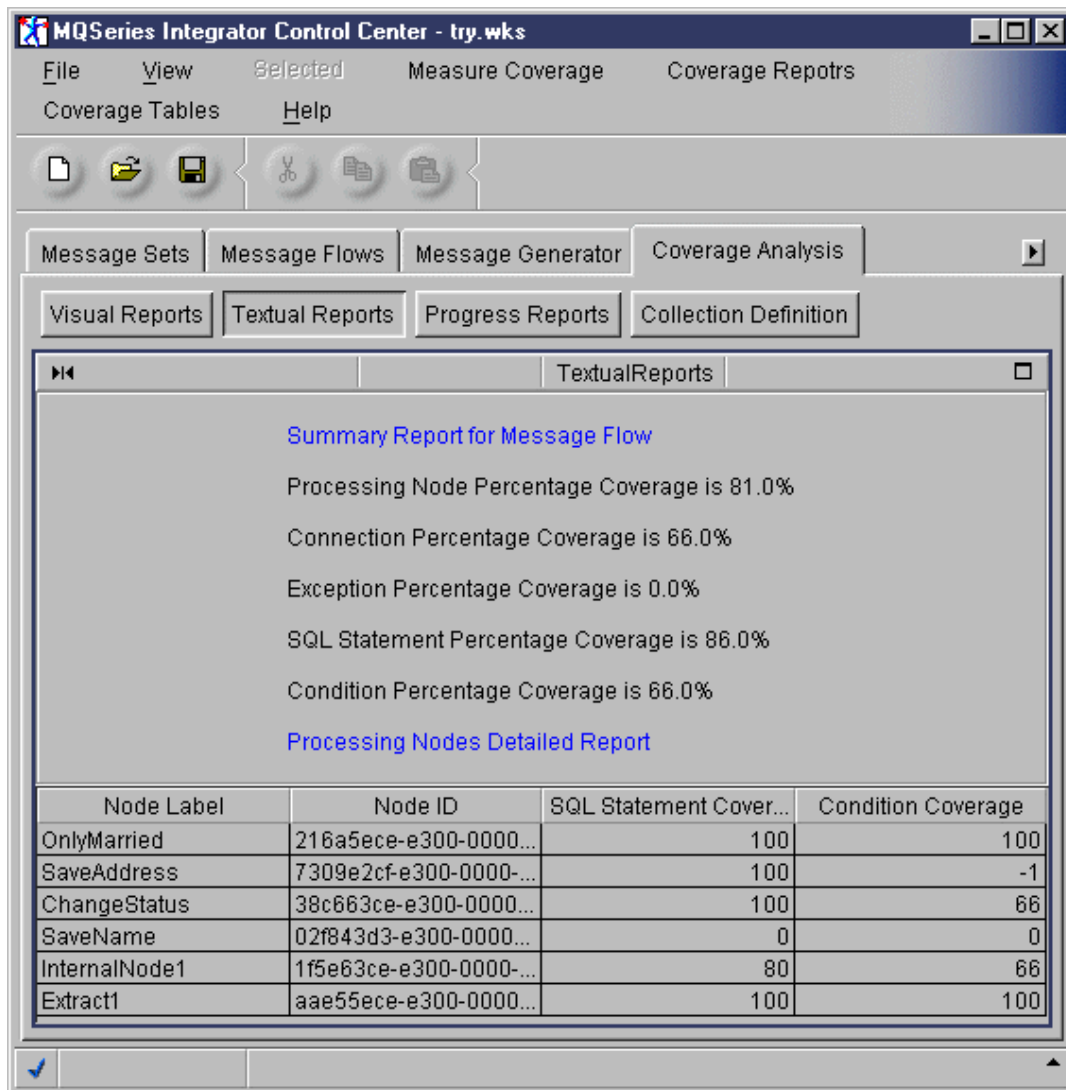
Textual and Table Report

The textual report display coverage information in two manners:

- A summary report displaying a summary of the coverage results for all the selected coverage criteria

- A specific report for a selected coverage criteria

To view the textual reports select the **Textual Reports** tab in the coverage analysis tool view.

