

Utmost IV SPICE Optimization Module

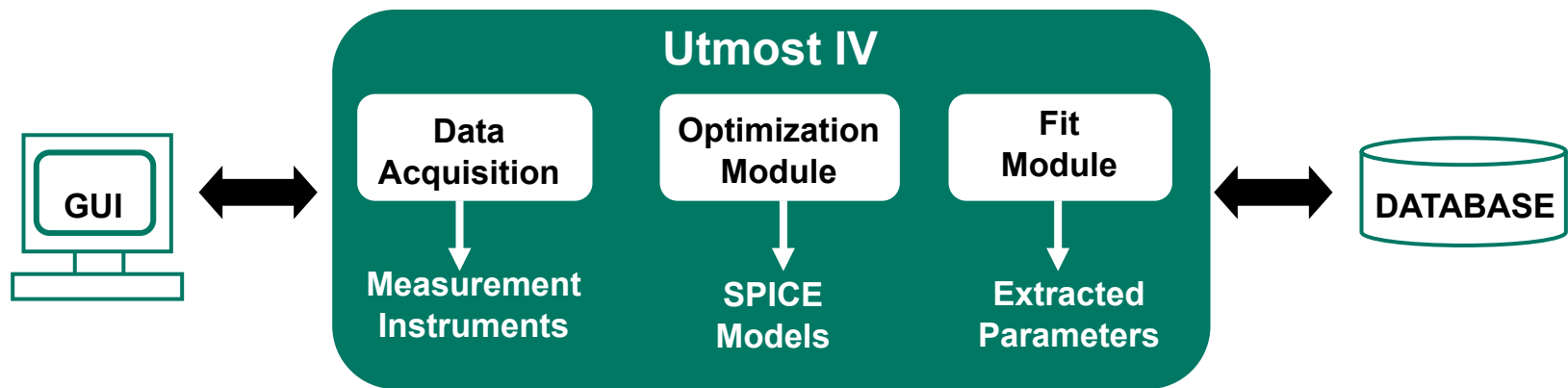


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Utmost IV Architecture



- Utmost IV is a ‘database’ based product unlike Utmost III and competitors which are file based



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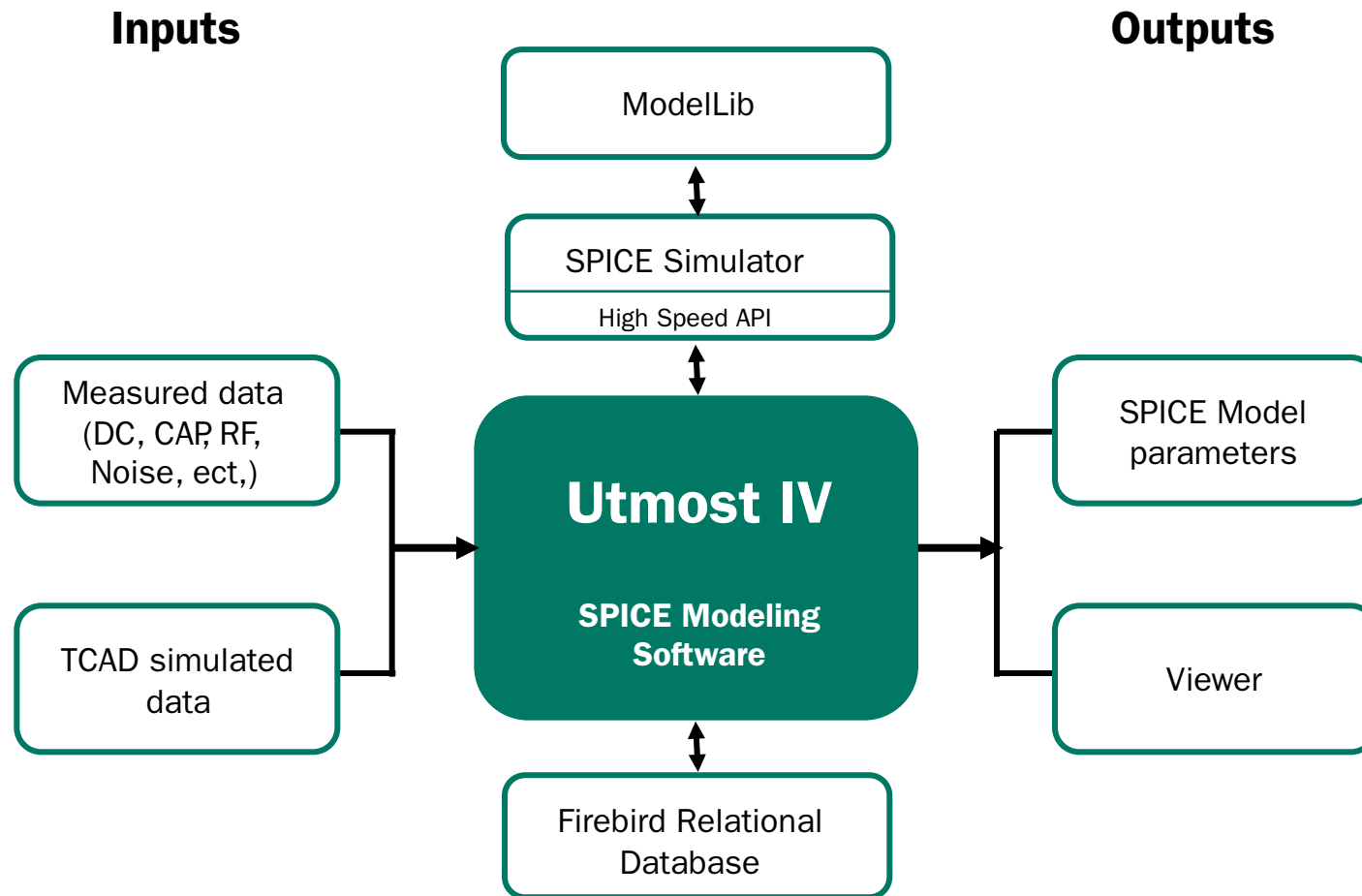
Optimization Module Overview



