

# REAL OPTIONS SUPER LATTICE SOLVER

## REAL OPTIONS SLS 2011

- American, Asian, Bermudan, Customized, European Options
- Abandonment, Barrier, Chooser, Contraction, Expansion, Wait and Defer, Simultaneous, Sequential Compound, Stage-Gate, Changing Volatility Options, Multiple Asset and Multiple Phased Options, All Types of Financial Options, Exotic Options, Performance-Based and Employee Stock Options (the U.S. Financial Accounting Standards Board uses this software!)
- Over 300+ Exotic and Advanced Options and Options-related Models (Closed-form, American Approximation, State Pricing, Bond Options, Variance Reduction Analytical Methods, Binomial, Trinomial Mean-Reversion, Quadrinomial Jump-Diffusion, Pentanomial Dual Asset Rainbow Compound, Forfeitures, Suboptimal Exercise, Structured Financial Vehicles, Non-marketability Discount, Performance-Based Options, Simulation-Based Option Valuation, and much more!)
- Create an Infinite Combination of Your Own Customizable Options
- Run Thousands of Lattice Steps in Seconds
- Software is in English, Chinese, Spanish, Japanese and Portuguese
- Standalone software with Excel add-in functionality (simulation and optimization compatible)
- Support materials: 8 books, training DVD, live courses, user manual, help file, extensive library of example files, sample business cases, and live project consultants
- Visible equations and functions



## REAL OPTIONS SUPER LATTICE SOFTWARE (SLS)

Move beyond the academic papers and theoretical realm, and start applying real options with this new software. Real Options SLS is a standalone software and spreadsheet accessible add-in for analyzing and valuing real options, financial options, exotic options and employee stock options and incorporating them into custom spreadsheet models. The newly designed customized option modules allow you to create your own à la carte fully customized models, where all the mathematical equations and functions are visible, thus demystifying the approach and results, making them easier to understand and explain.

## SOFTWARE FUNCTIONALITY, ALGORITHMS AND MODELS

- Solves Real Options such as sequential compound options, phased stage-gate options, and multiple asset options, with the combinations of options to abandon, barrier, choose, contract, expand, switch, wait and defer, and any user-specific customizable real options, with the ability to mix and match options (mutually exclusive and nested options)
- Solves Financial Options including mixed multiple assets, benchmark options, warrants, convertibles, structured financial vehicles, combined with American, European, Bermudan and Asian options, and any make-your-own options
- Solves Employee Stock Options with vesting, forfeitures, suboptimal exercise multiples, performance-based shares (external market or internal corporate), and make-your-own custom options
- This is the same software used by the U.S. Financial Accounting Standards Board when creating their FAS 123R in 2004
- You can create your own option models using predefined equations or your own equations, where a 1000-step binomial lattice can be computed in a few seconds (something that if done manually will take hundreds of years on a computer), and also has closed-form model benchmark models from Black-Scholes-Merton to other advanced closed-form American models
- Available in English, Spanish, Japanese, Chinese, Portuguese, and has multiple language detailed User Manuals with sample case studies and step-by-step modeling techniques and solutions as well as 80 detailed example models
- Runs Binomial, Trinomial (mean-reverting options), Quadrinomial (jump-diffusion options), Pentanomial (rainbow compound options) models as well as over 300+ closed-form advanced options models (state-pricing models, analytical methods, volatility computations, variance reduction, American approximation models, options valuation via simulation techniques, all types of bond-options and convertible warrants, changing volatility options, other options-related models and much more!)
- SLS is fully functional in Excel, where you can run Monte Carlo risk simulation on your option models, link to and from other existing Excel models, and apply other advanced analytics like Risk Simulator's Monte Carlo simulation, optimization, stochastic forecasting and VBA macros
- The generated lattices' equations and functions in Excel are fully visible with a live model with links and equations...
- It is a powerful options modeling learning tool
- SLS is a fully customizable modeling tool, with the ability to enter in your own options equations
- Leverage existing static NPV analysis to add financial sophistication including dynamic simulation, real options analysis, and optimization and you can use a framework for identifying, valuing, selecting, and prioritizing the right projects to gain additional insights into strategic value and management flexibility in decision making
- You can correctly evaluate a project's strategic intrinsic value and eliminate the possibility of undervaluing the strategic value of certain projects, identify, frame, and value future strategic opportunities, and incorporate new decisions over time, as opposed to NPV's requirement that all decisions be defined at the outset by analyzing multiple strategic decision pathways, as opposed to NPV's single decision pathway
- The SLS software is a reliable, repeatable, and consistent process for decision making within a user-friendly software with powerful analysis tools to solve problems that cannot be otherwise solved
- 8 books on risk analysis, real options, and options valuation written by the software's creator, a set of Training DVD on real options and risk analysis (simulation, forecasting, optimization, real options, and applied statistics)