Summary Report

By default the summary report is presented for the selected coverage criteria. The summary report displays the percentage of coverage achieved for each coverage criteria. If the SQL Statement or the Multiple Condition criteria are chosen, an additional table is presented that summarizes the coverage percentage of these models for each of the relevant nodes in the message flow. The rows in the table can be sorted according to the contents of a column by clicking on that column header. **Figure 11** presents an example of the textual summary report.

Figure 11: A Textual Summary Report Example.

Coverage Criteria Report

A coverage criteria report is displayed for a selected coverage criteria. To display this report click **Coverage Tables->Select Coverage Model** in the menu bar and then select the coverage criteria. For the SQL Statement and Multiple Condition criteria, a dialog opens with the list of relevant nodes from the message flow. Select a node from the list and click **Finish**. To cancel the operation click **Cancel** instead.

Once a coverage criteria is selected a table is presented with a detailed report on the coverage tasks comprising the specific criteria. The rows in the table can be sorted according to the contents of a column by clicking on that column header. The user can drop any of the columns from the table by right click with the mouse on the column header and select **Remove Column**. The dropped columns can be later added to the table by clicking **Coverage Tables->Add Column to the Table** and then selecting the column name from the list displayed.

The contents of the table can be exported to a text file to be later imported into a worksheet for further manipulations on the data. To do so select **Coverage Tables->Export Table to WorkSheet** from the menu bar. A file dialog opens where you need to select a file for output.

Figure 12 presents an example of coverage criteria report for the Multiple Condition criteria of a selected node.
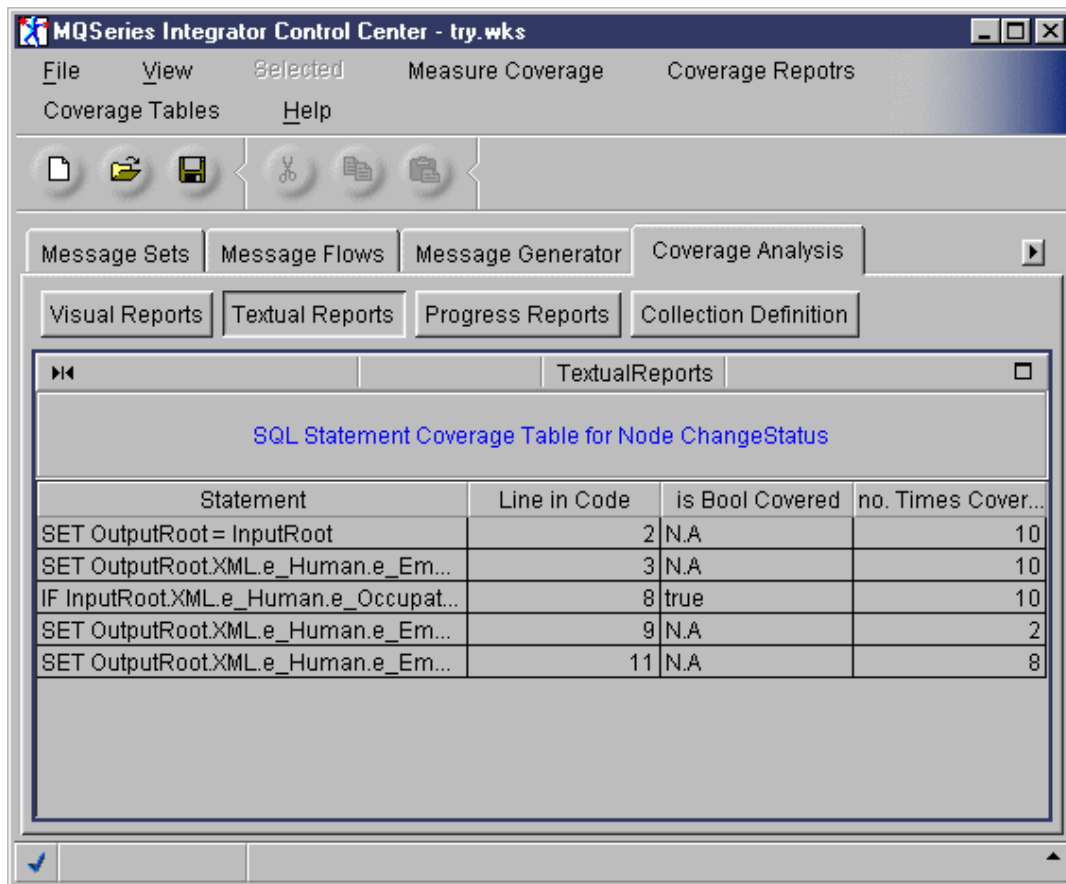

