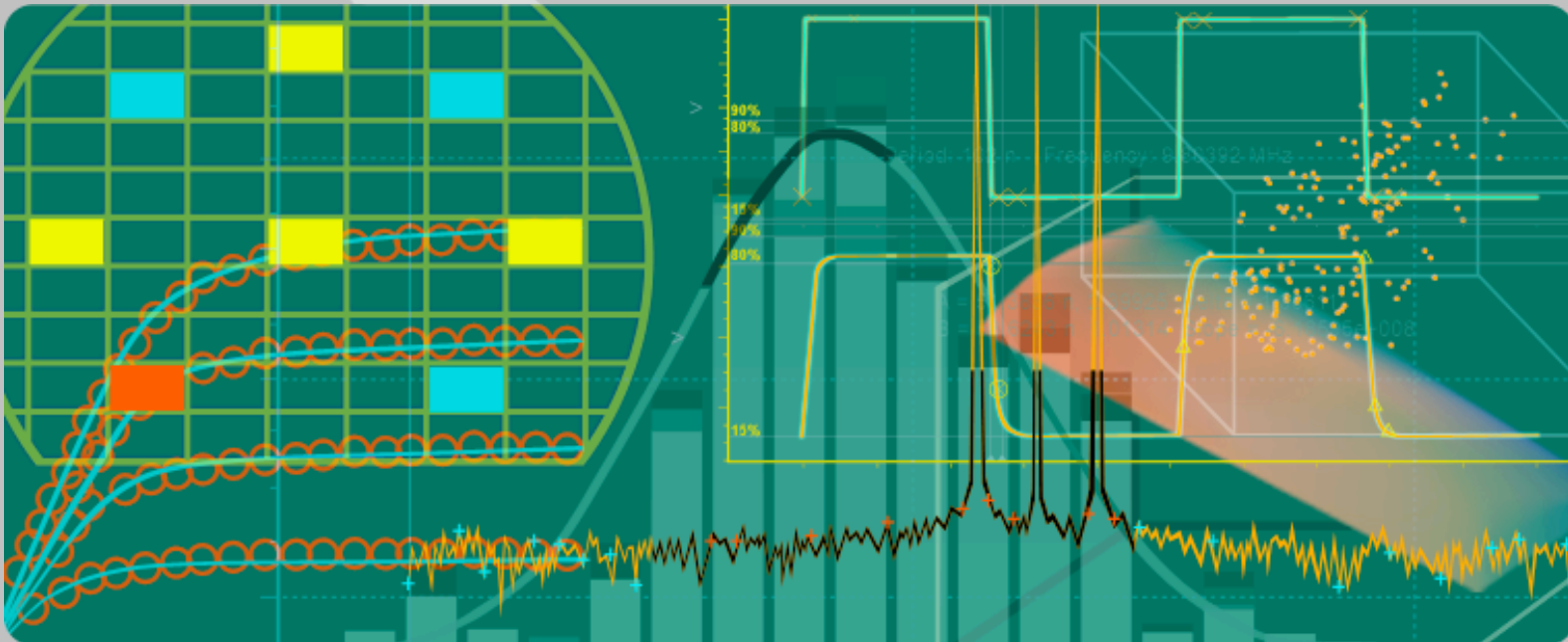


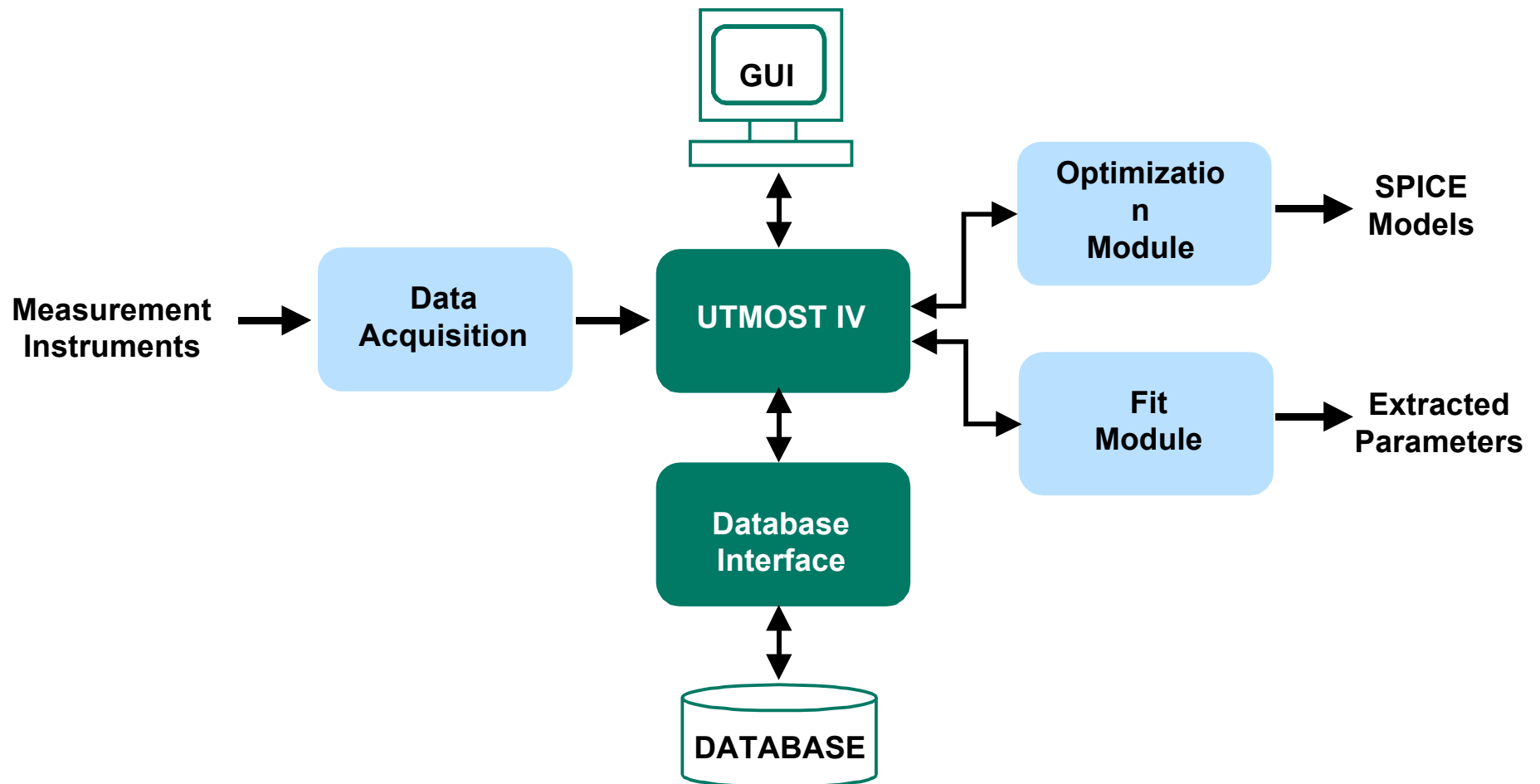
UTMOST IV SPICE Optimization Module



**Silvaco Japan Technology Seminar
Spring 2007**

UTMOST IV Architecture

- UTMOST IV is a 'database' based product unlike UTMOST III and competitors which are file based