## TRIAL AND ACADEMIC VERSIONS

Real Options SLS software can be downloaded immediately from our website with a default 10 day trial license. Our philosophy is you get to try before you buy. Once you use it, we are convinced you will fall in love with the simplicity and the power of the tool, and it will become an indispensable part of your modeling toolbox. We also have academic licenses for full-time professors teaching risk analysis (and their students) or other associated courses using Real Options SLS or our company's other software products. Contact [admin@realoptionsvaluation.com](mailto:admin@realoptionsvaluation.com) for details.

## TRAINING AND CONSULTING

Advanced analytical tools such as the Risk Simulator software are built to be easy to use but may get the analyst in trouble if used inappropriately. Sufficient theoretical understanding coupled with pragmatic application experience is vital; therefore, training is critical.

Our **Risk Analysis** course is a two-day seminar focused on hands-on computer-based software training, with topics covering the basics of risk and uncertainty, using Monte Carlo simulation (pitfalls and due diligence), and all of the detailed methods in forecasting and optimization.

We also have a **Real Options for Analysts** course for the analysts who want to immediately begin applying strategic real options in their work, but lack the hands-on experience with real options analytics and modeling. This two-day course covers how to set up real options models, apply real options, and solve real options problems using simulation, closed-form mathematics, binomial and multinomial lattices using the Real Options SLS software.

The **Certified in Risk Management (CRM)** seminar is a four-day hands-on class that covers the materials on our Risk Analysis and Real Options for Analysts courses and geared towards the CRM certification provided by the International Institute of Professional Education and Research (AACSB member and eligible for 30 PDU credits with the PMI).

Our **Risk Analysis for Senior Managers** is a one day course specially designed for senior executives, where we will review case studies in risk management from 3M, Airbus, Boeing, GE, and many others. It provides an executive overview of risk analysis, strategic real options, portfolio optimization, forecasting and risk concepts without the technical details.

Also available are other customized decision, valuation and risk analysis courses with an emphasis on on-site trainings customized to your firm's exact needs based on your business cases and models). Consulting services are available, including the framing of risk analysis problems, simulation, forecasting, real options, risk analytics, model building, decision analysis, integrated OEM and software customization.

