

Simtec Notes

A Discussion for Users of The RTSim Generation Simulation Software

Volume 1, Number 2

Simtec Notes provides samples solutions and discussion on current topics. *Simtec Notes* is published Simtec, Inc. for RTSim software clients. RTSim provides detailed hourly simulation of the real time operation of electrical generating systems including extensive market analysis.

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Transaction Optimization Made Easy

Version 4.00.ac of RTSim includes a modification to the transaction optimization to allow faster, easier studies. Many clients are not familiar with the powerful capability of transaction optimization in RTSim. The optimization will determine the best mix of transactions from a portfolio of possible transactions. The analysis can include the uncertainty of loads, market prices, depth of market, transmission access (congestion) and other variables. The output includes a distribution of profits/losses (risk). A simple example is the best way to describe the use of transaction optimization.

A Marketing/Trading Example

The transaction optimization feature in RTSim can be applied to a variety of situations ranging from next-day trading to optimizing your portfolio for the next twenty years. Any combination of transactions can be used including next-hour economy, next-day economy, bilateral sale/purchase agreements, daily puts/calls, monthly puts/calls and profile sale. To illustrate some of the features of the transaction optimization, a simple example of optimizing "next-day" trading will be used.

Next day trading is a relatively simple task compared to longer-term portfolio optimization. Obviously, there is much less data to analyze with a one-day study compared to a month, year or five-year study. (One RTSim client uses the transaction optimization for evaluating 20-year commitments.) But, the complexity is not just proportional to the number of hours to be analyzed. The number of combinations of potential transaction that need to be analyzed can increase significantl

with longer time periods. For example, assume your only options are to sell 100 MWs 24 hours of each day in the time period or to sell either 0, 100 or 200 MWs for a 16-hour period each weekday with the nomination (amount) allowed to change by month. If you are looking at just one month, there are four different scenarios to be evaluated. If you are looking at the next year, there are $1 + 3^{12}$ or 531,442 different scenarios. Not only are there more hours to evaluate, but the number of different scenarios increase dramatically. The point is, trading for the next day is *relatively* simple.

There are different types of products you may have to consider when trading for the next day. For discussion purposes, let's keep the example simple. Assume that there are only two: (1) there is the opportunity to sell, for \$45/MWH, a 16 hour strip in blocks of 50 MWs with a maximum of 500 MWs and (2) you can exercise, at \$55/MWH, a call for an 8 hour (peak) strip in blocks of 25 MWs with a maximum of 200 MWs. Given the current conditions of your units, the uncertain the load forecast for tomorrow and the probable unit availability for tomorrow, what should you do?

This is not as simple of a question to answer as it first may appear. You have to analyze each of the 99 (11 times 9) combinations of transactions using each forecast in the set of possible forecasts and each set of possible unit availabilities. Assume you have 50 significantly different load forecasts and 100 significantly different unit

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outage states. That means for this *relatively* simple problem you have 99 x 50 x 100 or 495,000 alternative outcomes to evaluate and weight to determine what combination of transactions is likely to make you the most money tomorrow.

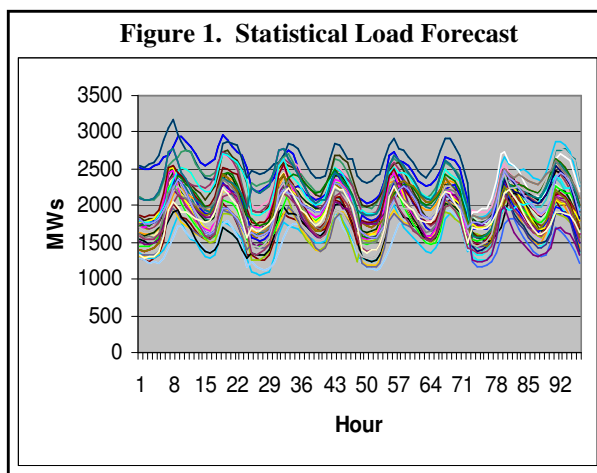
The transaction optimization in RTSim excels at this type of analysis. For the above example, you specify the two trading products; you select the statistical load option; and, assuming your general unit data file is up-to-date, you execute the run. The program returns the correct mix of transactions... all in one run, not 495,000 runs! RTSim also will return the least cost mode of operation for your combined cycle units; the correct fuel to burn in your fuel switching units; and other complicated operating options. Remember, the optimization is always done based on a full, accurate look-ahead unit commitment optimization.