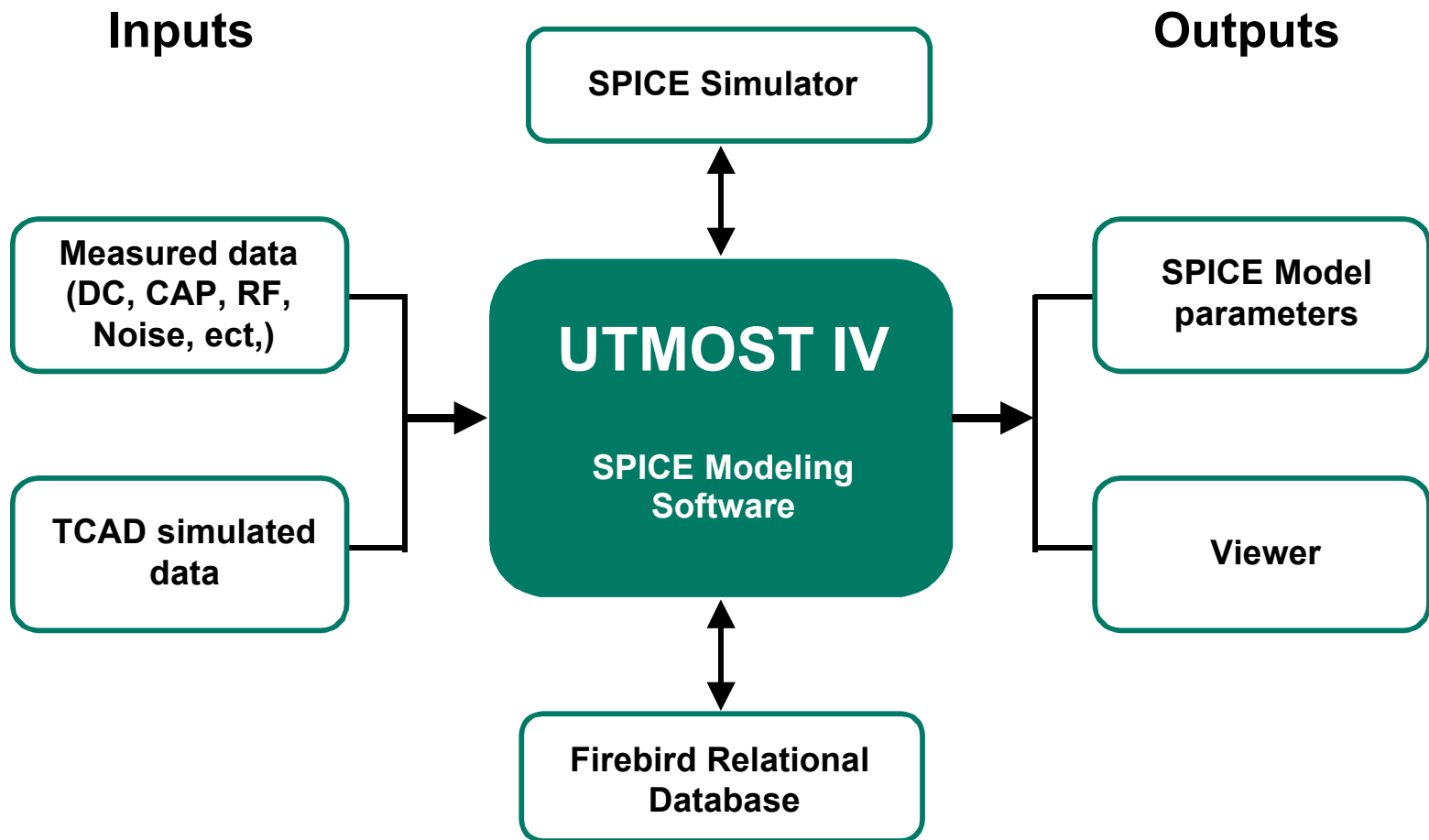




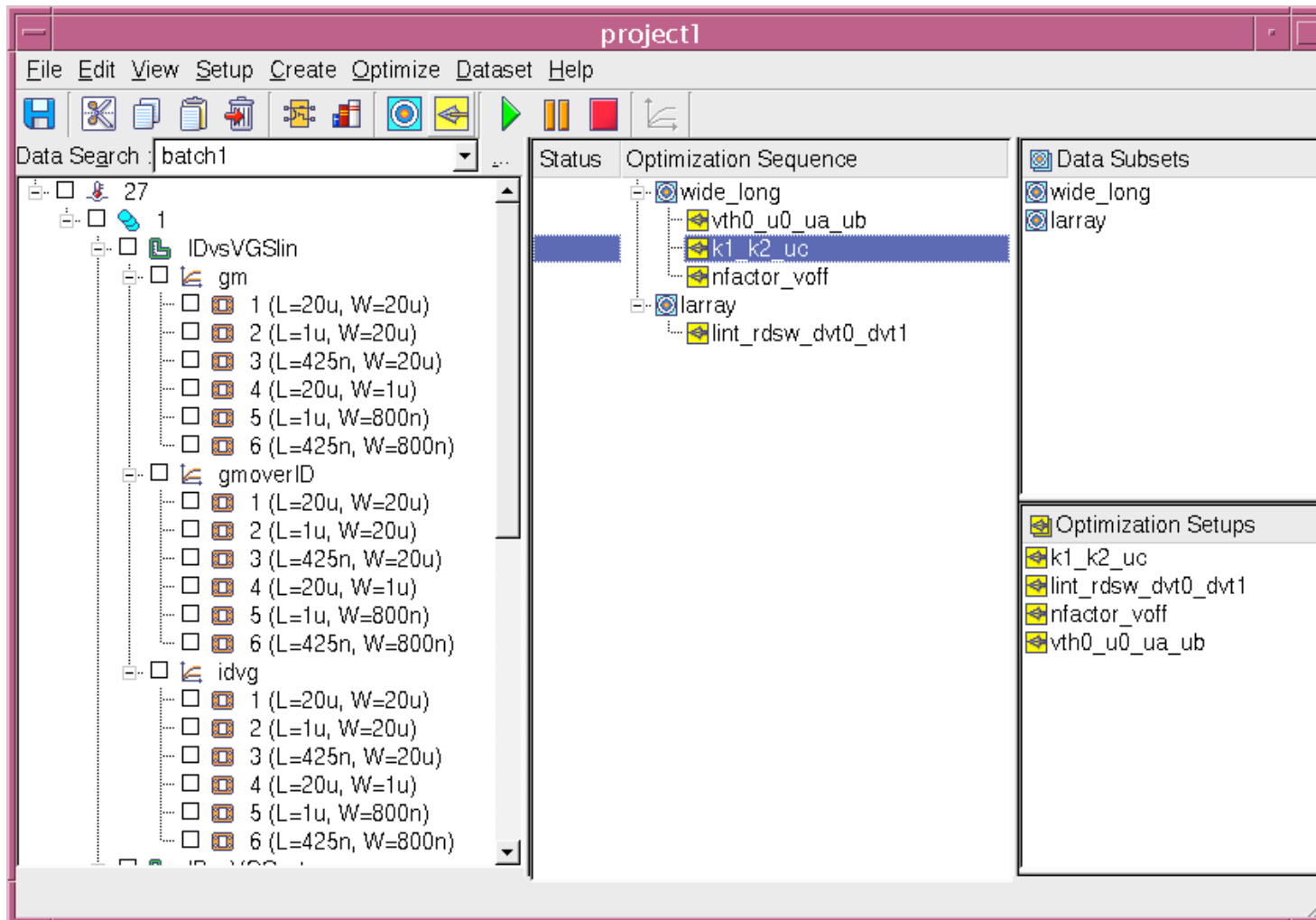
Optimization Module Overview

- 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

UTMOST IV Optimization Module Architecture

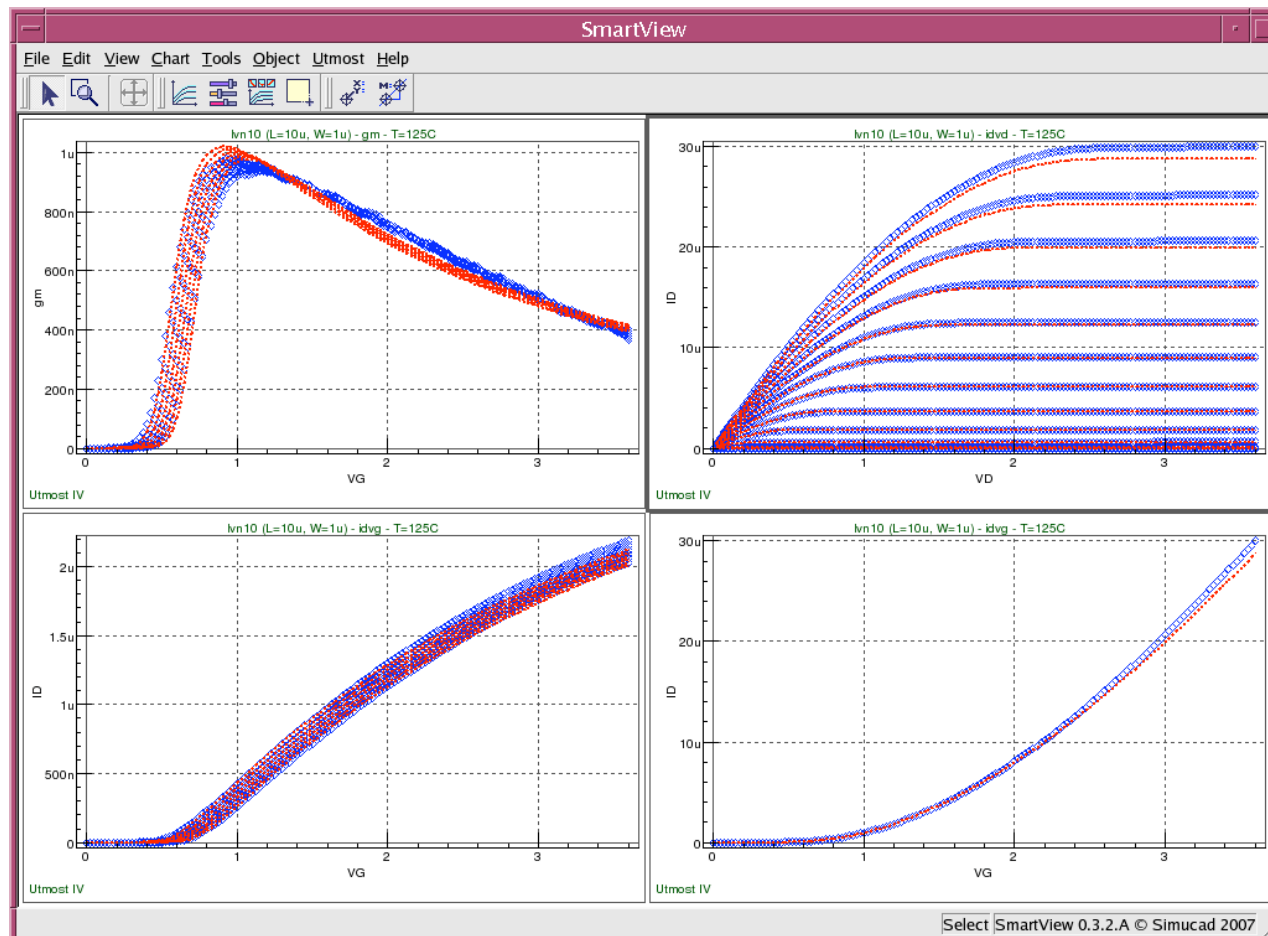