## EXPERTISE

**Dr. Johnathan Mun** is the software's creator and teaches the **Risk Analysis, Real Options for Analysts, Risk Analysis for Managers, CRM**, and other courses. He has consulted for many Fortune 500 firms (from 3M, Airbus, Boeing to GE, Motorola) and the government (Department of Defense, State and Federal Agencies) on risk analysis, valuation, and real options, and has written a number of books on the topic, including *Real Options Analysis: Tools and Techniques, 1st and 2nd Edition* (Wiley Finance, 2005, 2002); *Real Options Analysis Course: Business Cases* (Wiley Finance, 2003); *Applied Risk Analysis: Moving Beyond Uncertainty in Business* (Wiley, 2003); *Valuing Employee Stock Options Under 2004 FAS 123* (Wiley Finance, 2004); *Modeling Risk: Applying Monte Carlo Simulation, Real Options Analysis, Forecasting and Optimization* (Wiley, 2006); *Advanced Analytical Models: 800 Functions and 300 Models from Basel II to Wall Street and Beyond* (Wiley 2008); *The Banker's Handbook on Credit Risk: Implementing Basel II* (Elsevier 2008); and others. He is the founder and CEO of Real Options Valuation, Inc., and is responsible for the development of analytical software products, consulting, and training services. He was formerly Vice President of Analytics at Decisioneering, Inc. (Oracle), and was a Consulting Manager in KPMG's Global Financial Strategies practice. Before KPMG, he was head of financial forecasting for Viking, Inc. (an FDX/FedEx Company). Dr. Mun is also a full professor at the U.S. Naval Postgraduate School and a professor at the University of Applied Sciences and Swiss School of Management (Zurich and Frankfurt), and he has held other adjunct professorships at various universities. He has a Ph.D. in finance and economics, an MBA in business administration, an M.S. in the area of management science, and a BS in applied sciences. He is certified in Financial Risk Management (FRM), Certified in Financial Consulting (CFC), and Certified in Risk Management (CRM).

# Real Options SLS

## General Settings

- Software in English, Spanish, Japanese, Chinese, Portuguese
- Multiple language detailed user manuals with sample case studies and step-by-step modeling techniques and solutions
- 80 detailed example models

## Multinomial Lattice SLS Solver

- Solves Multiple Types of Real Options, Exotic Options, Financial Options, Employee Stock Options
  - fully customizable modeling tool, with the ability to enter in your own options equations
- Trinomial Lattices
  - for solving mean-reverting options and as a comparison tool for binomial lattices
- Quadrinomial Lattices
  - great for solving jump-diffusion options
- Pentanomial Lattices
  - used for solving rainbow compound options

## Exotic Options Calculator

- Solves Multiple Types of Real Options, Exotic Options, Financial Options, Employee Stock Options
- Over 300+ Models and Option Types Solved
  - all types of closed-form models
  - all types of lattice models
- Advanced Analytical Models
  - all types of volatility computations
  - state-pricing models, analytical methods, variance reduction, American approximation models, options valuation via simulation techniques, and much more!
- Options-related Models
  - all types of bond-options and convertible warrants and other options-related models

## Excel Functions

- Fully Functional in Excel
  - use SLS functions exactly the same way you would regular Excel functions
- Fully Compatible with Risk Simulator
  - you can run Monte Carlo risk simulation on your option models
  - you can link to and from other existing Excel models
  - other advanced analytics like optimization, stochastic forecasting and VBA macros are all compatible
- Changing Volatility Models with Nonrecombining Lattices

## Lattice Maker for Excel

- Works with Excel
  - lattices will be created inside Excel worksheets
- Fully Compatible with Risk Simulator
  - you can run Monte Carlo risk simulation on your option models
  - you can link to and from other existing Excel models
  - other advanced analytics like optimization, stochastic forecasting and VBA macros are all compatible
- Fully Visible Equations!
  - the generated lattices will be a live model with links and equations inside Excel that are completely visible... great as a learning tool on options modeling

## Single Asset and Single Phase SLS

Solves Multiple Types of Real Options, Exotic Options, Financial Options, and Employee Stock Options

real options such as options to abandon, barrier, choose, contract, expand, switch, wait and defer, and any user-specific customizable real options, with the ability to mix and match options (mutually exclusive and nested options)

financial options include all types of warrants, convertibles, and structured financial vehicles for American, European, Bermudan and Asian options, as well as any make-your-own options

employee stock options such as with vesting, forfeitures, suboptimal exercise multiples, performance-based shares (external market and internal corporate), and make-your-own custom options

you can create your own option models using predefined equations or your own equations!

runs binomial lattices

Completely Customizable Modeling

a 1000-step binomial lattice can be computed in a few seconds (something that if done manually will take hundreds of years on a computer!)

capable of running multiple thousands of lattice steps very quickly

Super Speed Computations and Algorithms

models from Black-Scholes-Merton to other advanced closed-form American models are all available

Closed-form Model Benchmarks

your customized options' binomial lattices are now available to be viewed in an Excel worksheet

Audit Sheet Lattices

used in the FAS 123R released in 2004 by FASB!

