A Platform for Compact Model Sharing

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THE ROLE OF COMPACT MODELS

- Device ➔ Models ➔ Simulator ➔ Applications

- Multi-Gate MOS
- Nanowire MOSFET
- Scaling MOSFET

- VBIC
- ACM
- USIM
- HiCUM
- BSIM
- Mextram
- HVEKV
- HiSIM
- PSP
- MM20

- Eldo
- Spectre
- ADS
- Smash
- HSIM
- APLAC
- Nanosim
- HSPICE
- Golden Gate
- AMS

-i-MOS Team, Department of Electronic & Computer Engineering, Hong Kong University of Science & Technology
CURRENT MODELING INFRASTRUCTURE

Technologist

Experimental data, Parameter Extraction

Modelers

Coding, Testing, implementing to a simulator

Designers

Implementation, Compiling, Evaluate Models, obtain parameters

Applications

Circuit Simulation

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STATUS OF PUBLISHED MODELS

- Some only describe a single quantity (like threshold voltage) rather than a complete model
- Some have implicit functions that require numerical solution
- Some models have discontinuities between different section of the characteristics
- Some have poorly behaved derivatives
- Some do not have charge and capacitance model
- Some do have an explicit parameter set
- Convergence issues of most models are not tested
- No follow-up after publication
The App store has significantly shortened the distance between programmer and users since July 11, 2008.

Can we have an App store for compact models?
AN APP STORE FOR COMPACT MODELING

![Diagram showing the process of compact modeling](image)

- A project started in June 2011

- Foundry
  - Model extracted
  - Design verified

- Circuit designer
  - Simulation verified

- EDA vendors
  - Simulator implementation

- Model developer

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THE i-MOS PROJECT

- It stands for interactive Modeling and Online Simulation
- Intended to be a social network for the compact modeling community including both developers or just users
- Provide a platform for model developers to distribute their models
- Provide a platform for users to evaluate models
- A place to discuss modeling related issues
- A source for updated modeling activities
- It runs under a user driven model with light moderation
COMPONENTS OF i-MOS

Browser Interface
- User authentication
- Simulation Instruction
- Graphic user interface

Ngspice
Simulation Engine
- Output Variables

User Input
- Parameter Library

Output to Users
MODEL IMPLEMENTATION

- Registered as a model developer
- Defining model pages with standard templates
- Submit model Verilog-A code
- Compilation with ADMS
- Model Verification

Internal qualification process
- Output to the i-MOS system
- User execution and feedback

Currently done by hand

qualification process

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THE NGSPICE ENGINE

- From de facto standard simulator SPICE
- Many standard device models have already been included
- It has a specific C interface
Verilog-A has become the standard modeling language

- Developer friendly
- Interpreted code has lower efficiency than C-code
- Widely used for new models

ADMS

- Convert Verilog-A to C-code
- Partial derivation for Jacobian matrix
- Model/instance setup API
- Similar efficiency to hand code
An authoring kit is being developed to automate the process.
i-MOS made many device models available for early access without the need of compilation and execution on a local machine.

Run simulations and do demonstrations anywhere.

Able to directly compare the completeness and performance of different models.

Uniform GUI with low learning barrier.

Come with standard parameters, benchmark, test circuits.

One stop service to model documents and modeling activities.
Users will be allowed to comment on models soon
You are welcome to post your modeling activities on i-MOS
BENEFIT TO MODEL DEVELOPERS

- Provide a standard on the requirements of a model, including I-V, Q-V, first derivatives, continuity, smoothness etc.
- Provide a simple authoring tool to interface the model to a circuit simulation engine directly
- Provide a simple and standard user interface to distribute models to users
- Facilitate the user feedback process for model refinement and improvement
- Promote interaction between model developers and users through various channel of discussion
## MODELS IMPLEMENTED IN CURRENT SYSTEM

<table>
<thead>
<tr>
<th>Device Type</th>
<th>Group</th>
<th>Availability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Symmetric Double Gate MOSFET</td>
<td>HKUST/Peking University</td>
<td>Online</td>
</tr>
<tr>
<td>Silicon Nanowire Transistor</td>
<td>HKUST/Peking University</td>
<td>Online</td>
</tr>
<tr>
<td>AlGaN HEMT</td>
<td>Tsinghua University</td>
<td>Online</td>
</tr>
<tr>
<td>CNT FET</td>
<td>Arizona University</td>
<td>Online</td>
</tr>
<tr>
<td>CNT FET</td>
<td>Stanford University</td>
<td>In Progress</td>
</tr>
<tr>
<td>Phase Change Memory</td>
<td>HKUST</td>
<td>In Progress</td>
</tr>
</tbody>
</table>

If you want your model to be included in i-MOS, please let us know!
BENEFITS TO EDA VENDORS

- Provide early access to new device models
- Evaluate and compare models under the same platform using standard GUI
- Collect user feedback to obtain popularity of various models based on model rating
- Provide a platform to communicate with model developers
- Provide parameter extraction service for a given model from foundry data
- Gain access to parameter sets from various sources (either as transparent data or blackbox plugin)
ISSUES TO RESOLVE

- Current version of ADMS only support a subset of Verilog-A syntax
  - \( V(\ldots) \leftarrow xxx \) not supported
  - \( I(\ldots) \) probes not supported
  - For loop not supported

- XML script of ADMS poorly documented

- Human interface need for some time before all the tools are ready
OTHER SERVICES TO BE LAUNCHED

- Automated Model Authoring kits
- Modeling rating and commenting
- Discussion group and professional networking
- Parameter extraction
- Standard parameter set
- Standard test results
- Online simulation (slightly longer term)
  - Phase I, input by submitting netlist text file
  - Phase II, complete circuit simulation GUI
A QUICK PREVIEW OF THE UP COMING SERVICES

- Pre-defined/saved parameters (blackbox parameters allowed)
- User Comments
- Upload Data and Extract Parameters (depends on availability of extractor)
- Modeling Rating
- If there is any service you think is useful to you, please let us know
PLEASE TRY OUT OUR SERVICE

- Please visit the following site:

  http://i-mos.org

- You will be able to try out our service after a simple and free registration

- It is not perfect at present stage and we appreciate your tolerance
THE i-MOS TEAM

- Principle Investigator: Prof. Mansun Chan
- Project Manager: Dr. Hao Wang
- Research Students:
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- Collaborators:
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  - Prof. Yu Cao, Arizona State University
- Funding: Hong Kong UGC AoE/P-04/08
THE BEGINNING

THANK YOU!