UTMOST IV is Project Organized



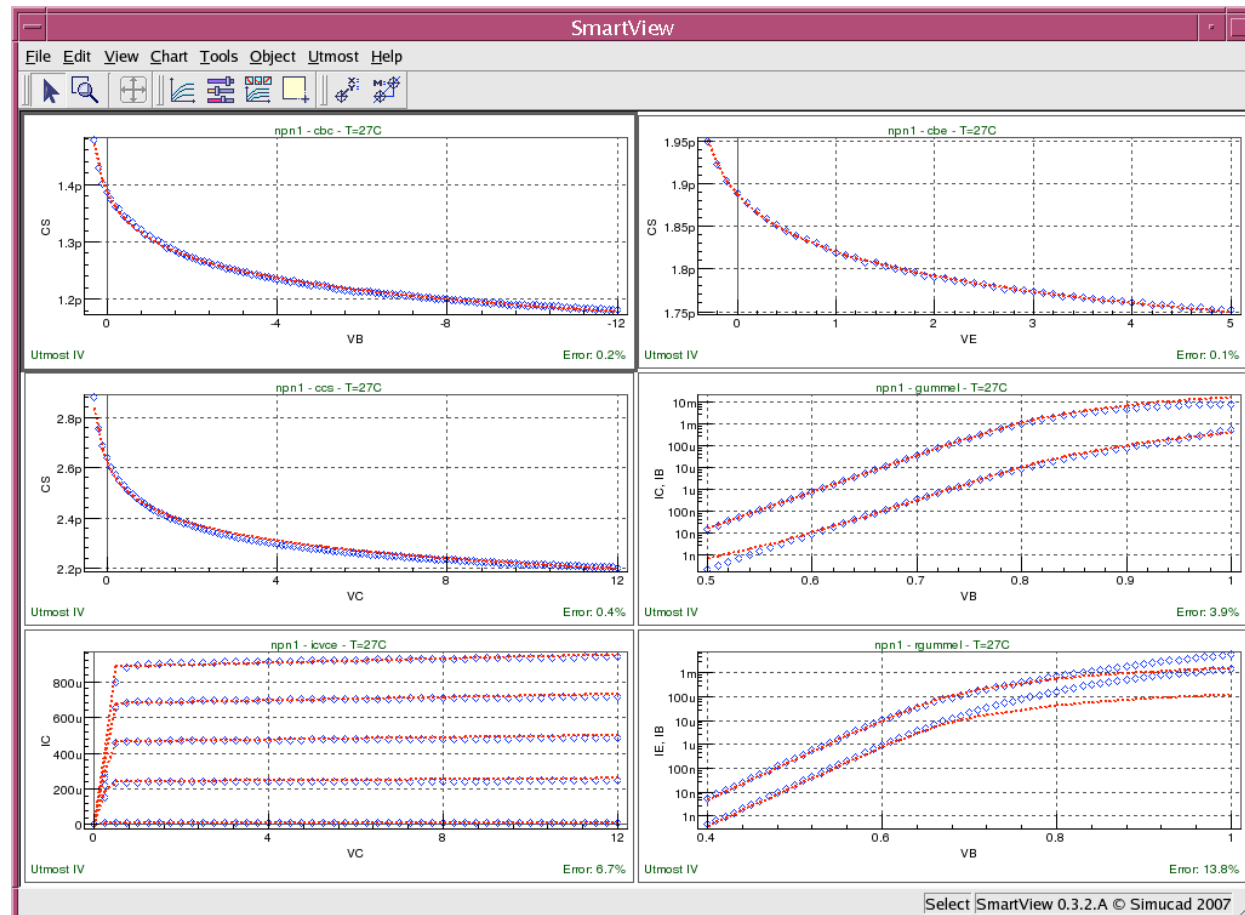
Multi-Target Optimization

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



Multi-Target Optimization 2

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

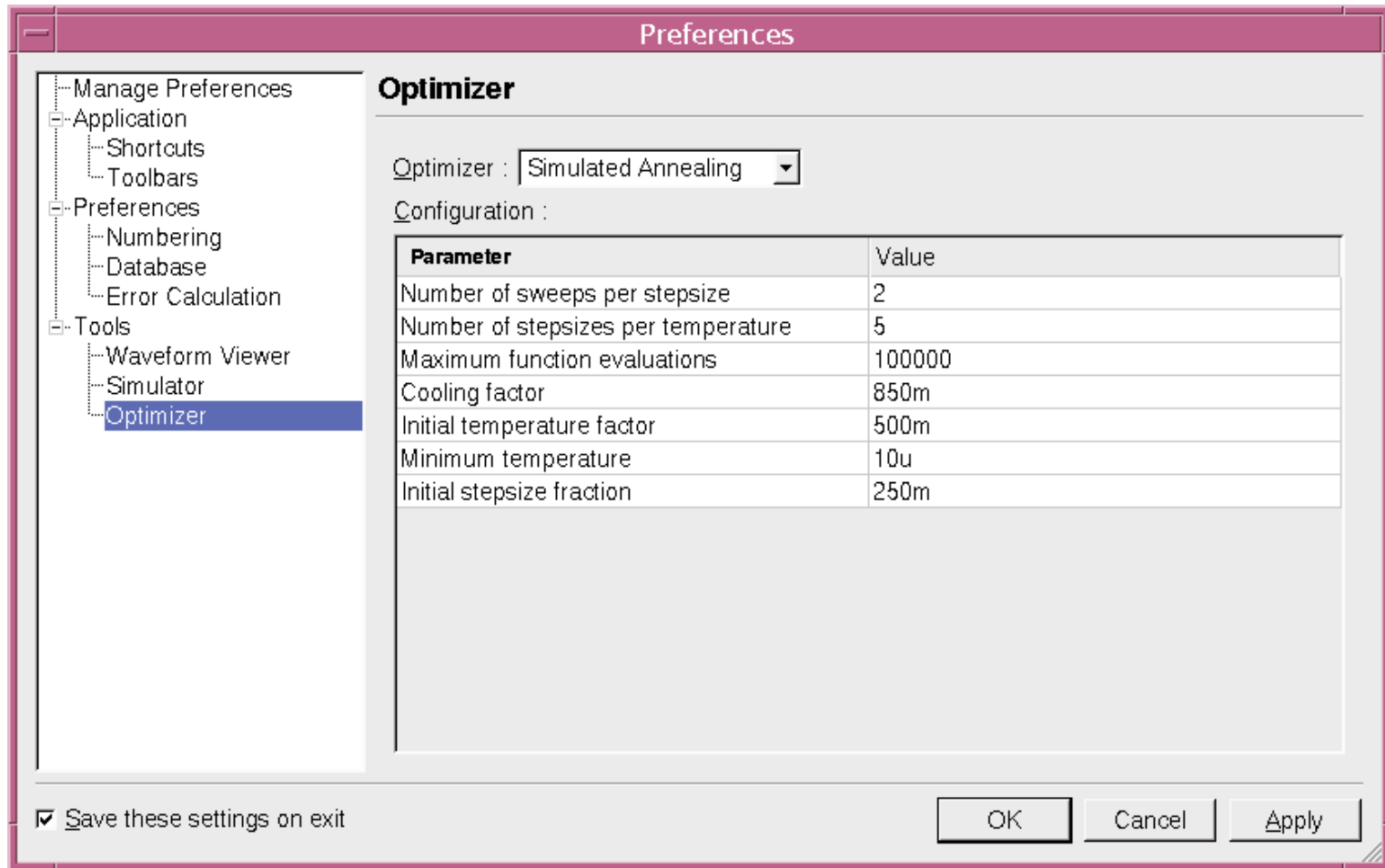