Used by the U.S. Financial Accounting Standards Board!

## Multiple Asset and Multiple Phase SLS

Solves Multiple Types of Real Options, Exotic Options, Financial Options, Employee Stock Options

real options such as sequential compound options, phased stage-gate options, and multiple asset options, with the combinations of options to abandon, barrier, choose, contract, expand, switch, wait and defer, and any user-specific customizable real options, with the ability to mix and match options (mutually exclusive and nested options)

financial options include all types of mixed multiple-asset and benchmark options, warrants, convertibles, and structured financial vehicles for American, European, Bermudan and Asian options, as well as any make-your-own options

capable of solving countless types of options and is fully customizable, and works with the single asset SLS and multinomial lattice SLS solvers

Runs Customizable Binomial Lattices with Closed-Form Model Benchmarks

**Pentanomial - Spread of Two Assets American Put (3D Binomial) - Multinomial Lattice Solver**

File Help

Comment: Pentanomial - Spread of Two Assets American Put Option (3D Binomial Equivalence)

Lattice Type:  Binomial  Trinomial  Trinomial Mean-Reverting  Quadranomial Jump-Diffusion  Pentanomial Rainbow Two Asset

Basic Inputs:

PV Underlying Asset (\$) 100 Dividend Rate (%)

PV Underlying Asset 2 (\$) 98 Long-Term Rate (\$)

Implementation Cost (\$) 103.15 Reversion Rate (%)

Volatility (%) 25 Market Price of Risk (λ)

Risk-Free Rate (%)

Maturity (Years)

Lattice Steps

Blackout Steps and Vesting Period (For Custom & Bermudan Option)

Example: 1, 2, 10-2

Terminal Node Eqn (Options at Expiration)

Max(Asset, Asset\*Expansion-ExpandCost, Asset\*Contraction-ContractSavings, Salvage)

Example: Max(Asset-Cost, 0)

Intermediate Node Eqn

Max(Asset, Asset\*Expansion-ExpandCost, Asset\*Contraction-ContractSavings, Salvage)

Example: OptionOpen

**Expand Contract Abandon Customized Option II - Single Asset Super Lattice Solver**

File Help

Comment: Customized Expansion, Contraction, and Abandonment Options with changing salvage values.

Option Type:  American  European  Bermudan  Custom

Basic Inputs:

PV Underlying Asset (\$) 100 Risk-Free Rate (%) 5

Implementation Cost (\$) 100 Dividend Rate (%) 0

Maturity (Years) 5 Volatility (%) 15

Lattice Steps 100 \* All inputs are annualized rates

Blackout Steps and Vesting Period (For Custom & Bermudan Option)

Example: 1, 2, 10-20, 35

Terminal Node Equation (Options at Expiration)

Max(Asset, Asset\*Expansion-ExpandCost, Asset\*Contraction-ContractSavings, Salvage)

Example: Max(Asset-Cost, 0)

Intermediate Node Eqn

Max(Asset, Asset\*Expansion-ExpandCost, Asset\*Contraction-ContractSavings, Salvage)

Example: OptionOpen

Custom Variables:

Variable Name	Value	Starting Step
Expansion	1.3	0
ExpandCost	25	0
Contraction	0.9	0
ContractSav...	25	0
Salvage	100	0
Salvage	101	11
Salvage	102	21
Salvage	103	31
Salvage	104	41

Benchmark:

	Call	Put
Black-Scholes	26.00	3.88
Closed-Form American	26.00	6.41
Binomial American	26.00	3.88
Binomial European	26.00	6.44

**Super Lattice Solver**

The Single Asset Option Model is used primarily for solving options with a single underlying asset within a single phase using binomial lattices. Even highly complex options with a single underlying asset can be solved. The typical types of options solved using this approach include American, Bermudan, and European options to abandon, choose, contract, defer, execute, expand, wait, with barriers, as well as any customized combinations of these options with changing inputs.

