ABSTRACT MICRO SYSTEMS

Contact Routing Simulator
Version 2.0
User Manual

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CONTACT ROUTING SIMULATOR

USER'S MANUAL

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1   Introduction

Thank you for choosing Contact Routing Simulator from Abstract Micro Systems.

Contact Routing Simulator is a software tool for simulating the operation of a contact center or network of contact centers, usually for a one-day time span. This manual will explain how to use this powerful tool.

1.1   What is simulation?

Simulation is the mimicking of a real world process on a computer.

To perform a simulation we construct a computer model of the process. For example, if we are simulating a contact center we model the arriving contacts, the agents handling those contacts, the rules that are used to match contacts to agents, and all of the events that occur as a contact moves through the system. We mimic contact arrivals by using a random number generator whose parameters are set to produce the appropriate contact volumes while allowing for contacts to arrive at random times. Similarly, we determine the length of a contact by drawing from a distribution of talk times and after-contact work times.

As each simulated contact arrives, we use the routing rules to assign it directly to an agent or, if no agent is available, we place it in queue. While the contact is in queue, we may randomly determine whether the contact will abandon before an agent becomes available. We can use the computer model to mimic events that might happen to a contact in the real world.

As the simulation proceeds, we keep careful track of every event that has occurred. Thus, when the simulation is complete, we can evaluate a set of statistics that are comparable to those we would expect from an ACD – contacts offered, handled and abandoned, average handle times, service quality for contacts, and utilization rates for agents. In a matter of seconds we will have experienced what might have taken hours to happen in real time.

1.2   Why bother to simulate?

Simulation is an alternative to experimenting with real customers and real agents. It is fast and it is inexpensive. It is an easy way to try out new ideas without disrupting operations.

Few modern contact centers operate very long without changing at least one key variable. New contact types are added, call volumes increase or decrease, agents acquire new skills, new technology is implemented, and new routing rules are put into effect. In even a moderately large contact center, the impact of these changes cannot be foretold with even minimally acceptable accuracy. You have to try out something new to see what its effect will be. The choice is between trying it out on a simulator and trying it out on your customers and agents.

1.3   Design of Contact Routing Simulator

Contact Routing Simulator has three components, or layers. At the core is a powerful simulation engine. It is designed to generate vast quantities of random numbers extremely rapidly and assign them to simulation events such as contact arrivals, contact abandonment, agent arrivals and departures, and so forth. This layer also keeps track of the sequence of events – the order in which contacts arrive and are handled and the timing of agent arrivals and departures.

Contact Routing Simulator's middle layer models the operation of contacts moving through the contact center. It provides for the assignment of individual contacts to individual agents by implementing the center's routing rules. It also collects the event data that will form the basis for all the statistics reported at the end of the simulation.

Contact Routing Simulator's outer layer is the user interface, which uses Microsoft Excel. It provides a mechanism for the user to specify parameters such as contact types, contact arrival rates, abandonment percentages, handle times, contact routing rules and agent data. It also generates the statistics that describe the results of each simulation run. It is designed to accommodate users that will be entering data on large numbers of contact types and agent groups.

1.4   Inputs and outputs

Contact Routing Simulator's basic inputs are contact data, agent data and routing rules.

Contact data includes a list of contact types and the parameters associated with each type, e.g., arrival rate, priority, abandonment rate and average handle time.

Agent data includes a count of agent groups (typically defined with respect to the contact types they are capable of handling), average handle time factors (how quickly, efficiently or effectively this particular agent group handles a contact type relative to other agent groups), priority rules and shrinkage factors.

Routing rules determine how contacts and agents are matched. They are of two kinds: skills-based routing and rules-based routing. Skills-based routing typically directs a contact to an agent group based on that group's ability to handle that type of contact and various contact-level or agent-level priority factors. Contacts are usually assigned to agents within a group on the basis of "agent longest idle." That is, when a contact is to be assigned to a group, the contact goes to the available agent that has gone the longest time without being on a contact.

Rules-based routing, on the other hand, directs individual contacts to individual agents. It makes use of contact routing technology now available that can identify the incoming caller, perform a database search to gather caller-specific data, and perform a calculation to determine the available agent most suited to handle that contact. This approach to contact routing raises the level of complexity several notches.

Contact Routing Simulator outputs include the standard set of key system performance statistics: service quality (service level and/or average delay, abandonment rate) to each group of incoming contacts and utilization statistics for each agent group or individual agent. It is also possible, in cases where complicated routing schemes are employed, to track the usage of the various paths that contacts can take through the system.

1.5   Computer configuration

All inputs and outputs for a single simulation are located in a Microsoft Excel workbook file called a *scenario workbook*. You will probably wish to store all such files on your computer in a single folder or tree of folders. You start program execution as you would any other Excel application – simply double click on the name of the scenario workbook you wish to open.

There are several other files necessary for running a simulation on your computer. These files are added when the Contact Routing Simulator software is installed on your computer. You will not

need to access these files directly. See **CRS Installation Instructions.pdf** for full details about installation.

The software is delivered with two Excel template files, *SampleScenario*.XLT and *EmptyScenario*.XLT. The installation program places shortcuts to these templates in two places: on your desktop, and in your Programs menu under Abstract Micro Systems. These templates work similarly to any other Excel template: when you open a template, Excel creates new workbook that contains the objects in the template. Initially this workbook exists only in the computer's memory, but you may at any time save a copy by means of Excel's menu option File|Save As.

For example, consider what happens when you open the template SampleScenario.XLT (you can do this by clicking on the shortcut to it on your desktop). Excel does not actually open the template file itself. Instead, Excel creates a new scenario workbook initially named SampleScenario1.xls. Excel then automatically copies into this new workbook all the worksheets and other objects in the scenario file. You now have an Excel workbook open on your screen, a workbook called SampleScenario1.xls that does not yet exist as a file on your hard disk. If Contact Routing Simulator is installed on your system, you also see at this time a small window that we call the Simulator Console on top of the Excel window. This contains the controls needed to run the simulator. You may save SampleScenario1.xls to disk, using Excel's menu option File|Save As.

In the rest of this manual we will assume that you have saved this workbook under the name **SampleScenario.xls**. (Be sure that you understand that *SampleScenario.XLT* and *SampleScenario.xls* are two different files.) We refer frequently to SampleScenario.xls in this workbook and also in training materials because this scenario workbook illustrates many features of Contact Routing Simulator.

You use the template EmptyScenario.XLT in similar fashion. You use this template to create a new scenario workbook that initially contains no data. (See chapter 5.)

You make most edits to a scenario workbook by means of standard Microsoft Excel techniques. If you know how to use Excel, then you already know how to edit a scenario workbook! However, Contact Routing Simulator provides an additional user interface tool, the Scenario Editor, which streamlines certain editing tasks. You will use Scenario Editor when you are creating a new scenario workbook from scratch, or when you are making a major reconfiguration of a scenario workbook, such as adding or removing sites, agent groups, or contact types.

1.6   Plan for this manual

The next chapter focuses on the contact routing problem itself. It addresses the pros and cons of different routing schemes and different technology options, including network-level routing in a multi-site environment.

The third, fourth, fifth, and sixth chapters contain instructions on preparing inputs, running Contact Routing Simulator, using Scenario Editor, and interpreting outputs. Finally, there are several appendices giving expanded documentation on several matters covered in the earlier chapters.

2   The contact routing problem

2.1   Routing basics

The problem is simply stated: "When a contact arrives or an agent becomes available, what should be done?" The answer to this question can be very simple or remarkably complicated.

Take the case of the arriving call. In the simplest case the call is matched to an available agent who possesses the skills needed to handle the call. If there are no such agents available, the call is placed in a queue. When an agent becomes available, queued calls are serviced in the order in which they arrived. Callers may occasionally grow impatient while waiting and abandon the queue.

The problem can quickly grow more complicated. Suppose, for instance, that there are several groups of agents, each one possessing a unique combination of skills. Any particular type of call might be handled by several different agent groups. The routing rules may simply call for looking across the entire pool of agents and choosing the one having the appropriate skills that has been idle longest. Or the rules may specify which group should be searched first for an available agent. In this latter case, they may also specify a preferred group and, if no agent is currently available in that group, they may call for a delay of several seconds before looking to another agent group.

Put these examples into the context of a large, multi-site contact center, with perhaps dozens of different contact types and hundreds of agent skill combinations, and the complexity is overwhelming.

New technology has given rise to an entirely different concept of contact routing, one that is often referred to as rules-based routing but which might better be described as contact/agent matching. This approach attempts to find the ideal match between contact and agent, making use of information collected from the contact and resident in various databases.

When a contact enters a rules-based contact routing environment, the contact is first identified. This is usually accomplished using IVR or the contact's dialing telephone number. The IVR may also obtain information concerning the nature of the contact or other data items. The system then searches a database for additional information on that contact. It may then employ sophisticated rules that determine the characteristics of an agent best suited to handle this contact. It then searches the pool of available agents and selects one to match to the contact. If no available agent is deemed suitable, the contact can be placed in queue until a better-suited agent becomes free. As time marches on, what constitutes "suitable" may also change, with the probability of abandonment being balanced against the use of a less well-suited agent.

2.2   Objectives and constraints

The goals and constraints that govern routing rules are usually much simpler than the rules themselves. Of first importance in most contact centers is customer service, usually measured by service level, average delay or abandonment rate. Contact center managers usually specify desired service quality levels for each contact type. In simple environments, we can easily compute the expected service quality parameters using standard queueing theory formulas. In an

environment using more complex routing rules, these values can only be estimated by using simulation.

Another very important measure is the expected utilization rate of agents. This figure represents the fraction of each hour that an agent can expect to be talking to a customer or performing after contact work. Again, managers usually specify a maximum desired utilization rate, a figure that may be different for different agent groups. In simple environments it too can be easily computed, and in more complicated environments it can only be estimated through simulation.

The question then becomes "What is a simple environment?" For our purposes, the practical answer is that a simple environment is one in which a single type of contact can be connected to a single group of agents. For example, customers calling for technical support are directed to a single group of agents, each member of which is capable of handling those customers' needs. These agents handle no other types of contacts and no other group of agents can take this type of contact. Everything else falls under the heading of "complex," at least as far as estimating performance parameters is concerned.

Other variables of interest often involve measures that relate directly to the purpose of the contact. For example, we may be interested in knowing the revenue that will be generated by a group of sales agents or the rate of first call resolution for a group of service agents, both of which may be easy to estimate directly in simple environments but can only be estimated through simulation in a more complex environment.

2.3   Technology options

Improvements in contact routing technology have made it increasingly more difficult to predict the value of key indicators without using simulation. Simply allowing contacts to overflow from one group to another eliminates the ability to easily compute performance measures. And when skills-based routing came along it simply made such computations even more difficult. In a skills-based routing environment, virtually no parameter of interest can be computed directly. Only simulation allows us to estimate the values of performance measures.

The ability of modern, rules-based routing engines to employ computational tools for deciding routing between individual customers and individual agents further complicates matters. In these environments, service quality may be highly individualized, with preferred customers getting great service and less desirable customers not faring nearly so well. Similarly, agent utilization may be less a matter of ensuring that agents on average work only so hard than of determining whether a particular set of routing rules produces an unacceptably wide range of agent utilization rates. In fact, in certain instances, it may be desirable that certain agents work more than others, such as in a sales environment where the best performers are rewarded with more opportunities.

2.4   Network control options

The previous section dealt with routing at the site level or in a multi-center network that acts as a single virtual center. Many companies have multiple independent contact centers with a network-level controller that determines the site to which each contact should be routed. Different network controllers may use different algorithms to determine the receiving site for each contact. This is really a two-stage routing procedure. The network controller first selects a destination site for a contact and then the routing mechanism at that site selects the agent.

These environments are obvious candidates for simulation. No other means exists for estimating the various performance measures.

2.5   Measurement issues

When assessing estimates of performance measures, it is customary to compare an estimate with the actual result. Subject to the randomness inherent in contact center events, there should be a reasonably close match if the simulation has been performed correctly.