Family of Advanced Optimization Algorithms

- 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

Easy to Select and Configure Optimizer



Rubberband Optimization

- No limit to number of parameters

Parameter Optimization

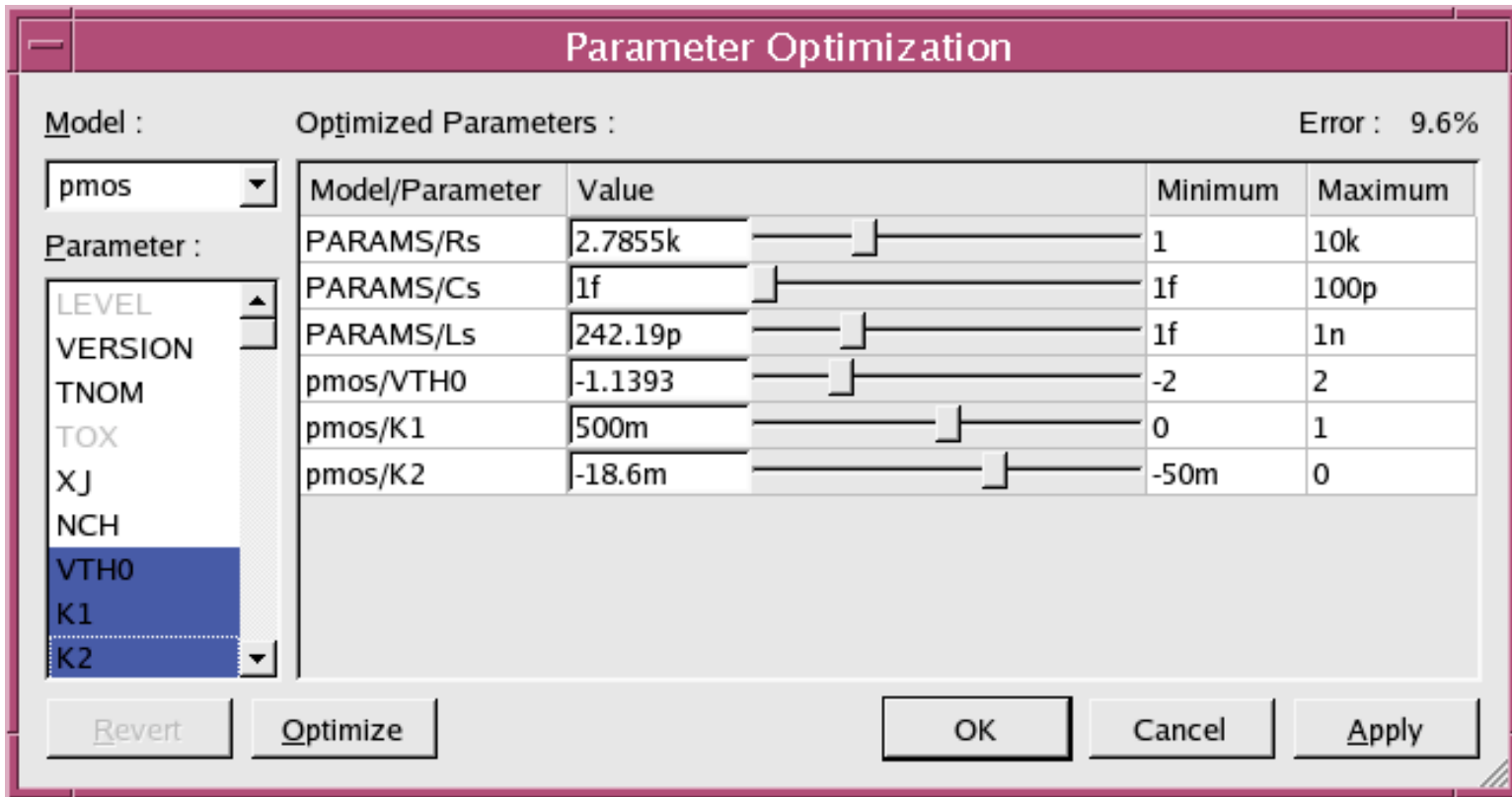
Model : nmos Optimized Parameters : Iteration : 207 Error = 4.0%

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

Buttons: Revert, Optimize, OK, Cancel, Apply

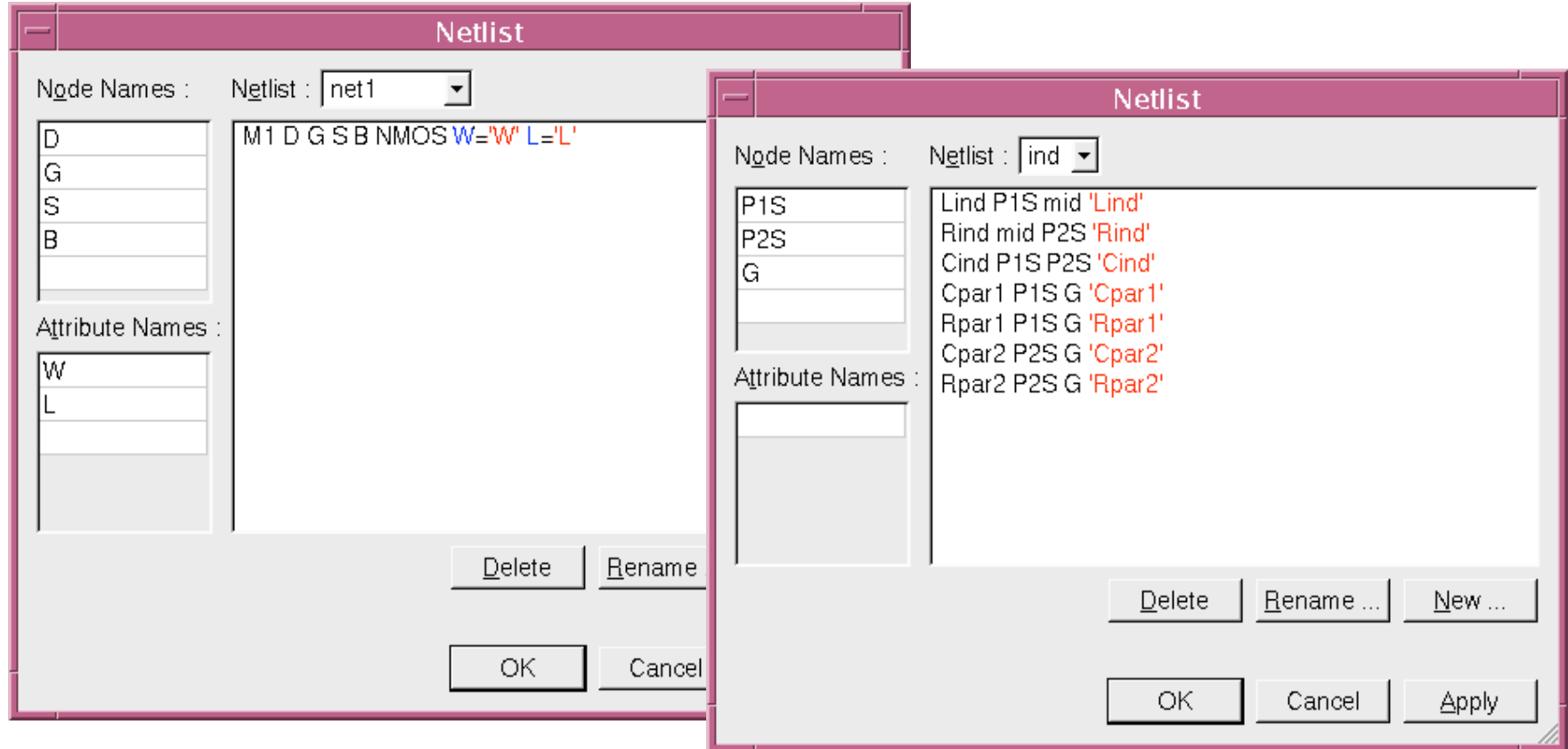
Rubberband Optimization 2

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



Macro-Model Optimization

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





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 Atlon64 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**