- Unlimited Multi-target Optimization
- Full Macro-model Support
- Family of Advanced Optimizers
- High-speed SmartSpice Interface
- Technology Independent
- Flexible Data Format
- Underlying 64-bit Relational Database

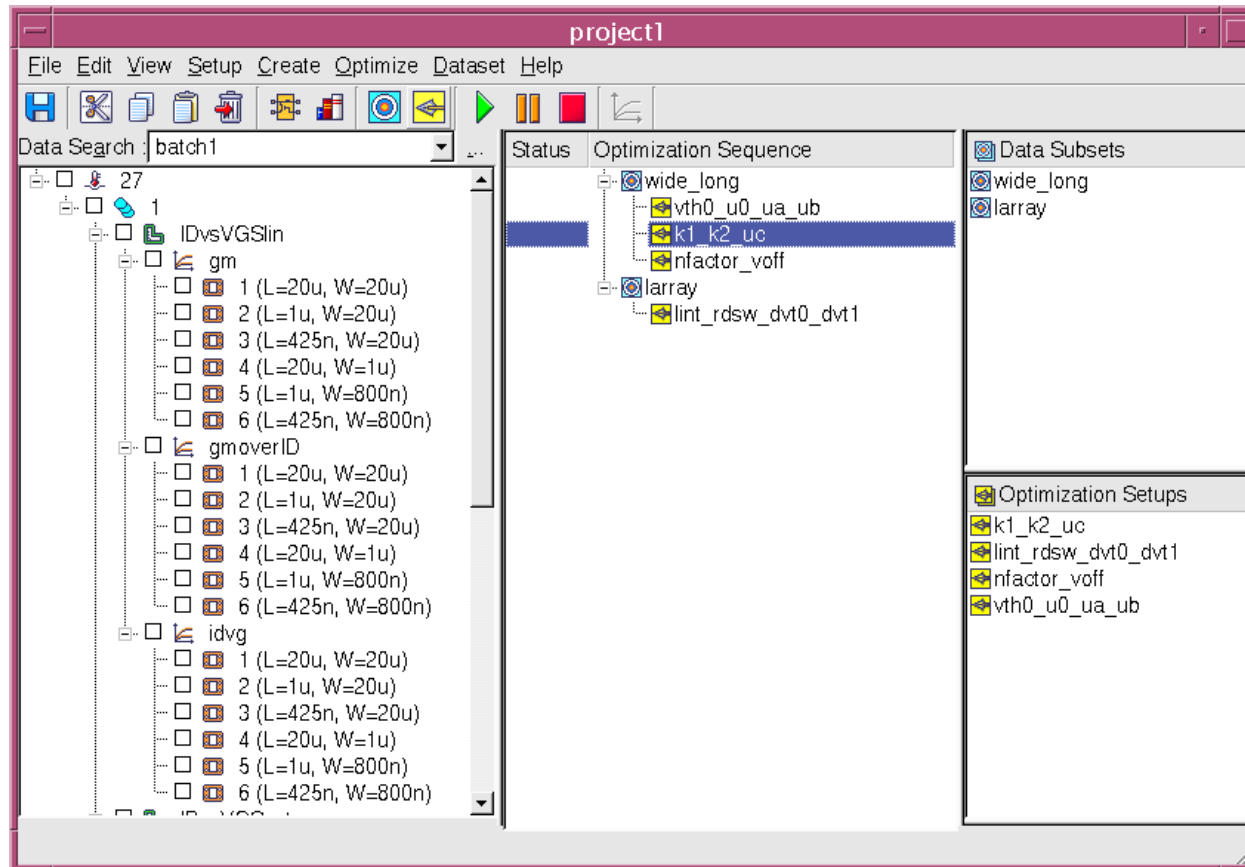
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Utmost IV Optimization Module Architecture