When discrepancies occur, it is natural to first ask whether the simulation itself has a problem. If all appears well with the simulation it may be appropriate to ask if the measures produced by Contact Routing Simulator are the same as those produced by the telecom infrastructure reporting system.

For example, when producing a statistic like service level, we must understand exactly what we're attempting to measure. When we track the fraction of contacts handled within some time limit, say calls handled within 20 seconds, how do we account for calls that were abandoned within 20 seconds? We can tell Contact Routing Simulator to deal with such calls any way we choose, but not all ACDs are programmed the same way. Thus, some ACDs may report calls that abandon within 20 seconds as handled calls (and thereby artificially raise the reported service level) while others may treat them as calls not handled within 20 seconds. Still other ACDs may attempt to finesse the problem by computing service level as the fraction of handled calls that were handled within 20 seconds. Bottom line: understand what your ACD is reporting before you attempt to produce comparable results with a simulator.

3   Preparing Inputs

3.1   General simulation parameters

The first set of inputs controls basic simulation setup and describes general characteristics of the network to be simulated.

3.1.1   General worksheet

The first item allows you to enter a *Scenario Name*. The name will appear on various output reports.

The *Number of Repetitions* determines how many times a complete simulation will be performed. For example, if you are simulating one day's worth of contacts and you set the Number of Repetitions to 100, Contact Routing Simulator will perform 100 independent simulations of that day's activities. The results will then show an average over the 100 repetitions.

The *Start Time* is the opening time for the contact center or the beginning of the day. The format is hh:mm. Midnight is entered as 00:00.

Period Length is the duration of the reporting period in minutes. Most ACDs and workforce management packages are set to report using either 15 or 30 minute period lengths.

The *Number of Periods* setting determines the length of the day. Forty-eight periods of length 30 minutes corresponds to a 24-hour operation. Note that some Start Time/Number of Period combinations may result in a "day" that crosses midnight.

3.1.2   Sites worksheet

This worksheet describes the sites in a single- or multi-site network.

Each site is listed along with the name of the *Routing Worksheet* holding that site's customer/agent routing rules information.

3.2   Contact source parameters

The contact source parameters describe the incoming contacts and the procedure for allocating them among sites.

3.2.1   Contact types worksheet

There is one row in this table for each incoming contact type.

The *Contact Type* is the name of an incoming contact group, for example, customer service calls.

Service Level Seconds is the benchmark time for contacts of this type to be answered by an agent. It can be thought of as the goal for how long contacts are forced to wait in queue. Note that the figure for calls may be in the range of several seconds, whereas it may be a matter of hours for emails. (Note further that no matter how lengthy the benchmark, it must always be expressed in seconds.)

Minimum Service Level is the desired percent of contacts that meet the service level seconds benchmark. It is expressed as a percentage, that is, seventy percent would be entered as 70.

The *Default Talk Time Seconds* is the average talk time for a contact of this type. This average figure will only be used if you do not enter period-by-period talk time data in the workloads worksheet. A contact that is not a voice call will have a talk time of zero.

The *Default Wrap Time Seconds* is the average after-call work time for a contact of this type. (Talk time plus wrap time is equal to handle time.) This average figure will only be used if you do not enter period-by-period wrap time data in the workloads worksheet. All agent time spent on a contact that is not a voice call should be shown as wrap time.

The *Abandon Rate* can be 0 or a positive number. If zero, then customers who begin waiting are infinitely patient—they will never abandon. If the abandon rate r is a positive number, then $r = 1/T$, where T is the average time that a caller of this contact type would wait in a "totally understaffed" call center, that is, in a call center having no agents at all. . (See 9.2 Abandon Rate).

Balkiness is the probability that customers of this contact type will immediately abandon when they learn that there is going to be wait. Balkiness is a number between 0 and 1 inclusive. (See 9.1 Balkiness).

The *Maximum Queue Length* is the upper limit on the number of contacts of this contact type that can be in queue at the same time. It is sometimes referred to as the number of queue slots.

3.2.2   Workload Sources worksheet

There is one row in this worksheet for each source of contacts.

The *Workload Source* is the name of a contact source. It can be the network, for example, or a local contact source.

The remaining columns list the site names. Each cell represents the percent of contacts from the source that should be allocated to that site. The percentages must add to 100.

3.2.3   Workload worksheet

The workload worksheet provides information on the amount of work to be done -- the volume of contacts and how long it takes to handle the average contact.

Workload Source is the name of the source of a particular type of contact. It must be contained in the list of workload sources in the Workload Sources worksheet.

The *Contact Type* is the name of an incoming contact group. It must be identical to one of the contact type names listed on the Contact Types worksheet.

The *Period Number* is the sequential number of the period. For example, if you are simulating an entire day using half-hour periods, the periods would range from one to 48. If you are simulating a 6 am to 11 pm operation, the periods would range from 13 to 46.

The *Number of Contacts* is the expected number of incoming contacts for the period.

The *Talk Time Seconds* is the expected talk time for the period. If the talk time for a particular period is left blank, the default value entered on the Contact Types worksheet will be used.

The *Wrap Time Seconds* is the expected wrap time for the period. If the wrap time for a particular period is left blank, the default value entered on the Contact Types worksheet will be used.

3.3   Contact handling resources

The following parameters describe the resources available to handle incoming contacts.

3.3.1   Agent Groups worksheet

The *Agent Group* is the name of each group of agents. Agents are typically grouped in accordance with the mix of skills they possess, but this is not absolutely required. For example, you may wish to form separate groups for new and experienced agents because of differences in contact handling speed, even though they have the same basic skill.

The *Talk Time Factor* is used to adjust the talk time of members of this agent group relative to the average talk time of all groups. For example, if you expect an agent group made up of trainees to take 25 percent more time talking to customers, the factor would be 1.25.

The *Wrap Time Factor* is used to adjust the wrap time of members of this agent group relative to the average wrap time of all groups. For example, if a group consisted entirely of very experienced agents who could be expected to wrap up contacts about 10 percent faster than average, the factor would be 0.9.

3.3.2   Staffing worksheet

Site is the name of the site where the agent group is located.

Period Number is the sequence number of the period. For example, if a contact center that uses 30-minute periods were open from 8:00 in the morning until 10:00 in the evening, the period numbers would go from 17 until 44.

The remaining columns represent the agent groups. The names must correspond exactly to the list of agent group names in the Agent Groups worksheet. Cells contain the number of agents of that agent group working during that period. This figure should represent the bodies in chairs number, net of all unproductive time.

3.4   Matching contacts with agents

The final worksheet (or worksheets) provides the rules by which contacts and agents are matched with each other. Because different contact routing devices use different rules for this matching process, the information is broken down into two separate tables.

3.4.1   Routing worksheet

The name of this worksheet is supplied by the user on the Sites worksheet. The same routing worksheet can be used for all sites or different ones for different sites.

The routing worksheet contains two tables. The first table gives the rules to follow if a contact is to choose an agent group and the second table gives the rules for an agent to use when selecting a contact type.

Both tables operate in much the same fashion, but they are read from a different direction. The left hand column lists the contact types and the column headings represent agent groups. Each cell shows the priority associated with a match of that contact type with that agent group and, if delays are being used, the delay contacts or agents must endure before they are eligible for matching. Delays are shown in parentheses immediately after the priority number and represent time in seconds measured from contact arrival, or in the case of agents, from the time the agent finishes the previous call.

The *Contact to Agent Priority* table shows how an arriving caller should act when entering the system. The caller in effect looks across the row to find the cell with the lowest priority number, usually a "1." This cell's column is the agent group that the caller will attempt first. If there are one or more agents available in that group, the caller will match with the agent idle longest. If multiple cells in this contact type's row have the same lowest priority number, the caller will attempt to match with the agent idle longest across all of the groups represented.

If no agent is available in any of the first priority groups, the caller looks through all the cells for the next highest priority number and repeats the process just described. This procedure continues until all groups having a priority number associated with this contact type have been checked. If no available agent is found, the contact goes into queue to await the first available agent from any eligible group. If you are using delays, the contact cannot go to a lower priority group until it has waited the appropriate delay time. If more than one group has the same priority number, they must also have the same delay.

If you choose to use delays in your routing instructions, you may also provide an additional column that contains the *Expected Wait Threshold* for that contact type. We calculate the expected delay for a contact at a site as the wait time of the currently longest-waiting contact. If this time is greater than the specified threshold, the delays are ignored for that contact. You may leave the cell blank for contact types that won't be using this feature. If no contact types will be using this feature, you need not include the column.

The *Agent to Contact Priority* table works in much the same fashion, but it is read from the top down instead of from left to right. It shows the set of decision rules used by agents that have just entered the system or have just become available after handling another contact. The agent looks for the highest priority contact type for its agent group, usually represented by the number "1." If there are contacts of that type in queue, the agent matches with the contact that has been waiting the longest. If there is more than one cell with the same lowest priority number, the agent will look for contacts in queue from all of those contact types and match with the caller waiting longest.

If no contacts are in queue in any of the first priority groups, the agent looks for cells having a lower priority and repeats the process. If none of the contact types for which priority numbers are listed have contacts in queue, the agent goes to an idle state.

Again, if you choose to use delays in your routing instructions, you may also provide an additional row that contains the *Expected Wait Threshold* for that agent group. The program calculates an expected wait time for the agent before being presented with the next high priority call. If this time is greater than the threshold, the delays are effectively set to zero for that agent

group. You may leave the cell blank for agent groups that won't be using this feature. If no agent groups will be using this feature, you need not include the row.

3.5   Cost/Revenue Parameters

If your software has been configured to calculate costs, revenues and net revenues for each simulation run, you will need to set cost/revenue parameters in the CR-In worksheet. The worksheet is divided into two primary sections, the first for Revenue and the second for Costs. Further divisions allow inputs for these items on a per contact basis, per unit of time, or per lost contact.

3.5.1   Revenue Inputs

The revenue inputs can be divided into two types, the revenue per contact and the revenue per minute. For each, there is one row for each contact type. For the revenue per contact, there is one column for each agent group since different agent groups may produce different average revenues for the same type of contact.

3.5.2   Cost Inputs

The cost inputs can be divided into four types. The first is cost per contact. There is one row for each contact type and one column for each agent group for this cost input. For cost per minute and cost per lost contact, there is one row for each contact type. For agent cost, there is one column for each agent group.

3.6   Advanced Parameters

There are several additional parameters with which some experienced users may wish to experiment. These are detailed on a worksheet named Advanced, which normally remains hidden. To display the advanced worksheet, first unhide it by using the Sheet – Unhide command on the Excel toolbar Format pull down menu. Choose Adv from the drop down list of hidden worksheets.

Tip: If your scenario workbook does not have a worksheet named "Adv", you can still perform a simulation if everything else needed by the simulator exists in your scenario workbook.   When you press the Run button in the Simulator Console, the simulator will create a new hidden worksheet named "Adv" and fill it with default values. You can unhide this worksheet by using the Sheet – Unhide command on the Excel toolbar Format pull down menu. Similarly, Scenario Editor too will create an Adv worksheet in your scenario workbook if none exists when you start the editor.

Most users will seldom if ever view the Adv worksheet or change its contents. So feel free to skip over the following table in a first reading of this user manual.

Table 1: Advanced Parameters Reference

Advanced Parameters		
Parameter	*Range of Values*	*Description*
Random Seed	Any integer, or the word "Randomize"	"Randomize" means that every run of the simulator will produce different results. Setting this value to a number (for example, 378932) means that every run of simulator will produce identical output. Users should almost always use "Randomize". An integer value is used mainly by personnel at Abstract Micro Systems for code testing and customer support.
Require Consent	Yes|No	Recommended setting for most ACD software is probably "No". Setting the value to "Yes" changes the way simulated calls and simulated agents are matched up during a simulator run. This setting has no effect unless you have introduced delays into your routing tables, or have an *asymmetric* routing scheme. See Appendix 10.
Renege Distribution Shape	Integer from 1 to 10	This is the "shape parameter" of an Erlang distribution, assumed during the simulation to be the distribution of customer wait time. A random variable having an Erlang distribution is the sum of s independent random variables that are exponentially distributed, where s is the shape parameter. Therefore, when $s = 1$, we have an exponential distribution. Setting s to a higher value causes wait times to be more concentrated about the mean.
Talk Distribution Shape	Integer from 1 to 10	See explanation of Renege Distribution Shape above.
Wrap Distribution Shape	Integer from 1 to 10	See explanation of Renege Distribution Shape above.