1. License Real Options SLS  
2. License Functions & Options Valuator

Language: Default

Exit

**MSLS Multiple-Phased Complex Sequential Compound Option - Multiple Asset Super Lattice Solver**

File Help

Maturity: 5

Comment: Multiple-Phased Complex Sequential Compound Option

Underlying Assets:

Name	PV Asset	Volat
Underlying	100	

Option Valuations:

Name	Cost	Risk Free...	Dividend...	Ste
Phase3	50	5	0	
Phase2	0	5	0	
Phase1	0	5	0	

Blackout and Vesting Period Steps: 0-20

Basic Option:

PV Asset (\$) 100  Implementation Cost (\$)

Volatility (%) 25

Risk-free (%) 2  Expansion Factor (.) 1.25

Dividend (%) 0  Expansion Cost (\$) 25

Maturity (Years) 2  Contraction Factor (.) 0.9

Lattice Steps 2  Contraction Savings (\$) 100

Abandonment Salvage (\$) 105

American Option  European Option  Show Formulae

Compute

Create Audit Sheet Run

**ROV Options Valuator - (C:\Program Files\Real Options Valuation\Real Options SLS\ModuleDefaultVa...**

File Languages

Model Category:  All Citigroups

Basic Options Models

Bond Related Options, Pricing and Yields

Delta Gamma Hedging

Exotic Options and Derivatives

Put-Call Parity and Option Sensitivity

Real Options Analysis

Value at Risk, Volatility, Portfolio Risk and Returns

Search

Model Selection:

Two Asset Cash or Nothing Call

Two Asset Cash or Nothing Down Up

Two Asset Cash or Nothing Put

Two Asset Cash or Nothing Up Down

Two Asset Correlation Call

Two Asset Correlation Put

Value at Risk (Correlation Method)

Volatility Implied for Default Risk

Model Description:

Computes the Value at Risk of a portfolio of correlated options

Single Input Parameters:

Horizon Days 10.00 Percentile 0.90 Input3

Input4 Input5 Input6

Input7 Input8 Input9

Input10 Input11 Input12

Input13

Multiple Series Input Parameters (Values are SPACE separated. Rows are SEMICOLON separated):

Asset Prices Quantities Deltas Load Sample Values

102.5; 106.3; 119.2; 12; 13; 13; 13; Result: 3303.028968

**Customized Real Options Results**

$=MAX(B12 - ImplementationCost, (UpProb * C24 + DownProb * C26) * Discount)$

Assumptions	Value	Intermediate Computations	Value
PV Asset Value (\$)	\$100.00	Stepping Time (dt)	0.1000
Volatility (%)	25.00%	Up Step Size (up)	1.0823
Risk-free Rate (%)	5.00%	Down Step Size (down)	0.9240
Dividends (%)	0.00%	Up Probability	0.5119
Maturity (Years)	1.00%	Down Probability	0.4881
Lattice Steps	10	Discount Factor	0.9950
Option Type	American	Implementation Cost (\$)	\$100.00

Underlying Asset Lattice:

	100.00	108.23	117.13	126.77	137.19	148.48	160.70	173.92	188.22	203.71	220.47
		92.40	100.00	108.23	117.13	126.77	137.19	148.48	160.70	173.92	188.22
			85.38	92.40	100.00	108.23	117.13	126.77	137.19	148.48	160.70
				78.89	85.38	92.40	100.00	108.23	117.13	126.77	137.19
					72.89	78.89	85.38	92.40	100.00	108.23	117.13
						67.35	72.89	78.89	85.38	92.40	100.00
							62.23	67.35	72.89	78.89	85.38
								57.50	62.23	67.35	72.89
									53.13	57.50	62.23
										49.09	53.13
											45.36