Performing The Optimization

So how do you perform this magic run? You start by setting up the basic run data such as the starting and ending date; you set the statistical load data including the subset of data to be used; you specify the unit data file and update the initial generating unit conditions; and, in RTRun, you specify a few parameters in the "Transaction Optimization" window. Then you execute the Run from RTCase. When the run completes, the best five solutions are reported in the logging file. If you want to repeat any of the best five solutions, five changes case files were automatically written to run each solution. Now let's look at this in more detail.

Utilize Your Statistical Load

Forecast. You are probably thinking "Why use a statistical load forecast? I know my load for tomorrow." You really don't. Sure you have a better idea of the likely range of loads for tomorrow than you would for a day three weeks from now. Your weather forecast is accurate for tomorrow. However you still do not exactly know your



hourly loads for tomorrow. You will be trading for tomorrow at 8 a.m. today. Your peak for tomorrow may be at 6 pm. That is 34 hours away. Will that arriving cold front move across your system before or after tomorrow's afternoon peak? It will make a significant difference in your hourly load shape.

It is assumed that you are already working with the statistical load forecasting capability in RTSim. If you are not, you are missing a real advantage of RTSim. Start by reading about statistical forecasts in the technical notes section under "Help" in RTSim. Call if you need more help setting up the data. You may, however, not realize that you can force RTSim to use only a subset of the statistical variation. For example, a normal statistical forecast may have weather-related variations that produce a range of

forecast for the next few days like those shown in Figure 1. This forecast assumes that you have no knowledge about tomorrow's weather forecast. However, if you know that the weather forecast for the next few days will produce load conditions in the 50-70 percentile of the full range of forecasts, specify that under "Statistical Parameters" in RTRun. Now the forecasts will just include that range. The results are shown in Figure 2.

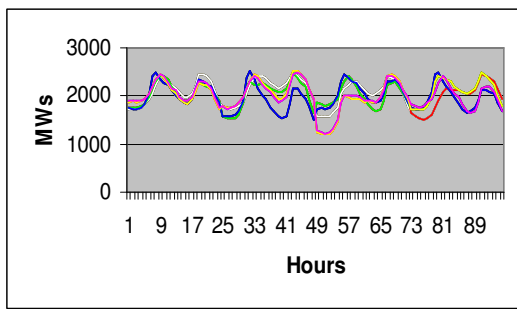
When you use statistical load forecasts, each transaction mix scenario will be examined using the range of load forecasts. The result will be the probability distribution of costs for each transaction mix scenario. An example of these costs is shown in Figure 3.

Utilize Your Generating Data.

You have a detailed RTSim data file describing your generating data. The data file contains a detailed description of I/O heatrate data, incremental heatrate data, hot start requirements, cold start requirements, cold down data, spin contribution, unscheduled outages, and much more. Here is another payback for developing that data; you can use it for transaction optimization by simply point to (specifying) the data file. However, in this example, there are two types of that data that need special attention.

You need to update the initial conditions for each unit. For example, is a unit currently on-line and, if so, how long has it been on-line? The initial conditions can significantly affect the transaction optimization for the next day so you need to update the values. For large systems, this can be an annoying task to do each day. However, have your real-time system write the current unit status to an ASCII file in the RTSim

Figure 2. Limited Range Load Forecast



card format. Then all you need to do is open the generating file with RTUnit and use the ASCII Card read function to read the file from your real-time system. Save the revised data to a new file that you now use in the next-day transaction optimization.