Advanced Parameters		
Parameter	*Range of Values*	*Description*
Calculate Cost/Revenue	Yes|No	If set to Yes, the simulator searches for Cost/Revenue inputs on the worksheet named CR-In, and at the end of the run, the simulator outputs Cost/Revenue results to the CR-Out worksheet. If set to No, the simulator ignores Cost/Revenue inputs and does not write to the CR-Out worksheet.
Subperiod Length	1, 5, 10, 15, 30, 60. (Value must be a divisor of Period Length)	Recommended setting is 5 for users. Other settings are used for testing at Abstract Micro Systems. The subperiod length can equal the period length (in minutes) or be any divisor of the period length. Using a subperiod length smaller than the period length means that the simulated arrival rate of calls will be "smoothed" across period boundaries, resulting in more realistic simulated performance.
Contact Generation Algorithm	Variable|Fixed	Most users use Variable as the setting. If Fixed, then the simulated number of calls m arriving in each period for each contact type and each workload source will *exactly* equal the number of arrivals n specified in the Workload worksheet for that workload source, contact type, and period. This will be true in every repetition of the simulator. If Variable, then m will vary randomly from repetition to repetition, but will have a mean close to n over a large number of repetitions.

4   Running a Simulation

When you load an Excel workbook that has been formatted as a scenario workbook, a small window that we call the Simulator Console appears near the top right of your screen. The Simulator Console contains five buttons: Run, Pause, Reset, Statistics and Edit. The first four of these buttons are associated with running a simulation and are therefore discussed in this chapter. The Edit button is described in Chapter 5, Scenario Editor. The Simulator Console also contains four textboxes: Arrivals, Repetition, Period, and time, expressed as hh:mm.

Figure 1: Simulator Console.

You may move the Simulator Console anywhere on your screen by simply dragging with your mouse. You may also hide the Simulator Console by pressing the Hide button that has appeared on your toolbar. (Pressing the "X" button in the upper right corner of the Simulator Console has exactly the same effect as pressing the Hide button). Pressing the Hide button removes the Simulator Console and changes the Hide button to a Show button. Pressing Show then restores the Simulator Console.

Note that the title bar of the Simulator Console contains the name of the scenario workbook associated with this simulation. It is possible to have several scenario workbooks open at the same time. In that case, each scenario workbook has its own, distinct Simulator Console. You can tell which is which by looking at the title bar.

4.1   Buttons on the Simulator Console

4.1.1   Run button

Press the Run button to start the simulation. The first thing that you should see is a small information box that tells you the program is initializing. Initialization causes the inputs to be read. Once all the input data are read the initialization process executes a number of procedures designed to maximize the efficiency of the simulation, thus increasing its execution speed. Finally, the initialization process sets up the output tables into which Contact Routing Simulator will write the results of the simulation. Once these steps are finished, the actual simulation begins.

4.1.2   Pause button

The Pause button is enabled whenever the simulator is running. Pressing the Pause button halts the simulation in mid-execution. You might want to pause the simulation to examine the statistics for the portion of the simulation that has been run so far, as described below. After pausing, the user can re-start the simulation by pressing the Run button or press one of the other

two buttons: Reset or Statistics. Note that if you press the Run button to re-start the simulation, you simply pick up where you left off when you pressed the Pause button. There is no re-reading of input data or re-initialization. If you change one of the input parameters, that change will not be reflected in the output.

4.1.3   Reset button

Pressing the Reset button puts you back to where you were before you initially pressed the Run button. All simulation results that you have generated so far are erased. All inputs that were read during the previous initialization are also cleared from the simulator engine's internal memory. (However, pressing Reset does not erase or affect in any way the data that you have entered in the input worksheets in the scenario workbook.) If you press the Run button after having pressed the Reset button all inputs will be re-read.

4.1.4   Statistics button

The Statistics button is enabled whenever the simulation has run long enough to create some output data. This happens when a simulation run is complete (i.e., all repetitions have been finished) or when the Pause button is pressed after at least one full period of one repetition has been simulated. If you press the Pause button after just beginning a simulation run, say after 20 minutes of the first 30-minute period have been simulated, the Statistics button will not be enabled.

When you press the Statistics button after simulating at least one full period, you are given an opportunity to view a variety of data items, some of which are not available as part of the standard simulation output. These data items can be viewed for all repetitions combined or only for the repetition just completed, for all periods combined or for a selected period, and for any site. Once you have set these parameters, you can choose a particular contact type or agent group for which to view detailed data.

The data available in the Statistics window, although rich in detail, are not as well organized as are the data items in the standard output tables. The intent is to allow expert users to investigate results more thoroughly than would otherwise be possible.

4.2   Textboxes

The content of these boxes (Arrivals, Repetition, Period, and time) is updated as the simulation progresses.

4.2.1   Arrivals

This item shows the number of contact arrivals in the current repetition. It is updated at 5-minute simulation intervals.

4.2.2   Repetition

This item shows the repetition number.

4.2.3   Period

This item shows the period number within the current repetition.

4.2.4   Time (hh:mm)

This item shows the time within the current repetition. If the simulation is for more than 24 hours, the field automatically changes to dd.hh:mm. It is updated at 5-minute simulation intervals.

4.3   Completion

When all repetitions are completed, an information box appears indicating that the output table is being written. When that box disappears, additional tabs will appear on the worksheet. These contain output graphs, output data tables and a log as explained in Chapter 6 Interpreting Results.

5   Scenario Editor

The Scenario Editor is a tool to streamline data entry for new scenarios. Scenario Editor is also useful when you need to make a major reconfiguration of a scenario workbook, as for example, when you need to add or remove one or more agent groups or call types. Changes made within Scenario Editor are reflected in the relevant worksheets of a scenario workbook when you exit Scenario Editor by pressing the Update Scenario button. Virtually all changes possible within a scenario workbook can be made through Scenario Editor as well. The task at hand will dictate whether the change can be more easily made with eh Scenario Editor.

5.1   Scenario Editor Overview

Scenario Editor is a set of data entry windows by means of which you add, remove, or change data in a scenario workbook. To use the Scenario editor, you first open a scenario workbook. When the Simulator Console appears, you press the Edit button on the Simulator Console. This action starts the Scenario Editor. Now you use the screens of the Scenario Editor to make the changes to the scenario. After making these changes, you press the Update Scenario button in Scenario Editor to close Scenario Editor and update the underlying Scenario Workbook. At this point you are back to using Excel as your user interface. Changes to the scenario workbook become final only if you save the workbook using the Excel menu option **File|Save** or **File|Save As**.

Many changes to existing scenario workbooks are most easily made without the services of Scenario Editor. This is especially true of changes to Workload, Staffing and Routing worksheets. Just make such changes using Excel's usual editing tools.

5.2   Using the Empty Scenario Template to Create a New Scenario

When you want to create a new scenario workbook from scratch, it is difficult to add all the necessary worksheets manually inside Excel, while maintaining all the necessary relations between the data in worksheets. A better approach is to use Scenario Editor in conjunction with the the Excel template file EmptyScenario.XLT (one of files installed into the Application Directory by the Contact Routing Simulator installer). In fact, this is why EmptyScenario.XLT exists!

The procedure is simply as follows:

1. Open the Excel workbook template EmptyScenario.XLT. (You may do this by clicking on the shortcut on your desktop, or by selecting the EmptyScenario.XLT menu option in your Programs menu under Abstract Micro Systems.) This causes Excel to open a new workbook called EmptyScenario1.xls. This workbook is formatted in such a way that Contact Routing Simulator recognizes it as a scenario workbook. Therefore, the Simulator Console appears and is ready to accept commands.

1) Press the Edit button on the Simulator Console. The Scenario Editor main screen appears.

2) Using Scenario Editor, specify the main scenario inputs including

      a.   Period Length

      b.   Simulation Start Time

      c.   Simulation End Time

      d. List of Routings

      e.   List of Sites

      f.   List of Agent Groups

      g. List of Workload Sources

      h. List of Contact Types

      i.   Workload Detail data[1]

      j.   Staffing Detail data

      k. Routing Detail data

3) Press the Update Scenario button. You are back in Excel, editing the EmptyScenario1.xls workbook. (As a result of your Scenario Editor session, however, this scenario is no longer "empty". It contains sites, agent groups, etc.)

4) Using **File|Save As** on the Excel menu bar, save this workbook under a new name.

5.3   Add or Remove a Site, Workload Source, Agent Group, etc.

Scenario Editor is useful if you have a scenario workbook in which you want to add or remove one or several sites, workload sources, agent groups, contact types, or routings. Just do the following:

1) Open the scenario workbook with Excel.

2) Press the Edit button on the Simulator Console to bring up Scenario Editor.

3) Perform the additions or deletions that you wish.

4) Press Update Scenario button on the Scenario Editor Console.

5) Scenario Editor closes, and your changes are reflected in the underlying scenario workbook. If these changes are what you want, save the scenario workbook using Excel menu option **File|Save** or **File|Save As**.

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[1] Workload Detail, Staffing Detail, and Routing Detail are most easily changed in Excel, rather than in Scenario Editor. So you usually will skip steps 2)i, 2)j, and 2)k. Add the detail information in Excel after pressing Update Scenario in Scenario Editor.

Tip: When you press Update Scenario, Scenario Editor **clears** each worksheet in your scenario workbook (General, Sites, Workload Sources, …) before updating that sheet. This means that if you have placed any items (values, formulas, charts, etc) in these sheets other than simulator inputs, all such data will be lost during the update process. Furthermore, if some of the simulator input cells in the scenario workbook contain Excel *formulas* rather than *values*, then after running Scenario Editor and pressing Update Scenario, all such cells will now contain *values*. In other words, all formulas are replaced by values. (This behavior of Scenario Editor is by design.) The conclusion is: if the worksheets used by the simulator contain additional data not used by the simulator, or if some of the inputs to the simulator are formulas rather than values, then you should probably make copies of all such material before you run Scenario Editor.

5.4   Scenario Editor Windows

The main window of Scenario Editor is the *Scenario Editor Console*. This window is the first window that appears when you start Scenario Editor by pressing the Edit button on the Simulator Console. You access all other Scenario Editor windows by pressing buttons on the Scenario Editor Console. All windows in Scenario Editor are *modal*. This means that at each moment during a Scenario Editor session exactly one Scenario Editor window has the focus; and you can not activate the controls on another Scenario Editor window unless you first close the window that now has the focus, or open another modal window which will then receive the focus.

5.4.1   <u>Scenario Editor Console</u>

Scenario Editor Console is the central organizing window of the editor. During a Scenario Editor session you are likely to open several subsidiary editor windows to view or change information displayed in the Scenario Editor Console. However, when you close any of these subsidiary windows, Scenario Editor returns you to the Scenario Editor Console.