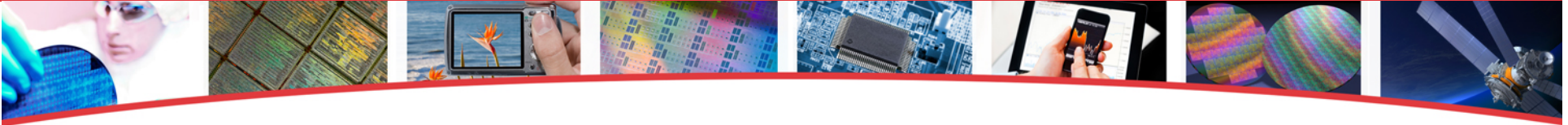
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Utmost IV is Project Organized

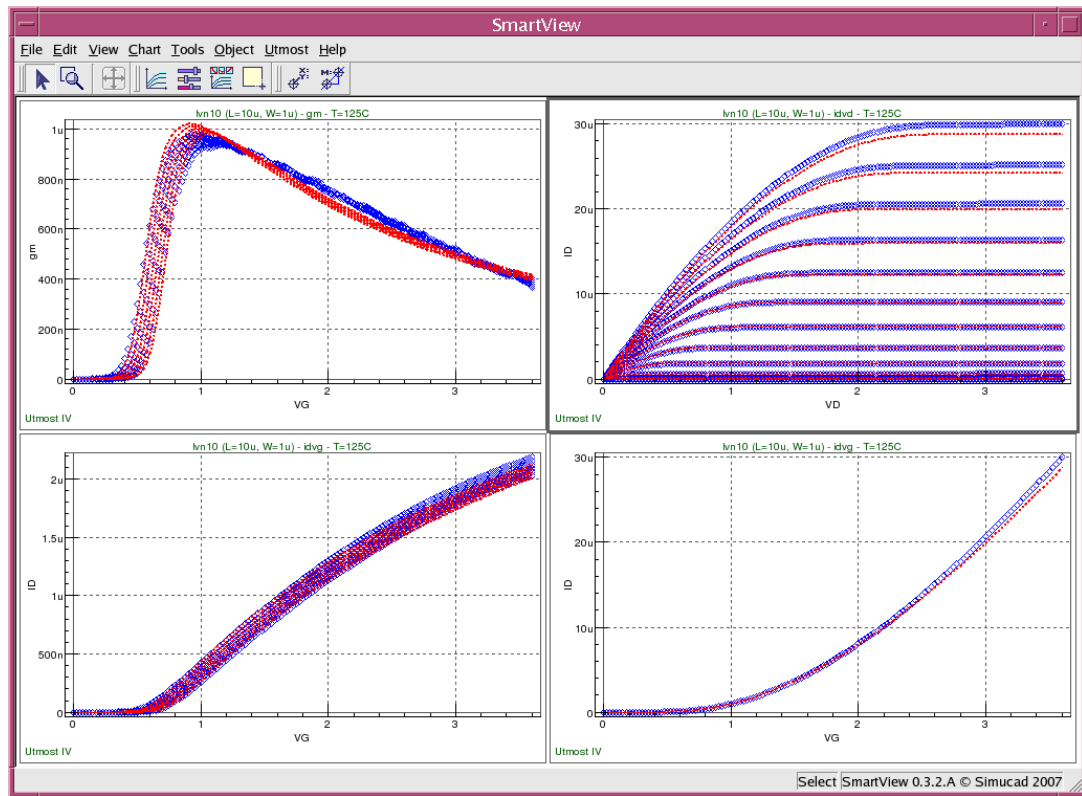


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Multi-Target Optimization



- Any combination of data can be used as the target for an optimization

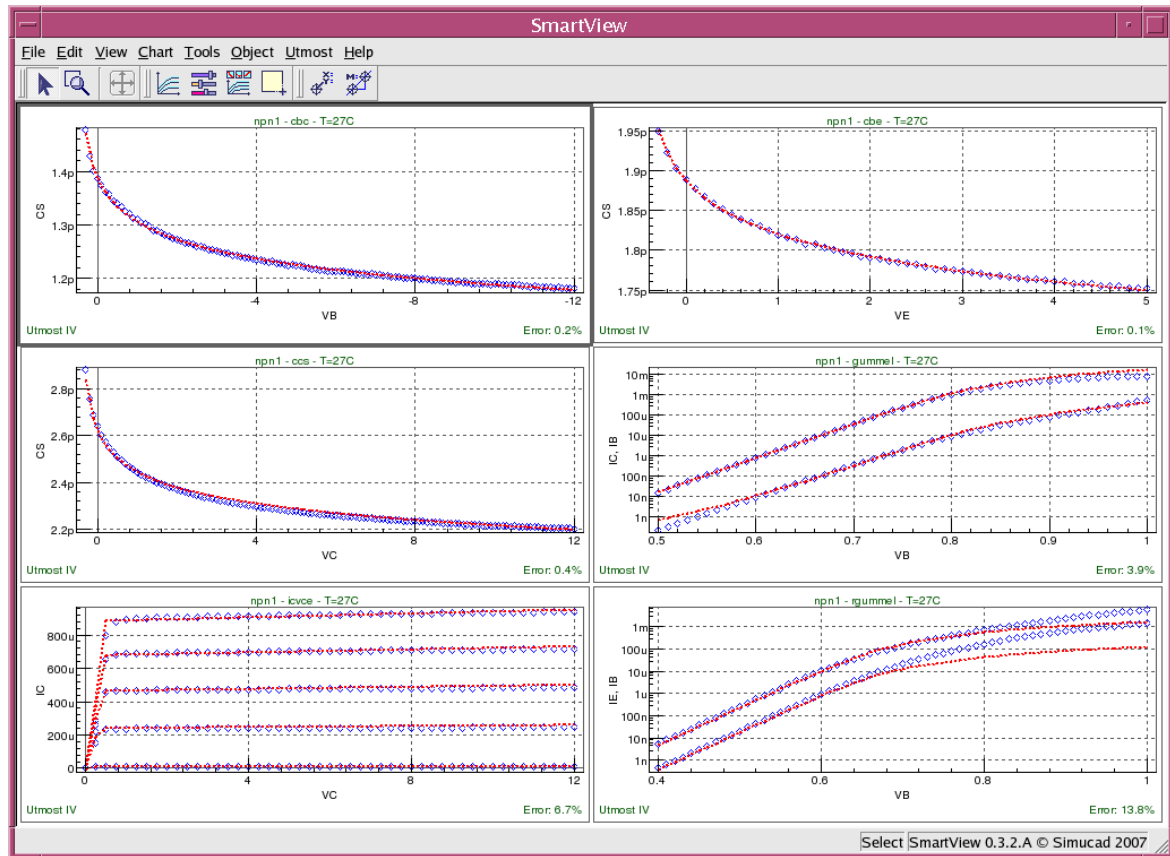


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Multi-Target Optimization 2



- Multiple temperatures, mix dc and ac, multiple batch or wafers



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Family of Advanced Optimization Algorithms



- Local (traditional) optimizers are fast, but need good starting point
 - Levenberg Marquartz
 - Hooke-Jeeves
- Global (next generation) optimizers run more iterations, but require less conditioning
 - Genetic Algorithm
 - Simulated Annealing
 - Parallel Tempering
 - Differential Evolution

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Easy to Select and Configure Optimizer



Preferences

Manage Preferences
Application
Shortcuts
Toolbars
Preferences
Numbering
Database
Error Calculation
Tools
Waveform Viewer
Simulator
Optimizer

Optimizer

Optimizer : Simulated Annealing

Configuration :

Parameter	Value
Number of sweeps per stepsize	2
Number of stepsizes per temperature	5
Maximum function evaluations	100000
Cooling factor	850m
Initial temperature factor	500m
Minimum temperature	10u
Initial stepsize fraction	250m