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

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	LEVEL	8	8	8		
2	VERSION	3.3	3.3	3.3	3	3.3
3	TNOM	27	27	27	-100	300
4	TOX	14n	14n	14n	5n	50n
5	XJ	150n	150n	150n	100n	1u
6	NCH	1.7e+17	1.7e+17	1.7e+17	5e+16	5e+17
7	NSUB				5e+15	3e+17
8	VTH0	700m	700m	700m	-2	2
9	K1	500m	500m	500m	0	1
10	K2	-18.6m	-18.6m	-18.6m	-50m	0
11	K3	80	80	80	1m	100
12	K3B	0	0	0	-10	10
13	W0	2.5u	2.5u	2.5u	1u	10u
14	NLX	174n	174n	174n	10n	1u
15	DVT0W	0	0	0	-500m	500m
16	DVT1W	0	0	0	0	10M
17	DVT2W	32m	32m	32m	500m	500m

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

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

New Model Parameter

Name : MY_PARAM

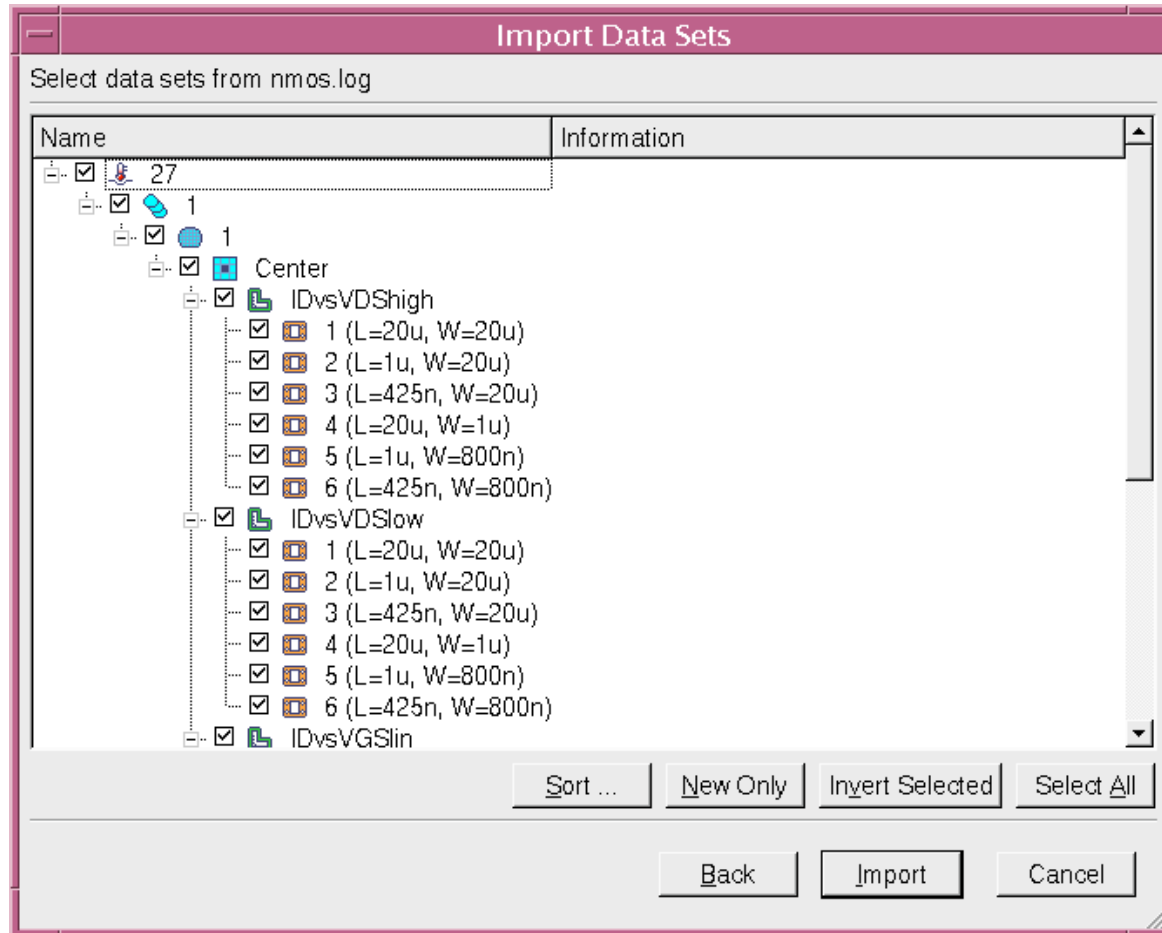
Close Apply