Figure 2: Scenario Editor Console

The main controls on the Scenario Editor Console are designed to correspond with the worksheets, columns and rows of a scenario workbook. The section at the top of the dialog box contains information found on the General worksheet. The data grids that follow have a one-to-one correspondence to the other input worksheets. Finally, there are a set of four command buttons at the bottom of the Scenario Editor screen that dictate what should be done with the data just entered.
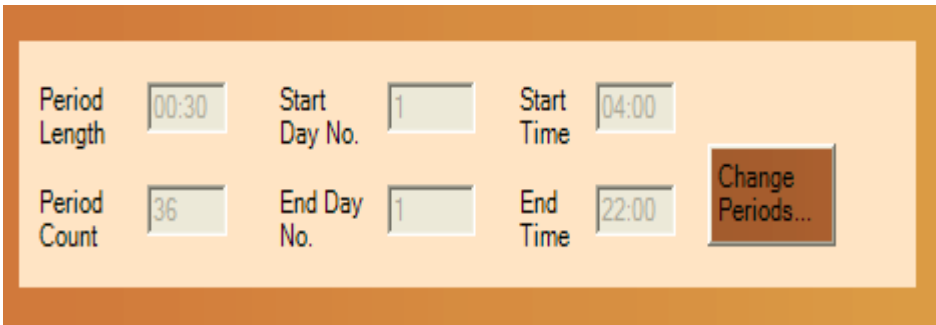
Below the buttons at the top of the window are eight data grids for various types of data entry. These eight data grids correspond to various worksheets within the scenario workbook. If you'd like to see more of a data grid, click on the full screen icon in the top right corner of the window. If the grid still is not as large as you would like, click on the blue header box at the top of the data grid to expand it. In general, the active field is indicated with an arrow while an asterisk denotes the next available row for an insertion.
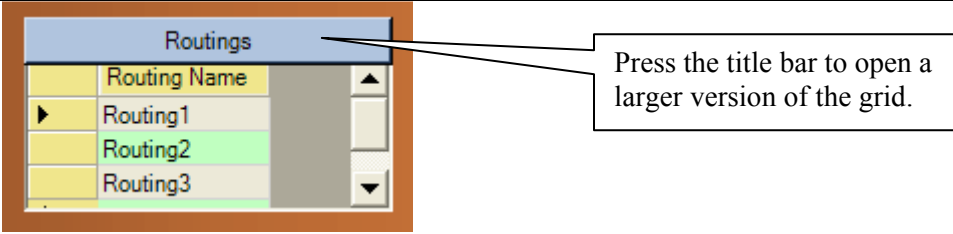
There are two general types of data grids: *dimension* grids and *detail* grids. The dimension grids provide information about the categories, for example, the sites, agent groups and contact types. The detail grids contain the details about each of those categories, for example, the staffing by time of day for each agent group. The five dimension grids are the Routings, Sites, Agent Groups, Workload Sources and Contact Types grids. The three detail grids are the Workload Detail, the Staffing Detail, and the Routing Detail grids.

At the bottom of the Scenario Editor window are four buttons that control exiting and saving.

Note that certain general data entry rules apply in all Scenario Editor data grids. For example, you must tab off a field before the software recognizes that you have changed the field. And buttons that appear grayed out are not enabled; the feature is only available if the button appears enabled. Most data grids have an extra row at the end labeled with an asterisk ("*"). If you navigate to this row and start typing data into it, the data grid adds a new row.

Table 2: Controls on the Scenario Editor Console

Scenario Editor Controls	
Control	*Description*
Scenario Name Text Box	Name you wish to give this scenario. It corresponds with the first field shown in the General Worksheet.
No. of Repetitions Combo Box	The number of repetitions. You may choose the appropriate number from the dropdown list or key in any positive integer yourself.
Periods Panel	The Periods Panel displays parameters associated with the simulation scenario time frame, including the period length, the number of periods (period count), the start day and time and the end day and time. You'll notice that each of these fields is disabled. Select the Change Periods button to make changes.
Change Periods Button	Click to open the Periods Window, where you view and change parameters related to the time periods of the simulation scenario.
Advanced Parameters Button	Click to open the Advanced Parameters window, where you view and edit the fields displayed on the Advanced parameters worksheet.

Scenario Editor Controls	
Control	*Description*
Routings Grid	Press the title bar to open a larger version of the grid. The Routings Grid names the Routing Worksheets that will be used for this scenario. It contains one row for each Routing Worksheet that will be used by the Simulator, and each row contains only the name of the Routing Worksheet. **Tip:** Notice that the title bar of this control, the blue bar containing the work "Routings", is a button. Push this button to open a larger, resizable window in which you can edit the same data.
Sites Grid	The Sites Grid reflects the information shown on the Sites Worksheet. It shows the sites that will be used for this scenario and which routing worksheet will be associated with each. It contains one row for each site, and in addition to the site name, each row contains the name of the Routing worksheet that will be used for that site. **Tip:** Notice that the title bar of this control is a button. Push this button to open a larger, resizable window in which you can edit the same data.
Agent Groups Grid	The Agent Groups Grid lists the agent groups to be used in the simulation and indicates the talk and wrap time for the group relative to other groups. Refer to Section 3.3.1 **Agent Groups worksheet** for more details. **Tip:** Notice that the title bar of this control is a button. Push this button to open a larger, resizable window in which you can edit the same data.
Workload Sources Grid	The Workload Sources Grid contains the information shown on the Workload Sources worksheet. For each workload source, the grid shows the percentage of that workload that will be allocated to each site. **Tip:** Notice that the title bar of this control is a button. Push this button to open a larger, resizable window in which you can edit the same data.
Contact Types Grid	The Contact Types Grid contains the data shown on the Contact Types worksheet. Refer to Section 3.2.1 **Contact types worksheet** for details. **Tip:** Notice that the title bar of this control is a button. Push this button to open a larger, resizable window in which you can edit the same data.

Scenario Editor Controls	
Control	*Description*
Workload Detail Button	Press this button to open the Workload Detail Window, where you edit the information in the Workload worksheet of the scenario workbook. **Tip:** Workload detail information is almost always easier to edit within Excel, rather than in the Scenario Editor.
Staffing Detail Button	Press this button to open the Staffing Detail Window, where you edit the information in the Staffing worksheet of the scenario workbook. **Tip:** Staffing detail information is almost always easier to edit within Excel, rather than in the Scenario Editor.
Routing Detail Button	Press this button to open the Routing Detail Window, where you edit the information in the routing worksheets of the scenario workbook. **Tip:** Routing detail information is almost always easier to edit within Excel, rather than in the Scenario Editor.
Partial Commit Button	This button commits the changes you've made thus far in this Scenario Editor session. Note that even after one or more Partial Commits, you can still choose Cancel to exit the Scenario Editor and discard all changes you've made in this Scenario Editor session.
Partial Rollback Button	The Partial Rollback feature allows you to undo the changes you've made since the last Partial Commit (or since you entered the Scenario Editor, if you haven't chosen to make a Partial Commit in this Scenario Editor session). For example, you might change the timeframe of the simulation by making several changes to the period parameters, and then select the Partial Commit button. If you then make some errors while editing the staffing detail, you might wish to restore the staffing table to the values shown before you started making changes. Choosing Partial Rollback will undo the changes you made to the staffing detail data grid, but not to the period parameters, because you altered those before the Partial Commit. If you've lost track of when you made the error relative to the last Partial Commit, you can always cancel the Scenario Editor session. That action would restore the values stored before you entered the Scenario Editor for this editing session.
Update Scenario Button	Press this button to exit Scenario Editor and update the open scenario workbook with the changes you've just made in Scenario Editor.
Cancel **Button**	Press this button to close Scenario Editor without updating the open scenario workbook. You will be presented with a dialog box that asks if you are sure. Selecting the X button in the top right corner of the Scenario Editor Console has the same effect as pressing the Cancel button.

5.4.2   Advanced Parameters Window

Figure 3: Advanced Scenario Parameters

Clicking on the button labeled Advanced presents a number of fields displayed on the Advanced parameters worksheets. In most cases, you should just use the default values (shown in Figure 3: Advanced Scenario Parameters). If you want to experiment with changing these values, please refer to their descriptions in Section 3.6 Advanced Parameters.

5.4.3   Periods Window

Figure 4: Periods Window

In the Periods Window, you may enter or select from the drop down menu for five of the fields: the Period Length, the Start Day number and time, and the End day number and time. The sixth field, period count, is calculated from the other fields and may not be changed directly by the user.

5.4.4   Workload Detail Window

Figure 5: Workload Detail Window

The Workload Detail Window contains the data on the workload worksheet. You get here by pressing the Workload Detail button on the Scenario Editor Console.

You will see two choice boxes on the top of the window, and data grid. Use the boxes to limit the data you wish to view. The data you have selected to view is organized within the data grid below first by workload Source, then by contact Type, then by period number and day number. The start and stop time is shown for each period number. Each row then shows then number of calls, the average talk time and the average after call work time for each combination of workload source, contact type, and period. To change the number of calls or the talk or work time, simply highlight the relevant field and replace it. Note that the fields for workload source, contact type and period are disabled and cannot be changed. For more information about workload detail fields, refer to Section 3.2.3 **Workload worksheet**.

5.4.5   Staffing Detail Window

Figure 6: Staffing Detail Window

The Staffing Detail Window contains the data on the Staffing Worksheet. You get here by pressing the Staffing Detail button on the Scenario Editor Console.

You will see two choice boxes on the top of the window, and a data grid. Use the boxes to limit the data you wish to view. The data you have selected to view is organized within the data grid below first by Site name, then by Agent Group name, then by period number and day number. The start and stop time is shown for each period number. Each row then shows the number of agents for that combination of site, agent group, and period. To change the number of agents, simply highlight the relevant field and replace it. Note that the fields for site name, agent group name and period are disabled and cannot be changed. For more information about Staffing Detail, refer to Section 3.3.2 Staffing worksheet.
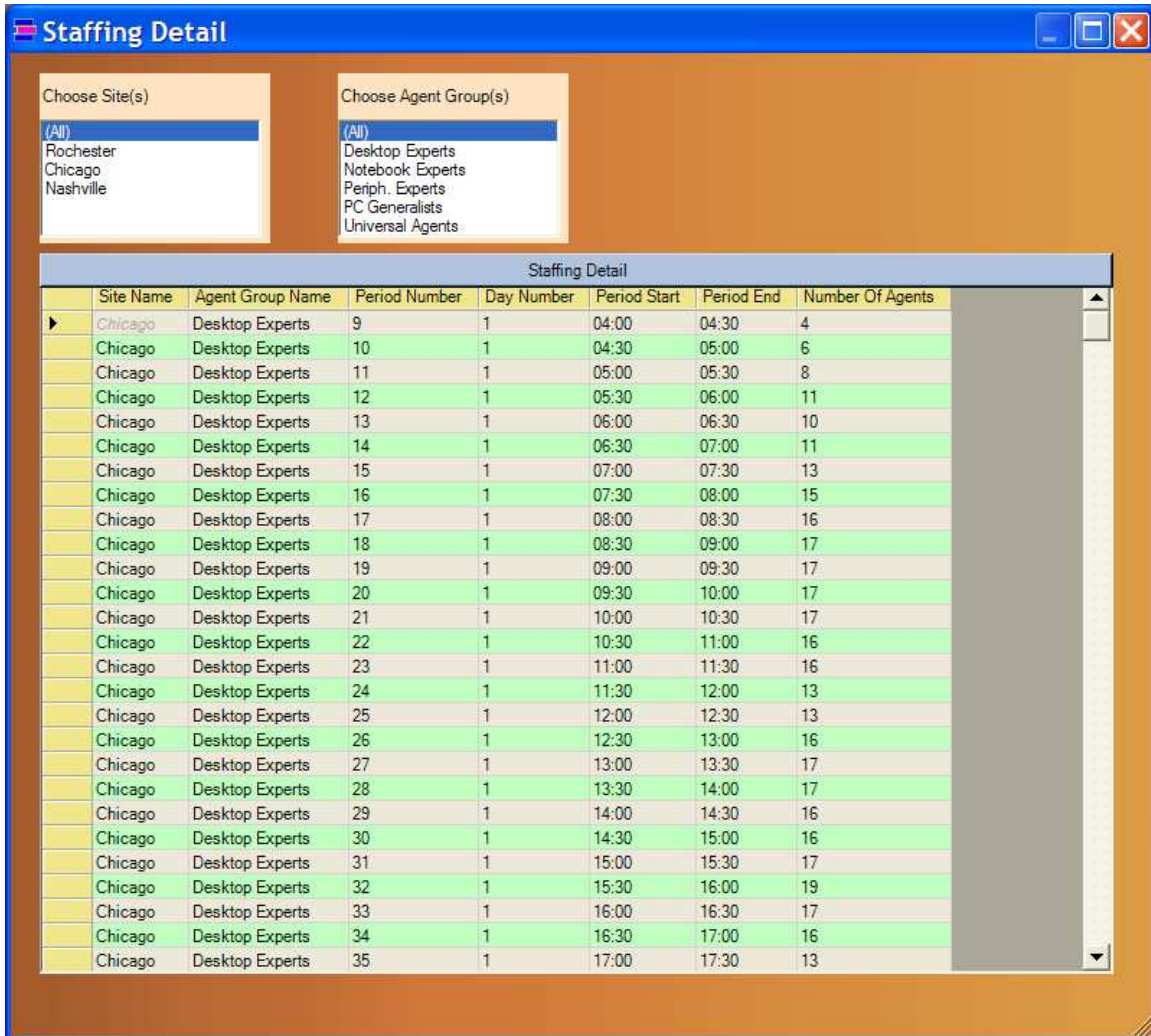
5.4.6   Routing Detail Window

Figure 7: Routing Detail Window

The Routing Detail Window contains the data on the Routing Worksheet(s). You get here by pressing the Routing Detail button on the Scenario Editor Console.