Save these settings on exit

OK Cancel Apply

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Rubberband Optimization



- No limit to number of parameters

Parameter Optimization

Model : nmos Optimized Parameters : Iteration : 207 Error = 4.0%

Model/Parameter	Value	Minimum	Maximum
nmos/TOX	7.3043n	5n	50n
nmos/VTH0	444.98m	-2	2
nmos/K1	639.28m	0	1
nmos/K2	-21.136u	-19	14.901n
nmos/K3	100	1m	100
nmos/U0	40.697m	10m	100m
nmos/UA	100p	100p	10n
nmos/UB	8.9745e-19	1e-21	5a
nmos/UC	45.958p	-100p	10n

Revert Optimize OK Cancel Apply

Rubberband Optimization 2



- Parameters for multiple models may be optimized at the same time

Parameter Optimization

Model : **pmos** Optimized Parameters : Error : 9.6%

Model/Parameter	Value	Minimum	Maximum
PARAMS/Rs	2.7855k	1	10k
PARAMS/Cs	1f	1f	100p
PARAMS/Ls	242.19p	1f	1n
pmos/VTH0	-1.1393	-2	2
pmos/K1	500m	0	1
pmos/K2	-18.6m	-50m	0

Parameter list: LEVEL, VERSION, TNOM, TOX, XJ, NCH, **VTH0**, K1, K2

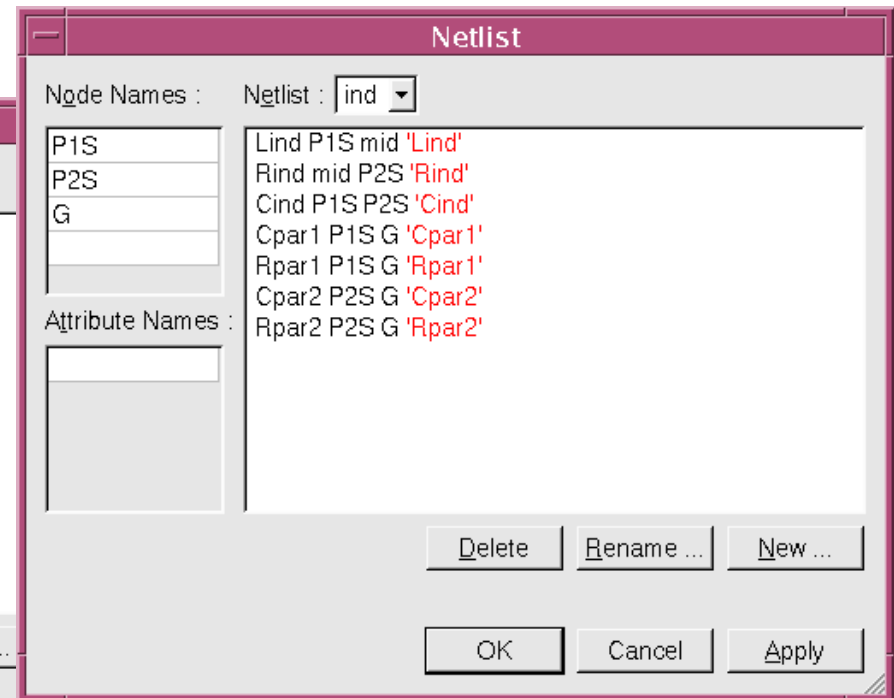
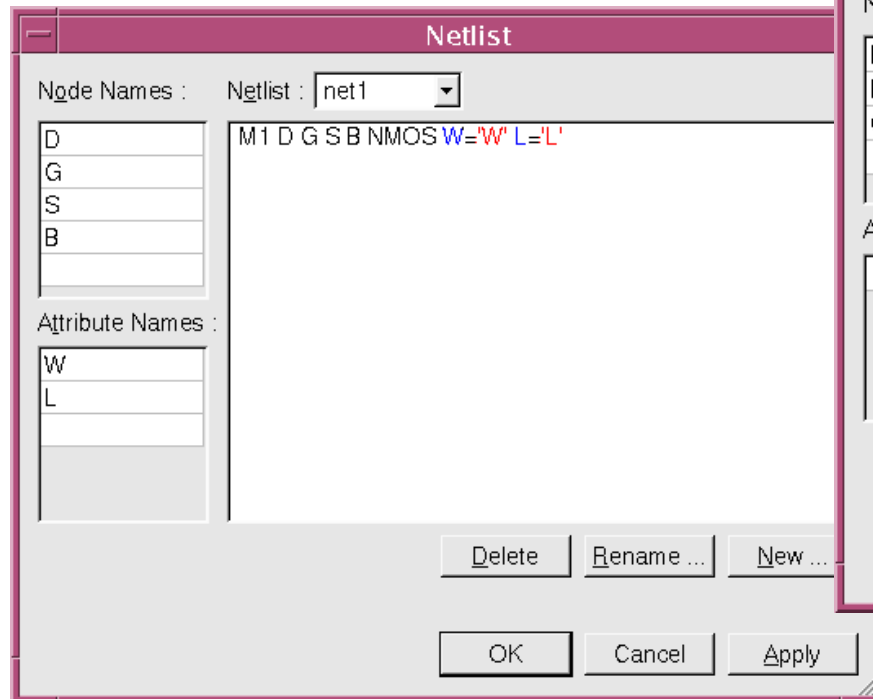
Buttons: Revert, Optimize, OK, Cancel, Apply