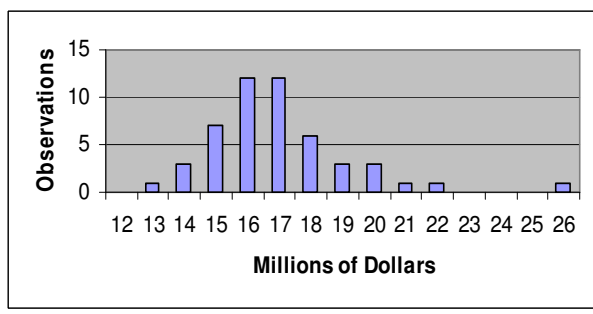
Pay particular attention to the “unforeseen” unplanned forced outage and derating data. Remember you can define the range of hours in the day in which a forced outage/derating will occur. A specific outage/derating event is “unforeseen” by the commitment optimization if it begins after the first hour of the day. The onset of a forced outage/derating is almost always unforeseen and can cause havoc to your plans of a profitable trading day.

Imagine losing 500MWs of your lowest cost generation right in the middle of a 16-hour 400 MW sale. You need to consider the probability of this type of outage when you optimize your next-day trades. This is done automatically in the transaction optimization if you properly specify the unplanned forced outage and derating data. Each transaction mix scenario will be examined over the range of generation availabilities. The resulting costs will be the probability distribution; an example is shown in Figure 3.

Specify the Market. The types and magnitudes of the potential transactions for the day need to be specified. For our simple example, you need to specify the two markets: (1) the opportunity to sell, for \$45/MWH, a 16 hour strip in blocks of 50 MWs with a maximum of 500 MWs and (2) at \$55/MWH, a call for an 8 hour (peak) strip in blocks of 25 MWs with a total of 400 MWs. Note there are no market price forecasts as the prices are now known.

Remember, if there is any transmis-

Figure 3. Cost Distribution



sion congestion possible, each market can have a physical location with competing/non-competing transmission access, transmission access probabilities, etc. which

To include the two markets in the transaction optimization, go to the transaction optimization window shown in Figure 4. Select the two markets (potential transactions) to be included in the optimization. The min/max range and the step size are also defined here. Refer to transaction optimization in the “Help” function of RTSim for information on how to set other input variables in the menu. Of course, you will need to “include” the transaction optimization in the run.

Base Run. With the input data set, select the “calculate” button and the optimization will start. The “status” screen reports the progress in “trys” completed. When the run is completed, check the logging file and you will see the best five transaction mixes. The results for our example are shown in Table 1. The costs are the expected value costs given the probability distribution of hourly loads, unit availability, transmission availability, fuel availability, etc. If you want to see detailed costs distributions for each of the “best 5” transaction mixes, make a regular RTSim run using the defined mix in Table 1.

Figure 4. Transaction Optimization Data Input Window

Edit Transaction Optimization Data

Exit Clear All [Icons]

Calculate Transaction Optimization in Current Run Discount Rate MCS: 0 MCS

Number of Tries (1-1,000,000): 200 Number of Trans. to Optimize: 2

Seed: 1 Times to Resize Solution Space: 0

Min MW Limit: 0.00000 0 MCS Max MW Limit: 0.0000 0 MCS

Select Transactions for Optimization		Min Cap	Max Cap	Cap Changes	Step Fract
<input type="checkbox"/> 01 Clear <input type="checkbox"/> MW Limits?	{ 6 } 16 Hour Sale	0.0000	1.0000	No Changes	0.1000
<input type="checkbox"/> 02 Clear <input type="checkbox"/> MW Limits?	{ 7 } 8 Hour Call	0.0000	1.0000	No Changes	0.1250
<input type="checkbox"/> 03 Clear <input type="checkbox"/> MW Limits?		1.0000	1.0000	No Changes	0.0000
<input type="checkbox"/> 04 Clear <input type="checkbox"/> MW Limits?		1.0000	1.0000	No Changes	0.0000

would define any limit that may occur during each hour for each possible transaction mix scenario.