You will see a Choice Box at the top of the window followed by three data grids. Use the choice box at the top to choose the routing worksheet for which you would like to see the details. Note that unlike the Workload and Staffing Details, All is not an option. For the routing you have selected, you will see the Contact and Agent Routing Priorities in the first two tables and the associated Expected Wait Thresholds in the last two. For more information about Routing Details, refer to Section 3.4.1 Routing worksheet.

5.5   Limitations of Scenario Editor

Scenario Editor is very useful in the cases discussed above, namely creating a scenario workbook from scratch, or major reconfiguration of a scenario workbook such as adding or removing sites, agent groups, etc. However the following limitations exist:

- Scenario Editor does not update the CR-In (Cost/Revenue inputs) sheet in a scenario workbook. If you enable Cost/Revenue computations (you do this by setting Calculate Cost/Revenue = Yes on the "Adv" worksheet), then you must set up the CR-In worksheet by hand within Excel.

- While you can edit Workload Detail, Staffing Detail, and Routing Detail in Scenario Editor, it is much easier to make such edits using Excel.

- Scenario Editor clears all data in the scenario workbook's worksheets that contain simulator inputs (General, Sites, Contact types, Workload Sources, …) before performing an Update Scenario action.

- After Scenario Editor performs an Update Scenario action, all workbook cells containing input for the simulator contain values rather than formulas.

6   Interpreting Results

Contact Routing Simulator provides graphical output on key performance measures and tabular statistical output on a wide variety of contact and agent measures. This chapter describes how to interpret those outputs.

In reviewing this data, you should recognize the difficulties inherent in reporting on contacts that may arrive in one period, begin service in another period and be completed in yet a third period. Thus, if you are simulating a contact center in which there are relatively few contacts in any period, some of the results may appear to defy intuition. If you are unable to reconcile any apparent inconsistencies, please call the help desk.

6.1   Key performance measures

6.1.1   <u>Service quality</u>

Service quality is typically measured in terms of delay before service. The two common service quality measures are Average Delay and Service Level. Average Delay is simply the total length of time that all contacts wait during a period divided by the number of contacts in that period, and is typically reported in seconds. Service Level represents the percent of all contacts that waited less than a specified number of seconds, and is typically reported as x percent within y seconds. Most call centers set goals using one of these two types of measures. For example, if the goal is to answer 80 percent of the calls within 25 seconds, but we actually answered only 65 percent of the calls within 25 seconds within a busy half-hour, then we know that we were understaffed for the workload during that period.

Service quality is presented graphically on the worksheet labeled SL. The initial graph shows service level by period for all sites and for all contact types. You can change the graph using the three drop down boxes. The box at the upper left allows you to select individual sites. Selecting an individual site rather than all sites controls what is displayed for each contact type. The box at the right allows you to select one or more contact types for display. Selecting contact types controls the number of contact types for which you will display data, that is, the number of lines of data shown on the graph. The box beneath the graph lets you choose a subset of the periods for which the simulation was run, if you wish to show fewer periods.

6.1.2   Agent utilization

Agent utilization is the fraction of time during a period that an agent spends working directly on a contact. It is normally expressed as a percent. Its complement is the fraction of time that an agent is waiting for a contact to arrive. As an example, an agent utilization statistic of 85 percent means that an agent is spending 51 minutes out of each hour working directly on contacts and nine minutes sitting idle waiting for the next contact to arrive.

Agent utilization is displayed graphically on the worksheet labeled UTIL. The initial display shows utilization percent for all sites and all agent groups. By using the box on the upper left corner you can change the display to an individual site. Similarly, you can use the box on the right side to select which agent groups you wish to view. The box beneath the graph lets you choose a subset of the periods for which the simulation was run, if you wish to show fewer periods.

6.2   Cross tabulations

6.2.1   Contact type

In a skills-based routing environment many different agent groups may be capable of handling each call type. It is interesting to know, for a specific contact type, how the workload of servicing that contact type has been shared among the various agent groups. The graph on the worksheet labeled XC provides this information.

Just as in the case of the service quality and utilization graphs, you can use the boxes at the upper left corner, right side, and at the bottom to focus in on the site, contact type, agent groups, and periods you'd like to view. However, the cross tabulations graph provides an interesting option in addition to the contact types – idle. You can choose to view a period by period graph of the distribution of agent groups in the idle state.

6.2.2   Agent group

The worksheet labeled XA graphically displays the breakdown of an agent group's activity for each period. That is, it shows the fraction of time an agent group spent handling each type of contact and the fraction of time spent in the idle state. The specific site, agent group, and contact type displayed can be changed using the boxes in the upper left corner, the right side, and beneath the graph.

This display is interesting because it tells us how an agent group spent its time during a period. In a skills-based environment, we may prefer that agents get the chance to handle a representative sample of all the contact types they are trained for. This graph provides that information.

6.3   Performance Details

During a simulation run, Contact Routing Simulator continually updates very several large internal tabulations which aggregate the performance data from the run. At the end of the run, the simulator writes out the results of these tabulations to several worksheets: C_DBS, A_DBS, XC_DBS, and XA_DBS.

Typically these output worksheets contain many thousands of numbers, far too many numbers to comprehend in a useful way without the aid of powerful data analysis and visualization tools. Such tools are readily available in Excel: pivot tables and pivot charts. For that reason, the worksheets C_DBS, A_DBS, XC_DBS, and XA_DBS are organized in such a way that they can provide the raw data for pivot tables and pivot charts. The pivot charts worksheets SL, UTIL, XC, and XA that the simulator creates during each run are examples of what can be done with the data in the performance detail worksheets C_DBS, A_DBS, XC_DBS, and XA_DBS.

6.3.1   <u>Contact Performance Worksheet</u>

The worksheet labeled C_DBS holds a variety of contact statistics. Each row in the table represents data for a specific site, contact type and period combination. For a detailed and complete definition of each of the data columns in this worksheet, see 7 APPENDIX: C_DBS . We give an abbreviated description here:

Avg NPresent (*Average Number Present*) is the average number of contacts present in the system during the period. This includes contacts being serviced by an agent and those waiting in queue.

Avg Handle Time is the average time it took to handle a contact of this type during the period.

Avg NWait = Average queue length.

Avg Wait Time All is the average time spent in queue by all contacts, including those who were serviced immediately.

Avg Wait Time Delayed is the average time spent in queue by those contacts that were not serviced immediately, including contacts that reneged.

Avg Wait Time Reneged is the average time spent in queue by those delayed contacts that abandoned before they could be served.

Avg Wait Time Served is the average time spent in queue by contacts that were eventually served. Thus, it does not include contacts that abandoned.

NArrive (*Number Arrive*) represents the number of contacts that arrived during the period.

NDepart (*Number Depart)* is the number of contacts whose service was completed during the period, or who abandoned during the period.

NBlock (*Number Blocked*) is the number of contacts that arrived when all agents were busy and all queue slots were full.

NBalk (*Number Balked*) is the number of contacts that arrived when all agents were busy and then immediately abandoned without waiting at all.

NRenege (*Number Reneged*) is the number of contacts that abandoned the queue after waiting for a while.

The last two columns, *Service Level Seconds* and *Service Level Fraction* show the service level for the period.

6.3.2   Agent Performance Worksheet

The worksheet A_DBS holds a variety of agent group statistics. Each row in the table represents data for a specific site, agent group and period combination. For a detailed and complete definition of each of the data columns in this worksheet, see 8 APPENDIX: A_DBS . We give an abbreviated description here:

Avg NAvail (*Average Number Available*) is the number of agents in the group that are logged in and working. Working means that the agents are in one of three states: talking with a contact, doing after call work or waiting for a call to arrive.

Avg Handle Time is the average time spent by agents in this group handling contacts. It includes time spent talking to customers and doing after call work.

Avg NServeOrWrap (*Average Number Serve or Wrap*) is the average number of agents that are either talking to a customer or performing after call work.

Avg NWait (*Average Number Waiting*) is the average number of agents that are waiting for a contact to arrive to be connected to them.

Avg Wait Time All is the average time spent by agents awaiting the arrival of the next contact. This is the average of all agent wait times, including wait times of 0 duration. Wait times of duration 0 occur when an agent finishes one call and immediately begins talking to the next caller.

Avg Wait Time Delayed is the average of all agent wait times that were greater than 0.

NArrive (*Number Arrive*) is the number of agents that signed on during the period.

NDepart (*Number Depart)* is the number of agents that logged off during the period.

Utilization Fraction is the percentage of the period that an agent spent handling contacts.

6.4   Cost/Revenue Analysis

The worksheet labeled CR-Out contains Cost Revenue figures that will have been calculated if your system has been configured to provide such an analysis. The worksheet is divided into three primary sections, the first for Revenue Totals, the second for Cost Totals, and the third for Net Revenue Totals. Each of these three sections mimics the layout of the inputs entered in the CR-In worksheet.

6.4.1   Revenue Totals

Revenues are shown in two categories, the revenues calculated on a per contact basis and the revenue calculated on a per minute basis. The revenue per contact shown by contact type and agent group. CRS calculates multiplies the potential revenue of a contact of type a being handled

by an agent of type x by the number of contacts of type a that were handled by agents of type x to determine the total revenue for that contact/agent type pair. The result of this calculation is shown in each cell of the table on the top left of the worksheet. To the right of that is the revenue per minute for each contact type multiplied by the number of minutes spent handling that contact type. Totals are shown both at the foot of each column as well as the right of each row so that revenues can be seen across agent groups or contact types.

6.4.2   Cost Totals

There are four different categories of costs shown. The cost per contact is calculated and displayed as is described above for revenue per contact. The per minute costs are calculated and displayed as is described above for revenue per minute.

The costs of lost contacts are calculated as the cost per lost contact of each contact type multiplied by the number of lost contacts of that type. The agent cost totals are calculated as the cost per hour of an agent of that type scheduled to be handling contacts multiplied by the number of hours agents of that type were scheduled to be handling contacts. Totals are shown both at the foot of each column and the right of each row.

6.4.3   Net Revenue Totals

The format of the Net Revenue table mirrors that of the Cost Totals table, that is, it shows four different categories of net revenue. The net revenue per contact is the revenue for a particular contact type/agent group pair less the cost for that contact type/agent group pair. The net revenue per minute is the revenue for a particular contact type less any costs for that contact type. Because there is no potential revenue associated with lost contacts, the net revenue is shown as the negative of the cost per lost contact for each contact type. The same is true for net revenue on a per agent hour basis; net revenue is shown as the negative of the cost per agent hour by agent type. As with costs and revenues, net revenue totals are shown both at the foot of each column and the right of each row.