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Macro-Model Optimization



- Netlist of any complexity can be defined for macro-model
- All macro-model parameters available for simultaneous optimization and rubberbanding



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High Speed SmartSpice Interface



- Simulation is provided using the full power and flexibility of SmartSpice
- Very fast simulation times provided by high speed API interface
 - 80 dc simulations per second on AMD Athlon64 X2 4800
- No significant loss in speed when using macro-model instead of compact model
- Optimization time for typical LDMOS macro-model
 - Utmost III approx. 1.5 - 2.0 hours
 - Utmost IV approx. 2-3 minutes

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ModelLib Saves the Day



- Utmost IV no longer contains the models
- Model information provided by ModelLib in SmartSpice
- No difference between SPICE simulator and model extractor is possible
- Any new SPICE models in SmartSpice are also instantly available to Utmost IV
- Web-based and web-delivered model updates

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Store all your Models in the Model Library



- No limit to number or type of models
- Versatile import and export

Model Library : project1

Model Parameter Simulation

Model Name : Type : NMOS 0 marked. Find : Go

	Mark	Name	Optimized	Fit Initial	User Initial	Minimum	Maximum
1	<input checked="" type="checkbox"/>	LEVEL	8	8	8		
2	<input type="checkbox"/>	VERSION	3.3	3.3	3.3	3	3.3
3	<input type="checkbox"/>	TNOM	27	27	27	-100	300
4	<input type="checkbox"/>	TOX	14n	14n	14n	5n	50n
5	<input type="checkbox"/>	XJ	150n	150n	150n	100n	1u
6	<input type="checkbox"/>	NCH	1.7e+17	1.7e+17	1.7e+17	5e+16	5e+17
7	<input type="checkbox"/>	NSUB				5e+15	3e+17
8	<input type="checkbox"/>	VTH0	700m	700m	700m	-2	2
9	<input type="checkbox"/>	K1	500m	500m	500m	0	1
10	<input type="checkbox"/>	K2	-18.6m	-18.6m	-18.6m	-50m	0
11	<input type="checkbox"/>	K3	80	80	80	1m	100
12	<input type="checkbox"/>	K3B	0	0	0	-10	10
13	<input type="checkbox"/>	W0	2.5u	2.5u	2.5u	1u	10u
14	<input type="checkbox"/>	NLX	174n	174n	174n	10n	1u
15	<input type="checkbox"/>	DVT0W	0	0	0	-500m	500m
16	<input type="checkbox"/>	DVT1W	0	0	0	0	10M
17	<input type="checkbox"/>	DVT2W	32m	32m	32m	500m	500m

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Model Customization and Development Environment



- Use equations to specify model parameters
- Develop scalable custom macro models
- Using SmartSpice model development environment your own SPICE models
- Instantly add new model, new parameters, verify in Utmost IV and develop model extraction sequence in parallel