Autorun of 5 Best Cases. To make the analysis easier, the trans-

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action optimization logic also writes the change case files for each of the “best 5” transaction mixes. The names of the change cases are set to the market file

Table 1. Base Run Output

Transaction Optimization	
Seed: 1	Total trys: 200
Best 1: System cost:	580997.
2002	Jan
16 Hour Sale	1.000
8 Hour Call	0.125
Monthly System Costs	580997.
Transaction Optimization	
Seed: 1	Total trys: 200
Best 2: System cost:	583285.
2002	Jan
16 Hour Sale	1.000
8 Hour Call	0.125
Monthly System Costs	583285.
Transaction Optimization	
Seed: 1	Total trys: 200
Best 3: System cost:	584395.
2002	Jan
16 Hour Sale	1.000
8 Hour Call	0.125
Monthly System Costs	584395.

name (without the extension) used in the base case for the transaction optimization run plus a “_1”, “_2”, etc. for the corresponding five best cases. These change case files also turn off the transaction optimization so that you can run the change cases right after the optimization run without even leaving the RTCase main window.

Advantages of Approach

Speed, convenience and minimum effort are the obvious advantages of this transaction optimization. An incredible complicated procedure is reduced to one relatively simple run. However, the real strength of the analysis is that you will be properly determining the probability distribution of potential profits. The unpredictability of hourly loads, generating unit availability, fuel availability, transmission access/congestion, and market

price are included in the analysis. Ignoring these uncertainties when comparing the potential profits of different transaction mixes can be extremely costly; you could lose more money that you make.

Of course, once you have determined the optimal transaction mix, you can use RTSim to set your commitment for the day. It is a simple calculation. Take your best guess at what the hourly load profile will be. Input it as a “standard” load forecast. Remove the “uncertainty data” such as input unplanned outage/derating data (assign a generating unit data file with no unplanned outage/derating data). Then make a one iteration run. The resulting hourly loading is calculated. An example is shown in Figure 5. Of course, the load will turn out differently, generating units will fully or partially be forced out, etc. However, you know that your transaction mix is the best possible considering all these uncertainties.

Extending the Example

This approach, as illustrated with the simple next-day trading example, works essentially the same way with longer-term trading. You simply specify a longer time period in RTRun, the potential market products (including put/calls) , the depth of the market and any data needed for statistical market price forecasts. RTSim returns the optimum mix of transactions.

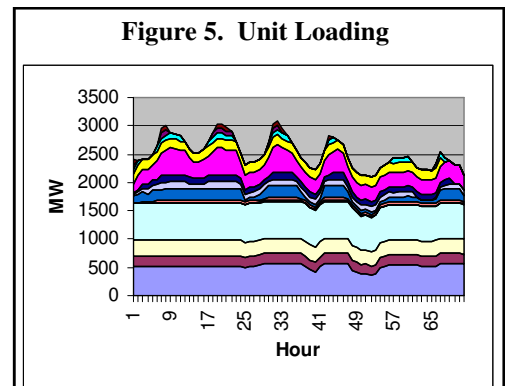
Coordinating Decisions

One final point, RTSim can integrate the decisions of the next-day trading group with other analysis groups such as fuel budgeting, longer-term purchase/sales, and maintenance scheduling. RTSim simulates your short-term decision

making (trading, commitment, fuel switching, etc.) in the longer-term studies AND it uses the same detailed optimization that you use in the short-term.

Think about it. Are you scheduling maintenance to give your traders the best opportunities to make money? How can you schedule the correct fuel deliveries if the fuel-budgeting model cannot simulate your day trading decisions including fuel switching decisions? How can you maximize your short-term day trading if the you do not enter into the optimum long-term sale/purchase options (puts/calls) that you can exercise on a short-term basis? Each analysis group should make its decisions by integrating with the decisions of all other groups. RTSim can provide the framework for doing that.

Further, all these coordinated decisions can include risk (uncertainty). Loads can be represented as a statistical distribution. Market price forecasts can be represented as a statisti-



cal distribution. Transmission access can be represented as a statistical distribution. Unit forced outage/derating can be properly represented. Fuel prices can vary with market condition. Most importantly, all these statistical variations can be correlated with each other.