6.4.4   Log Worksheet

At the beginning and end of each simulation run, Contact Routing Simulator writes certain information to a worksheet named "Log" in your scenario workbook. (If no worksheet with this name exists, then the simulator creates one.) The data in the Log worksheet is seldom of interest, with one exception: the Log entries provide essential information for Abstract Micro Systems when you have a customer support question.

Here is an example Log worksheet (Figure 8):

Figure 8: Log worksheet created by the simulator

In this example, the simulator wrote rows 1-16 when the user first pressed the Run button on the Simulator Console. These rows disclose when the run started, what software versions were used, the scenario name, the initial number of repetitions, whether the user specified "Randomize" as the Random Seed on the General worksheet, shape parameters for probability distributions for talk time, wrap time, and wait time, etc. Especially useful for customer support is line 9, the value of the Random Seed that the simulator used. This allows someone having a copy of your scenario file to replicate the exact outputs from your simulation.

The simulator wrote lines 18-21 after the simulation run finished. If line 21, "Inputs Synchronized" has the value "No", then the user has changed the values of some input parameters after starting the simulator. The user can do this by pressing the Pause button on the Simulator Console, then performing some edits, and then pressing Run again and ignoring the simulator's warning message that "inputs have changed..". If you send a scenario workbook file to Customer

Support at Abstract Micro Systems, please be sure that the simulator has written "Yes" as the value of "Inputs Synchronized".

6.5   A final note

You can create your own graphs. Contact Routing Simulator stores data in Microsoft Excel worksheets. You have complete flexibility to use the Excel graphing functionality with the data in these tables to create any graph that you choose.

7   APPENDIX: C_DBS Reference

At the end of each simulator run, Contact Routing Simulator produces a worksheet called C_DBS (see below, Figure 9) containing a wealth of information about the simulated performance, from a Contact Type perspective, of your ACD or network of ACDs. We gave an overview of this worksheet in Section 6.3.1 Contact Performance Worksheet. In the current appendix, we provide additional details about the structure and contents of the C_DBS.

7.1   Need for Precise Specifications and Definitions

Why might you refer to this appendix? It is surely true that the general meanings of the data items reported on the C_DBS worksheet are familiar to you. However, in many cases, the *precise* definitions may not be obvious. For example, consider Service Level Fraction. Clearly

> Service Level Fraction = M/N where
> M = the number of calls that began service within T seconds, with
> T = Service Level Seconds, and
> N = the total number of calls.

But consider the fact that some calls abandon (renege or balk). Are they included in N? Also, be aware that many talk time spans, wrap time spans, and wait time spans cross the boundaries between one period and the next period. Some calls or wait spans may actually extend through 3 or more simulation periods. For calls spanning period boundaries, how do we decide which period to assign them to for purposes of calculating Service Level Fraction? Finally, remember that a Contact Routing Simulator run usually involves multiple **repetitions**. How does this fact affect the calculation of the performance data?

When you need precise answers to such questions please refer to this appendix.

> **Tip:** Feel free to skip this section in your first reading of the User Manual.

7.2   Structure of the C_DBS Worksheet

The C_DBS worksheet is structured as a normalized EXCEL "database". That is, there are several columns which together form a unique "key" and several other columns that represent the data associated with each "key". The key fields are Site, Contact Type, and Period Number, and the worksheet contains one row for each unique combination of (Site, Contact Type, Period Number).
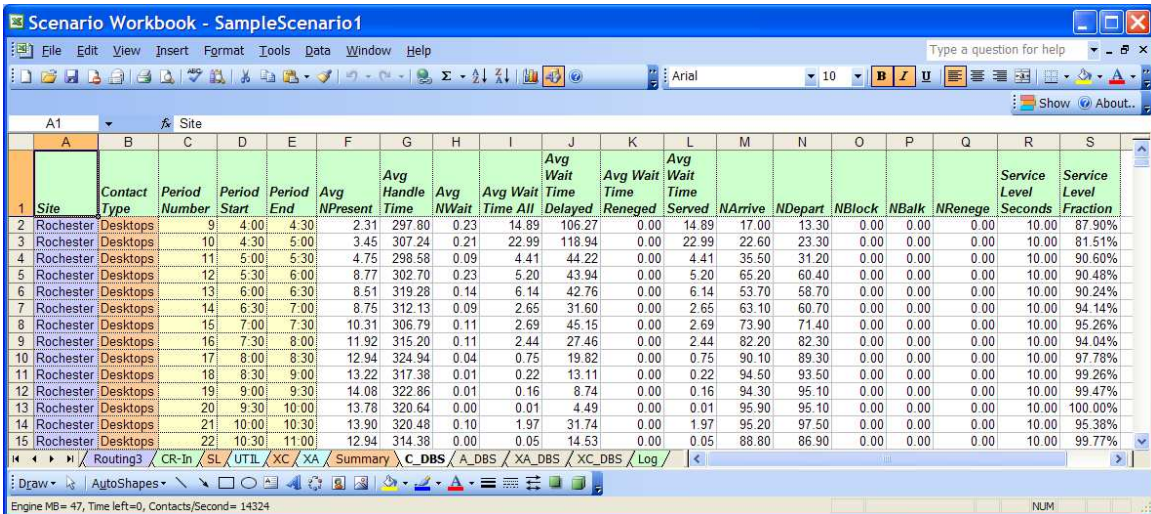
Figure 9: Top Portion of C_DBS Worksheet

The data in C_DBS are laid out so as to facilitate building Excel pivot tables and pivot charts. If you are familiar with pivot charts, you have the ability to create many *ad hoc* reports and/or charts based on the data in C_DBS. Contact Routing Simulator itself uses C_DBS to create the pivot chart SL, showing the service level outputs of the simulation.

7.3   Column Definitions in C_DBS

Refer Table 3 to for detailed descriptions of the data in each column of C_DBS.

Table 3: C_DBS Worksheet Column Descriptions

C_DBS: Contact Performance Worksheet	
Column Heading	**Description**
1. Site	The name of a Site on the Sites worksheet
2. Contact Type	The name of a Contact Type on the Contact Types worksheet
3. Period Number	Integer identifying a time period. Time period number 1 begins at midnight (00:00)
4. Period Start	Time (hh:mm) at which period begins
5. Period End	Time (hh:mm) at which period ends
6. Avg NPresent	Average over all repetitions of number of contacts in the system of the specified (Site, Contact Type) during the specified period. Includes contacts that are waiting and those that are talking.
7. Avg Handle Time	Average over all repetitions of Talk Time + Wrap Time for calls of the specified (Site, Contact Type) that finish wrap during the specified period.

C_DBS: Contact Performance Worksheet	
Column Heading	**Description**
8. Avg NWait	Average over all repetitions of number of **waiting** calls of the specified (Site, Contact Type) during the specified period. Sometimes called **Average Queue Length**.
9. Avg Wait Time All	Average over all repetitions of wait time experienced by all calls of the specified (Site, Contact Type) during the specified period. The average includes all calls that renege during the period, all calls that begin talking during the period after waiting, and all calls that begin talking during the period after no wait (these calls have a wait time of 0 that is included in the average). Blocked or balked calls are not included in the average.
10. Avg Wait Time Delayed	Average over all repetitions of wait time experienced by all **delayed** calls of the specified (Site, Contact Type) during the specified period. The average includes all calls that renege during the period and all calls that begin talking during the period after waiting. Calls that begin talking after no wait are not included in the average. Likewise, blocked or balked calls are not included in the average.
11. Avg Wait Time Reneged	Average over all repetitions of wait time experienced by all calls of the specified (Site, Contact Type) which renege (i.e., abandon after a wait) during the period. The Average over all repetitions includes all calls that renege during the period and all calls that begin talking during the period after waiting. Calls that begin talking after no wait are not included in the Average over all repetitions. Likewise, blocked or balked calls are not included in the Average over all repetitions.
12. Avg Wait Time Served	Average over all repetitions of wait time experienced by all calls of the specified (Site, Contact Type) which finish wrap during the period. The Average over all repetitions includes both calls that waited before beginning service, and those that had no wait (for such calls, a 0 wait time is averaged in).
13. NArrive	Average over all repetitions of number of calls of the specified (Site, Contact Type) which arrive at the site during the specified period. Blocked or balked calls are not included.
14. NDepart	Average over all repetitions of number of calls of the specified (Site, Contact Type) which leave the system during the period. Calls leave the system either by finishing talking or by reneging. Blocked or balked calls
15. NBlock	Average over all repetitions of number of calls of the specified (Site, Contact Type) which arrive at the site but which can not enter the system because all agents able to handle the call are busy and the Maximum Queue Length for this contact type would be exceeded if the call were placed in queue.

C_DBS: Contact Performance Worksheet	
Column Heading	**Description**
16. NBalk	Average over all repetitions of number of calls of the specified (Site, Contact Type) which balk during the period. (A caller is said to **balk** if the caller immediately abandons upon learning that there will be a wait.)
17. NRenege	Average over all repetitions of number of calls of the specified (Site, Contact Type) which renege during the period. (A caller is said to **renege** if the caller abandons after waiting for a while.)
18. Service Level Seconds	This data item replicates the Service Level Seconds that was specified for this Contact Type on the Contact Types sheet.
19. Service Level Fraction	Average over all repetitions of the service level fraction (displayed as a percent) for calls of the specified (Contact Type) during the specified period. Precisely, this is a fraction N_1/N_2 where N_1 = number of callers of specified (Site, Contact Type) who began service during the period after either no wait or after a wait time that was less than or equal to Service Level Seconds; and N_2 = number of callers of specified (Site, Contact Type) who began service, reneged or balked during the period.

8   APPENDIX: A_DBS Reference

At the end of each simulator run Contact Routing Simulator creates a worksheet called A_DBS (see below, Figure 10) containing a wealth of information about the simulated performance, from an Agent perspective, of your ACD or network of ACDs. We gave an overview of this worksheet in Section 6.3.2 Agent Performance Worksheet. In the current appendix, we provide additional details about the structure and contents of A_DBS.

8.1   Need for Precise Specifications and Definitions

Considerations similar to those discussed in Section 7.1 (where we discussed the C_DBS worksheet) apply here. Take Average Handle Time as an example. On the A_DBS worksheet, Contact Routing Simulator reports Average Handle Time for each combination of Site, Agent Group, and Period. Clearly Average Handle Time equals the sum of all handle times divided by the number of calls handled in a period. But what about calls that cross period boundaries? In which period do we tabulate such calls? When you need precise answers to these and similar questions, please refer to this appendix.

Tip: Feel free to skip this appendix in your first reading of the User Manual.