Model Library : bjt1

Model Parameter Simulation

Model Name : npn Type : NPN 9 marked. Find : Go

	Mark	Name	Optimized	Fit Initial	User Initial	Minimum	Maximum
1	<input type="checkbox"/>	LEVEL	1	1	1		
2	<input type="checkbox"/>	IS	$IS_AREA * area + IS_PERIM * perim$				
3	<input type="checkbox"/>	BF	128.95	100	100	10	500
4	<input checked="" type="checkbox"/>	NF	1	1	1	950m	1.05
5	<input type="checkbox"/>	BR	100m	3	3	10m	20
6	<input type="checkbox"/>	NR	1	1	1	950m	1.05
7	<input type="checkbox"/>	ISE	8.6678f	400a	400a	1a	100p
8	<input type="checkbox"/>	NE	1.748	1.5	1.5	1	2
9	<input type="checkbox"/>	ISC	1a	200a	200a	1a	100p
10	<input type="checkbox"/>	NC	1.5838	2	2	1	2
11	<input type="checkbox"/>	VAF	153.88	100	100	25	200
12	<input type="checkbox"/>	VAR	34.334	20	20	1	50
13	<input type="checkbox"/>	IKF	3.9484m	10m	10m	100u	1
14	<input type="checkbox"/>	IKR	586.02m	10m	10m	100u	1

New Model Parameter

Name :

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Technology Independent



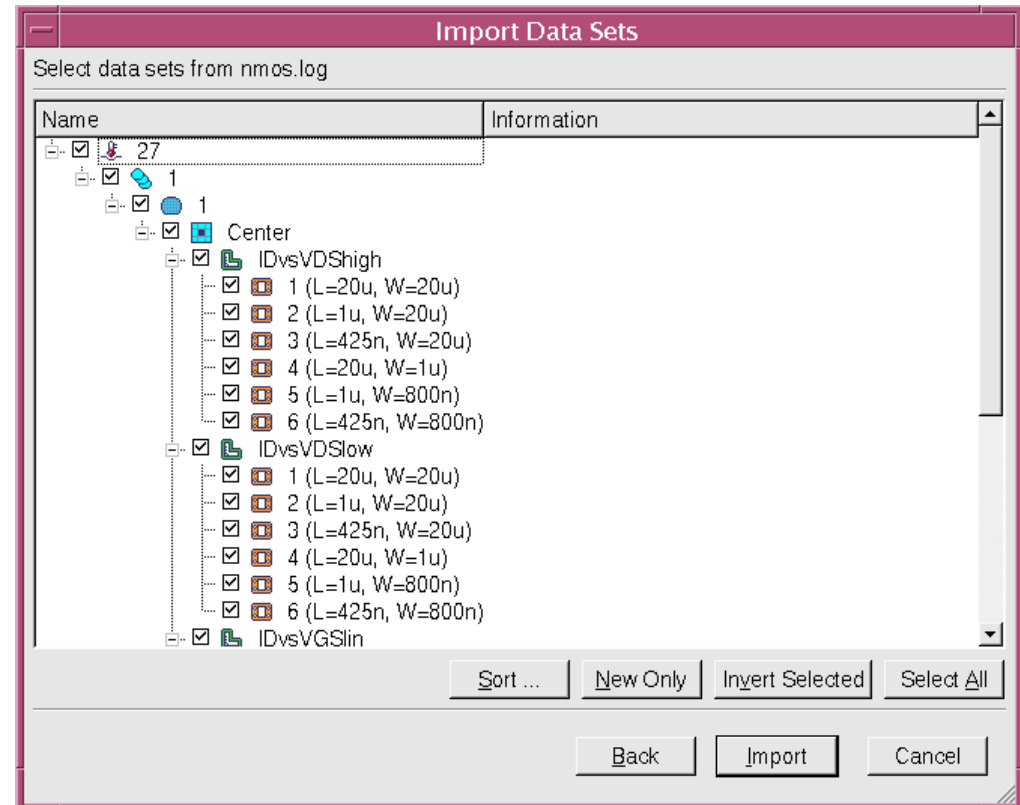
- No more BIP, MOS, SOI, SPICE model modules to buy like in Utmost III and competitors' software
- No limit to number of name of device nodes
- Supports all types of semiconductor devices
- All spice model types available through SmartSpice

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Flexible Data Format



- Dataset import for legacy Utmost III logfiles
- Flexible dataset import using Utmost IV datafiles
- No longer any requirement for data to have equally spaced points
- Sweeps can be linear or logarithmic, or simply a list of values