Figure 12: Coverage Criteria Report Example

To switch back to the summary report select **Coverage Reports->Display Summary Report** from the menu bar.

Progress Report

The progress report is a graph displaying the progress of coverage achieved for each coverage criteria according to the number of executions loaded to the coverage analysis tool. Each line in the graph represents a single coverage criteria and is colored differently. **Figure 13** displays the progress report view, when all the coverage criteria are selected.
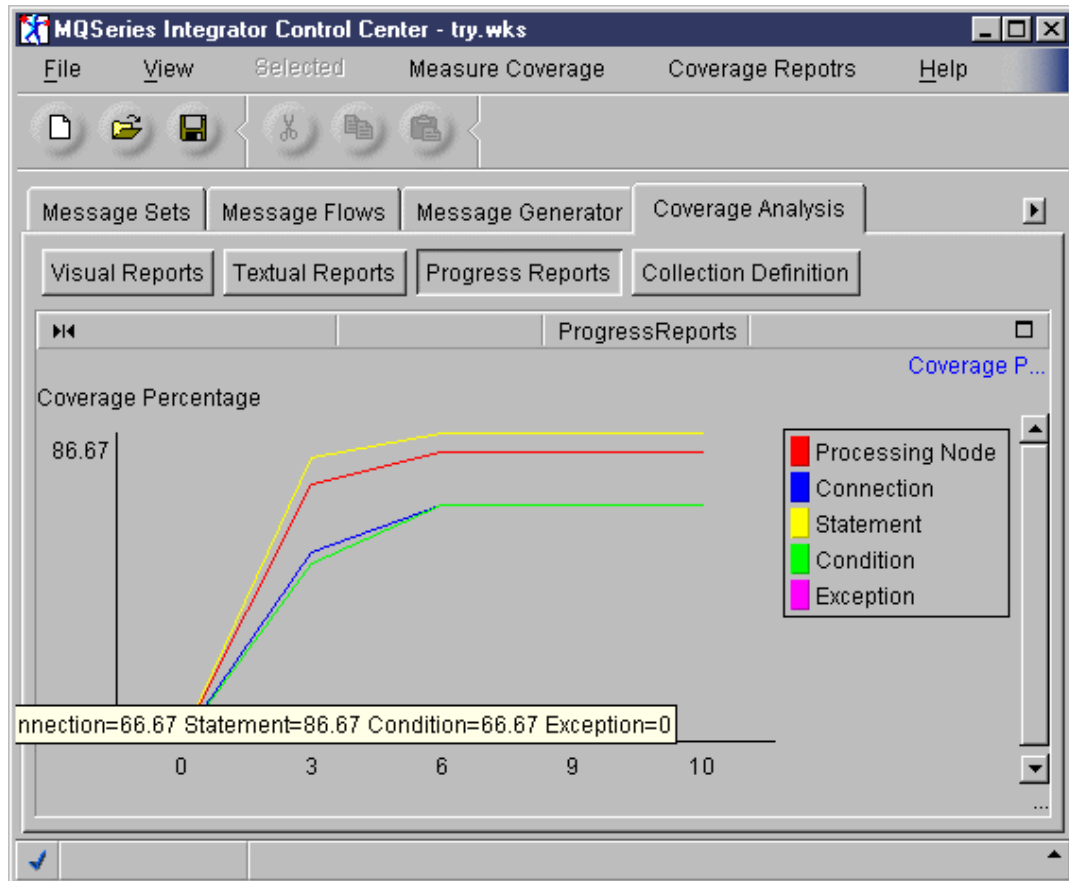

Figure 13: A Progress Report Example

Export Report

The information in the progress report can be exported to a text file to be later imported into a worksheet for further manipulations on the data. To do so select **Coverage Reports->Export Progress Report to WorkSheet** from the menu bar. A file dialog opens where you need to select a file for output.