8.2   Structure of the A_DBS Worksheet

This worksheet is structured as a normalized EXCEL "database". That is, there are several columns which together form a unique "key" and several other columns that represent the data associated with each "key". The key fields are Site, Agent Group, and Period Number, and the worksheet contains one row for each unique combination of (Site, Agent Group, Period Number).
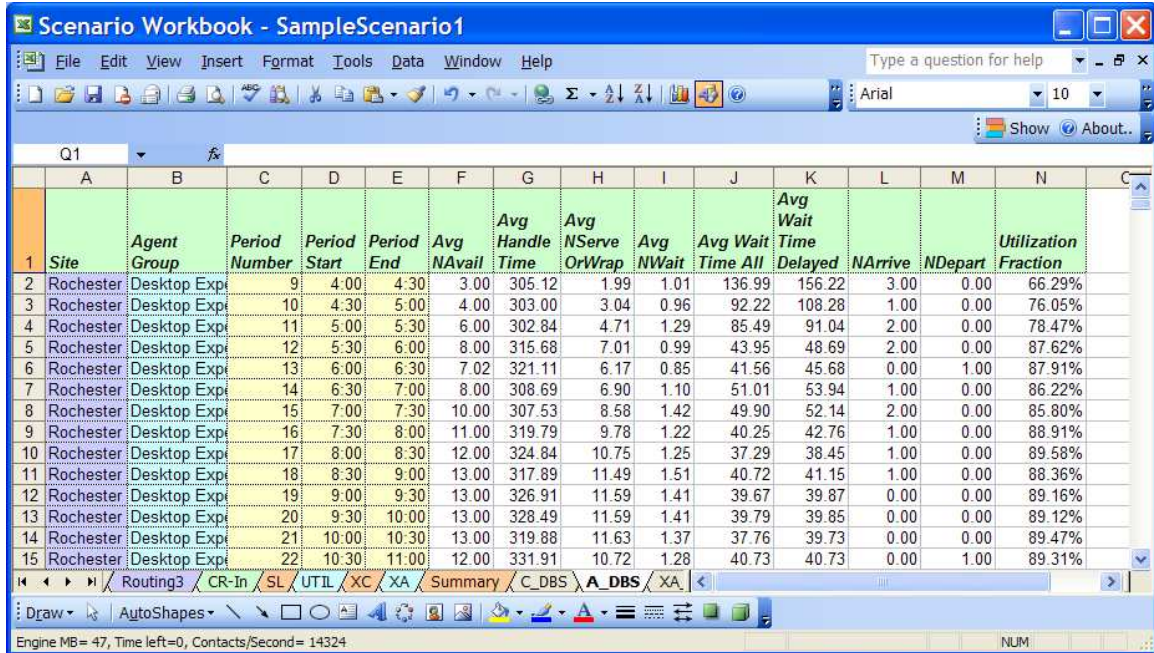
Figure 10: Top portion of A_DBS Worksheet

The data in A_DBS are laid out so as to facilitate building Excel pivot tables and pivot charts. If you are familiar with pivot charts, you have the ability to create many *ad hoc* reports and/or charts based on the data in A_DBS. Contact Routing Simulator itself uses A_DBS to create the pivot chart UTIL, showing the agent utilization outputs of the simulation.

8.3   Column Definitions in A_DBS

Refer Table 4 to for detailed descriptions of the data in each column of A_DBS.

Table 4: A_DBS Worksheet Column Descriptions

A_DBS: Agent Performance Worksheet	
Column Heading	*Description*
1. Site	The name of a Site on the Sites worksheet.
2. Agent Group	The name of an Agent Group on the Agent Groups worksheet.

A_DBS: Agent Performance Worksheet	
Column Heading	**Description**
3. Period Number	Integer identifying a time period. Time period number 1 begins at midnight (00:00)
4. Period Start	Time (hh:mm) at which period begins
5. Period End	Time (hh:mm) at which period ends
6. Avg NAvail	Average over all repetitions of number of agents of the specified (Site, Agent Group) who are present in the call center during the period. Note that Avg NAvail = Avg NServeOrWrap + AvgNWait
7. Avg Handle Time	Average over all repetitions of TalkTime + Wrap Time for all calls handled by agents of the specified (Site, Agent Group); the calls included in this average are those whose wrap ends during the specified period.
8. AvgNServeOrWrap	Average over all repetitions of number of agents of the specified (Site, Agent Group) who are busy talking or wrapping during the period. Note that Avg NAvail = Avg NServeOrWrap + AvgNWait
9. Avg NWait	Average over all repetitions of number of agents of the specified (Site, Agent Group) who are waiting during the specified period. (This number could also be called the **Average Agent Queue Length**.) Note that Avg NAvail = Avg NServeOrWrap + AvgNWait
10. Avg Wait Time All	Average over all repetitions of the wait times experienced by agents of the specified (Site, Agent Group) during the period. More precisely, consider each occurrence of an agent beginning to service a call during the period. Let N = the number of such occurrences. Add up the wait times that preceded each occurrence, adding 0 if there was no wait (that is, if the agent connected immediately to a call after finishing the previous call). Take this sum and divided by N.
11. Avg Wait Time Delayed	Average over all repetitions of the wait intervals experienced by agents of the specified (Site, Agent Group) during the period. More precisely, consider each occurrence of an agent beginning to service a call after waiting for a **non-zero** amount of time during the period. Let N_1 = the number of such occurrences. Add up the wait times that preceded each occurrence. Take this sum and divide by N_1.

A_DBS: Agent Performance Worksheet	
Column Heading	**Description**
12. NArrive	Average over all repetitions of the number of agents of the specified (Site, Agent Group) who join the workforce during the period. See also: comment at end of description of NDepart (next item).
13. NDepart	Average over all repetitions of the number of agents of the specified (Site, Agent Group) who leave the workforce during the period. **Note:** in Contact Routing Simulator, the number of agents entering and the number leaving are determined so that the number present will conform to the staffing numbers specified on the Staffing worksheet. Agents always arrive at the beginning of a period, and agents always leave at the end of a period, or soon after the end of a period. Why do agents not always leave at the end of a period? It can happen that n agents must leave in order to reduce the staffing in the next period to the staffing level specified in the Staffing worksheet, where $n > 0$; but sometimes **all agents are busy** at the moment marking the boundary between two periods. In such cases, Contact Routing Simulator selects the next n agents to finish a call as the agents who leave.
14. Utilization Fraction	Average over all repetitions for agents of the specified (Site, Agent Group) of the ratio T_0/T_1 where T_0 = sum of all time spent by agents talking and wrapping during the period and T_1 = sum of all time that agents were present during the period. **Note:** It is also true that Utilization Fraction = AvgNServeOrWrap / (Avg NAvail)

9   APPENDIX: Explanation of Abandon Rate and Balkiness

This appendix discusses how Contact Routing Simulator models the impatience of customers who experience a delay before their call is answered, and explains how you should decide what values to enter on the Contact Types worksheet for Abandon Rate and Balkiness.

Queueing theory distinguishes two types of impatient behavior (also called *abandonment*) for customers arriving at a queuing facility: *balking* and *reneging*.

Figure 11: Abandon Rate and Balkiness on Contact Types worksheet

9.1   Balkiness

A customer who refuses to enter a queue when he discovers that there will be a wait is said to *balk*. An example would be a customer who calls your call center, receives the message "All representatives are currently assisting other customers..." and then **immediately** hangs up.

The conditional probability that a caller will balk given that the caller discovers that there will be a wait is called *balkiness* in Contact Routing Simulator. Balkiness must be a number between 0 and 1 inclusive. When balkiness = 0, every caller who learns that there will be a wait will stay on the line at least for a while. When balkiness = 1, every caller who learns that there will be a wait will immediately hang up.

Note that if, for example, balkiness = 0.2 (or 20%), then this does not mean that 20% of callers balk. It means that, over many simulator repetitions it will be true that among simulated callers who arrive at the system and learn that there will be a wait, close to 20% of them immediately abandon without waiting at all. So the actual fraction of callers who balk during any simulation run will range between 0 and roughly 20%.

Tip: Set balkiness to 0 in almost all cases. Simulator outputs are easier to understand in this case, and there is enough flexibility built into the wait time distributions (*i.e.*, ability to set the shape parameter of the wait time distribution on the Adv worksheet), so that we can properly simulate abandonment behavior by manipulating the Abandon Rate (see below) and the shape parameter. At Abstract Micro Systems we sometimes use non-zero values of balkiness for testing and validating the simulator against theoretical queueing theory models.

9.2   Abandon Rate

A customer who waits for a while and then leaves the system is said to *renege*. An example would be a customer who calls your call center, is told there will be a wait, waits for a while, and then hangs up before being connected to an agent. In Contact Routing simulator, the degree to which a waiting customer is likely to renege is called *Abandon Rate*.

The Abandon Rate for a contact type has the following precise meaning. First, if Abandon Rate = 0, then every caller who begins a wait is infinitely patient, that is, will never abandon. If Abandon Rate is a positive number *r*, then

$$r = 1 \; / \; T$$

where T = average length of time (in seconds) that customers will wait before abandoning given that the following conditions are true:

- Customer has begun waiting (i.e., was told there is a wait, and the customer did not balk)

- There are no agents in the call center (but the caller does not know this).

This is tricky. A concrete example may help.

Example: In the SampleScenario.xls workbook, consider the Peripherals contact type, for example (see **Figure 11**). Here Abandon Rate = .005. This means that the average time T to abandon for waiting customers, given that there are no agents in the system, is 1/0.005 = 200 seconds. However, when we look at the "Avg Wait Time Reneged" column on the C_DBS worksheet after a simulation, we see that the values in this column for Peripherals calls are sometimes 0, and often in the range 60 to 90 seconds, but never near 200 seconds. What is going on? The answer is that the measured average wait time for abandoning Peripherals customers is 0 if no customers abandon during the period, and will likely be less than 200 when the call center is well-staffed so that almost all calls are answered quickly. Another way of looking at it is: if there are lots of agents to handle a type a caller, then all wait times will be small, so the average wait to abandon must also be small.

Now, modify the Staffing worksheet of SampleScenario.xls so that the number of agents in the call center is 0 for every site, agent group, and period. Run the simulator again and look in the C_DBS worksheet in the scenario workbook. Note that for Peripherals, the values in the "Avg Wait Time Reneged" column are all fairly close to 200 seconds.

9.3   What value should you use for Abandon Rate?

How should you select the value of Abandon Rate in your scenarios? If possible, find an ACD report that covers a time period during which as large a fraction as possible of callers are

abandoning[2]. Determine from this report what the average time T to abandon is for waiting customers. (Make sure that customers whose wait time is 0 are not included in the computation of the average value T.) Now compute $r_1 = 1/T$. The number r_1 is a lower bound for the value to enter for Abandon Rate. Therefore pick a somewhat larger number and enter it as Abandon Rate.

Tip: Don't worry excessively about getting an exact Abandon Rate. This parameter cannot be estimated exactly from your ACD reports. Moreover, remember that your goal is a well-functioning contact center, and in such a center there will not be very many abandoned calls anyway. The simulation model is not very sensitive to the Abandon Rate parameter in the types of configurations that you are trying to achieve.

Just pick a value for Abandon Rate that seems reasonable based on your understanding of the ACD reports and based on your intuition about your customers' behavior. Then do a simulation. If the simulation outputs for number of abandoned calls and/or Avg Wait Time Reneged seem too large or too small to fit the actual behavior of your call center, then experiment with adjusting Abandon Rate to try to get a better fit.

9.4   Should Abandon Rate ever be 0?

Setting Abandon Rate to 0 means that a customer who begins waiting will never abandon, no matter how long the call has to wait. For telephone calls, this almost never is a realistic assumption. Human nature and physiology do not produce an infinitely patient caller. Therefore:

Tip: Don't use Abandon Rate = 0 for a contact type corresponding to telephone calls. Even if you think the callers are extremely patient, use a small number such as .0001 instead of 0.

However, if you are modeling emails coming into your call centers, then you may realistically set Abandon Rate = 0 for each email Contact Type. Those emails will never go away until they are processed.

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[2] This may be less difficult than it sounds, because it is likely that one reason you are trying to model this particular call center is that the number of abandoned calls is too high, and you are trying to correct the problem.

10 APPENDIX: The Require Consent Parameter.

Figure 12: Routing2 worksheet, used to illustrate Require Consent

The Require Consent parameter (see section 3.6 Advanced Parameters) affects the matching of callers and agents when your routing worksheet specifies either delayed eligibility or asymmetric eligibility.

Delayed eligibility occurs when your routing worksheet contains numbers in parentheses specifying delays; for example, see cell E2 in sheet Routing2 of SampleScenario.xls. See Section 10.1 for an extended discussion of this example.

Asymmetric eligibility occurs when there exists a contact type *A* and agent group *G* such that calls of type *A* are allowed to connect to agents of type *G*, but agents of type *G* are not allowed to connect to calls of type *A*. Asymmetric routing also occurs when there exists a contact type *A* and agent group *G* such that calls of type *A* are not allowed to connect to agents of type *G*, but agents of type *G* are allowed to connect to calls of type *A*. The issues surrounding asymmetric routing will become clearer when you study the example in section 10.2.