Option Valuation Lattice:

	12.09	16.98	23.27	31.06	40.34	50.95	62.68	75.40	89.22	104.21	120.47
Continue		Continue	Execute								
		7.09	10.55	15.33	21.65	29.63	39.17	49.97	61.69	74.41	88.22
			Continue	Execute							
				Continue	Execute						
					Continue	Continue	Continue	Continue	Continue	Continue	Execute
						Continue	Continue	Continue	Continue	Continue	Execute
							Continue	Continue	Continue	Continue	Execute
								Continue	Continue	Continue	Execute
									Continue	Continue	Execute
										Continue	Execute
											Execute

**Plain Vanilla Call Option I - Single Asset Super Lattice Solver**

File Help

Options SLS | Payoff Chart | Sensitivity | Scenario | Convergence

The option value sensitivity chart shows the different option results based on the different values of the input variable selected.

Select Input Variable: PV Underlying Asset Min: Step Size: Max: Lattice Steps: 100

Option Type: American

Option Value Sensitivity and Payoff

Option Value vs Input Variable

Chart Type: Line

**Plain Vanilla Call Option I - Single Asset Super Lattice Solver**

File Help

Options SLS | Payoff Chart | Sensitivity | Scenario | Convergence

This analysis runs a quick static sensitivity of each input variable of the model one at a time and lists the input variables with the highest impact to the lowest. For sensitivity of lattice steps, please use the Convergence analysis.

Option Type: American

Lattice Steps: 100

Show Decimals: 2

Sensitivity +/-: 10.00%

Update

Tornado Chart

Inputs: Output Downside Output Upside Effective Range Input Downside Input Upside

Inputs	Output Downside	Output Upside	Effective Range	Input Downside	Input Upside
PV Underlyin	15.02	32.66	17.64	90.00	110
Implementat...	30.35	17.29	13.06	90.00	110
Maturity	21.53	25.23	3.70	4.50	5.50
Risk-Free Rate	21.76	25.04	3.28	0.05	0.06
Volatility	23.01	23.84	0.83	0.09	0.11
Dividend Rate	23.40	23.40	0.00	0.00	0.00

**Plain Vanilla Call Option I - Single Asset Super Lattice Solver**

File Help

Options SLS | Payoff Chart | Sensitivity | Scenario | Convergence

The following table returns the option results based on different lattice steps.

Column Variable (Across): PV Underlying Asset

Row Variable (Down): Implementation Cost

Min: Max: Step Size:

	10.00	20.00	30.00	40.00	50.00
10.00	2.34	12.21	22.21	32.21	42.21
20.00	0.02	4.68	14.43	24.42	34.42
30.00	0.00	0.68	7.02	16.65	26.64
40.00	0.00	0.05	2.17	9.36	18.90
50.00	0.00	0.00	0.44	4.04	11.70
60.00	0.00	0.00	0.07	1.36	6.11
70.00	0.00	0.00	0.01	0.38	2.71
80.00	0.00	0.00	0.00	0.09	1.04
90.00	0.00	0.00	0.00	0.02	0.35
100.00	0.00	0.00	0.00	0.00	0.11
110.00	0.00	0.00	0.00	0.00	0.03

**Plain Vanilla Call Option I - Single Asset Super Lattice Solver**

File Help

Options SLS | Payoff Chart | Sensitivity | Scenario | Convergence

The higher the number of lattice steps, the higher the level of precision of the option result (the result remains the same for additional decimal precision). At some point, the lattice result converges. This convergence test will run between 5 and 5000 steps to test for the convergence level. Once there is convergence, further lattice steps are not required.

Lattice Step Convergence

Option Type: American

Steps Value Steps Value Steps Value

Steps	Value	Steps	Value	Steps	Value
5	23.32	300	23.41	2000	23.42
10	23.19	400	23.42	3000	23.42
100	23.40	500	23.42	4000	23.42
200	23.41	1000	23.42	5000	23.42