Change Graph Resolution

As default the resolution of executions in the progress report is three executions. To change this resolution select **Coverage Reports->Change Report Execution Resolution** from the menu bar. A dialog opens where the former number is displayed. Enter a new number and click **Finish**. To cancel this operation click **Cancel** instead.

Filter an Execution

By default, any of the coverage reports presents information gathered and accumulated from all the trace files loaded to the coverage analysis tool. The user is able to filter the information presented in the **Visual Report** view and the **Textual Report** view by selecting **Coverage Reports->Filter Report for Execution** from the menu bar. A dialog opens with all executions loaded listed in the left hand side, where a time stamp identifies the execution. When an execution is selected, the input message that initiated this execution is presented in the right hand side. This information should aid the user to select the execution according to which the information is filtered. Select an execution and click **Finish**. To cancel this operation click **Cancel** instead. **Figure 14** presents the execution filter dialog.
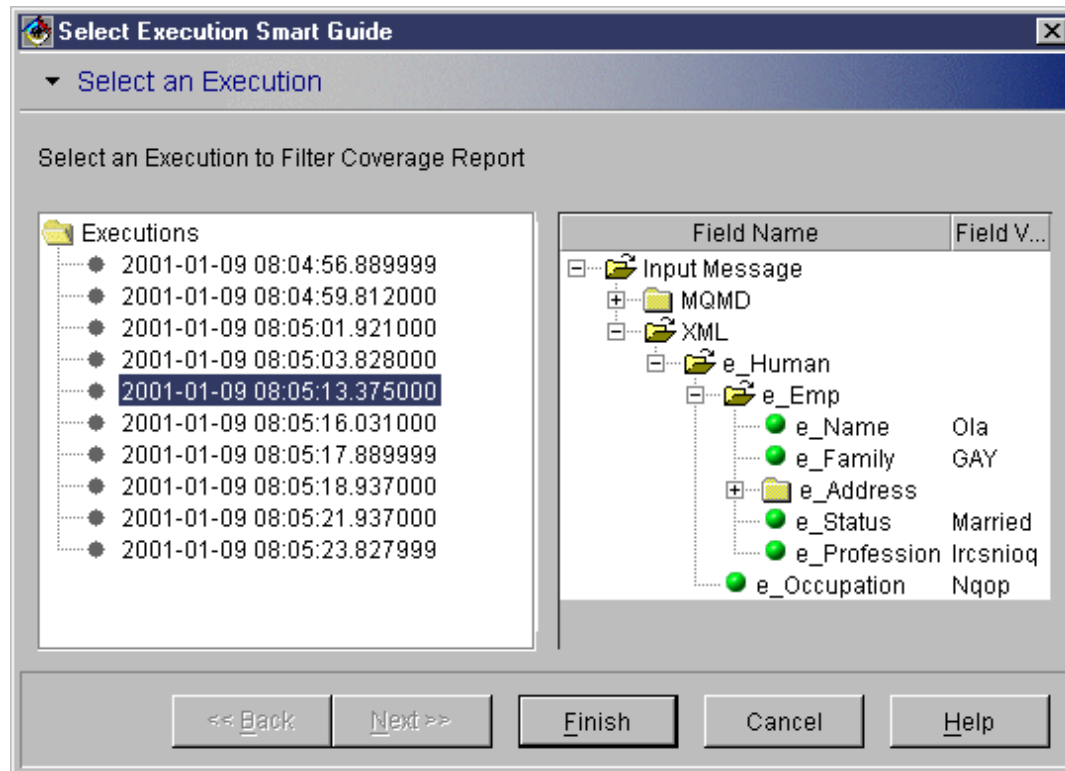

Figure 14: Execution Filter Dialog

Overall Report

To switch back from the filtered view to the accumulated view select **Coverage Reports->Show Overall Report** from the menu bar.

End of Document