10.1 Example: David and Patti—Delayed Eligibility Matching

An example will help explain how the Require Consent parameter affects matching when there is delayed eligibility. Consider the routing that is defined in the Routing2 worksheet of SampleScenario.xls (see Figure 12). In this scenario, the Routing2 worksheet, associated with the

Chicago site, uses *delayed eligibility* routing; that is, a match between a call and an agent able to handle the call may be disallowed until the call and/or agent have waited for a specified delay period. An example of this is cell E2 of the Routing2 worksheet. The cell's contents, "2(10)", specify that PC Generalists are a 2nd choice agent group for Desktops calls, and that a Desktops call must wait 10 seconds before trying to connect to a PC Generalist agent.

Suppose that the following sequence of events occurs at the Chicago site, beginning at 12:00:00 noon.

hh:mm:ss	*Event*
12:00:00	Suppose that no agents in any agent group are available to take calls (*i.e.*, all agents are busy) at this instant AND suppose that no calls of any type are in queue.
12:00:00	A "Desktops" call from a caller named David arrives
12:00:00 to 12:00:05	Suppose no other call of any type arrives during this 5-second period, and that no agent becomes available during this period.
12:00:05	An agent Patti in "PC Generalists" group becomes available
12:00:05 to 12:00:15	Suppose that no call of any type arrives during this 10-second period, and that no other agent becomes available during this period

Under these assumptions, David's call will be connected to Patti, but at different times depending on the value of the Require Consent parameter. In fact, David is connected to Patti
    at 12:00:05 if Require Consent = No, and
    at 12:00:10 if Require Consent = Yes.

Why is this? When David's call arrives at 12:00:00, the routing instructions in row 2 of the routing worksheet apply to his call because the call is a Desktops call. This means that if there were a Desktops agent available, then the ACD would immediately connect David to such an agent. However, no Desktops agent is available at 12:00:00. Therefore, the routing algorithm says to wait 10 seconds, and then see if there is either a Desktops agent or a PC Generalists agent available.

Now consider the routing from Patti's point of view. At 12:00:05, she becomes available. Her routing rules are contained in column E, in cells E8, E9, and E10. The first choice for Patti would be a Notebooks call; however, our assumptions imply that no such call is waiting. Therefore the ACD looks to see if any calls are waiting in Patti's second priority, namely, Desktops. There is one such call in queue, namely David's call.

It is now 12:00:05, in the middle of the 10-second wait by David's call. The question is, should Patti and David be connected now? David "doesn't want to be connected" because his call's routing rules specify a 10-second delay before connecting to PC Generalists agent. But Patti "wants to be connected" because her routing rules have no built-in delays.

If Require Consent is Yes, then Patti is **not** allowed to connect to David during his 10-second delay because such a connection would be "without David's consent". In this case, the next event which triggers a routing decision occurs at 12:00:10, when David's call "wakes up" after its 10-second sleep. At that time, David routing algorithm implies that he will immediately be connected to Patti.

On the other hand, if Require Consent is No, then Patti is connected immediately to David at 12:00:05 when Patti becomes available. Patti can connect because her routing rules say to do so, overriding David's "objections".

10.2   Example: Daniel, Nancy and Della—Asymmetric Eligibility Matching

To understand how Require Consent works when there is asymmetric eligibility, consider a site whose routing is determined by the routing worksheet displayed in Figure 13.

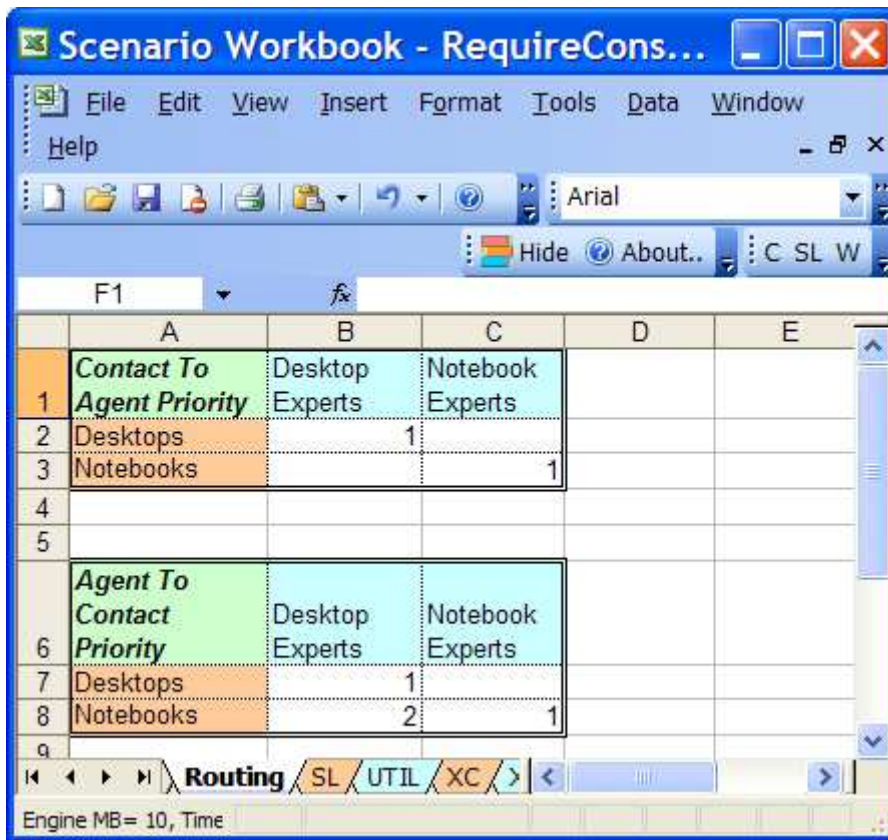**Figure 13: Asymmetric Eligibility Routing**

Suppose that the following events occur at this site, beginning at 12:00:00 noon.

hh:mm:ss	Event
12:00:00	Suppose that no agents in any agent group are available to take calls (*i.e.*, all agents are busy) at this instant AND suppose that no calls of any type are in queue.
12:00:00	A "Desktops" call from a caller named Daniel arrives

12:00:00 to 12:00:05	Suppose no other call of any type arrives during this 5-second period, and that no agent becomes available during this period.
12:00:05	Agent Nancy in "Notebook Experts" group becomes available
12:00:05 to 12:00:10	Suppose that no call of any type arrives during this 5-second period, and that no other agent becomes available during this period
12:00:10	Desktops Experts agent Della becomes available.

Under these assumptions, Daniel's call will connect to Nancy at 12:00:05 if Require Consent = No. On the other hand, if Require Consent = Yes, then Nancy can not connect to Daniel, but 5 seconds later, at 12:00:10, **Della** will connect to Daniel!

10.3   Further comments on Require Consent

Both examples (David/Patty and Daniel/Nancy/Della) illustrate how the Require Consent parameter on the Advanced Parameters worksheet (the hidden worksheet always named "Adv") controls what happens during the simulator's routing decisions if there is a conflict between routing rules for calls and the routing rules for agents.

The David/Patty example shows how a conflict can occur when a call is in the middle of a delay (mandated by the routing rules) when the agent tries to connect, or vice versa. When such a conflict occurs, caller and agent are connected if Require Consent = No, and are not connected if Require Consent = Yes.

The Daniel/Nancy/Della example shows that the Require Consent setting can have a significant effect if your routing scheme involves asymmetric eligibility.

Tip: Don't use routing schemes with asymmetric eligibility. Such schemes are unlikely to accurately reflect the inner workings of your ACD software. Instead use routing with symmetric eligibility. You do this by making sure that the blank cells (if any) in the call routing matrix on your routing worksheet are matched by corresponding blank cells in the same places in the agent routing matrix on that routing worksheet. In other words, both matrices should have blank cells in exactly the same places.

What setting for Require Consent is appropriate for your ACD software? Abstract Micro Systems believes that for almost all ACDs, you should set Require Consent = No. For that reason we have chosen No as the default value for Require Consent when you run a simulation on a scenario workbook in which there is no Advanced Parameters worksheet (i.e., a worksheet named "Adv"). (In that case, Contact Routing Simulator *creates* a new, hidden worksheet named "Adv" and sets Require Consent = No on that worksheet.)

Nevertheless, it may be that for some ACDs you should put Require Consent = Yes. Users wishing to simulate delayed eligibility or asymmetric eligibility in their routing rules should

consult their ACD software documentation to determine how their system resolves conflicts between call routing rules and agent routing rules.

On the other hand, if your routing rules contain no delays or asymmetric eligibility, then forget about Require Consent—the same simulation results will occur no matter what setting you use.

11 APPENDIX: Frequently Asked Questions

11.1 Strange Behavior

I pressed the Run button on the Simulator Console and nothing happened; what's going on? Did you make some edits to cells in the EXCEL worksheet, and then leave the cursor in the last cell that you changed? If so, TAB off this cell or click on another cell; then press Run again. The simulator can not operate when a cell in your workbook has the focus for editing.

11.2 Surprising Results

Why do I see poor service quality in Period n even though I have plenty of agents during that period? It might be because you were badly understaffed in an earlier period, leading to a large number of calls in queue at the beginning of Period n. Another possibility is a problem with your routing worksheet(s). Make sure that your routing enables your agents to take calls of the type in question.

On the Contact performance worksheet C_DBS, why do I see non-integer values for NArrive, NDepart, NBlock, etc.? Remember, these numbers are averaged over multiple repetitions of the simulator. In each repetition, these values are integers, but the average over several repetitions often is not an integer.

I have two scenarios that differ only in their routing scheme. The first scenario shows a higher service level percent than the second. But the first scenario also has a higher number of abandoned calls. Does this make sense? Yes. For example, your first scenario may use delays in the routing matrices while the second scenario does not. This can lead to improved service level in some call types in the first scenario, but at the expense of making callers wait longer on average. When callers wait longer, a higher percentage will abandon. Suppose for example that your service level goal is 90% answered in 20 seconds. For a certain call type we might find:

	1st Scenario	2nd Scenario
Percent of calls answered after wait ≤ 20 seconds	91%	88%
Percent of calls answered after wait > 20 seconds	4%	8%
Percent of calls abandoned	5%	4%

Here the 1st scenario has a higher service level than the 2nd scenario, but the 1st also has a higher percent abandoned than the second.

11.3   Multiple Scenario Workbooks Open at the Same Time

Can I have two or more scenario workbooks open at the same time? Yes, you can have any number of scenario workbooks open at the same time in Excel, limited only by your computer's memory.

Can I run two or more simulations simultaneously? Yes, but each simulation must be running inside a separate instance of the Excel application. For example, open a scenario workbook. Press the Run button on the Simulator Console. Now, use the All Programs menu on the Windows Taskbar to open another instance of Excel. With this Excel window's menu bar, use File|Open to open another Scenario Workbook. Press the Run button on the Simulator Console. You now have two simulators running simultaneously.

Why would I want to run two or more simulations simultaneously? Because you might get the work done sooner. Suppose, for example, that you have two simulations to run. Suppose also that your computer has a multiprocessing CPU, as do many PCs today. Then you might get your two simulations done sooner if they run simultaneously than if they run one after the other. This would require that the simulations run in separate processors, something over which you probably have no control. Experiment with this! (**Tip:** if you do not have a multiprocessing CPU, then there will be no speed advantage from running simulations simultaneously.)

11.4   Simulator Memory Usage

How much memory does Contact Routing Simulator use? Loading the Excel addin A_ContactRoutingSimulator.xla consumes a small amount of memory, about 2 MB. When you open a scenario workbook, and press the Run button on the Simulator Console, the simulator engine then begins using a larger amount of memory that depends on the nature of the simulation inputs. An approximate, empirically-determined formula for the amount of memory needed by the simulator engine is

MB of memory used = 20 + (0.025)*NPeriod*NSite*(NContactType+NAgentGroup)

A rule of thumb is that if the amount of memory calculated from this formula is greater than the installed physical memory on the user's computer, then the program will either not run at all or will run extremely slowly due to excessive paging.

12   CREDITS

Design of Contact Routing Simulator: Tom Potter, Bob Hayes, Karen Weir, and Gene Johnson.
Programming: Tom Potter.
User Manual: Written by Karen Weir, revised and expanded by Tom Potter.