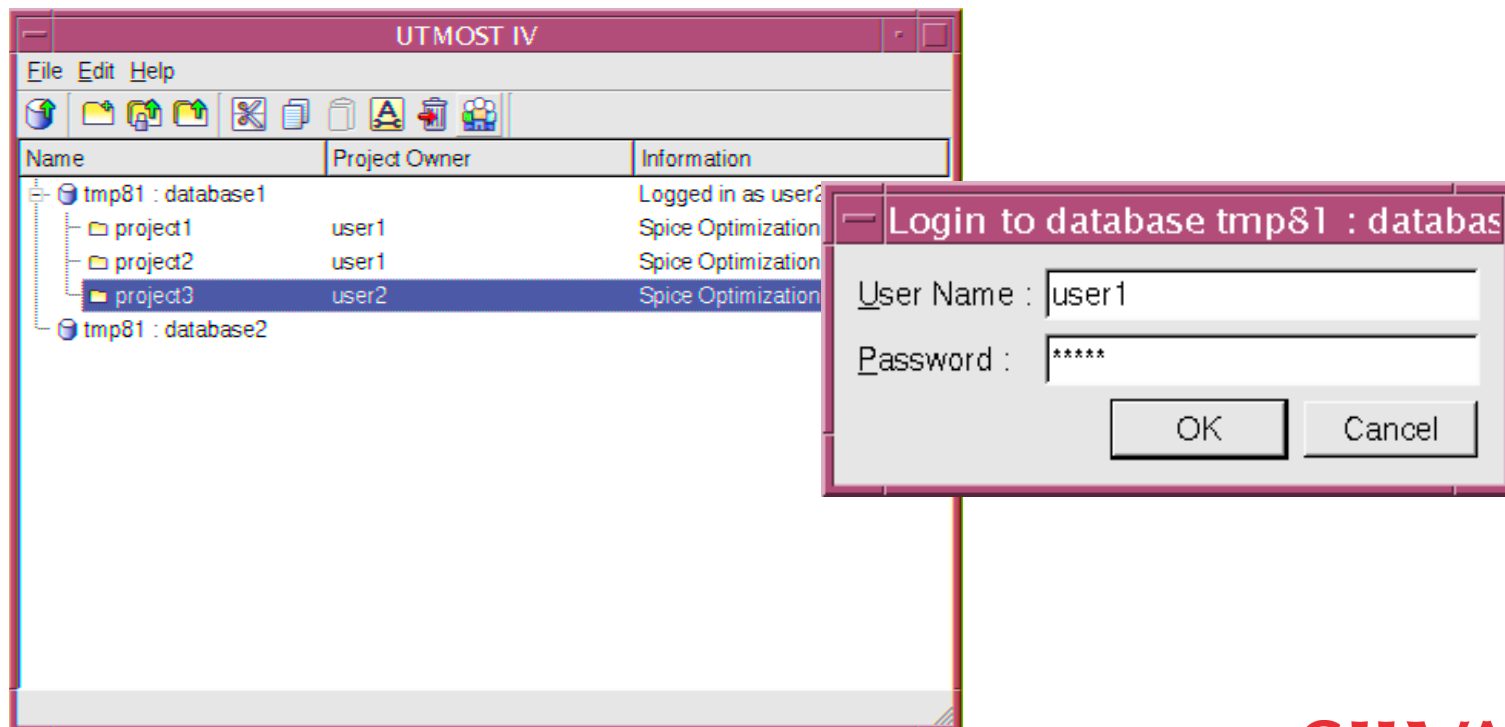


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64-bit Relational Database



- Multi-user, multi-access Firebird 64bit relational database organises your work
- Data sharing, storage and retrieval



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Search Editor



- Database search allows you to retrieve and share information

Search Editor

Name :

Search Parameter : Name : Comparison : Value :

Expression	AND/OR
Temperature = "27"	AND
Measurement Setup = "*lin"	AND
Attribute "W" = "20u"	AND
Attribute "L" = "20u"	

Case Sensitive () Replace Delete Insert

OK Cancel Apply

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Database Permissions



- Full access control for data security

New project for database1

Project Name: project1

Project Type: Spice Optimization

Name	Read	Modify	Information
Owner	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Owner is user1
All	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Groups			
group1	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Users			
user1	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
user2	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
user3	<input checked="" type="checkbox"/>	<input type="checkbox"/>	

OK Cancel

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Conclusion



- Utmost IV Optimization Module provides an easy to use, database-driven environment for the generation of accurate, high quality SPICE models and macro-models for analog, mixed-signal and RF applications
- Utmost IV provides model extraction solution for problems that were not possible to solve with Utmost III and competitors' software
 - Deep sub-micron CMOS with the new generation of SPICE models (HiSIM, PSP, Dual Gate, BSIM, etc.)
 - Complex power MOS/Bipolar macro-models
 - Passive and active RF macro-model (varactor, inductor, etc.) s-parameter optimization
- Utmost IV allows parallel development of device models for SPICE applications and model extraction strategies

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