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

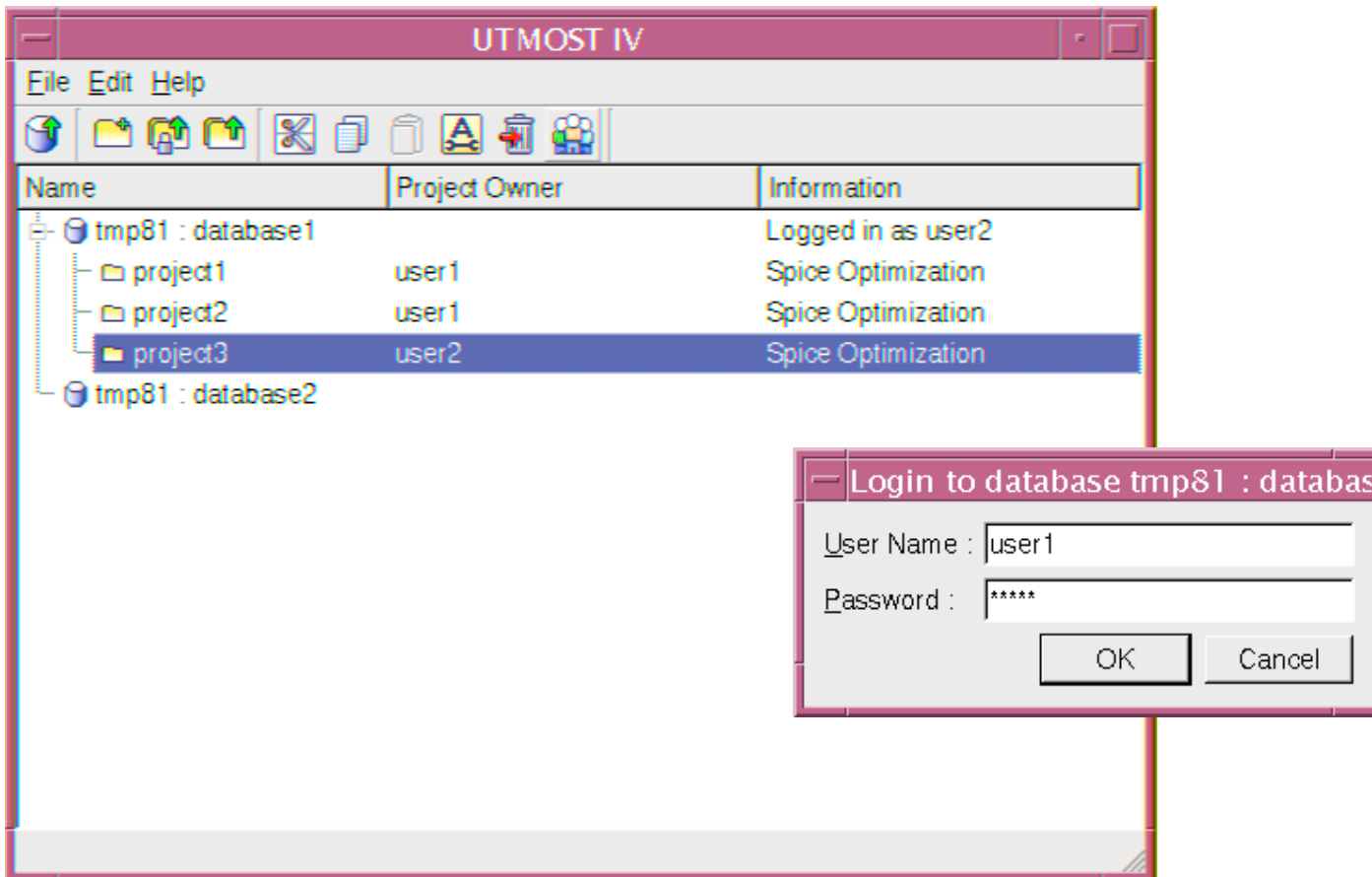
Flexible Data Format



- 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

64-bit Relational Database

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



Search Editor

- Database search allows you to retrieve and share information

Name : rtp_idvg_large

Search Parameter : Attribute Name : L Comparison : = Value : 20u

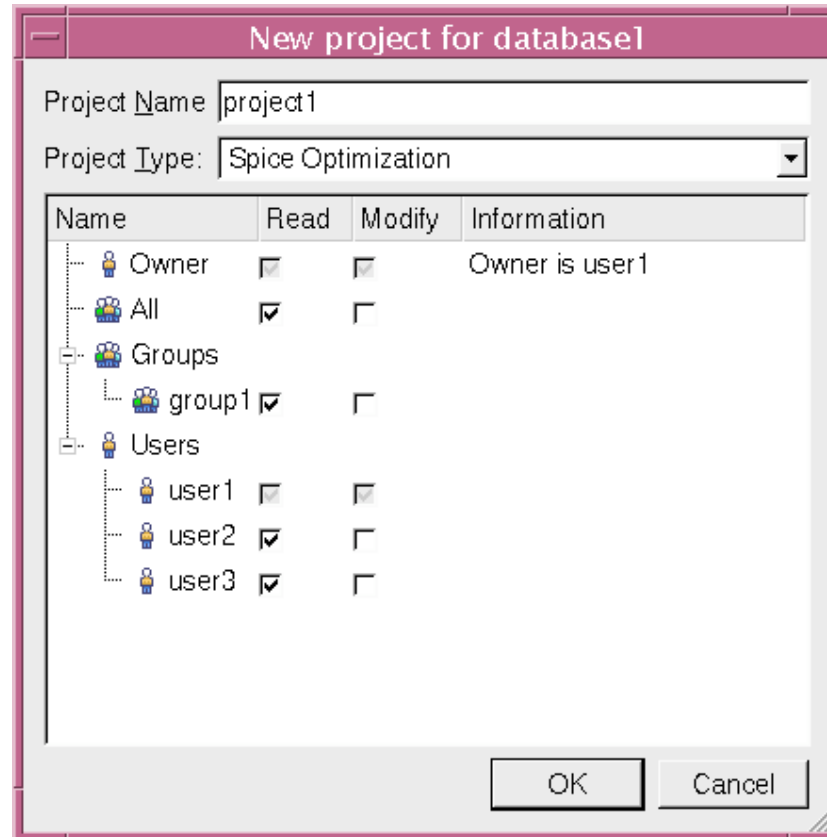
Expression	AND/OR
Temperature = "27"	AND
Measurement Setup = "*lin"	AND
Attribute "W" = "20u"	AND
Attribute "L" = "20u"	

Case Sensitive () Replace Delete Insert

OK Cancel Apply

Database Permissions

- Full access control for data security





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